



# 10

## Production and yield

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## 10.1 Production and yield

Total cocoa production and yield are important factors that determine household income in cocoa growing areas.

A number of earlier studies have reported average cocoa yields in Ghana, which typically range between 400 and 530 kg/ha (Table 10.1). It is important to note that some of these studies involve farmers that have been involved in projects that have tried to boost productivity, and thus may present higher yield figures than an unbiased random sample of cocoa farmers. Some studies have suggested that there are regional differences, with highest yields in Western region.<sup>1,2,3</sup> However, we also note that studies that attempt to show regional differences often have small sample sizes which are vulnerable to sampling bias.

Table 10.1 Recent yield estimates for Ghana, means in kg/ha

Yield	Source
+/- 400 kg/ha	Barrientos & Akyere (2012) <sup>4</sup>
>400 kg/ha	Asamoah <i>et al.</i> (2013) <sup>5</sup>
500 kg/ha	Lambert <i>et al.</i> (2014) <sup>6</sup>
400 kg/ha	Wessel & Quist-Wessel (2015) <sup>7</sup>
400 kg/ha	Kumi & Daymond (2015) <sup>8</sup>
420 kg/ha	Oomes <i>et al.</i> (2016) <sup>9</sup>
400-530 kg/ha	Donovan <i>et al.</i> (2016) <sup>10</sup>
402 kg/ha	Vigneri and Serra (2016) <sup>11</sup>

In Côte d'Ivoire, average yields are also reported to be quite low in most studies, and fairly similar to those in Ghana. Averages tend to vary between 300 and 500

<sup>1</sup> Kolavalli, S., Vigneri, M., Gockowski, J. (2016). The Cocoa Coast: the board managed cocoa sector in Ghana. Ghana strategy support program, International Food Policy Research Institute (IFPRI). Available at <http://www.ifpri.org/publication/cocoa-coast-board-managed-cocoa-sector-ghana>

<sup>2</sup> Waarts, Y., Ge, L., Ton, G., van der Meen, J. (2013). A touch of cocoa: Baseline study of six UTZ- Solidaridad cocoa projects in Ghana. LEI report 2013-2014. LEI Wageningen UR. Available at <http://edepot.wur.nl/305316>

<sup>3</sup> Vigneri, M. and Serra, R. (2016). Researching the Impact of Increased Cocoa Yields on the Labour Market and Child Labour Risk in Ghana and Côte d'Ivoire. ICI Labour market research study. Available at: [http://www.cocoainitiative.org/wp-content/uploads/2016/12/market\\_research\\_full\\_web.pdf](http://www.cocoainitiative.org/wp-content/uploads/2016/12/market_research_full_web.pdf)

<sup>4</sup> Barrientos, S.W., Asenso Akyere, K. (2012). Mapping sustainable production in Ghanaian cocoa, Report to Cadbury. Institute of Development Studies & University of Ghana. Available at <https://www.cocoalife.org/progress/mapping-sustainable-production-in-ghanaian-cocoa>

<sup>5</sup> Asamoah, M., Ansah, F. O., Anchirinah, V., Aneani, F., Agyapong, D. (2013). Insight into the standard of living of Ghanaian Cocoa Farmers. Greener Journal of Agricultural Sciences, 3(5), 363-370. Available at <http://www.gjournals.org/GJAS/GJAS%20Pdf/2013/May/031313522%20Asamoah%20et%20al.pdf>

<sup>6</sup> Lambert, A., Gearhart, J. McGill, A., Wrinkle, H. (2014). The Fairness Gap: Farmer incomes and root cause solutions to ending child labor in the cocoa industry. International Labour Rights Forum, Washington D.C. Available at [https://laborrights.org/sites/default/files/publications/Fairness%20gap\\_low\\_res.pdf](https://laborrights.org/sites/default/files/publications/Fairness%20gap_low_res.pdf)

<sup>7</sup> Wessel, M., Quist-Wessel, P. F. (2015). Cocoa production in West Africa, a review and analysis of recent developments. NJAS-Wageningen Journal of Life Sciences, 74, 1-7. Available at [https://www.researchgate.net/publication/282316360\\_Cocoa\\_production\\_in\\_West\\_Africa\\_a\\_review\\_and\\_analysis\\_of\\_recent\\_developments](https://www.researchgate.net/publication/282316360_Cocoa_production_in_West_Africa_a_review_and_analysis_of_recent_developments)

<sup>8</sup> Kumi, E., Daymond, A. J. (2015). Farmers' perceptions of the effectiveness of the Cocoa Disease and Pest Control Programme (CODAPEC) in Ghana and its effects on poverty reduction. American Journal of Experimental Agriculture, 7(5), 257-274. Available at [http://www.journalrepository.org/media/journals/AJEA\\_2/2015/Mar/Kumi752015AJEA16388.pdf](http://www.journalrepository.org/media/journals/AJEA_2/2015/Mar/Kumi752015AJEA16388.pdf)

<sup>9</sup> Oomes, N., Tieben, B., Laven, A., Ammerlaan, T., Appelman, R., Biesenbeek, C., Buunk, E. (2016). Market concentration and price formation in the global cocoa value chain. SEO Amsterdam Economics. Available at <http://www.seo.nl/en/page/article/marktconcentratie-en-prijsvorming-in-de-mondiale-waardeketen-voor-cacao/>

<sup>10</sup> Donovan, J., Stoian, D., Foundjem, D., Degrande, A. (2016). Fairtrade Cocoa in Ghana: Taking Stock and Looking Ahead. Sweet Vision, Vol. 61(3), 14-17. Available at <https://www.bioversityinternational.org/e-library/publications/detail/fairtrade-cocoa-in-ghana-taking-stock-and-looking-ahead/>

<sup>11</sup> Vigneri, M. and Serra, R. (2016). Researching the Impact of Increased Cocoa Yields on the Labour Market and Child Labour Risk in Ghana and Côte d'Ivoire. ICI Labour market research study. Available at: [http://www.cocoainitiative.org/wp-content/uploads/2016/12/market\\_research\\_full\\_web.pdf](http://www.cocoainitiative.org/wp-content/uploads/2016/12/market_research_full_web.pdf)

kg/ha (Table 10.2). One study by Vigneri and Serra (2015), commissioned by the International Cocoa Initiative (ICI), estimated that 41% of cocoa farmers were ‘low yield’ farmers, producing less than 250 kg/ha, with a further 44% belonging to the ‘medium yield farmers’, with averages of 250-600 kg/ha. The remaining 15% were so-called ‘high-yield farmers’, producing on average more than 600 kg/ha.<sup>12</sup>

Table 10.2 Recent yield estimates for Côte d’Ivoire, means in kg/ha

Yield	Source
447 kg/ha	Tano (2012) <sup>13</sup>
493 kg/ha	Ingram <i>et al.</i> (2013) <sup>14</sup>
300-500 kg/ha	Ingram <i>et al.</i> (2014) <sup>15</sup>
500 kg/ha	Lambert <i>et al.</i> (2014) <sup>16</sup>
500 kg/ha	Barry Callebaut (2014) <sup>17</sup>
300-400 kg/ha	FLA (2015) <sup>18</sup>

In Ghana and Côte d’Ivoire, studies report that average farmer yields are well below potential yields, which are often cited as between 1,000 kg/ha and 1,900 kg/ha.<sup>19, 20, 21, 22</sup> The differences between potential and actual yields have given an impetus for researchers, companies, NGOs and policymakers to look for reasons for low yields, and ways to unleash the potential of cocoa farmers (Chapter 8).

In most research, an underlying assumption is that cocoa households would want to invest their labour and invest their capital in inputs to increase yields. While the assumption appears reasonable, we note that some households can be regarded as ‘harvesters’<sup>23</sup> rather than active farmers. Harvesters may, for instance, have other more important income sources or be retirees. They may be relatively content harvesting whatever cocoa is produced with the least cost and effort, and may be

<sup>12</sup> Vigneri, M. and Serra, R. (2016). Researching the Impact of Increased Cocoa Yields on the Labour Market and Child Labour Risk in Ghana and Côte d’Ivoire. ICI Labour market research study. Available at: [http://www.cocoainitiative.org/wp-content/uploads/2016/12/market\\_research\\_full\\_web.pdf](http://www.cocoainitiative.org/wp-content/uploads/2016/12/market_research_full_web.pdf)

<sup>13</sup> Tano, M.A. (2012). Crise cacaoyère et stratégies des producteurs de la sous-préfecture de Meadji au sud-ouest ivoirien (Doctoral dissertation, Université Toulouse le Mirail-Toulouse II). Available at <https://tel.archives-ouvertes.fr/tel-00713662/document>

<sup>14</sup> Ingram V., Waarts Y., van Vugt S.M., Ge L., Wegner L., Puister-Jansen L. (2013). Towards sustainable cocoa: Assessment of Cargill and Solidaridad cocoa farmer support activities in Côte d’Ivoire 2008-2012. LEI, Wageningen UR. Wageningen. Available at <http://edepot.wur.nl/314177>

<sup>15</sup> Ingram, V., Waarts, Y., Ge, L., van Vugt, S., Wegner, L., Puister-Jansen, L., Ruf, F., Tanoh, R. (2014). Impact of UTZ certification of cocoa in Ivory Coast; Assessment framework and baseline. Wageningen, LEI Wageningen UR (University & Research centre), LEI Report 2014-010. Available at [https://utz.org/wp-content/uploads/2016/03/Impact-of-UTZ-certification-of-cocoa-in-Ivory-Coast\\_2014.pdf](https://utz.org/wp-content/uploads/2016/03/Impact-of-UTZ-certification-of-cocoa-in-Ivory-Coast_2014.pdf)

<sup>16</sup> Lambert, A., Gearhart, J. McGill, A., Wrinkle, H. (2014). The Fairness Gap: Farmer incomes and root cause solutions to ending child labor in the cocoa industry. International Labour Rights Forum, Washington D.C. Available at [https://laborrights.org/sites/default/files/publications/Fairness%20gap\\_low\\_res.pdf](https://laborrights.org/sites/default/files/publications/Fairness%20gap_low_res.pdf)

<sup>17</sup> Barry Callebaut (2014). Cocoa Sustainability Report 103/2014. Available at [https://www.barry-callebaut.com/system/files/download/barry\\_callebaut\\_cocoa\\_sustainability\\_report\\_2014\\_web.pdf](https://www.barry-callebaut.com/system/files/download/barry_callebaut_cocoa_sustainability_report_2014_web.pdf)

<sup>18</sup> FLA (2015). Evaluer la situation actuelle des femmes et des jeunes agriculteurs et l’état nutritionnel de leurs familles dans deux communautés productrices de cacao en Côte d’Ivoire. Rapport préparé par Fair Labour Association, Juillet 2015. Available at [http://www.fairlabor.org/sites/default/files/documents/reports/femmes\\_et\\_des\\_jeunes\\_nutrition\\_dans\\_communautes\\_de\\_dacao\\_juillet\\_2015.pdf](http://www.fairlabor.org/sites/default/files/documents/reports/femmes_et_des_jeunes_nutrition_dans_communautes_de_dacao_juillet_2015.pdf)

<sup>19</sup> Oomes, N., Tieben, B., Laven, A., Ammerlaan, T., Appelman, R., Biesenbeek, C., Buunk, E. (2016). Market concentration and price formation in the global cocoa value chain. SEO Amsterdam Economics. Available at <http://www.seo.nl/en/page/article/marktconcentratie-en-prijsvorming-in-de-mondiale-waardeketen-voor-cacao/>

<sup>20</sup> Aneani, F., Anchirinah, V., Owusu-Ansah, F., Asamoah, M. (2012). Adoption of Some Cocoa Production Technologies by Cocoa Farmers in Ghana. Sustainable Agriculture Research Vol. 1, No. 1; February 2012. Available at <http://www.ccsenet.org/journal/index.php/sar/article/view/14550>

<sup>21</sup> Kumi, E., Daymond, A. (2015). Farmers’ Perceptions of the Effectiveness of the Cocoa Disease and Pest Control Programme (CODAPEC) in Ghana and Its Effects on Poverty Reduction. American Journal of Experimental Agriculture 7(5): 257-274, 2015, Article no.AJEA.2015.128. Available at [http://www.journalrepository.org/media/journals/AJEA\\_2/2015/Mar/Kumi752015AJEA16388.pdf](http://www.journalrepository.org/media/journals/AJEA_2/2015/Mar/Kumi752015AJEA16388.pdf)

<sup>22</sup> Vigneri, M. and Serra, R. (2016). Researching the Impact of Increased Cocoa Yields on the Labour Market and Child Labour Risk in Ghana and Côte d’Ivoire. ICI Labour market research study. Available at: [http://www.cocoainitiative.org/wp-content/uploads/2016/12/market\\_research\\_full\\_web.pdf](http://www.cocoainitiative.org/wp-content/uploads/2016/12/market_research_full_web.pdf)

<sup>23</sup> This term comes from companies that the researchers have previously worked with.

disinterested in replanting cocoa trees as they age. Nevertheless, surveys like ours capture their data, which tends to pull down the overall average. For this reason, a distribution of cocoa yields provides a better impression of farmer yields than a simple mean.

In our household survey, care was taken to only record data from respondents who were confident that they knew their household's cocoa production. Respondents were first asked what unit of measurement they used (such as bags or kilogrammes) and then were asked 'Do you know how many [bags or KGs] of cocoa your household produced last year?' Only respondents who answered 'yes' were asked further questions about their production levels. As Table 10.3 indicates, In Ghana, 95% of male respondents said that they knew how many much cocoa their household produced, compared with 82% of female respondents. In Côte d'Ivoire, only 67% of male respondents said they knew how much they produced, compared with 21% of female respondents. A similar process was also used to test a respondent's knowledge of their household's land size used in yield calculations. 93% of Ghana respondents knew their total land under cocoa while 89% of the respondents in Côte d'Ivoire knew how much land was under cocoa. These simple checks of respondent's knowledge is important for establishing reliable figures.

#### **Box 10.1 Methodological considerations when including only respondents who confidently know their production**

We have considered whether the sample of respondents who 'don't know' their land size and/or production are significantly different from those who do know. Our concern was whether excluding observations from respondents who don't know might in itself introduce a selection bias.

To understand the meaning of this bias we have looked into how 'knowledge' is correlated. For example, out of the 9% of farmers that do not know the size of their cocoa land, 60% also do not know their cocoa production figures, compared to only 20% that do not know production figures if they do know the size of their cocoa land. In both countries, respondents that don't know their production have slightly smaller land sizes than those that do know. Female-headed households are also less likely to know their production figures, as are households where the head has no formal education.

Nevertheless, we believe that our calculation methodology allows a good indication about the population of interest, and comparative statistics between groups remain valid. We believe that it would be more problematic to include data from respondents who are essentially guessing their land size or production.

Table 10.3 Cocoa, percent of respondents who said they know how much cocoa their household produced in the 2015-2016 season

	Ghana female respondent	Ghana male respondent	pvalue	sig	Côte d'Ivoire female respondent	Côte d'Ivoire male respondent	pvalue	sig
mean	82%	95%	0.00	***	21%	67%	0.00	***
std.error	2%	1%			3%	2%		
N	435	883			214	694		
cocoa_prod_known_yn								

Note: p-value from a one-way ANOVA test

Note: In our household survey, farmers were first asked what unit they preferred to discuss production, such as bags or kilogrammes.

Respondents were then asked 'Do you know how many \$(cocoa\_prod\_unit) of cocoa your household produced in the 2015-2016 cocoa season?' (where \$(cocoa\_prod\_unit) was the value for the unit of measurement previously entered in digital survey form.)

Yield figures are calculated from total production (main season + light season) divided by the amount of land under productive cocoa (over 5 years old). It is important to note that respondents were able to answer questions in any unit they liked for both production (usually bags or kilogrammes) and land size (usually acres, poles or hectares) to enhance data quality and accuracy. The data was then re-calculated by researchers as kilogrammes per hectare. Data has also been cleaned, removing a few extreme outlier values more than 4 standard deviations from the mean.

In Ghana, respondents reported an average production of 806 kg in the main season and 281 kg in the light season on all household land under cocoa. This amounts to an average of 1,087 kg of cocoa produced per household per year (Table 10.4). From this we calculate a mean annual yield of 423 kg/ha (Table 10.5). We also find a median yield of 369 kg/ha and a yield distribution between 100 and 1,400 kg/ha, with the majority between 100 and 800 kg/ha (Figure 10.2).

In Côte d'Ivoire, respondents reported producing an average of 1,222 kg per year on all cocoa land (Table 10.4). This is a little higher than Ghanaian respondents reported because Ivorian households produce cocoa on more land, on average, than Ghanaian cocoa farmers. However, yields were found to be lower in Côte d'Ivoire, with an average of 352 kg/ha (Table 10.5) (*significant difference with Ghana*), with a median of 312 kg/ha. In terms of distribution, Côte d'Ivoire farmers also typically yielded between 100 and 1,000 kg/ha, with the majority grouping between 100 and 600 kg/ha (Figure 10.2). We remind the reader that these figures are derived from a random sample of cocoa households, and therefore yield figures may be lower than those recorded in projects or programmes that focus on improving farmer productivity.

Table 10.4 Mean cocoa production (all cocoa land) in main and light seasons 2015-2016 (kg), by country

	Ghana			Côte d'Ivoire		
	Main season	Light season	Year production	Main season	Light season	Year production
mean	806	281	1087	934	288	1222
std.error	23	8	29	43	16	55
N	997	997	997	442	442	442

Note: Differences between Ghana and Côte d'Ivoire were highly significant for the main season (pvalue 0.00) and not significant for the light season (pvalue 0.25). Main season + light season do not add up because not all respondents either reported harvesting cocoa in both seasons, or did not know their production levels in one of the seasons.

Figure 10.1 Cocoa production (all land) (kg), Ghana and Côte d'Ivoire

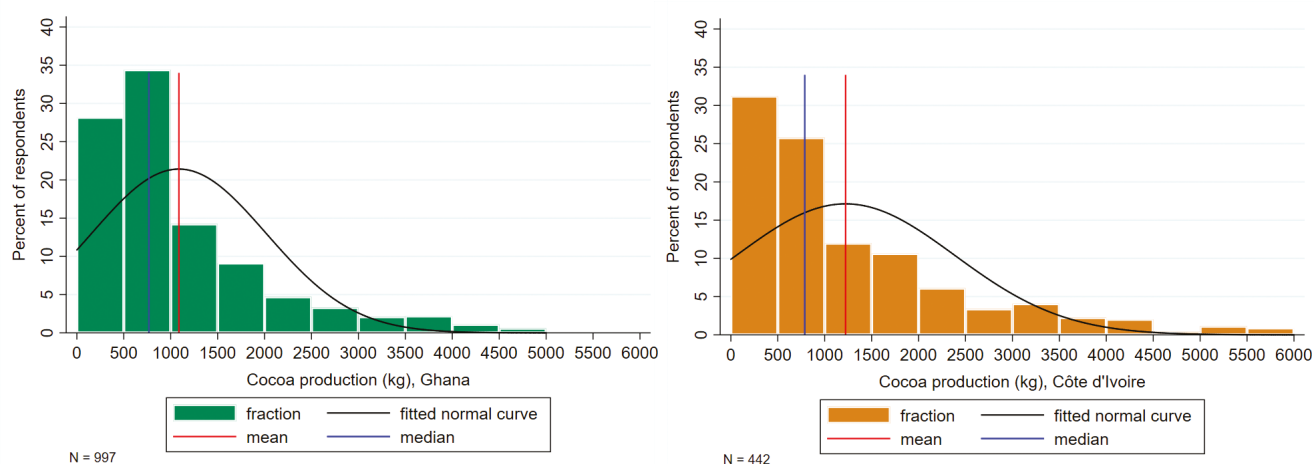
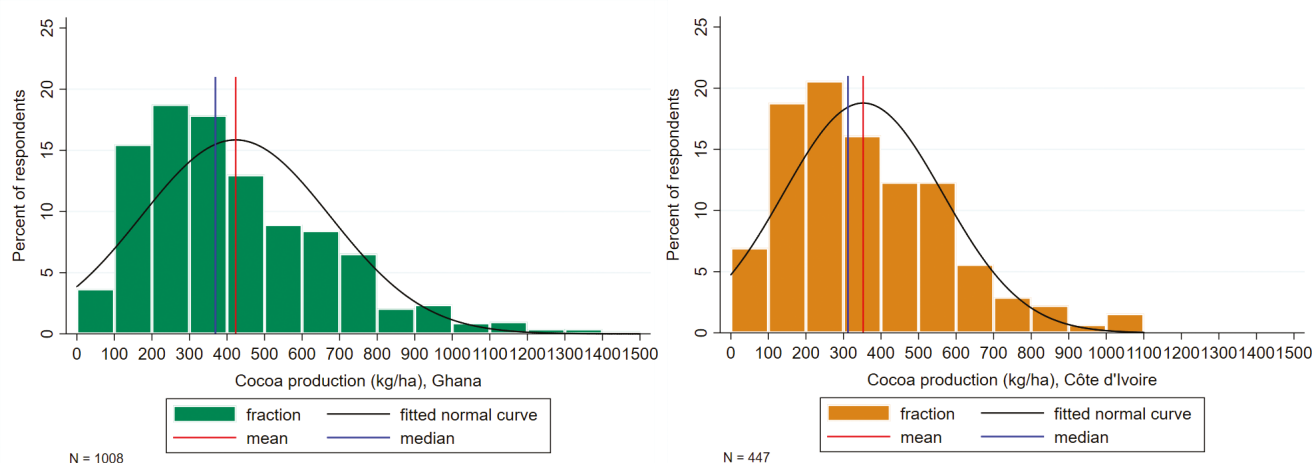


Table 10.5 Mean cocoa yield in main and light seasons 2015-2016 (kg/ha), by country

	Ghana			Côte d'Ivoire		
	Main season	Light season	Year	Main season	Light season	Year
mean	311	112	423	271	82	352
std.error	6	3	8	8	3	10
N	1,008	1,008	1,008	447	447	447

Note: Differences between Ghana and Côte d'Ivoire are highly significant (pvalue 0.00) for main season, light season and total yield for the 2015-2016 season. Main season + light season do not add up because not all respondents either reported harvesting cocoa in both seasons, or did not know their production levels in one of the seasons.

Figure 10.2 Cocoa yields (kg/ha), Ghana and Côte d'Ivoire



In Ghana, a difference of around 58 kg/ha was found between male and female-headed households (*highly significant*). However, it is important to consider what differences in practices are actually driving differences in yields. Determinants of yield are analysed in the regression analysis below.

In Côte d'Ivoire, we find no statistically significant differences in yield between male-headed and female-headed households. However this is also due to the very low number of female observations (due to many respondents who did not know either their production or land size).

Table 10.6 Cocoa, yield (kg/ha) for 2015-2016 season, by sex of household head

	Ghana female head	Ghana male head	pvalue	sig	Côte d'Ivoire female head	Côte d'Ivoire male head	pvalue	sig
mean	374	432	0.01	***	386	351	0.53	
std.error	19	9			46	10		
N	162	846			15	437		
cocoa_prod_total_kgsha								

Note: p-value from a one-way ANOVA test

In Ghana, significant differences in yield were also found across regions, although we must take care not to draw too precise conclusions from a small sample size in some regions. The Central and Western regions recorded the highest mean yields, which may reflect environmental conditions (such as soil and rainfall) as much as differences in farming practices.

In Côte d'Ivoire, the greater number of regions and the relatively high proportion of respondents who reported 'don't know', has left us with too few observations to provide an accurate regional disaggregation.

Table 10.7 Cocoa, yield (kg/ha) for 2015-2016 season, by Ghana region

	Ashanti	Brong Ahafo	Central	Eastern	Western	pvalue	sig
mean	360	367	538	390	468	0.00	***
std.error	16	18	34	16	13		
N	197	141	53	209	414		
cocoa_prod_total_kgsha							

Note: p-value from a one-way ANOVA test

No significant differences in yield were found between youth and non-youth in either country, and no significant differences in yield were found between migrant and non-migrants in Ghana. Migrants were found to have a larger yield than non-migrants in Côte d'Ivoire (*significant*) but, due to the small sample size, we do not have strong

confidence in this finding. We also observe a significant yield difference between leaders (458 kg/ha) and non-leaders (403 kg/ha) in Ghana. However, we also find the reverse relationship in Côte d'Ivoire where non-leaders (376 kg/ha) have a higher average yield than leaders (339 kg/ha), although this is only significant at the 10% level.

## 10.2 Regression analysis of yield

Linear regression analysis was conducted to understand which independent variables are significantly correlated with the dependent variable 'yield (kg/ha)'. Two regressions were run with the results shown in Column 1 and Column 2 (Table 10.8). These are essentially the same (we will discuss column 1 in the description), with the difference being that, in column 1, we analyse the dependent variable yield with the likelihood of being under the \$1.25/day poverty line.<sup>24</sup> In column 2, we include the dependent variable 'DHS index' which is a composite wealth index that measures a household's living standard.<sup>25</sup>

In Ghana, we find that households with a farmer group member produce approximately 85 kg/ha more than households that do not (*highly significant*). The question is then how being a member of a farmer group contributes to an increase in yield. It is possible that there is a two-way relationship here – more professional farmers seek to organise themselves, and being part of a farmer organisation helps one to professionalise. The regression model already controls for the use of inputs and access to training, but we hypothesise that being a member of a farmer group may improve access to greater quantities of inputs, and/or more timeliness of application. These farmers may also have greater exposure to ongoing discussion (both formally and informally) on GAP. In Chapter 9 we showed that of the cocoa households in Ghana only 11% was member of a cocoa producer group.

Those who consider themselves to be a 'leader' in their community yield around 34 kg/ha more than non-leaders (significant). Previous research confirms this finding (Chapter 3), showing in Ghana there is a significant positive correlation between leadership, ownership and productivity levels,<sup>26</sup> which suggests that social relations can play a major role in facilitating or constraining farmers in accessing inputs and services. In addition, we hypothesise that community leaders have better access to knowledge, inputs and services, or that they are more conscientious in their application of labour to GAP.

<sup>24</sup> For this we use the Poverty Probability Index (PPI) likelihood of being under \$1.25/day PPP 2005. We describe the PPI in detail in our chapter on poverty, wealth and income. See: PPI. (2016). About the PPI: A Poverty Measurement Tool. Available at <https://www.povertyindex.org/about-ppi>

<sup>25</sup> We describe the Demographic and Health Survey (DHS) in detail in our chapter on poverty, wealth and income. See DHS (2016). What is the DHS wealth index? Available at <https://www.dhsprogram.com/topics/wealth-index/index.cfm>

<sup>26</sup> Laven, A. (2010). The risks of inclusion: Shifts in governance processes and upgrading opportunities for cocoa farmers in Ghana. Amsterdam: KIT. Available at: [https://pure.uva.nl/ws/files/1437472/77981\\_18.pdf](https://pure.uva.nl/ws/files/1437472/77981_18.pdf)



In Ghana, we find that female-headed households yield, on average, approximately 63 kg/ha less than male-headed households after controlling for all other variables (*highly significant*). The model cannot explain exactly what combination of factors has caused female-headed households to have lower yields (many variables are already controlled for), but there are a number of reasonable factors to consider including amount of inputs used, number of labour days invested, quality of labour used, and knowledge and application of good practices, as well as factors such as reporting bias (female respondents reported ‘don’t know’ at a significantly higher frequency than men). We also note that, after excluding ‘don’t know’ respondents from our sample, we only have 163 female-headed households (or less than 10% of the total number of cocoa farmers) left in the model so, while the finding is highly significant, it is not necessarily robust.

Regional differences in Ghana were found to be highly significant, with the reference region as Ashanti. Yields in Central (around 172 kg/ha) and Western (around 113 kg/ha) regions were found to be significantly higher, after controlling for other factors in this model. We are particularly confident in the robustness of this finding for Western region, as it had the largest sample size of more than 400 respondents, however the Central region sample lacks power for drawing robust conclusions. Our analysis on regional differences confirms findings of earlier studies.<sup>27,28,29</sup> The cause of regional differences are likely to be environmental factors, including soil quality, rainfall and climate. It may also be caused by farmers utilising a greater amount and quality of labour and/or inputs, which we have not included in this model due to the small sample of respondents who accurately know their costs of production.

A significant negative correlation was found between yield and the amount of productive land under cocoa. The model shows that, for every additional hectare under cocoa, yields fall by approximately 71 kg (*highly significant*). Of course, this is not a linear relationship. The independent variable, ‘productive land under cocoa squared’ shows a parabolic effect that curves and levels off as land size under cocoa increases (*highly significant*). This finding is not uncommon in smallholder agricultural systems, and is usually attributed to a shortage of household labour and higher total hired labour costs resulting in fewer labour days invested per hectare. It is also commonly associated with lower input investments per hectare because, as cultivated land size increases, farmers may be unable or unwilling to meet the cost of optimal input application and instead may apply inputs sparingly or only on some plots.

<sup>27</sup> Kolavalli, S., Vigneri, M., Gockowski, J. (2016). The Cocoa Coast: the board managed cocoa sector in Ghana. Ghana strategy support program, International Food Policy Research Institute (IFPRI). Available at <http://www.ifpri.org/publication/cocoa-coast-board-managed-cocoa-sector-ghana>

<sup>28</sup> Waarts, Y., Ge, L., Ton, G., van der Meen, J. (2013). A touch of cocoa: Baseline study of six UTZ- Solidaridad cocoa projects in Ghana. LEI report 2013-2014. LEI Wageningen UR. Available at <http://edepot.wur.nl/305316>

<sup>29</sup> Vigneri, M. and Serra, R. (2016). Researching the Impact of Increased Cocoa Yields on the Labour Market and Child Labour Risk in Ghana and Côte d’Ivoire. ICI Labour market research study. Available at: [http://www.cocoainitiative.org/wp-content/uploads/2016/12/market\\_research\\_full\\_web.pdf](http://www.cocoainitiative.org/wp-content/uploads/2016/12/market_research_full_web.pdf)

In Ghana, the application of granular fertiliser is an important predictor of yields. Applying granular fertiliser increases yields by an average of 95 kg/ha (*highly significant*). (We do not use volumes of fertiliser in the model due to a high proportion of 'don't know' responses and high variation in fertiliser estimates). Interestingly, we do not find significance for liquid fertiliser application. The application of pesticides boosts yields by around 63 kg/ha (*significant*). The model shows that the use of herbicides actually reduces yields by 39 kg/ha (highly significant). We are not sure whether this finding is a direct effect of herbicide application, or if this reflects lower labour inputs for weeding which affects yields.

We also find that Ghanaian households with lower poverty and higher relative wealth have higher productivity. In the first column, this is reflected in the PPI 'likelihood of being under \$1.25/day PPP 2005'. This is difficult to interpret without an understanding of the PPI index. However, it suggests that, as households become more likely fall into poverty, their yield falls (by 5 kg/ha per percentage point of likelihood) and, conversely, households with a lower likelihood of being in poverty have a higher yield. In the second column, we can see these same dynamics in the DHS wealth index. Those in the 2<sup>nd</sup> quintile have a slightly higher yield compared with those in the poorest bottom quintile (significant at 10%). However, those in the 3<sup>rd</sup> quintile produce around 127 kg/ha more than those in the bottom quintile (*highly significant*). This is likely to be a two-way relationship, as those who are better off are more able to be make the investments to achieve higher cocoa yields, and those who achieve better yields are likely to be better off. For more details on the PPI and DHS the reader should refer to the Poverty, Wealth and Income chapter.

We do not find any statistical significance for a number of variables including: education level of the household head, whether the head is a migrant, the number of household members, the number of crops produced by the household, whether the land is owned or under an *abunu* land tenure arrangement, whether a household is certified, and whether the household has received training in the past 5 years.

Table 10.8 Determinants of yield (regression), Ghana

	1 Cocoa yield (kg/ha)	2 Cocoa yield (kg/ha)
Borrowed money last year: yes	3.36 (16.69)	7.09 (16.72)
Household is member of a farmer group: yes	84.67 (25.42)***	75.69 (25.47)***
Leader: yes	34.09 (16.63)**	32.15 (16.60)*
Head: Sex: female	-63.39 (22.07)***	-66.90 (21.97)***
Head: Education level: Primary school	16.11 (26.32)	19.77 (26.29)
Head: Education level: Junior high school (JHS) / middle school	-0.99 (20.77)	-3.66 (20.64)
Head: Education level: Senior high school (SHS) A/O level	-8.42 (29.75)	-16.72 (29.73)
Head: Education level: University	-31.52 (45.45)	-58.84 (45.31)
Head: Education level: Technical college/vocational	-3.44 (48.25)	-14.05 (49.16)
Head: Education level: Other	40.27 (94.42)	36.73 (102.31)
Region: Central	172.69 (36.53)***	172.62 (36.46)***
Region: Brong Ahafo	-35.51 (26.79)	-7.83 (27.22)
Region: Western	113.30 (21.69)***	111.22 (21.66)***
Region: Eastern	16.58 (23.86)	11.29 (23.92)
Age group (head): 26-35	-1.20 (58.42)	6.17 (58.15)
Age group (head): 36-45	65.06 (56.29)	63.05 (55.95)
Age group (head): 46-55	32.01 (55.76)	36.48 (55.48)
Age group (head): 56-65	28.00 (56.11)	35.16 (55.93)
Age group (head): 66-older	-5.26 (57.02)	-0.05 (56.77)
Migrant: yes	7.08 (18.92)	13.22 (18.87)
Number of household members living in the compound	0.17 (3.26)	-2.47 (2.91)
Number of crops produced	2.11 (3.09)	4.03 (3.07)
Productive land under cocoa(ha)	-71.28 (9.66)***	-69.21 (9.65)***
Productive land under cocoa (ha) squared	4.48 (0.87)***	4.30 (0.87)***
Owned land: yes	33.98 (26.97)	32.14 (26.94)
Leased land: yes	-59.76 (80.18)	-37.44 (80.25)
Abunu: yes	-4.48 (22.74)	-4.65 (22.68)
Granular fertiliser: Yes	94.74 (15.97)***	90.48 (16.00)***
Liquid fertiliser: Yes	18.75 (15.42)	17.96 (15.40)
Herbicides: Yes	-38.97 (16.11)**	-34.63 (16.16)**
Pesticides: Yes	63.28 (24.52)**	60.62 (24.47)**
Fungicides: Yes	29.34 (18.15)	32.18 (18.11)*
Pruning: Yes	-4.36 (20.51)	-6.75 (20.45)
Certification: yes	-22.94 (23.41)	-17.76 (23.54)
Certification: don't know	-28.30 (20.23)	-31.29 (20.26)
Received training in the last 5 years: yes	-2.56 (18.18)	-5.43 (18.27)
Likelihood of being under \$1.25/day PPP 2005	-4.63 (1.51)***	
According to DHS Wealth Index: 2nd quintile		35.54 (18.56)*
According to DHS Wealth Index: 3rd quintile		126.76 (23.46)***
According to DHS Wealth Index: 4th quintile		93.90 (53.39)*
Constant	375.16 (71.45)***	313.19 (71.81)***
N	957	950
R2	0.22	0.24

\* p<0.1; \*\* p<0.05; \*\*\* p<0.01  
Robust se in parenthesis

In Côte d'Ivoire, fewer variables significantly correlate with yield compared with Ghana. This may be due partly to the smaller sample of cocoa farmers within the overall sample, and the higher proportion of respondents who replied that they 'don't know' their cocoa land size or production and were therefore not included in the model.

In Côte d'Ivoire, the strongest predictor of higher productivity was pesticide use, which increases yields by around 105 kg/ha (*highly significant*). While the use of fertiliser and other inputs trends towards higher yields, these were not found to be statistically significant in Côte d'Ivoire. Many reasons could be hypothesised for this, including the volumes of inputs supplied, or their timeliness, frequency of application or quality. Another consideration could be that respondent estimations of land size are less precise than in Ghana, because of the larger unit of hectares, rather than acres, being used. As yield is a function of total production /productive cocoa land (ha), this estimation bias could obscure the variables that drive higher yields.

In Côte d'Ivoire, we also find that households with lower poverty and higher relative wealth have higher productivity. In the first column, this is reflected in the PPI 'likelihood of being under \$1.25/day PPP 2005'. Households that are more likely to be below the poverty line have lower yields (significant at 10% level). In the second column, we include the DHS wealth index and can more clearly see the relationship between wealth and yields. Those in the 2<sup>nd</sup> quintile produce 85 kg/ha more than those in the poorest bottom quintile (*highly significant*), and this same effect is evident in all other quintiles. For more details on the PPI and DHS the reader should refer to the Poverty, Wealth and Income chapter.

Table 10.9 Determinants of yield (regression), Côte d'Ivoire

	1 Cocoa yield (kg/ha)	2 Cocoa yield (kg/ha)
Borrowed money last year: yes	-31.08 (24.16)	-35.29 (25.01)
Household is member of a farmer group: yes	5.16 (28.97)	-2.99 (29.97)
Leader: yes	-23.92 (24.21)	-28.92 (24.93)
Head: Sex: female	52.55 (68.80)	46.64 (74.46)
Head: Education level: Primary school	-34.76 (32.07)	-21.40 (32.33)
Head: Education level: Junior high school (JHS) / middle school	-37.45 (35.48)	-39.16 (36.16)
Head: Education level: Senior high school (SHS) A/O level	-24.19 (48.35)	-28.53 (49.98)
Head: Education level: University	-106.53 (90.04)	-125.46 (105.53)
Head: Education level: Technical college / vocational	-99.48 (130.96)	-122.27 (130.87)
Head: Education level: Other	-40.23 (78.26)	-44.99 (82.67)
Region: Lacs	47.75 (131.28)	25.62 (131.84)
Region: Montagnes	168.48 (134.49)	158.51 (135.13)
Region: Bas-Sassandra	180.06 (133.16)	184.51 (134.73)
Region: Goh-Djiboua	164.42 (133.88)	141.94 (134.70)
Region: Zanzan	22.94 (140.98)	-4.83 (141.36)
Region: Sassandra-Marahoue	171.72 (130.53)	166.14 (131.42)
Region: Comoe	198.88 (134.08)	201.54 (134.62)
Region: Lagunes	180.15 (133.26)	181.11 (133.89)
Age group (head): 26-35	45.01 (98.45)	3.54 (107.90)
Age group (head): 36-45	99.08 (96.25)	58.03 (105.61)
Age group (head): 46-55	74.49 (96.86)	43.89 (105.99)
Age group (head): 56-65	66.98 (96.99)	27.39 (106.74)
Age group (head): 66-older	69.79 (103.56)	44.02 (112.97)
Migrant: yes	14.05 (33.03)	15.52 (34.42)
Number of household members living in the compound	13.22 (4.75)***	6.06 (3.45)*
Number of crops Produced	7.30 (3.51)**	7.50 (3.59)**
Productive land under cocoa(ha)	-20.41 (15.57)	-18.03 (15.77)
Productive land under cocoa (ha) squared	0.83 (1.35)	0.52 (1.37)
Owned land: yes	-129.73 (134.55)	-132.12 (135.41)
Leased land: yes	22.30 (188.41)	5.09 (189.14)
Abunu: yes	-157.69 (131.99)	-175.27 (132.37)
Granular fertiliser: Yes	48.90 (32.03)	37.67 (33.30)
Liquid fertiliser: Yes	15.20 (40.59)	19.51 (41.65)
Herbicides: Yes	-31.42 (24.57)	-33.47 (25.16)
Pesticides: Yes	105.01 (29.74)***	96.29 (30.60)***
Fungicides: Yes	51.15 (31.95)	45.10 (32.51)
Pruning: Yes	29.53 (23.19)	20.91 (23.76)
Certification: yes	10.93 (45.55)	16.01 (46.75)
Certification: don't know	-62.66 (26.20)**	-73.86 (26.96)***
Received training in the last 5 years: yes	33.74 (35.05)	15.36 (35.92)
Likelihood of being under \$1.25/day PPP 2005	-2.02 (1.05)*	
According to DHS Wealth Index: 2nd quintile		85.18 (37.30)**
According to DHS Wealth Index: 3rd quintile		48.87 (43.32)
According to DHS Wealth Index: 4th quintile		190.32 (44.09)***
According to DHS Wealth Index: 5th quintile		57.13
Constant	186.47 (205.31)	164.51 (208.50)
N	417	397
R2	0.24	0.28

## 10.3 Summary

**Not all farmers know how much cocoa they produce per year.** In Ghana, 95% of male respondents said that they knew how many bags of cocoa they produced last season, compared with 82% of female respondents. In Côte d'Ivoire, 67% of male respondents said they knew how much cocoa they produced, compared with only 21% of female respondents.

**In Ghana, average cocoa yields were estimated to be 423kg/ha in 2015-2016, with a median yield of 369 kg/ha.** The distribution shows that farmers typically yield between 100 and 1,000 kg/ha, with the majority between 100 and 500 kg/ha. This is well below potential yields commonly cited between 1,000 and 1,900 kg/ha.

**In Côte d'Ivoire, average yields were estimated to be 352 kg/ha, with a median of 312 kg/ha.** In terms of distribution, Côte d'Ivoire farmers also typically yielded between 100 and 1,000 kg/ha, with the majority grouping between 100 and 500 kg/ha. Compared with Ghana, the main difference is that there is a slightly higher proportion of farmers with a very low yield of 0-100 kg/ha and a lower proportion of farmers with more than 500 kg/ha.

**In Ghana, a regression analysis shows that several variables are significantly correlated with yield.** Controlling for other variables, we find that farmer group members produce 85 kg/ha more than non-members, female-headed households yield approximately 63 kg/ha less than male-headed households, and Central and Western regions yield more than other regions. Input use was also significantly correlated, with fertiliser use increasing yields by 95 kg/ha, and pesticide use boosting yields by 65 kg/ha. However, herbicide use is negatively correlated with yields. A significant negative correlation was also found between the amount of productive land under cocoa and yield. The model shows that, for every additional hectare under cocoa, yields fall by approximately 71 kg. We also find that Ghanaian households with lower poverty and higher relative wealth have higher productivity.

**In Côte d'Ivoire, a regression analysis shows fewer variables significantly correlate with yield compared with Ghana.** The strongest predictor of higher productivity was the use of pesticides, which increases yields by around 105 kg/ha. While the use of fertiliser and other inputs trends towards higher yields, these were not found to be statistically significant. The fact so few Ivorian cocoa households use fertiliser may have influenced this result. As in Ghana, we find that Ivorian households with lower poverty and higher relative wealth have higher yields.