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Contract farming, contract design and smallholder livelihoods*

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Contract farming has gained in importance in many developing countries. Previous studies analysed effects of contracts on smallholder farmers' welfare, yet mostly without considering that different types of contractual relationships exist. Here, we examine associations between contract farming and farm household income in the oil palm sector of Ghana, explicitly differentiating between two types of contracts, namely simple marketing contracts and more comprehensive resource-providing contracts. Moreover, we look at different income sources to better understand how both contracts are linked to farmers' livelihood strategies. We use cross-sectional survey data and regression models. Issues of endogeneity are addressed through measuring farmers' willingness-to-participate in contracts and using this indicator as an additional covariate. Farmers with both types of contracts have significantly higher household incomes than farmers without a contract, yet with notable differences in terms of the income sources. Farmers with a marketing contract allocate more household labour to off-farm activities and thus have higher off-farm income. In contrast, farmers with a resource-providing contract have larger oil palm plantations and thus higher farm incomes. The findings suggest that the two contract types are associated with different livelihood strategies and that disaggregated analysis of different income sources is important to better understand possible underlying mechanisms.

Key words: contract farming, credit schemes, Ghana, household income, off-farm income, oil palm.

JEL classifications: I31, O12, O13, Q12, Q13

1. Introduction

Contract farming has gained in importance in the small farm sector of developing countries (Minot & Sawyer, 2016; Reardon et al., 2009). The effects of contract farming on smallholder welfare have long been under

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investigation (Barrett et al., 2012; Meemken & Bellemare, 2020; Ton et al., 2018). Various studies examined effects of contract farming on revenues and profits of the contracted crop (e.g. Bidzakin et al., 2019; Kumar et al., 2019; Mishra et al., 2018). Other studies analysed effects of contracts on farm income (e.g. Champika & Abeywickrama, 2014; Islam et al., 2019) or total household income (e.g. Andersson et al., 2015; Ongutu et al., 2020; Rao & Qaim, 2011).

Although the majority of the existing studies report positive welfare effects of contract farming, results are heterogeneous and, in several cases, insignificant or negative (Hernández et al., 2007; Meemken & Bellemare, 2020; Mwambi et al., 2016; Narayanan, 2014; Ragasa et al., 2018; Wang et al., 2014).¹ This is probably also due to the fact that very different types of contractual relationships were analysed in very different crops and geographical contexts (Bellemare & Bloem, 2018; Khan et al., 2019; Otsuka et al., 2016; Ton et al., 2018). Most studies evaluated the effects of one type of contract in a specific situation, neglecting that a different type of contract in the same situation might possibly have different effects. Moreover, little is known about the pathways through which contract farming affects household incomes. We argue that the income effects, as well as the effect pathways, can differ by contract type. Evidence of differential effects might help to better understand what types of contracts contribute most effectively to smallholder livelihood improvements and broader rural development.

Here, we analyse the associations between contract farming and household income in the Ghanaian oil palm sector, explicitly comparing two different types of contracts. The first contract is a simple marketing contract, which specifies only output conditions, such as price, quantity and timing of sales. The second contract additionally offers input provision for plantation establishment and maintenance through an in-kind credit scheme. For the remainder of this study, we refer to this second contract as a 'resource-providing contract'.

We are aware of three previous studies that evaluated and compared welfare effects of different contract types, namely Arouna et al. (2021) for rice in Benin, Ashraf et al. (2009) for horticultural crops in Kenya and Mishra et al. (2016) for rice seed in Nepal. All three studies find only minor differences between the different contract types.² However, rice and

¹ Wang et al. (2014) found that 75% of the studies analyzing income effects of contract farming report positive and statistically significant results.

² Arouna et al. (2021) examine three different types of contracts: a marketing contract with a fixed price, a production management contract with extension training and a resource-providing contract. Ashraf et al. (2009) examine a contract that is linked to the credit scheme of a bank and a contract that only arranges the sale of the produce. Mishra et al. (2016) examine three different types of contracts: a contract with output conditions specified, a contract with input conditions specified and a contract with both output and input conditions specified.

horticultural crops are annual crops that require much lower investments than a plantation crop such as oil palm. To the best of our knowledge, no previous study has analysed and compared income and livelihood implications of marketing contracts and resource-providing contracts in a more capital-intensive crop sector, where the differences may potentially be larger. Oil palm is an interesting example of a capital-intensive crop, as it has recently gained in importance among smallholders in different parts of the world (Qaim *et al.*, 2020).

Related to oil palm in Ghana, another recent study showed that farmers with a simple marketing contract have the same input intensity and productivity as farmers without a contract, whereas resource-providing contracts are associated with larger input investments and higher yields (Ruml & Qaim, 2020). These findings suggest that contract type matters in a capital-intensive sector. Associations between the two contract types and household income were not analysed and require investigation to understand welfare implications, as yield and revenue gains may possibly be overturned by production cost increases (Ragasa *et al.*, 2018). Moreover, oil palm production is only one source of income for the contracted smallholders in Ghana, so possible differences in other household income sources need to be analysed as well.

We analyse how marketing and resource-providing contracts in oil palm farming are linked to total household income and different income sources to identify possible spillovers of each contract on the households' other economic activities. Bellemare (2018) used data for more than 12 cash and food crops in Madagascar, showing that farmers under contract had higher income from the contracted crop but lower income from other sources, because producing the crop under contract required more labour and thus reduced farmers' participation in off-farm activities. We analyse such spillovers in a context in which contract farming leads to substantial reductions in agricultural labour requirements, as on-farm post-harvest handling is no longer required (Ruml & Qaim, 2021). Thus, depending on individual opportunities, which seem to differ by contract type, other income sources may gain in importance. We know of no study that compares differences in spillovers of different types of contracts.

We contribute to the existing literature in two ways: (1) by estimating and comparing the associations between marketing and resource-providing contracts and household income in a capital-intensive crop sector, and (2) by differentiating between incomes from the contracted crop and the households' other income sources. We use cross-sectional survey data and include a willingness-to-participate measure as an additional covariate in the regression models to deal with possible issues of endogeneity. Both contracts are offered by different companies. Thus, we investigate and compare two contract farming schemes, which are bundles of contract and company characteristics, in the same local setting.

We find that both contract schemes are associated with higher household incomes, but with different livelihood strategies. The marketing contract scheme is associated with lower incomes from agricultural production, yet with higher incomes from off-farm activities, whereas the resource-providing contract scheme is associated with higher farm incomes. The differences can be explained by factors related to the contractual design.

The rest of this article is structured as follows: Section 2 describes relevant market failures in Ghana's oil palm sector and how these are addressed by the two types of contracts. Section 3 describes the data collection and the statistical methods used for the analysis. Section 4 presents the empirical results, while Section 5 concludes.

2. Market failures and how these are addressed by the contracts

In Ghana, oil palm is a traditional crop that was – until recently – mainly produced for home consumption and sales in local markets. Traditionally, farmers either sell the oil palm fruits to small artisanal processing mills or they manually process the oil palm fruits into palm oil for direct sales to local traders and consumers. With rising national and international demand for vegetable oil, oil palm cultivation gained in importance in Ghana and other West African countries (Byerlee et al., 2017). Several large national and international palm oil processing companies have entered the Ghanaian market.³ These companies typically have own plantations (nucleus estates) and additionally procure supply from farmers through contractual agreements (Huddleston & Tonts, 2007; Ministry of Food & Agriculture, 2011).

Despite the rising economic importance of oil palm, Ghana remains a net importer of palm oil. While the agroecological conditions are favourable for oil palm production (Rhebergen et al., 2016), institutional constraints pose challenges for small-scale producers. As in most agricultural markets in developing countries, Ghanaian oil palm producers face several forms of market failures. On the output side, a lack of large buyers and low market coordination result in high market risk and uncertainty about future sales and fluctuating market prices. Until now, the national supply of oil palm fruit bunches exceeds processing capacity in peak seasons, which leads to a strong seasonal decline in prices and a temporary inability of farmers to sell their harvested produce. Hence, the modern marketing channels established by the contracting companies, which guarantee farmers regular sales at stable annual prices, improve the situation by reducing market risk. A contract that specifies output conditions, such as timing and price of the sales, is called a marketing contract. In this study, we investigate a marketing contract that is offered by Benso Oil Palm Plantation (BOPP), a subsidiary of Wilmar International. The contract is a verbal agreement between the processing

³ At the time of our survey in 2018, five companies had oil palm plantations and contract schemes in the Southern parts of Ghana.

company and farmers, specifying the quantity and time schedule of oil palm fruit bunches to be supplied and an annually fixed price.

In addition to market risk, smallholders often produce under land, labour and capital constraints (Grosh, 1994). In the South of Ghana, where our study is located, land constraints are not severe, as most of the households have more land available than they can cultivate due to labour and capital constraints (Ruml & Qaim, 2020). Producing oil palm in the artisanal supply chain is labour-intensive. Post-harvest handling (picking of the fruits, manual palm oil processing) is required to sell to artisanal processing mills or local consumers. The contracting companies purchase the produce in the form of whole fruit bunches, which leads to substantial labour savings and thus relaxes the households' labour constraints (Ruml & Qaim, 2021). However, smallholders lack access to the capital required for the establishment of new oil palm plantations, including investments in high-quality planting material, labour, fertiliser and other types of inputs (Ministry of Food & Agriculture, 2011). Credit market offers a potential solution to this capital constraint; however, both supply and demand for formal credit are low in rural Ghana considering the risk associated with agricultural production, as well as lack of collateral, high interest rates and high default rates as experienced in previous credit programmes (Ragasa *et al.*, 2018). Access to credit and actual loan applications are very low in the study area. Another potential solution to capital constraints and credit market failures is linking input, credit and output markets through contract farming (Deb & Suri, 2013; Ragasa *et al.*, 2018). Resource-providing contracts are designed to offer such credits for the establishment and maintenance of new oil palm plantations, in addition to the output conditions. Such credit options do not exist under simple marketing contracts.

In this study, we investigate a resource-providing contract that is offered by the Twifo Oil Palm Plantation (TOPP), which is owned by Unilever. On the output side, regular pick-ups and an annual fixed price are specified. On the input side, the company offers in-kind credits for plantation establishment, including technical support, equipment and inputs (e.g. seedlings, agrochemicals). In addition to the initial credit, farmers with a resource-providing contract can obtain regular production inputs on credit throughout the entire contract duration.⁴

In summary, participation in a simple marketing contract scheme can resolve market risk for farmers. In this specific context of oil palm farming in Ghana, the marketing contract scheme further reduces households' labour constraints, as post-harvest handling is not required. However, credit constraints persist in the simple marketing contract scheme, and these credit constraints limit the households' ability to expand their agricultural production (Ruml & Qaim, 2020). Credit constraints are addressed through

⁴ Additional details on both contract farming schemes are provided in the online appendix part B.

resource-providing contracts, which offer the provision of agricultural inputs, in addition to the output conditions.

Based on these differences in terms of how the two types of contracts can or cannot address relevant market failures, we hypothesise that both contracts are associated with higher household incomes, yet through different pathways. In particular, we hypothesise that the marketing contract is associated with higher off-farm income: with limited funds or without access to credit for establishing and maintaining additional oil palm plantations, households reallocate some of the labour saved to off-farm activities. As the resource-providing contract relaxes the credit constraint and allows the establishment of new oil palm plantations, we further hypothesise that the resource-providing contract is associated with higher incomes from agricultural production.

3. Materials and methods

3.1 General approach

Our objective is to analyse how the marketing and resource-providing contract schemes are associated with total household income and with different income sources. We evaluate these associations with regression models of the following type:

$$\text{asinh}(Y_{hj}) = \beta_0 + \beta_1 MC_{hj} + \beta_2 RPC_{hj} + \beta_3 X_{hj} + \mu_j + u_{hj}, \quad (1)$$

where Y_{hj} is the respective income measure (per capita) of farm household h in village j , and MC_{hj} and RPC_{hj} are the two treatment dummies, which equal one, respectively, if the household has a marketing contract (MC) or a resource-providing contract (RPC). MC and RPC represent participation in the contract farming schemes, not whether the contract itself has marketing and resource-providing features. Thus, the two contract variables are mutually exclusive. X_{hj} is a vector of control variables (see below), μ_j are village fixed effects, and u_{hj} is an error term with mean zero. We are particularly interested in the coefficients β_1 and β_2 . If MC is positively associated with income compared with no-contract farmers, β_1 should be positive and significant. If RPC is positively associated with income compared to no-contract farmers, β_2 should be positive and significant. We estimate separate models for total income and for each income source. Income models are often estimated with income expressed in logarithmic terms. However, as individual households may have zero observations for particular income sources,⁵ and the logarithm of zero observations is not defined, we use the inverse hyperbolic sine transformation and then calculate

⁵ While we do not observe zero values for total household income and oil palm income, around half of the sample households have zero off-farm income.

semi-elasticities for β_1 and β_2 , as described by Bellemare and Wichman (2020). Hence, $\text{asinh}(Y_{hj})$ in equation (1) represents the hyperbolic sine transformation of Y_{hj} . The semi-elasticities can be interpreted as the association between contract type and income in percentage terms, compared to the no-contract farmers.

We look at annual income as reported by farmers over the 12-month period prior to the survey.⁶ The different income sources we consider are income from oil palm cultivation, income from other crops, livestock income, and income from off-farm wage and self-employment. Oil palm income is calculated as the total value of production minus all production costs for purchased inputs and transportation. Household labour time is not valued in these calculations, so that the income can be interpreted as the return to the households' own labour. Income from other crops and livestock is calculated in the same way. Income from off-farm wage and self-employment is the sum of all annual salaries/wages received by household members as well as profits from own non-farm businesses.⁷ Total household income is the sum of all the different income sources. We calculate per capita income using the Oxford Equivalent Scale, to account for adult equivalents and potential economies-of-scale within the household (Klasen, 2000).⁸

As control variables X_{hj} , we include socioeconomic characteristics of the farmer (age, sex, experience in oil palm farming) and the household (number of adult and child household members). We further include a variable indicating whether a member of the household holds an official position in the village, which is a measure of personal and economic connectivity. Land availability of the household is included in lagged form, referring to the time period prior to contracting and derived through recall data. At the village level, we control for market distance.

Income data are prone to measurement error, particularly if respondents are asked to recall information for an entire year. To minimise the risk of bias, we dedicated ample time to pre-testing the relevant questions. For the income from oil palm and other crops, we asked the questions separately for each plot.⁹ To capture hired labour costs, we also separated by gender of the labourers and by operation, following the seasonal cycle, in order to properly account for the number of hours worked and the wages paid. Income from off-farm sources was easier to collect, as the number of off-farm jobs and

⁶ The 12-month period also considers seasonal fluctuations in harvested quantities and prices. While farmers with a contract have a price for oil palm fruit bunches that is fixed annually, farmers without a contract face seasonal price fluctuations.

⁷ Typical off-farm wage employment activities in the study region include teaching, mining, construction, security services and work in offices, churches and companies. Own non-farm businesses include small shops and services within the local context.

⁸ The Oxford Equivalent Scale (also called the old OECD Scale) assigns a value of 1 to the first adult in the household and a value of 0.7 to each subsequent adult household member. Each child is valued with 0.5.

⁹ Most farmers in our sample only had one plot. Only 23 percent of the farmers had two or more plots.

businesses is small in most households. While measurement error cannot be ruled out completely, we do not expect any systematic bias between the different groups of contracted and non-contracted farmers.

3.2 Controlling for potential biases

We use cross-sectional observational data, where the identification of causal effects is difficult. This is why we talk about associations between contract farming and household income and not about effects of contract farming in a narrow sense. Nevertheless, we try to control for potential biases as much as possible.¹⁰ In the following, we first describe possible biases and then explain how we deal with them through our sampling framework and other statistical approaches.

3.2.1 Potential biases

For the analysis, farmers with and without contracts should be similar in terms of their general characteristics, with the only difference being their contract status. However, in our study participation in contracting is not randomised; it is based on company and farmer selection, meaning that heterogeneity between farmers with and without contracts is possible. First, the contracting companies may select locations for their contract schemes that are particularly suitable for oil palm production and to minimise logistical costs. The same conditions may possibly not be found in other locations. Second, within the selected locations companies may choose farmers with certain characteristics to whom they offer the contracts. Third, farmers decide whether or not to accept the contract offer based on individual characteristics.

Some of this heterogeneity may be observable, such that it can be controlled for through proper specification of the vector of control variables X_{hj} in equation (1). However, there may also be unobserved heterogeneity between farmers with and without contracts, including differences in individual entrepreneurial skills or spatial attributes (Bellemare, 2012). Hence, some strategy to deal with unobserved heterogeneity is also required.

3.2.2 Sampling framework

Data collection for this study involved a structured interview-based survey of market-oriented oil palm farmers in the southern parts of Ghana, where most of the country's oil palm area is concentrated. Market-oriented in this context simply means that our study population are farmers who cultivate oil palm beyond just having a small number of palms for home consumption. This is

¹⁰ Ton (2012) describes an approach that can help to increase the rigor in impact evaluations, even with restricted budgets and timelines, through mixing quantitative with qualitative research approaches. While we used focus group discussions to guide our research design (see below), more qualitative elements could have been included, which is a possible direction for follow-up work.

the same population of farmers that palm oil companies also consider as relevant for their contract schemes. The survey was carried out between April and July 2018.

We sampled locations and farmers with and without contracts with the intention to minimise possible sources of bias due to heterogeneity. At first, we selected two contracting companies based on their contract types, namely BOPP with a marketing contract scheme and TOPP with a resource-providing contract scheme (see above). Both schemes are in neighbouring regions yet without any overlap in the catchment area, so in each region only one of the contracts exists.¹¹ The marketing contract is offered in the Western Region, whereas the resource-providing contract is offered in the Central Region (Figure A1 in the Appendix S1).

Prior to the structured survey, we conducted a series of focus group discussions with company officials, village chiefs and farmers. The focus groups were held to better understand the contract selection process and to observe differences across regions and villages. In the focus group discussions with company officials, we collected information on the contract procedure, offer and the selection of farmers. Both companies offered the contracts to all farmers in the selected villages willing to accept the contract conditions. This information was confirmed in the subsequent focus group discussions with village officials and farmers. Thus, the selection by companies was made at the village level, not the individual farmer level, which was considered in our sampling strategy.

Within the Western and Central regions, we randomly sampled villages from complete lists of contract villages, and within the contract villages, we randomly sampled farmers from complete lists of contract farmers. These lists were provided by the companies and verified through our own cross-checks on the ground. It should be noted that within the contract villages the large majority of the market-oriented oil palm farmers (>90%) actually hold a contract. Thus, we decided not to sample comparison farmers without contracts in the same villages, as these farmers are likely quite different from those who accepted the contract offer and therefore not a suitable comparison group.

Choosing comparison farmers in other, non-contract villages in the same regions could also lead to issues with observed or unobserved heterogeneity, because the contracting companies decided to not offer the contracts in these other villages based on certain criteria. Our strategy was therefore to select comparison farmers in a third, neighbouring region, namely the Ashanti Region, where no oil palm contract scheme existed at the time of our survey.¹² However, a new contract scheme for oil palm farmers was planned

¹¹ The company's catchment area refers to the location of the farmland. Farmers with their land rights in one area cannot simply move to another area to participate in a particular contract farming scheme, as they would have no access to land there.

¹² The Ashanti Region has an ongoing oil palm contract scheme in the north (Figure A1 in the online appendix), but not in the locations that we selected as comparison area in our study.

in the Ashanti Region by a different company. When we sampled for our survey, the company had already selected the villages for a marketing contract scheme with contracts very similar to those offered by BOPP in the Western Region. The contract villages in the Ashanti Region were identified together with the local Ministry of Food and Agriculture (MoFA), which shared the village list with us. Farmers in these villages were not aware of the upcoming contract scheme when we randomly sampled and interviewed them. All of them sold their harvest in traditional palm oil supply chains, including local traders and artisanal mills. Also in these villages, we only sampled market-oriented oil palm producers, most of whom would likely be contracted soon, in order to have comparison farmers very similar to those with a contract in our sample.

One important question is how similar the three regions are, as regional differences that are correlated with the contract status of farmers could lead to bias in our estimates. For instance, the regions could differ in terms of agroecological suitability, initial welfare levels or off-farm employment opportunities. However, based on the data available the three regions are very similar. All three are bordering each other and had at least one existing contract scheme for oil palm at the time of the survey. Moreover, the selected villages are all located relatively close to the joint regional borders (the largest distance between any two villages in our sample is 140 km). All three regions are very similar in terms of their agroecological and socioeconomic conditions and their suitability for oil palm cultivation (Table A1 in the Appendix S1).

We randomly sampled 9 villages under the marketing contract, 13 villages under the resource-providing contract and 9 comparison villages registered for the upcoming contract farming scheme. Within each of these villages, we randomly selected and interviewed 75% of the market-oriented oil palm farmers. Our total sample includes 463 farm households, of which 193 produced oil palm under the marketing contract, 164 under the resource-providing contract and 106 without any contract at the time of the survey in 2018.

Table A2 in the Appendix S1 shows that the sampled villages in all three regions are similar in terms of population numbers and general infrastructure conditions. To account for remaining unobserved heterogeneity across villages, we include village fixed effects into the regression models. Any unobserved variation across villages due to differences in infrastructure, proximity to the palm oil mills, agroecology, socioeconomic conditions or other factors is captured by these village fixed effects.

3.2.3 Willingness-to-participate measure

We tried to select regions and villages with and without contracts that are similar in terms of observed characteristics and try to control for unobserved regional factors by using village fixed effects. As explained, we also control for observed farm and household characteristics in the regression models.

However, unobserved household characteristics could still lead to bias in the estimates. To reduce such bias, we use willingness-to-participate in contract farming (WTP) as an additional covariate in the regression models. The household's WTP is likely correlated with less observable variables that determine participation in contract schemes, such as individual motivation and entrepreneurial skills. Hence, including WTP in the models can control for unobserved heterogeneity between farmers and households with and without contracts. A very similar approach was also employed in several other recent studies (Bellemare *et al.*, 2021; Bellemare & Novak, 2017; Meemken & Qaim, 2018; Verhofstadt & Maertens, 2014).

The WTP measure was constructed through a set of hypothetical contract offers to farmers with required initial investments. The WTP variable captures the highest initial investment the farmer was willing to make for participating in the hypothetical contract scheme. Further details of how this variable was derived are provided in the Appendix S1 (part C).

4. Results

4.1 Descriptive statistics

Table 1 compares oil palm prices, yields and profits between contract and comparison groups (other farm and household descriptives are shown in Table A3 in the Appendix S1). Farmers in both contract groups receive lower average output prices than non-contract farmers, but the output sold is not exactly the same. While farmers with a contract sell fresh fruit bunches in larger quantities without any post-harvest handling, farmers without a contract can only sell smaller quantities of either the picked fruits or the processed palm oil, both of which requiring substantial extra labour for post-harvest handling. Due to the absence of large buyers in traditional markets, farmers without company contracts have more frequent smaller transactions that also involve higher search costs.

Table 1 also shows that farmers under both contracts can sell a larger share of their oil palm production than farmers without a contract. Farmers without a contract only sell 89% of their harvest on average, compared to contracted farmers who sell 99–100%. This indicates an additional advantage of the contracts, due to the difficulty of finding buyers for larger quantities in traditional supply chains.

In terms of oil palm yield, production costs and income per acre, we find no statistically significant differences between farmers under the marketing contract and farmers without a contract. However, farmers under the resource-providing contract have much higher oil palm yields and profits per acre than the other two groups. Farmers under the resource-providing contract also cultivate significantly larger land areas with oil palm, leading to much larger total oil palm production and profits. This also translates to higher oil palm income at the farm level. These differences are expected, as

Table 1 Descriptive statistics related to oil palm income

	Mean			Significant difference				
	Marketing (MC)	contract	Resource-providing (RPC)	contract	No contract (NC)	MC- RPC	MC- NC	RPC- NC
Price per ton of fruit bunches (in GHS)	336.63 (13.22)		307.09 (24.00)		350.82 (146.62)	***	-	**
Per acre values								
Yield per acre (in tons)	3.13 (1.75)		5.37 (3.33)		2.69 (2.36)	***	-	***
Revenue per acre (in GHS)	1037.04 (590.36)		1248.58 (773.75)		903.02 (1095.20)	-	-	*
Production costs per acre (in GHS)	637.49 (778.38)		509.69 (562.62)		697.46 (1288.63)	-	-	-
Oil palm income per acre (in GHS)	399.55 (826.15)		738.88 (832.71)		205.56 (1416.95)	**	-	***
Farm-level values								
Total area under oil palm (in acres)	4.59 (3.89)		8.02 (7.89)		5.05 (5.40)	***	-	***
Total production quantity (in tons)	13.90 (16.46)		43.08 (68.02)		13.08 (20.06)	***	-	***
Total revenue (in GHS)	4604.69 (5486.47)		10017.24 (15815.94)		4267.88 (9959.23)	***	-	***
Total production costs (in GHS)	2548.50 (3089.15)		3931.67 (7160.85)		3650.16 (10601.21)	**	*	-
Total oil palm profits (in GHS)	2056.20 (4736.86)		6057.57 (11547.49)		617.73 (12102.88)	**	-	**
Total oil palm income (in GHS)	2128.98 (225.14)		6085.57 (1752.89)		2292.26 (778.81)	**	-	*
Total quantity sold (in tons)	13.69 (16.31)		43.08 (68.02)		9.76 (14.80)	***	**	***
Share of quantity sold	0.99 (0.08)		1.00 (—)		0.89 (0.26)	-	***	***

Note: The significant difference tests are based on a Wald test with village-level clustered standard errors. The prices of oil palm fruit bunches are average prices across all sales and weighted by the quantity the household was able to sell at that price. Revenue is the product of the total output sold and the respective sales price. Profits are calculated based on sold quantities. Income is calculated based on the total production value, including the unsold quantities. Credit repayments for the resource-providing contract are deducted. Production costs include the costs of all agrochemical inputs, planting material, hired labour, transportation costs and processing services. All average per acre values were calculated by dividing the total values per farm by the number of acres under oil palm cultivation. Standard deviations in parentheses. GHS = Ghanaian Cedis. The exchange rate at the time of the survey was approximately 0.22 GHS = 1 US\$. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

farmers with a resource-providing contract have access to credits for oil palm-related investments.

Table 2 provides descriptive statistics on per capita income from oil palm and other income sources (also see Table A4 in the Appendix S1), as well as the share of farmers involved in other crop and livestock production, and off-farm employment. We find no statistically significant differences between no-contract households and those with a resource-providing contract. However, a significantly lower share of households with a marketing contract cultivates other cash crops and livestock, compared to no-contract producers. The per capita income values referring to the entire farm and household are used as dependent variables in the regression analysis. While large differences can be observed between the contract and comparison groups, most of these differences are not statistically significant in these simple comparisons, probably due to the large standard deviations observed for all variables.

4.2 Regression results

Table 3 presents the regression results of the associations between contract participation and per capita income after controlling for confounding factors. For the interpretation of the results, we focus on the semi-elasticities shown in the lower part of Table 3. Various significant associations can be observed.

We start by discussing the results for the marketing contract. Compared to farmers without a contract, producing with a marketing contract is associated with a 33% higher oil palm income, on average. This is not due to higher oil palm yields, but to the ability to sell larger quantities at lower costs and stable output prices. At the same time, the marketing contract is associated with a 47% lower income from other crops compared to no-contract farmers. Together, we find a statistically insignificant association between the marketing contract and total farm income. Yet, the marketing contract is associated with a 54% higher income from off-farm wage and self-employment compared to no-contract farmers. Overall, the marketing contract is associated with a 70% higher total per capita household income compared to no-contract farmers, after controlling for other factors. These results suggest that the marketing contract is associated with sizeable welfare gains, which are partly channelled through higher oil palm incomes but also through a reallocation of the labour time saved in oil palm to off-farm activities. These findings support our hypothesis in terms of the marketing contract's livelihood implications.

We now discuss the results for the resource-providing contract, which are also shown in Table 3. Compared to farmers without a contract, producing with a resource-providing contract is associated with a 161% higher oil palm income, which is substantially larger than for the marketing contract. Further, the resource-providing contract relates to a 31% lower income from livestock compared to no-contract farmers, implying some degree of on-farm specialisation. Total farm income is 110% higher with a resource-providing

Table 2 Descriptive statistics on per capita income, by income source

	Mean			Significant difference			
	Marketing contract (MC)	Resource-providing contract (RPC)	No (NC)	No contract	MC- RPC	MC- NC	RPC- NC
Household shares							
Income from other crops	0.82 (0.04)	0.85 (0.04)	0.91 (0.03)	-	*	-	-
Livestock income	0.13 (0.03)	0.16 (0.04)	0.21 (0.04)	-	**	-	-
Income from off-farm wage and self-employment	0.49 (0.05)	0.46 (0.05)	0.48 (0.05)	-	-	-	-
Household incomes							
Oil palm income (in GHS)	843.04 (2028.82)	2196.28 (5635.14)	920.46 (4736.96)	-	-	-	-
Income from other crops (in GHS)	1595.00 (3115.78)	1773.11 (3556.68)	1891.46 (8863.18)	-	-	-	-
Livestock income (in GHS)	28.93 (166.91)	44.79 (208.74)	43.38 (146.17)	-	-	-	-
Income from off-farm wage and self-employment (in GHS)	623.08 (1150.66)	638.75 (2165.27)	1019.39 (3602.58)	-	-	-	-
Total household income (in GHS)	3035.89 (4331.72)	4657.72 (8306.80)	3500.91 (9478.49)	*	-	-	-

Note: The significant difference tests are based on a Wald test with village-level clustered standard errors. GHS = Ghanaian Cedis. The exchange rate at the time of the survey was approximately 0.22 GHS = 1 US\$. Standard deviations in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3 Associations between contracts and per capita income (regression results)

	Oil income	palm crops	Income other	Livestock Income	Total income	farm	Income self-employment	off-farm wage	and Total household income
Marketing contract (dummy)	0.81*** (0.29)	-1.12*** (0.29)	0.20 (0.15)	0.51 (0.34)	0.71** (0.27)				1.68*** (0.24)
Resource-providing contract (dummy)	4.55*** (0.57)	0.55 (0.34)	-0.87*** (0.21)	3.09*** (0.48)	-2.75*** (0.39)				3.79*** (0.46)
Willingness-to-participate	0.14 (0.20)	-0.05 (0.07)	0.06 (0.06)	0.03 (0.15)	0.01 (0.09)				0.04 (0.13)
Age of household head (in years)	-0.01 (0.03)	0.01 (0.02)	-0.00 (0.01)	-0.01 (0.03)	-0.06* (0.01)				-0.04 (0.03)
Experience of household head (in years)	-0.03 (0.03)	0.00 (0.02)	0.01 (0.01)	-0.01 (0.02)	-0.01 (0.01)				-0.03 (0.03)
Female household head (dummy)	-0.93 (0.67)	-1.55*** (0.40)	0.27 (0.20)	-1.15* (0.61)	-0.07 (0.49)				-1.27* (0.63)
Number of adult household members	0.16 (0.26)	-0.08 (0.17)	0.06 (0.10)	0.02 (0.22)	0.28* (0.16)				-0.02 (0.21)
Number of children	-0.16 (0.16)	-0.29** (0.11)	0.07 (0.05)	-0.10 (0.17)	-0.18 (0.11)				-0.15 (0.18)
Official position (dummy)	-0.17 (0.40)	-0.18 (0.47)	0.67** (0.31)	-0.40 (0.57)	0.52 (0.50)				0.37 (0.33)
Land availability 2008 (in acres)	0.05 (0.04)	0.13*** (0.02)	0.03* (0.02)	0.07** (0.03)	-0.05* (0.03)				0.01 (0.04)
Land availability squared	-0.00 (0.00)	-0.00*** (0.00)	0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)				0.00 (0.00)
Market distance (in km)	-0.30*** (0.05)	0.19*** (0.02)	-0.04** (0.02)	-0.36*** (0.04)	0.08*** (0.02)				-0.17*** (0.03)
Constant	2.88 (1.89)	5.18*** (0.93)	-0.73 (0.67)	5.31*** (1.36)	6.51*** (1.09)				7.57*** (1.32)
Semi-elasticities									
Marketing contract	0.33*** (0.12)	-0.47*** (0.12)	0.08 (0.06)	0.21 (0.14)	0.54** (0.25)				0.70*** (0.10)
Resource-providing contract	1.61*** (0.20)	0.20 (0.12)	-0.31*** (0.08)	1.10*** (0.17)	-0.21 (0.19)				1.34*** (0.16)
Village-fixed effects	Yes	Yes	Yes	Yes	Yes				Yes
Observations	463	463	463	463	463				463

Note: Results are based on per capita income. Cluster corrected standard errors at the village level in parentheses. Results with total income (instead of per capita income) as dependent variables are presented in Table A5 in the Appendix S1, supporting the same conclusions. Alternative results using wild bootstrapped standard errors without village fixed effects are presented in Table A6 in the Appendix S1.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

contract compared to no-contract farmers, whereas the income from off-farm wage and self-employment seems unaffected. Overall, the resource-providing contract is associated with a total per capita household income gain of 134%. These results support our hypothesis for the effects of the resource-providing contract.

Our results show that both contract schemes are associated with substantially higher household incomes. Yet, the magnitudes of the estimates differ: the total income differences associated with the resource-providing contract are much larger than those associated with the marketing contract. Quite notable are also the differences in terms of the various household income sources, which are due to dissimilar labour allocation and capital investment mechanisms. The reduction in market risk alone, as achieved by the marketing contract, is not associated with higher total farm incomes. While both contracts are associated with lower labour requirements per acre of oil palm and thus relax household labour constraints,¹³ credit constraints likely persist under the marketing contract, which can explain the observed differences in terms of how the family labour is allocated. Farmers with a marketing contract allocate more labour time to off-farm activities, so their earnings from off-farm wage and self-employment are higher. While these farmers also have higher oil palm incomes (largely because of lower labour requirements per acre), they often lack the capital to expand their oil palm business through the establishment of new plantations. In contrast, the resource-providing contract relaxes the households' credit constraints, thus enabling more intensive oil palm production on an expanded area, which explains the much higher farm incomes.

5. Conclusion

In this article, we have examined the associations between contract farming and the livelihoods of oil palm producers in Ghana. In doing so, we have added to the existing literature in two ways. First, we have compared two different types of contracts, namely marketing contracts and resource-providing contracts, which can help to better understand the links between contract design and smallholder welfare. To the best of our knowledge, this is the first study that compares different types of contracts and their relationship with household welfare for a capital-intensive plantation crop in a developing country. Second, instead of only looking at the income derived from the contracted crop or at total household income, we have also analysed associations between contracting and other income sources, which helps to better understand indirect mechanisms and broader implications for household livelihoods.

¹³ This is different from Bellemare (2018), who finds that contracted smallholders rather turn away from off-farm activities due to higher labor use for the contracted crop. Obviously, the labour use and reallocation effects of contract farming depend on the particular context.

The results suggest that marketing contracts and resource-providing contracts are both associated with higher total household income. Thus, participation in modern oil palm marketing channels, which are always connected to company contracts in Ghana, seems to be beneficial for smallholder farmers. However, the type of contract appears to influence the magnitude of the income differences and the underlying mechanisms. This suggests that contract characteristics matter and should not be ignored when designing contract farming policies and estimating livelihood effects. Follow-up research on the implications of different types of contracts in different situations will be useful to provide the knowledge required for the development of suitable contract designs. Moreover, additional research with experimental set-ups is required to verify the results and draw causal conclusions about the associations identified in this article.

Our findings further suggest that the associations between contract farming and total household income and different income sources depend on the type of contract used. This has important policy implications, as the choice of the best contract in a particular situation depends on the concrete policy objective. If the main policy objective is to help farmers overcome their constraints in accessing credit, inputs and technologies, and thus increase their farm incomes, resource-providing contracts may be better suited than marketing contracts. Simple marketing contracts alone are not sufficient to overcome smallholders' credit, input and technology constraints. However, if the main policy objective is to improve the well-being of smallholders – not necessarily only through farm income but through total household income gains, including from off-farm activities – marketing contracts may also serve the purpose, as our results from the oil palm sector in Ghana tentatively suggest. This finding is particularly relevant for urbanising areas, where off-farm employment opportunities are available and labour scarcity in farming is increasingly becoming a challenge.

The two contract schemes analysed here effectively address relevant market failures to varying extents. Of course, it is important to mention that high market risks and credit constraints cannot only be addressed through contract farming but also through other institutional mechanisms, possibly leading to similar results. For example, regular sales at more reliable prices could also be achieved through farmer cooperatives. Cooperatives and innovative finance schemes tailored to the needs of small-scale producers could also help to improve farmers' access to inputs, technology and credit. As such, contract farming is one possible but not the only mechanism to address typical market failures in the small farm sector. However, contract farming is a useful mechanism to increase coordination to reduce risk and transaction costs for both buyers and sellers, and can address capital constraints, loan defaults and other credit market failures by linking input, credit and output markets.

One aspect that should be stressed to avoid misinterpretation of our empirical results is that in our study the marketing contract and the resource-

providing contract are offered by different companies. Hence, we are not able to fully disentangle differences in contract features from possible differences in company characteristics. Against this background, our results should be interpreted as implications of contract schemes, consisting of the bundle of contract features and company characteristics, not as effects of different contract features under otherwise identical conditions. Disentangling contract and company characteristics would require alternative sampling strategies, either with one single company offering different contracts (which is hardly found in the real world but could be done in an experiment) or with a much larger number of companies included. These might be interesting directions for future research.

Of course, the concrete estimates from the oil palm sector in Ghana cannot be generalised, as the outcomes depend on the type of crop, the type of market failures, and the agricultural and non-agricultural employment opportunities in a particular context. However, the general finding that the type of contract scheme can matter substantially for the livelihood implications and the underlying mechanisms is certainly valid beyond the case of oil palm in Ghana, given similar sectoral characteristics.

Conflict of interest

None.

Data availability statement

Data and code will be made available through <https://doi.org/10.17632/cbm6xfvxwd.1> upon publication.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table A1. Regional characteristics.
 Table A2. Descriptive statistics for sample villages.
 Table A3. Descriptive statistics of household characteristics
 Table A4. Additional descriptive statistics on per capita income, by income source.
 Table A5. Associations between contracts and total incomes
 Table A6. Associations between contracts and per capita income using wild bootstrapped standard errors
 Figure A1. Study area with contract and comparison regions