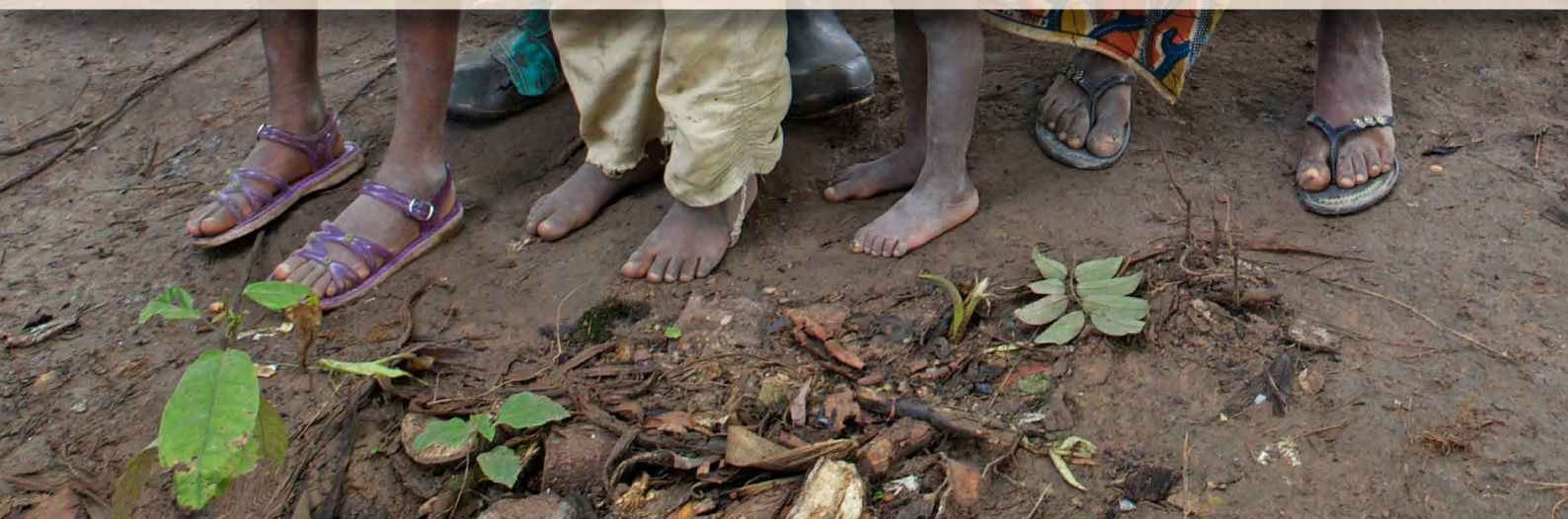
13 Farmer profiles and cluster analysis

Bymolt, R., Laven, A., Tyszler, M. (2018). Demystifying the cocoa sector in Ghana and Côte d'Ivoire. Chapter 13, Farmer profiles and cluster analysis. The Royal Tropical Institute (KIT).



The idea of 'farmer profiles' is a recurring theme in discussions with cocoa research partners, industry representatives and other stakeholders. In a number of recent studies, farmer profiles and segmentation have been addressed in relation to cocoa farming,[1,2,3,4,5] to other sectors[6,7,8] and to agriculture in general.[9]

There is an idea that if farmer profiles can be identified, then interventions and policies can be better targeted and therefore more efficient, effective and inclusive.

While there is a good argument for trying to identify farmer profiles, in practice, this is not a simple task. Farming households are different from, and similar to, each other in a multitude of ways. For instance, some households may have a similar land size, but grow different crops, or grow the same crops on different sized land. They may also sell or consume a different proportion of the crops they produce or have other non-agricultural income sources. Another difference could be the composition of the household and the life-stage in which they find themselves, which may affect their behaviour.[10]

We argue that a generic set of farmer profiles does not exist. There are, however, two approaches than can be applied to the development of farmer profiles.

One approach is conceptually driven, where the researcher chooses the categories or characteristics of interest, such as the number of crops grown, usage of specific inputs, land size, farmer age, sex, education, etc. The other approach is data-driven. Based on a set of data points and characteristics, there are different statistical techniques to create groups of farmers from which profiles can be derived. Farm, farmer and household characteristics can all form part of the profile. Researchers need to decide whether output characteristics (such as yield or total production) are themselves profiling characteristics, or whether the interest is in how certain characteristics correlate with output variables.

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1 Rijn, F. van, M. Kuit, Y. Waarts and V. Ingram (2015). Cluster analysis among UTZ certified cocoa farmers in Ghana and Ivory Coast. Den Haag, LEI, Wageningen UR.

2 Ataa-Asantewaa, M, Derkyi, M., Obeng-Ofori, D., Ros-Tonen, M. (2016). Diversity among Ghanaian cocoa crop farmers in the Ahafo-Ano North District, Ashanti Region. Inclusive Value Chain Collaboration. Infosheet 03 - January 2016. Available at https://inclusivevcc.files.wordpress.com/2015/07/wotro-inclusive-vcc-info-sheet-03-diversity-among-ghanaian-cocoa-crop-farmers-in-the-ahafo-ano-north-district-ashanti-region.pdf

3 Laven, A. and Heck, P. van (2016) Ideation of Small Medium Enterprise (SME) services in cocoa growing communities in Ghana. KIT Royal Tropical Institute. This study was commissioned by Solidaridad and Marks & Spencer and supported by Barry Callebaut. Available at http://www.cocoaconnect.org/publication/ideation-small-medium-enterprise-sme-services-cocoa-growing-communities-ghana

4 Cocoa Research Institute Ghana (2010). Cocoa Manual. A Source Book For Sustainable Cocoa Production. Cocoa Research Institute Ghana.

5 Laven, A. and Verhart, N. (2015) Getting to know female cocoa farmers. PPT during WCF Conference, session Innovations in Sustainability PPP. Women in cocoa farming. "Bridging the Gap". Available at http://www.worldcocoafoundation.org/wp-content/uploads/files_mf/womenincocoafarming_presentations.pdf

6 Solano, C., León, H., Pérez, E., Tole, L., Fawcett, R.H., Herrero, M. Solano et al. (2006) Using farmer decision-making profiles and managerial capacity as predictors of farm management and performance in Costa Rican dairy farms. Agricultural Systems, Vol. 88, 2-3: 395-428, Elsevier. Available at https://www.infona.pl/resource/bwmeta1.element.elsevier-cddce103-e05d-3cc3-83dd-ebbd4cb81c58

7 Eckert, E. and Bell, A. (2005). Invisible Force: Farmers' Mental Models and How They Influence Learning and Actions Journal of Extension, Vol. 43: 3. Available at https://extension.unh.edu/adultlearning/invisibleforce.pdf

8 Djamen, P., Havard, M., Lossaouarn, J. (2006). Transformation of livestock farming in Cameroon: Changes in breeding practices and evolution of farmer profiles. In H. Langeveld and N. Rôling (eds) Changing European farming systems for a better future. New visions for rural areas., Publisher: Wageninger Academic Publishers, pp.285 Available at https://www.researchgate.net/publication/236683469_Transformation_of_livestock_farming_in_Cameroon_Changes_in_breeding_practices_and_evolution_of_farmer_profiles

9 Peck Christen, R. and Anderson, J. (2013). Segmentation of Smallholder Households: Meeting the Range of Financial Needs in Agricultural Families. CCAP. Available at https://www.cgap.org/research/publication/segmentation-smallholder-households

10 Buurman, B. (2017) Field report, Anthropological Research Ghana 2017. Demystifying the cocoa sector in Ghana and Côte d'Ivoire. KIT Royal Tropical Institute. Available at https://www.kit.nl/wp-content/uploads/2018/10/Field-Report_Anthropological-Research-Ghana-2017-KIT_Bas-Buurman.pdf

A conceptual approach is likely to be more suitable when there is a specific usage in mind. For example, an initiative that targets take-up of fertiliser application could group farmers according to current input usage.

A data-driven approach is more of an exploratory approach. This allows profiles to naturally emerge from the data. This is a naturally iterative process, where the researcher choses characteristics which could potentially differentiate groups and, after groups are created, checks if these characteristics indeed show differentiation. Characteristics that do not prove to be key in creating different groups are removed.

A recent example[11] of a data-driven approach identified five main profiles of cocoa farmers in Ghana and Côte d'Ivoire, based on age, farm size, income, farm ownership, costs, agro-ecological zone location, participation in certification and good agricultural practices. Each profile had meaningfully different cocoa production levels.

In our research, we followed a similar data-driven approach. However, our analysis suggests there are three main groups:

1 Female-headed household;

2 Male-headed households, with typical productive land size;

3 Male-headed household with large productive land size.

In our iterative analytical process, other variables, such as family size, age of the household head, share of hired labour were used, but it was our conclusion that the sex of the household head and the size of the productive land were the strongest profiling variables.

Box 13.1

Content from this chapter can also be found in two separate reports, 'Analysis of the income gap of cocoa producing households in Côte d'Ivoire' and 'Analysis of the income gap of cocoa producing households in Ghana'. These two reports were produced with the support of the Living Income Community of Practice.[12,13] Each report, however, has a clear goal, with different methodological discussions and different monetary value indexation.

[11] Rijn, F. van, M. Kuit, Y. Waarts and V. Ingram (2015). Cluster analysis among UTZ certified cocoa farmers in Ghana and Ivory Coast. Den Haag, LEI, Wageningen UR.

[12] Tyszler, M., Bymolt, Laven, A. (2018) Analysis of the income gap of cocoa producing households in Ghana. Comparison of actual incomes with the Living Income Benchmark. Prepared for the Living Income Community of Practice. KIT Royal Tropical Institute. Available at https://docs.wixstatic.com/ugd/0c5ab3_93560a9b816d40c3a28daaa686e972a5.pdf

[13] www.living-income.com

13.1 Grouping of households

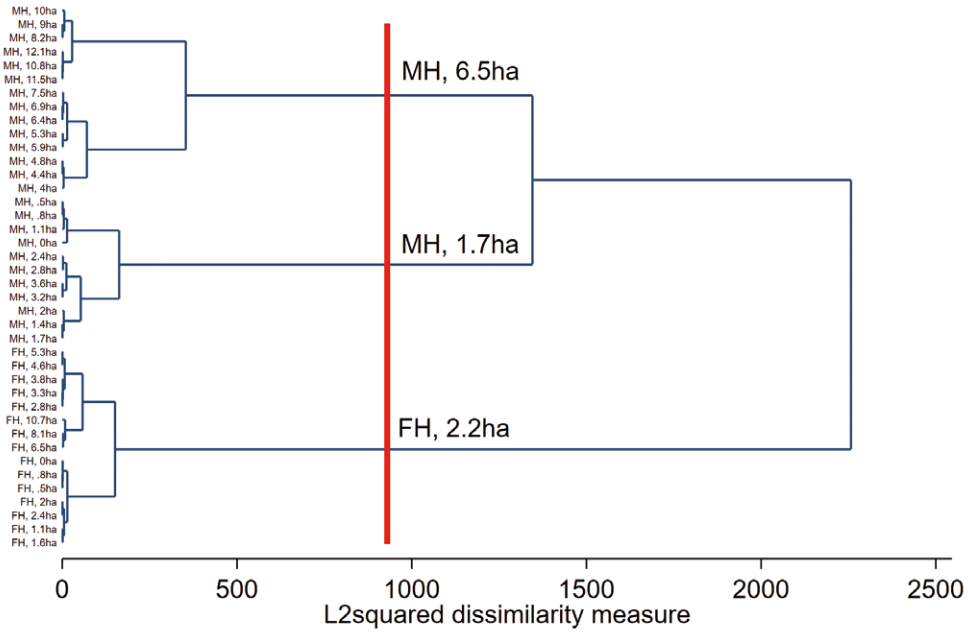
We chose a hierarchical cluster analysis technique to create the groups of farming households. This is a data-driven approach, which does not require the pre-definition of the number of groups. The technique was independently applied to the Ghana and Côte d'Ivoire sub-samples, but returned similar results.

13.1.1 Cluster analysis

Cluster analysis is a technique used to group observations. The goal is to create clusters which are as distinct as possible from each other, whilst cluster members are as similar as possible to each other. For this analysis, we clustered observations on the basis of the sex of the household head and productive cocoa land.[14]

In a hierarchical cluster analysis, each observation is initially set to be its own cluster and, in each round, clusters are progressively merged based on how similar they are to each other until there is only one single cluster with all observations. An output of this exercise is a dendogram (Figure 13.1, Figure 13.2)

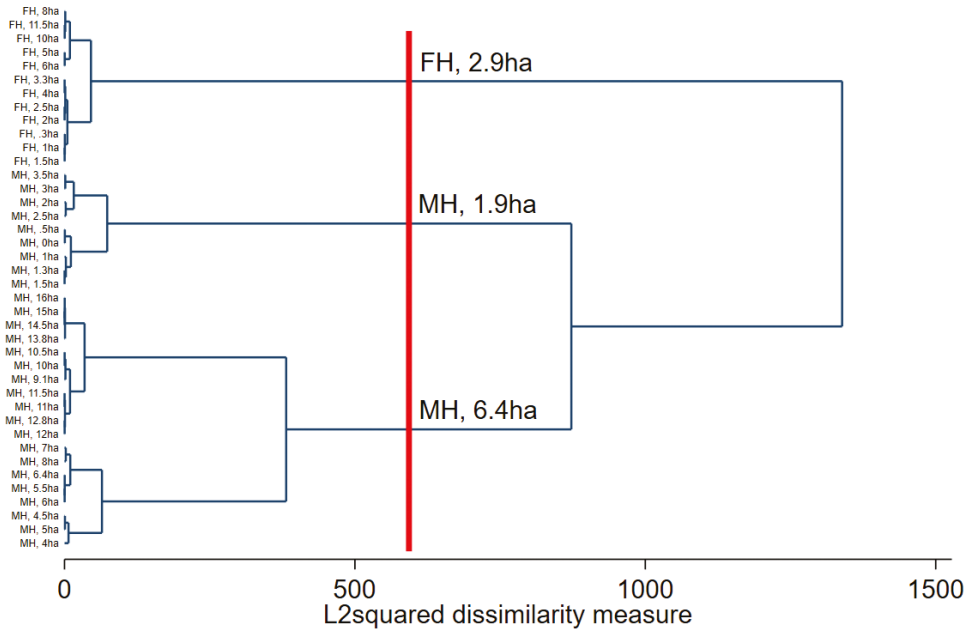
Figure 13.1 Dendogram, Ghana



Note: FH = Female-headed; MH = Male-headed; X ha indicates the average productive cocoa land size of that cluster

[14] Other variables were also considered, but the strong grouping variables were sex of the household head and productive land.

Figure 13.2 Dendogram, Côte d'Ivoire



Note: FH = Female-headed; MH = Male-headed; X ha indicates the average productive cocoa land size of that cluster

In the dendogram, the horizontal axis indicates the threshold to merge clusters. Very similar clusters will be merged with a low threshold (e.g. female-headed households with 1 ha and female-headed households with 1.1 ha), while distinct clusters will require a high threshold to be merged (e.g. female-headed households with 1 ha and male-headed households with 10 ha), The more the threshold has to be raised to merge clusters, the more distinct the clusters are. This is indicated by long horizontal strikes in the dendogram.

Both dendograms suggests three clusters from the data set. The first cluster has all female-headed households. The second comprises male-headed households with a typically sized area of productive cocoa land. The third cluster comprises male-headed households with a relatively large productive cocoa farm (Table 13.1 and Table 13.2.)

Table 13.1 Cluster characteristics, Ghana

	All	Cluster 1	Cluster 2	Cluster 3
Observations	1,181	194	744	243
	(100%)	(21%)	(63%)	(16%)
Sex of the household head				
Female	16%	100%	0%	0%
Male	84%	0%	100%	100%
Productive cocoa land (ha)				
Min	0	0	0	3.77
1st quartile	1.21	1.01	1.01	4.41
Median	2.03	1.62	1.62	5.39
Mean	2.73	2.21	1.74	6.45
3rd quartile	3.65	2.83	2.43	7.35
Max	12.14	11.3	3.65	12.14

Table 13.2 Cluster characteristics, Côte d'Ivoire

	All	Cluster 1	Cluster 2	Cluster 3
Observations	760	35	474	272
	(100%)	(4%)	(61%)	(35%)
Sex of the household head				
Female	5%	100%	0%	0%
Male	95%	0%	100%	100%
Productive cocoa land (ha)				
Min	0	0	0	3.75
1st quartile	1.5	1	1	4
Median	3	2	2	5
Mean	3.5	2.9	1.9	6.4
3rd quartile	4.5	4	2.5	7
Max	16	11.5	3.5	16

13.1.2 Analytical groups

Based on the cluster analysis, we defined three analytical groups for further use in this chapter:

- *Female-headed:* all female-headed cocoa households;
- *Male-headed, typical:* all male-headed households with up to 4 ha of productive cocoa land;
- *Male-headed, large:* all male-headed household with more than 4 ha of productive cocoa land.

The analytical groups differ only slightly from the cluster groups, but have a definition which is easier to identify and, eventually, implement on the field. Most importantly, the *male-headed, typical* is the biggest group, and is most likely to represent the typical household in the sample. In Côte d'Ivoire, the number of observations within the *female-headed* analytical group was found to be too small. Therefore, we do not report statistics from this group, since the confidence level and representativeness is too low and analysis would likely be be misleading.

13.1.3 Characteristics of the groups[15]

Table 13.3 shows the grouping characteristics of the three analytical groups in Ghana. *Male-headed, typical* households have an average of 1.9 ha and a median of 1.8 ha of productive cocoa land. *Female-headed* households have a slightly higher average, 2.2 ha, but a lower median, 1.6 ha. *Male-headed, large* households start at 4 ha, with an average of 6.3 ha and a median of 5.7 ha of productive cocoa land.

[15] In this section, we include characteristics which directly feed into the annual income analysis.

Table 13.3 Household grouping characteristics, Ghana

	Female-headed	Male-headed, typical	Male-headed, large
Observations	288	705	228
	(24%)	(58%)	(18%)
Sex of the household head			
Female	100%	0%	0%
Male	0%	100%	100%
Productive cocoa land (ha)			
Min	0	0.20	4.05
1st quartile	1.01	1.21	4.45
Median	1.62	1.82	5.66
Mean	2.22	1.91	6.34
3rd quartile	2.83	2.45	7.46
Max	11.33	3.97	12.15

Table 13.4 shows the grouping characteristics of the two analytical groups in Côte d'Ivoire. *Male-headed, typical* households have an average of 2.3 ha and a median of 2 ha of productive cocoa land. *Male-headed, large* households start at 4.5 ha, with an average of 7.3 ha and a median of 6 ha of productive cocoa land.

Table 13.4 Household grouping characteristics, Côte d'Ivoire

	Male-headed, typical	Male-headed, large
Observations	514	198
	(72%)	(28%)
Sex of the household head		
Female	0%	0%
Male	100%	100%
Productive cocoa land (ha)		
Min	0.25	4.5
1st quartile	1.5	5
Median	2	6
Mean	2.3	7.3
3rd quartile	3	9
Max	4	16

Figure 13.3 shows the detailed distribution of productive cocoa land of each analytical group from Ghana. The distribution suggests that *female-headed* and *male-headed, typical* households are fairly similar with regards to the land area they have under productive cocoa. Figure 13.4 shows the detailed distribution of productive cocoa land of the two distinct analytical groups in Côte d'Ivoire.

Figure 13.3 Distribution of productive cocoa land of the analytical groups in Ghana (Gaussian kernel smoothed)

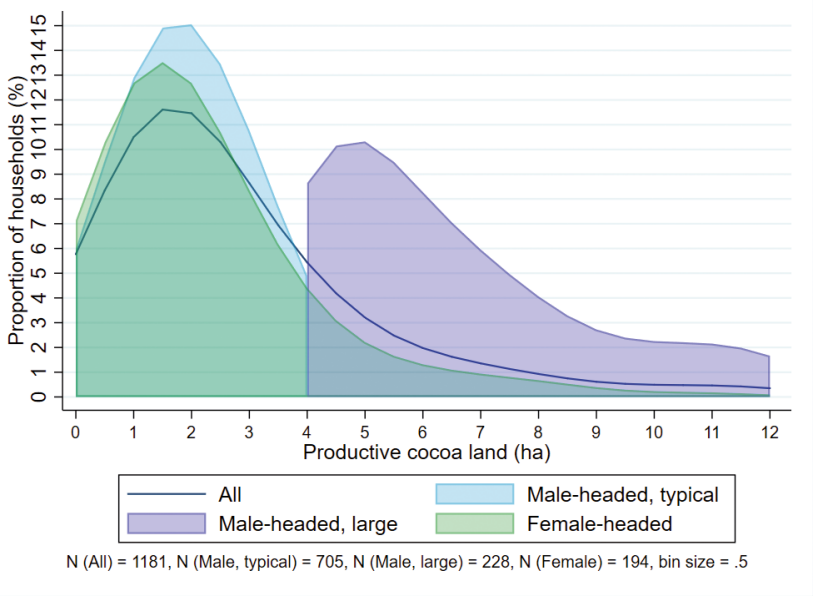


Figure 13.4 Distribution of productive cocoa land of the analytical groups in Côte d'Ivoire (Gaussian kernel smoothed)

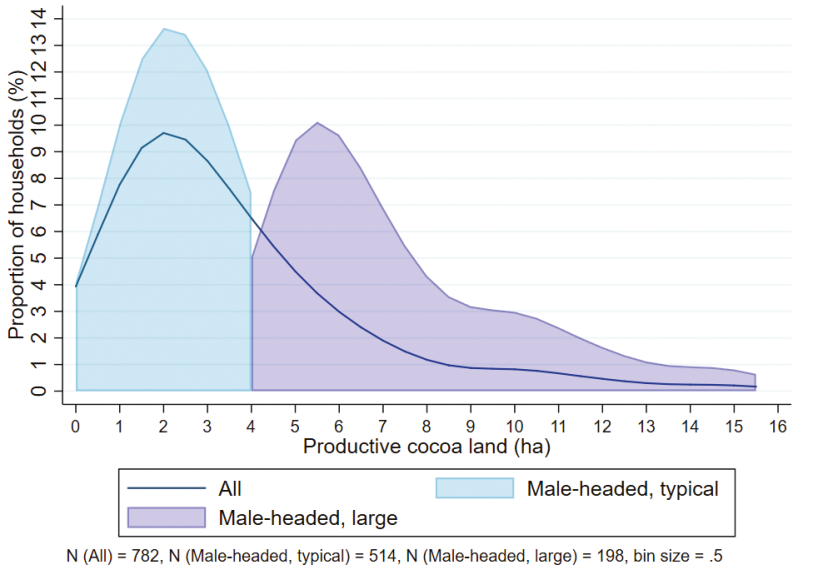


Table 13.5 shows household composition of the analytical groups in Ghana. *Female-headed* households have approximately 0.5 adult males less than *male-headed, typical* households. *Male-headed, large* households have about 0.5 person more than *male-headed, typical* households. This is important to note when considering dependency ratios, or calculating per person income. It is also relevant to note that male-headed households typically comprise women, and *female-headed* households comprise men. Therefore, it would not be correct to think of these analytical groups as representing respectively male and female farmers, but rather should be thought of in terms of the household unit.

Table 13.5 Household composition, Ghana

	All	Female-headed	Male-headed, typical	Male-headed, large
Average household size (number of persons)	5.87	5.13	5.91	6.42
Detailed composition (number of persons)				
Males, children 0 to 17 years old	1.38	1.13	1.45	1.36
Females, children 0 to 17 years old	1.23	0.97	1.28	1.46
Males, 18 to 29 years old	0.55	0.56	0.53	0.62
Females, 18 to 29 years old	0.52	0.53	0.49	0.58
Males, 30 to 60 years old	0.85	0.47	0.90	1.04
Females, 30 to 60 years old	0.91	0.96	0.87	0.97
Males, over 60 years old	0.25	0.07	0.27	0.29
Females, over 60 years old	0.18	0.44	0.11	0.09

Table 13.6 shows household composition of the analytical groups in Côtê d'Ivoire. *Male-headed, large* households have about 0.5 person more than *male-headed, typical* households, distributed among male and female household members between 18 and 60 years of age.

Table 13.6 Household composition, Côte d'Ivoire

	All	Male-headed, typical	Male-headed, large
Average household size (number of persons)	6.51	6.41	6.97
Detailed composition (number of persons)			
Males, children 0 to 17 years old	1.75	1.82	1.86
Females, children 0 to 17 years old	1.49	1.53	1.47
Males, 18 to 29 years old	0.54	0.44	0.66
Females, 18 to 29 years old	0.50	0.48	0.54
Males, 30 to 60 years old	0.99	0.97	1.11
Females, 30 to 60 years old	0.89	0.83	0.95
Males, over 60 years old	0.18	0.18	0.22
Females, over 60 years old	0.17	0.16	0.16

It is also interesting to compare the number of income earners and income sources within the household. Table 13.7 shows the average number of income earners per household in Ghana. *Female-headed* households have 2.33 income earners, compared with 2.59 income earners in *male-headed, typical* households. *Male-headed, large* households have around 2.94 income earners. These differences are similar to the differences in household size.

Table 13.7 Income earners per household, Ghana

	All	Female-headed	Male-headed, typical	Male-headed, large
Average number of income earners (number of persons)	2.64	2.33	2.59	2.94
Detailed composition (number of persons)				
Males, children 0 to 17 years old	0.02	0.01	0.02	0.02
Females, children 0 to 17 years old	0.02	0.01	0.02	0.02
Males, 18 to 29 years old	0.27	0.28	0.27	0.31
Females, 18 to 29 years old	0.24	0.22	0.23	0.26
Males, 30 to 60 years old	0.82	0.41	0.87	1.02
Females, 30 to 60 years old	0.86	0.92	0.82	0.94
Males, over 60 years old	0.25	0.06	0.27	0.29
Females, over 60 years old	0.16	0.41	0.10	0.08

Table 13.8 shows the average number of income earners per household in Côte d'Ivoire is similar to that in Ghana. *Male-headed, typical* households have, approximately, 2.37 income earners, whereas *Male-headed, large* households have, approximately, 2.78 income earners.

Table 13.8 Income earners per household, Côte d'Ivoire

	All	Male-headed, typical	Male-headed, large
Average number of income earners (number of persons)	2.56	2.37	2.78
Detailed composition (number of persons)			
Males, children 0 to 17 years old	0.02	0.02	0.02
Females, children 0 to 17 years old	0.02	0.01	0.03
Males, 18 to 29 years old	0.25	0.22	0.28
Females, 18 to 29 years old	0.19	0.19	0.16
Males, 30 to 60 years old	0.89	0.85	0.95
Females, 30 to 60 years old	0.57	0.54	0.57
Males, over 60 years old	0.16	0.16	0.20
Females, over 60 years old	0.05	0.05	0.05

Table 13.9 shows the income sources of cocoa households in Ghana. The sale of cocoa is the leading income source; according to respondents, cocoa sales contribute about 60% of total income, followed by sales of other crops (see also Chapter 5 Crop Choice

and diversification). This is also the same ranking order for the number of income earners per income source, with an average of just over 2.1 persons in a household earning income from cocoa sales, followed by sales of other crops. Income from small businesses is the third most important income source involving, on average, 0.7 persons. Income from small businesses provides about 10% of total household income on average. The largest group within the households earning income from small businesses are females between 30 and 60 years old.

Table 13.9 Income sources, Ghana

	Sale of cocoa	Sale of other crops	Sale of livestock or livestock products	Own small business or trading
Estimated contribution to total household income*	61%	20%	2%	10%
Average number of income earners (number of persons)	2.13	1.70	0.36	0.73
Detailed composition (number of persons)				
Males, children 15 to 17 years old	0.01	0.01	0.00	0.00
Females, children 15 to 17 years old	0.01	0.01	0.00	0.00
Males, 18 to 29 years old	0.18	0.15	0.02	0.05
Females, 18 to 29 years old	0.06	0.05	0.01	0.03
Males, 30 to 60 years old	0.73	0.59	0.15	0.20
Females, 30 to 60 years old	0.67	0.56	0.10	0.33
Males, over 60 years old	0.24	0.18	0.05	0.03
Females, over 60 years old	0.14	0.10	0.02	0.03

Note: Based on perception of respondents in the household survey. Each person may have multiple income sources

Table 13.10 shows the income sources of the cocoa households in Côte d'Ivoire. Similar to Ghana, the sale of cocoa contributes to about 66% of total household income, followed by the sale of other crops (see also Chapter 5: Crop choices and diversification). This is also the same ranking order for the number of income earners per income source, with an average of just under 1.5 persons in a household contributing to income from cocoa sales, followed by sales of other crops. Income from small businesses, with about 3.5%, is the third most important income source involving, on average, 0.3 persons. Income from sale of cocoa is primarily earned by males (see also Chapter 8: Cocoa production practices). Income from other crops is more often earned by men and women (although these may not be the same crops). Income from small businesses is primarily earned by females, 30 to 60 years old.

Table 13.10 Income sources, Côte d'Ivoire

	Sale of cocoa	Sale of other crops	Sale of livestock or livestock products	Own small business or trading
Estimated contribution to total household income*	66%	24%	3%	3.5%
Average number of income earners (number of persons)	1.46	1.50	0.02	0.27
Detailed composition (number of persons)				
Males, children 15 to 17 years old	0.01	0.01	0.00	0.00
Females, children 15 to 17 years old	0.00	0.00	0.00	0.00
Males, 18 to 29 years old	0.16	0.09	0.00	0.02
Females, 18 to 29 years old	0.00	0.04	0.00	0.03
Males, 30 to 60 years old	0.81	0.49	0.01	0.04
Females, 30 to 60 years old	0.13	0.38	0.00	0.13
Males, over 60 years old	0.16	0.09	0.00	0.00
Females, over 60 years old	0.03	0.03	0.00	0.00

Note: Based on perception of respondents in the household survey. Each person may have multiple income sources

Figure 13.5 shows the main income contributors for each analytical group in Ghana. We find that the three groups follow similar patterns with regards to their main income sources. Figure 13.6 shows the main income contributors for each analytical group in Côte d'Ivoire. We also find that the two groups follow similar patterns, although *male-headed, large* households have a slightly higher income share from the sale of cocoa.

Figure 13.5 Main income sources of cocoa households, Ghana

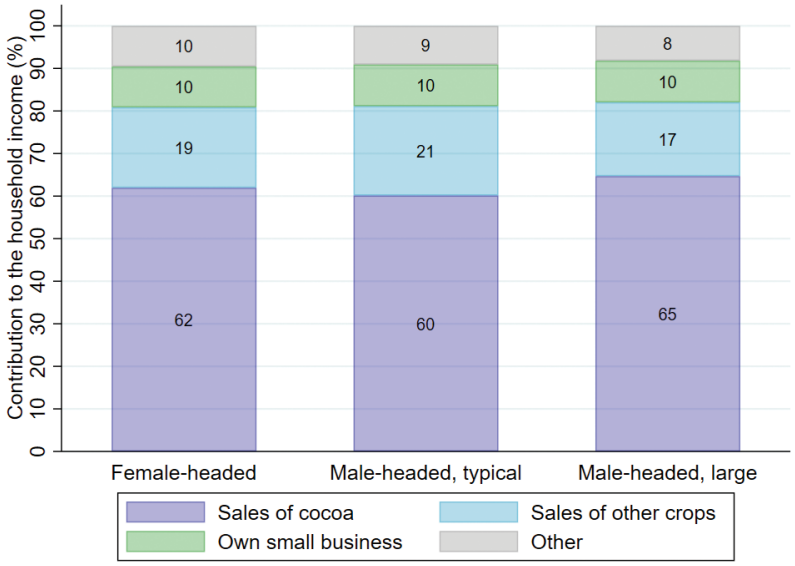
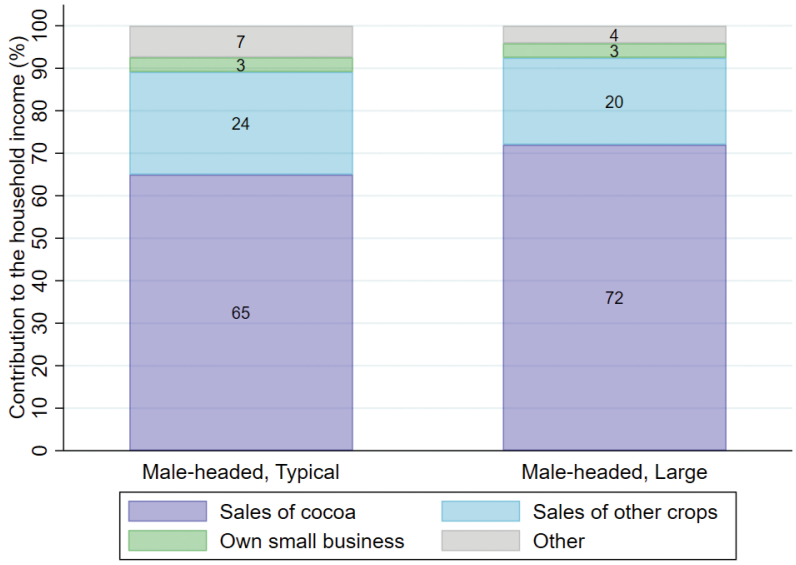


Figure 13.6 Main income sources of cocoa households,Côte d'Ivoire



13.2 Household annual income

13.2.1 How household income was calculated

Chapter 12 (Household income, poverty and wealth) explains in detail how household annual cocoa income and household total income were calculated. In summary, total household cocoa income is based on cocoa production costs and revenue data. Since the sale of cocoa provides the major income source for cocoa households, total household income is extrapolated from the share (proportion) of total household income that comes from sales of cocoa. Conversions to USD were made using the exchange rate of USD 0.26116 per GHS and USD 0.00166 per CFA, as in January 2016.

There is one difference in the calculations in this chapter compared to the calculations presented in chapter 12. As explained in chapter 12, in cases where a respondent mentioned doing a production activity, but where the data was missing, an imputation was made based on the median expenses per ha per household of the *male- or female-headed households* in each country. In this chapter, a similar approach was used but, in case of imputation, we use the median expenses per ha per household of the analytical group in each country. (Because of this, there are some small numerical differences our figures in chapter 12 and chapter 13.)

13.2.2 Net cocoa income

We estimate an average net income from cocoa of GHS 5,829 (USD 1,522) per year per household in Ghana. Table 13.11 shows the details of the averages for each analytical group.

Table 13.11 Calculation of household income from cocoa, Ghana*

	All	Female-headed	Male-headed, typical	Male-headed, large
Revenues				
Productive land (ha/household)	2.7	2.2	1.9	6.3
Total production (kg/year/household)	1,087	748	840	2,096
Land productivity (kg/ha)	398	338	438	331
Price (USD/kg)	$1.73	$1.73	$1.73	$1.73
Value of production (USD/year/household)	$1,885	$1,297	$1,457	$3,635
Costs				
Input costs (USD/year/household)	$96	$63	$80	$200
Hired labor costs (USD/year/household)	$233	$327	$149	$466
Total costs (USD/year/household)	$326	$390	$226	$660
Net income				
USD/year/household	$1,522	$960	$1,225	$2,873
GHS/year/household	5,829	3,677	4,692	11,003

* Each item (row) is calculated per household and the group average is presented in the table. Therefore, differences can occur from calculating totals based on the averages. This is because of a slight difference in number of observations per item, due to removing outliers or missing values that could not be inputted. The net income per year per household is the most relevant and complete number, while other numbers help in understanding the differences between groups.

From the table, it can be noted that *female-headed households* earn less income from cocoa than *male-headed, typical* households. While female-headed households do tend to have slightly more land under cocoa, compared to male-headed, typical households, they tend to have lower yields, on average (Figure 13.7). *Female-headed* households also tend to have higher hired labour costs than *male-headed, typical* households, which is probably due to the lower availability of household labour or because certain tasks are seen more as 'men tasks' (Figure 13.8). The *male-headed, large* group earns considerably more than both of the other groups. This group tends to have much more land under cocoa, but does have lower productivity per hectare.[16]

[16] The reason why lower productivity correlates with larger land size is discussed alongside a regression analysis in Chapter 10: Production and yield.

Figure 13.7 Distribution of cocoa yield (kg/ha) and revenue in Ghana (Gaussian kernel smoothed)

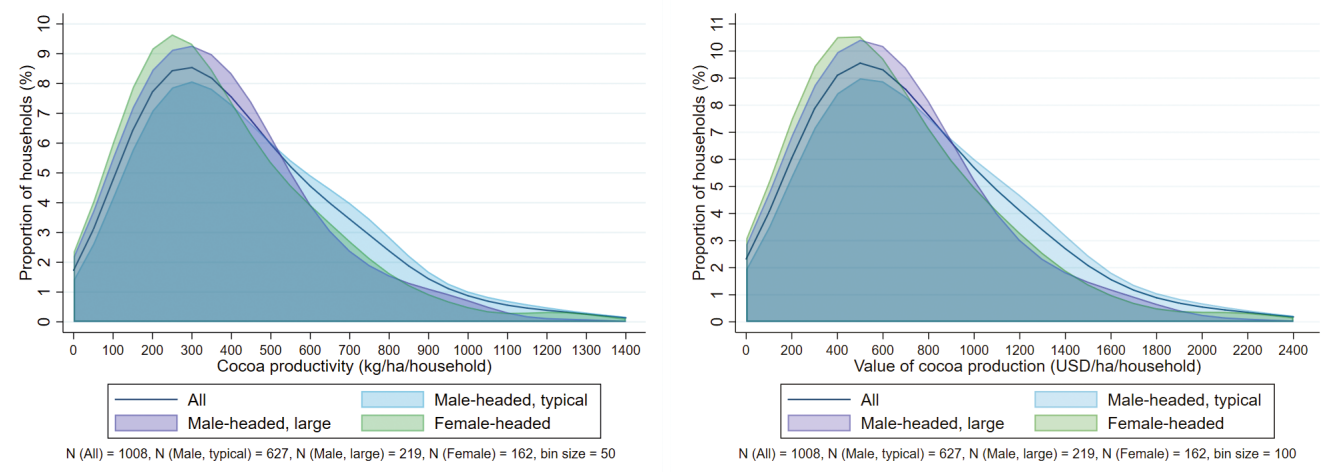
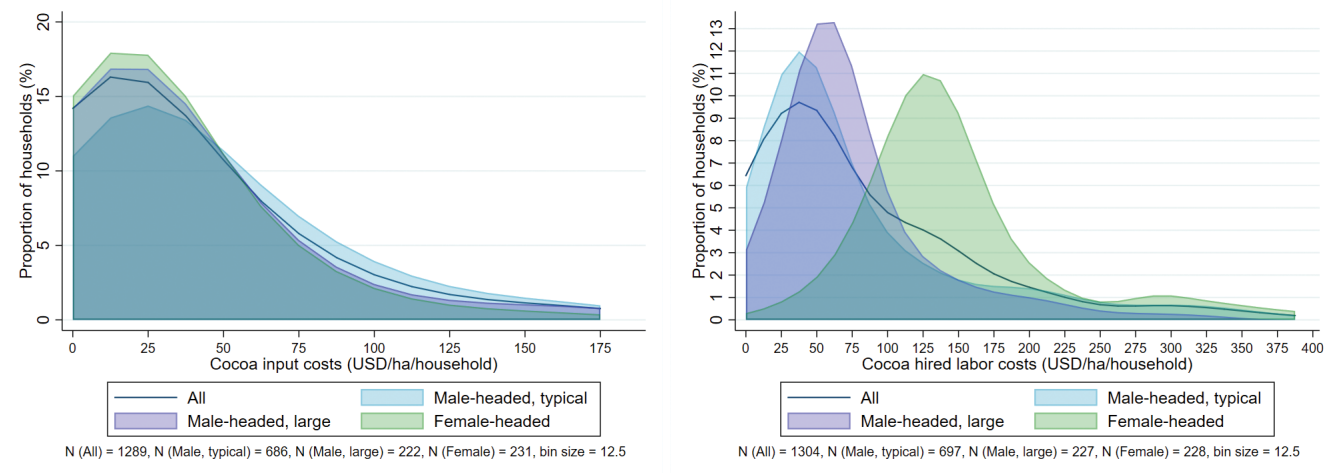


Figure 13.8 Distribution of cocoa input and labour costs in Ghana (Gaussian kernel smoothed)



In Côte d'Ivoire, we estimate an average net income from cocoa of CFA 1,155,190 (USD $1,918) per year per household. Table 13.12 shows the averages for each analytical group.

Table 13.12 Calculation of household income from cocoa, Côte d'Ivoire*

	All	Male-headed, typical	Male-headed, large
Revenues			
Productive land (ha/household)	3.5	2.3	7.3
Total production (kg/year/household)	1,222	798	2,407
Land productivity (kg/ha)	349	344	331
Price (USD/kg)	$1.66	$1.66	$1.66
Value of production (USD/year/household)	$2,029	$1,325	$3,996
Costs			
Input costs (USD/year/household)	$71	$50	$143
Hired labor costs (USD/year/household)	$14	$12	$24
Total costs (USD/year/household)	$84	$60	$167
Net income			
USD/year/household	$1,918	$1,277	$3,796
CFA/year/household	1,155,190	769,162	2,286,856

* Each item (row) is calculated per household and the group average is presented in the table. Therefore, differences can occur from calculating totals based on the averages. This is because of a slight difference in number of observations per item, due to removing outliers or missing values that could not be inputted. The net income per year per household is the most relevant and complete number, while other numbers help in understanding the differences between groups.

From the Table 13.above, it can be noted that the income from the *male-headed, large* group is about three times as large as the *male-headed, typical* household. Figure 13.9 suggests that net cocoa income differences are not due to differences in household productivity nor value of production. While the *male-headed, large* group will have a higher net income because of their larger land size, Figure 13.10 also suggests that *male-headed, large* households use less hired labour than *male-headed, typical* households.

Figure 13.9 Distribution of cocoa production (kg/ha) and revenue in Côte d'Ivoire (Gaussian kernel smoothed)

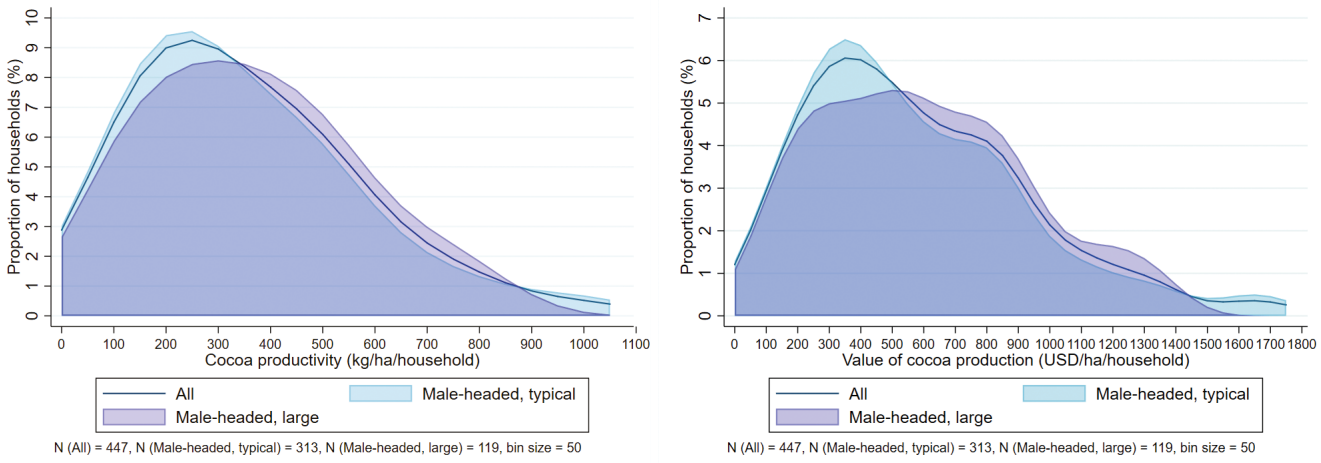
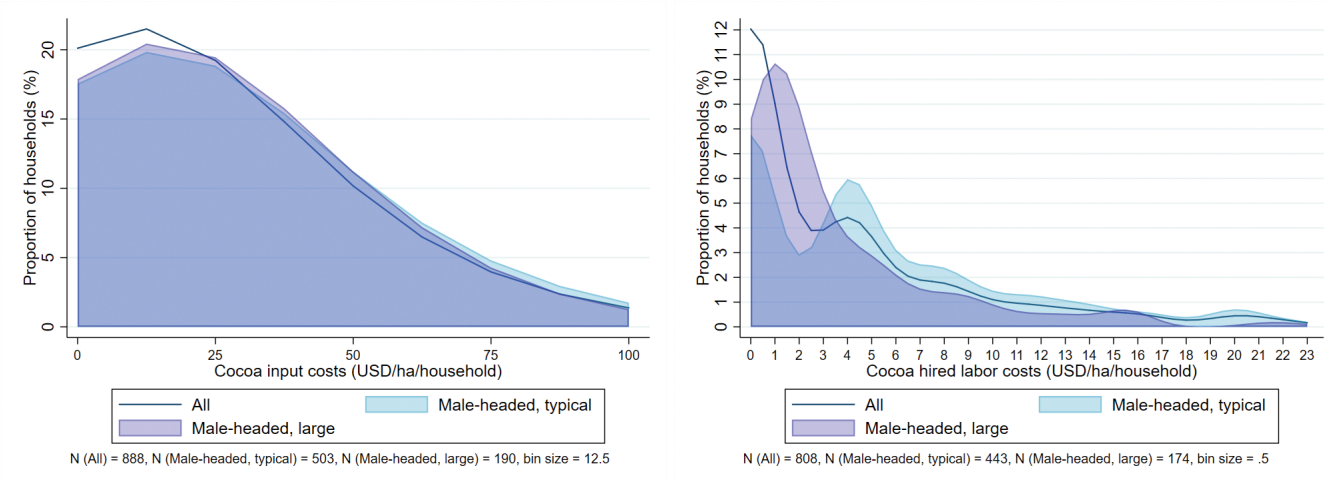


Figure 13.10 Distribution of cocoa input and labour costs in Côte d'Ivoire (Gaussian kernel smoothed)



Finally, Figure 13.11 shows the distribution of the estimated net annual cocoa income per household in Ghana. We find that *female-headed* households are very similar to the *male-headed, typical* household. The *male-headed, large* households have higher income but also higher income variability.

Figure 13.11 Distribution of net cocoa income, Ghana (Gaussian kernel smoothed)

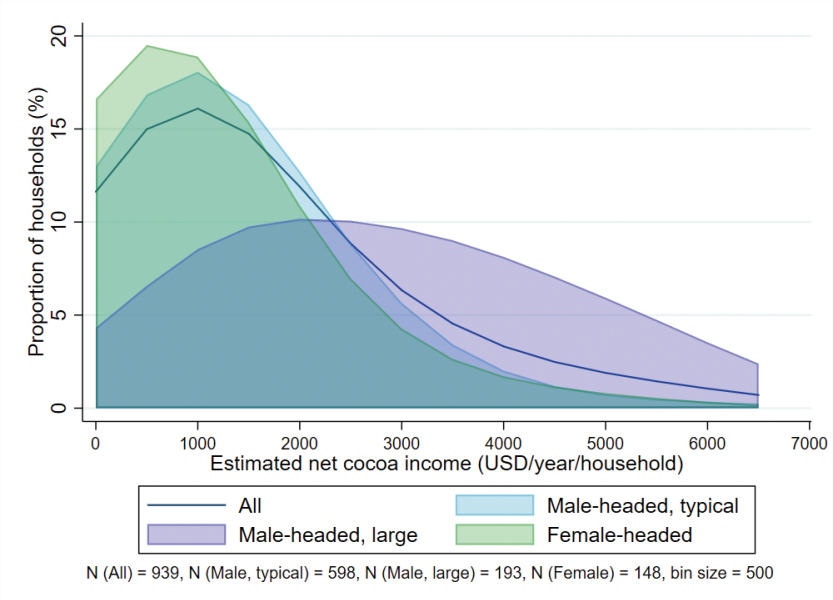
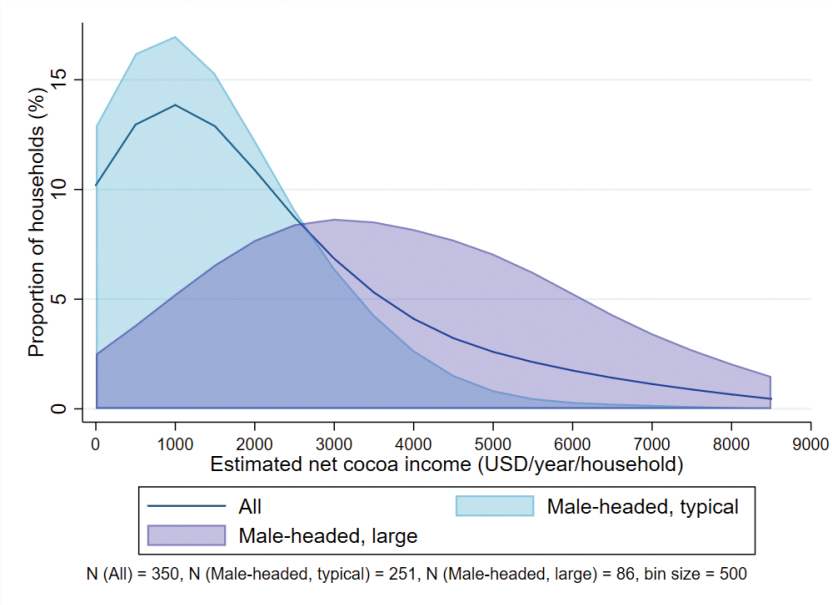


Figure 13.12 shows the distribution of the estimated net annual cocoa income per household in Côte d'Ivoire. As in Ghana, *male-headed, large* households have higher income but there is also greater income variability within this group.

Figure 13.12 Distribution of net cocoa income, Côte d'Ivoire (Gaussian kernel smoothed)



13.2.3 Total annual income estimation

We estimated the total annual household income by using the proportion of cocoa income contributing to the total household income. Given our dataset, we consider this to be the best proxy to cover for other income sources, such as sales of other crops, labouring and ownership of small businesses. We apply this procedure per household and then compute averages.

In Ghana, the distribution shows that *male-headed, typical* and *female-headed* households are quite similar, just as they are for cocoa income. This is because both groups report a similar proportion of their income coming from cocoa compared with other sources (Figure 13.13). We estimate that, on average, *male-headed, typical* households earn GHS 8,149 (USD 2,128) per year. *Female-headed* households earn GHS 6,240 (USD 1,630) per year. Although this is lower, we should also recall that they also have smaller household sizes, on average, and hence lower household expenditures. *Male-headed, large* households earn GHS 18,183 (USD 4,749) per year, on average. However, there is a large variability across this group (Table 13.13).

Figure 13.13 Distribution of annual household income, Ghana (Gaussian kernel smoothed)

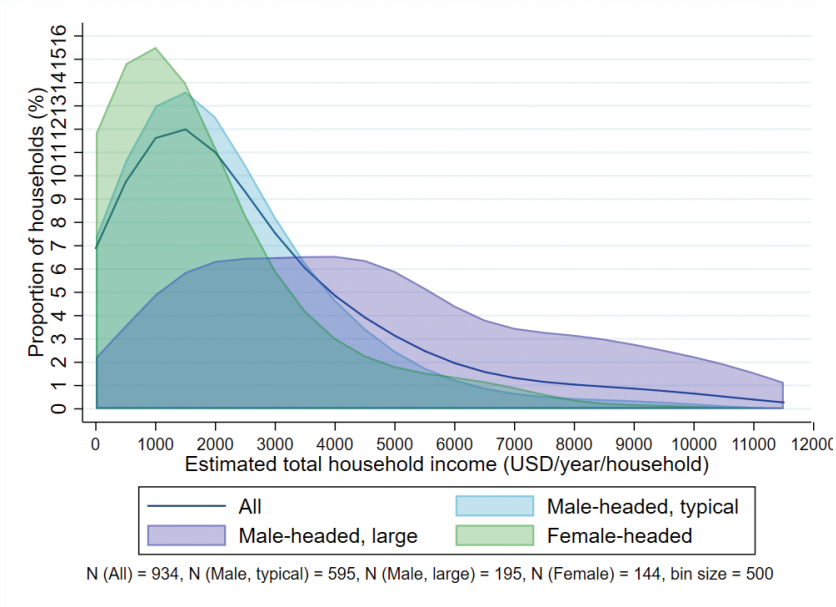


Table 13.13 Annual household income, Ghana

	All	Female-headed	Male-headed, typical	Male-headed, large
Annual household income				
Income from cocoa (USD//year/household)	$1,522	$960	$1,225	$2,873
Contribution of cocoa income to total income	61%	62%	60%	65%
Total income (USD/ year/household)	$2,598	$1,630	$2,128	$4,749
Total income (GHS/ year/household)	9,950	6,240	8,149	18,183
Total income (USD/year/household)				
Min	23	23	84	269
1st quartile	989	501	983	2,352
Median	1,788	1,073	1,619	4,398
Mean	2,598	1,630	2,128	4,749
3rd quartile	3,520	2,020	2,791	7,059
Max	11,739	9,300	10,062	11,739

For Côte d'Ivoire, we find that, on average, *male-headed, typical* households earn CFA 1,334,540 (USD 2,215) per year and *male-headed, large* households earn CFA 3,426,039 (USD 5,687) per year (Table 13.14). We find that the distribution of total annual household income follows a similar pattern to annual cocoa income (Figure 13.14).

Figure 13.14 Distribution of annual household income, Côte d'Ivoire (Gaussian kernel smoothed)

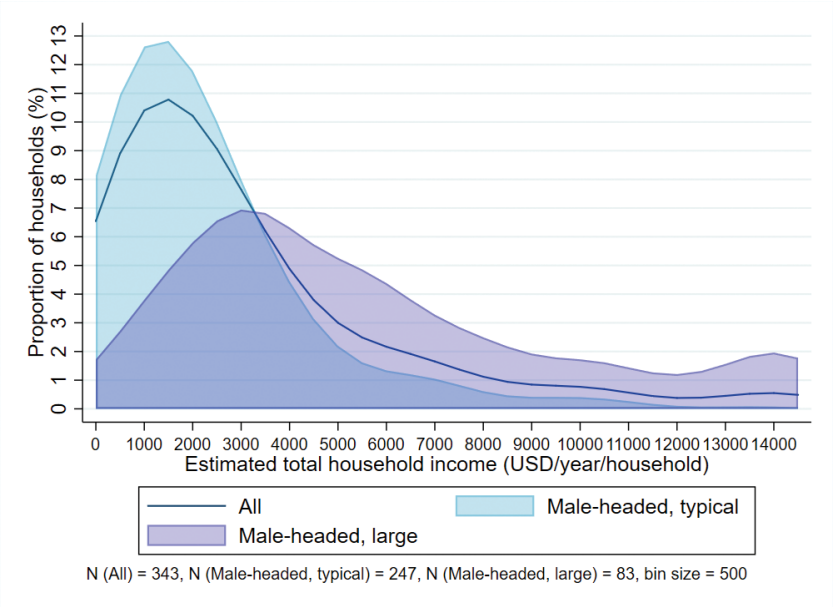


Table 13.14 Annual household income, Côte d'Ivoire

	All	Male-headed, typical	Male-headed, large
Annual household income			
Income from cocoa (USD//year/household)	$1,918	$1,277	$3,796
Contribution of cocoa income to total income	66%	66%	72%
Total income (USD/ year/household)	$3,075	$2,215	$5,687
Total income (CFA/ year/household)	1,852,165	1,334,540	3,426,039
Total income (USD/year/household)			
Min	18	18	377
1st quartile	906	793	2,913
Median	2,125	1,694	4,430
Mean	3,075	2,215	5,687
3rd quartile	3,938	2,772	7,879
Max	14,500	13,588	14,500

13.3 Summary

Our data-driven cluster analysis led us to define three key farmer profiles: *female-headed*, *male-headed, typical* and *male-headed, large* households. *Male-headed, typical* households are characterised by productive cocoa land up to 4 ha (with an average of 1.91 ha in Ghana and 2.3 ha in Côte d'Ivoire), while *male-headed, large* households reported more than 4 ha under cocoa (with an average of 6.34 ha in Ghana and 7.3 ha in Côte d'Ivoire). *Female-headed* households have, on average, 2.22

ha in Ghana. In Côte d'Ivoire, there were too few *female-headed* households producing cocoa and so this group was not included.

In Ghana, *male-headed, typical* comprised 58% of the sample, whilst *female-headed* comprised 24% and *male-headed, large* 18%. In Côte d'Ivoire, *male-headed, typical* comprised 72% of the sample, compared with 28% for *male-headed, large*.

In Ghana, *male-headed, typical* (1.9ha) and *female-headed* (2.2ha) households have similarly sized cocoa farms. However, in Chapter 6: Land, we show that there are significant differences in mean land sizes between male and female-headed households. Our cluster analysis suggests that these differences are actually driven by a relatively small proportion of male-headed households with much larger land sizes (6.3ha), rather than typical cases.

In Côte d'Ivoire, *male-headed*, typical households have an average of 2.3ha under cocoa compared with 7.3 for *male-headed, large* households.

In Ghana, *male-headed, typical* (USD 1,225) and *female-headed* (USD 960) households earn a similar annual net income from cocoa. Nevertheless, *male-headed, typical* and *female-headed* households are different in several respects. Female-headed households have a slightly higher mean land size, but slightly lower mean yield (kg/ha). Female-headed households have 0.5 fewer adult males in the household, which appears to drive higher hired labour costs, leading to lower net cocoa income. In Côte d'Ivoire, *male-headed, typical* households earn a mean annual net income from cocoa of USD 1,277.

In Ghana (USD 2,873) and Côte d'Ivoire (USD 3,796), *male-headed, large* households have much higher net cocoa income than other groups. This difference is primarily driven by their larger productive land size, resulting in higher total production. Their higher net income is not typically due to higher cocoa yields.

In Ghana, *male-headed, typical* households (60%) and *female-headed* households (62%) derive a similar proportion of their total income from cocoa, which leads to a quite similar total household income.

In Ghana, *male-headed, typical* households earn USD 2,128 per year while *female-headed* households earn USD 1,630 on average, from all income sources. We note female-headed households do tend to be smaller and hence have lower household expenditures. *Male-headed, large* households earn USD 4,749 on average, but there is considerable variability within this group.

In Côte d'Ivoire, *male-headed, typical* households earn USD 2,215 per year while *male-headed, large* households earn USD 5,687 per year from all income sources.