



Research Article

Contract Farming in Low and Lower-Middle-Income Countries: Using Meta-Analysis and Factor Analysis

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Abstract

Purpose: Smallholder farmers' agriculture in developing countries particularly in low and lower-middle-income countries is known for poor production and productivity levels which has been related to the inadequate use of improved agricultural inputs and marketing systems, and in this case, contract farming. Therefore, this study aimed to investigate the various factors which affect contract farming among smallholder farmers in developing countries. However, trying to investigate those contract farming determinants by a single analytical method leads it to have limited findings, narrowed generalizability and difficulty in investigating major determinants that determine contract farming success. Therefore, a joint approach using factor analysis and meta-analysis can give a more comprehensive understanding of contract farming factors. **Methodology:** The data was gathered through a Systematic Literature Review, finding a total of 3007 studies from SCOPUS, PubMed, PubAg, and EMBASE. The PRISMA method was applied to, and finally, 35 peer-reviewed articles in English between January 1990 to September 2023 were selected. **Findings:** The meta-analysis showed interesting insights into factors influencing contract farming participation. Education and household size exhibited a negative association, suggesting that farmers with higher education levels and larger families may be less likely to participate in contract farming arrangements. This could be due to a preference for independent decision-making or the need for family labor in alternative income-generating activities. On the other hand, farmers with larger landholdings are more inclined to participate. To encourage broader participation, policymakers, and program designers could consider targeted outreach and support services for these specific demographics. **Originality and value:** Our new approach, joining meta-analysis and factor analysis, sheds innovative light on contract farming determinants. While the expected determinants like farm and household size, along with education, remained significant, our analysis showed unexpected nuances. Age of the household head emerged as potentially favoring younger, less experienced farmers. Moreover, access to extension services played an important role, while large household size might have a more complex influence depending on age composition. This comprehensive approach offers valuable insights for targeted outreach programs and collaboration with extension services to optimize contract farming adoption and success in developing countries.

Keywords

Contract Farming Participation, Factor Analysis, Low and Lower-middle-income Countries, Meta-regression Analysis, Smallholder Farmers

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1. Introduction

With increasing concerns about fighting hunger and promoting rural development in developing countries, policy-makers need strong evidence to develop effective programs helping contract farming. Doing meta-regression analysis allows for a more comprehensive understanding of the factors influencing smallholder farmers' contract farming participation across various contexts within low and lower-middle-income countries. Contract farming is defined as a way of organizing agricultural production whereby farmers are obliged to supply their produce to agro-enterprises following conditions specified in written or oral agreements [1]. It is a commercial relationship between a firm and a group of farmers [2]. Contract farming mutually benefits smallholders and agribusiness firms by significantly reducing imperfections in the spot market and costs arising from uncertainty over quantity and prices [3]. Thus, both parties are expected to gain from each other [1].

Investigating the major drivers of smallholder farmers' contract farming participation benefits a wide range of stakeholders which empowers farmers, informs policy interventions, promotes sustainable models, and contributes to valuable academic research, ultimately leading to improved livelihoods and rural development in developing countries as a whole, and Ethiopia in particular. Previous researchers have concentrated on using a single econometric model to assess the relationship between smallholder farmers' contract farming participation decisions and its major drivers in developing countries [9, 12, 16]. Those individual findings may not apply to other contexts or farmer groups due to the specific focus and they have a controversial finding regarding the type of explanatory variables and their effect on contract farming technology. Ironically, this is just as true for the empirical economic literature [4]. Individual researchers' perspectives and methodologies can influence findings, potentially limiting objectivity. Contract farming activities can vary significantly depending on the level of price, crop, company involved, and local conditions. This meta-regression analysis helps to identify which factors are the most important drivers in diverse scenarios within developing countries, leading to more targeted interventions.

To harmonize this dissonance, we used a quantitative methodology for reviewing the empirical economic literature, meta-regression analysis which is the regression analysis of regression analyses [4]. While several studies analyze factors affecting contract farming participation in various study areas, a meta-regression analysis can offer unique insights by revealing generalizable patterns across contexts. Furthermore, it estimated the combined effect size across studies, providing a clearer picture of the average effect of determinant variables on contract farming adoption, and it provides robust evidence for policymakers and development agencies to design or refine interventions promoting contract farming effectively and to leverage identified factors for promoting mutually beneficial

contract farming arrangements. Not only this but also, combining all findings from different locations is necessary to gain a common understanding.

However, doing a research on contract farming determinants by a single analytical method such as meta regression analysis leads it to have limited findings, narrowed generalizability and difficulty in investigating major determinants that determine contract farming success. A joint approach using factor analysis and meta-analysis can give a more comprehensive understanding of contract farming factors. Factor analysis can find underlying dimensions affecting these factors, such as financial benefits, technical support, and trust worthy. Meta regression-analysis can then develop findings across several studies, revealing robust and consistent effects of factors like access to credit, household and farming characteristics.

2. Materials and Methods

2.1. Structure of the Article

The study is organized into the following sections. Section one contains the overall introduction and problem justification of contract farming. Section two deals with methodology which includes study protocol, data management, article selection, and data analysis methods. Section four is a place for the results and discussion of the study.

2.2. Methodology

2.2.1. Study Protocol

This joint review analysis aimed to synthesize existing research on the determinants of farmers' contract farming participation decisions. We included studies that explore factors of contract farming in the crop sub-sector and contract farming itself. By incorporating these perspectives, we hope to gain a more comprehensive understanding of how various variables influence farmers' contract farming participation decisions in the crop sub-sector. Articles that address the objective of this study were identified based on the inclusion and exclusion criteria. Therefore, studies related to contract farming adoption and its determinants were well identified in this study. The data inclusion (selection) criteria were language: English, subject area: articles, country/territory: Ethiopia, Contract farming: focus on crop sub-sector, studies considering contract farming technology, and cross-sectional studies. The data was gathered through a Systematic Literature Review, finding a total of 3007 studies from SCOPUS (n=298), PubMed (n=1091), PubAg (n=738), and EMBASE (n=561), and records identified from other sources (n=319): Google scholar (n=300), Website searching (n=19). The PRISMA method was applied to, and

finally, 35 peer-reviewed articles in English between January 1990 to September 2023 were selected (Figure 1).

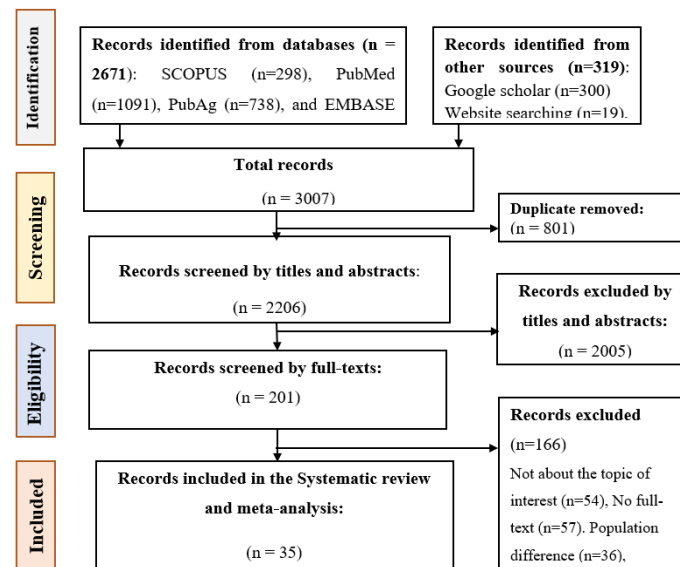


Figure 1. Flow diagram of study selection for this systematic review and meta-analysis, 2024.

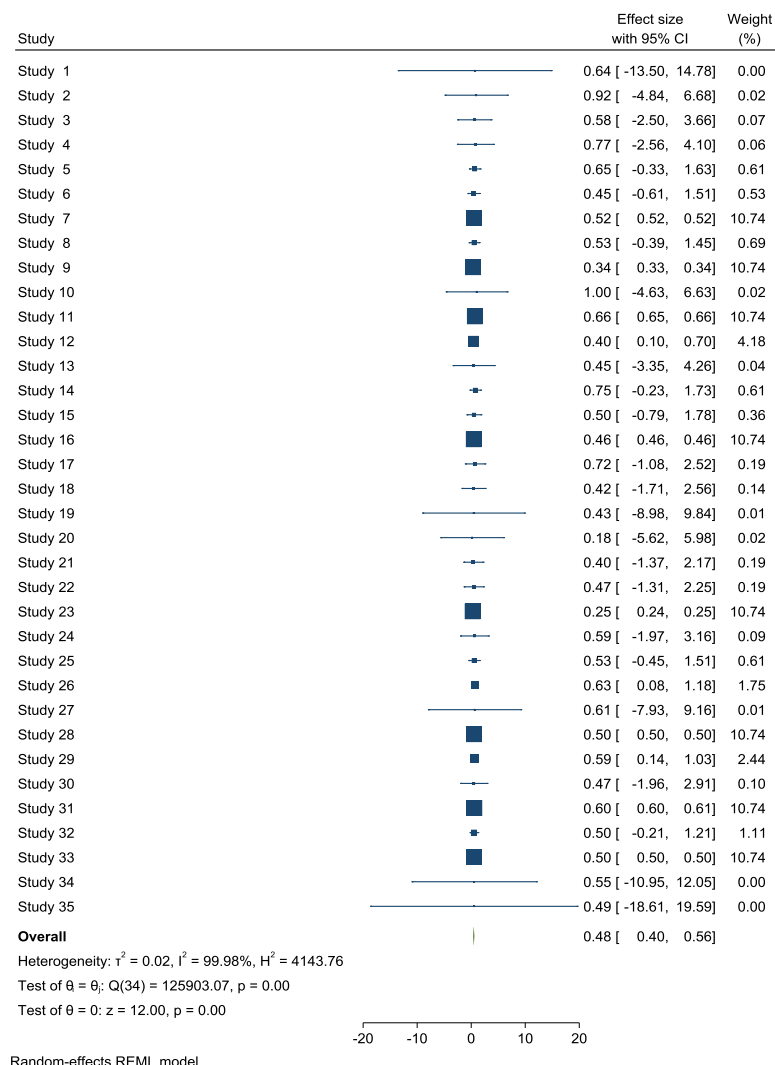


Figure 2. Graphic asymmetry test of the funnel plot.

2.2.2. Types of Articles to Be Included

It is done through an electronic web-based search strategy using PubMed, PubAg, EMBASE, Web of Science, and Scopus with a combination of search terms and others such as Google Scholar and website searching. All statistical analyses are analyzed by using Stata version 17 software. The odds ratios of risk factors are pooled using a random-effect meta-analysis model. I-square was used for heterogeneity measure in this study [5]. Furthermore, publication bias was checked based on the graphic asymmetry test of the funnel plot and/or Egger's test ($p < 0.05$). A funnel plot was also done to check publication bias (Figure 2).

2.2.3. Data Extraction Process

Data were extracted from study documents, including information about study design and methodology, participant demographics and baseline characteristics, and numbers of events or measures of effect. Data extraction were centralized contract farming, in which one central buyer enters into agreements with several farmers. The means of recording data was an Excel spreadsheet or Stata version 17 software data editor; these was reported on which one we use after the information is consolidated.

2.2.4. Meta-regression and Statistical Analysis

Meta-regression

To investigate and analyze the major explanatory variables of contract farming adoption in the low and lower-middle-income countries context this study did a meta-analysis. In doing so, the study developed an econometrics equation for integrating the empirical findings across various studies: $P_i = B_0 + \sum B_j x_i + u_i, j = 1, 2, 3, \dots, N$, where P_i refers to the reported estimate of contract farming participation in the study J from a total of N studies and X_i refers to i

explanatory variables of meta-independent variables which measure relevant characteristics of an empirical study that might explain effect variations in across studies in the meta sample.

2.2.5. Statistical Analysis

Excel and STATA software version 17 was used for the data analysis. Meta-regression analysis suggested by [4] was applied to explore and assess the variations in the results across the sample studies concerning the effect of various explanatory variables for contract farming technology adoption by smallholder farmers in low and lower-middle-income countries. Both qualitative and quantitative data were included. The outcome variable in this study was the adoption probability of contract farming technology. Meta-regression extends the random effects meta-analysis model by considering one or more study-level characteristics (covariates) and determines how much heterogeneity can be explained by considering both within and between-study variance [6]. Stata/SE's "metareg" function provides a tool for conducting this analysis [6]. A random-effects model was used when heterogeneity was observed.

3. Results and Discussion

3.1. Article Selection Procedure

The research review used both exclusion and inclusion criteria to select articles for the meta-regression analysis. The study's focus was on factors/determinants of contract farming technology adoption/contract farming participation in the crop sub-sector economy, which was considered for this review. Finally, the following 35 studies were included in this meta-regression analysis (Table 1).

Table 1. Articles used in meta-analysis.

| Authors | Publication | Study area | Model | Significant variables (S/T) | Product Type |
|-----------------------|-------------|------------|----------------|-----------------------------|--------------|
| H. A. Ba et al [7] | 2019 | Vietnam | Multino. logit | 8/12 | Rice |
| Ibrahim [8] | 2019 | Nigeria | DHM | 7/13 | Tomato |
| Kumar [1] | 2017 | India | Logistic | 6/10 | GC |
| Muroiwa et al [9] | 2021 | Zimbabwe | Logistic | 9/13 | Tobacco |
| Koshuma et al [10] | 2020 | Tanzania | Logistic | 4/8 | Sugarcane |
| Dubbert [11] | 2020 | Ghana | ESR | 5/21 | Nut |
| B. Nazifi et al. [12] | 2020 | Nigeria | DHM | 6/11 | Maize |
| Paul Maganga [13] | 2021 | Tanzania | TEM | 10/15 | Cotton |
| G. Johnny et al [14] | 2020 | Kenya | Probit | 8/18 | FFG |
| P. Musara et al [15] | 2005 | Zimbabwe | Logistic | 6/7 | Cotton |

| Authors | Publication | Study area | Model | Significant variables (S/T) | Product Type |
|-----------------------|-------------|-------------|----------|-----------------------------|--------------|
| Rondhi et al [16] | 2023 | Indonesia | Logistic | 12/14 | Sugarcane |
| Kanburi et al [17] | 2022 | Ghana | ESR | 5/13 | Rice |
| Agana et al [18] | 2011 | Ghana | Logistic | 5/13 | Maize |
| Ichaou Mounirou [19] | 2019 | Ghana | Logistic | 6/8 | Rice |
| Addisu et al [20] | 2016 | Ethiopia | Probit | 7/11 | Barely |
| Anh Tru [21] | 2019 | Vietnam | Logistic | 6/7 | Tea |
| P. Loquias et al [22] | 2018 | Philippines | Probit | 4/12 | FFG |
| Mounirou et al [19] | 2015 | Benin | ESR | 8/13 | Rice |
| Saroj et al [23] | 2020 | India | ESR | 7/12 | Wheat |
| Ashok K. et al [3] | 2019 | India | ESR | 6/13 | Onion |
| Kanburi et al [24] | 2018 | Ghana | ESR | 3/10 | Rice |
| A. Kumara et al [25] | 2019 | Nepal | Logistic | 2/13 | Rice |
| Nalini et al [26] | 2018 | Malaysia | Logistic | 9/11 | FFG |
| Erick et al [27] | 2021 | Malaysia | ESR | 3/15 | Beans |
| Hoang et al [28] | 2020 | Vietnam | Probit | 5/19 | FD |
| Brigitte et al [29] | 2023 | Ghana | LPM | 8/20 | Maize |
| Mmbando et al [30] | 2020 | Tanzania | Heckman | 10/17 | Maize |
| Odongo et al [38] | 2019 | Uganda | Logistic | 8/14 | Sunflower |
| Abdulai et al [31] | 2023 | Ghana | TEM | 6/11 | Soybean |
| Abebe D. et al [32] | 2019 | Ethiopia | Probit | 6/16 | Barely |
| Ambaliou et al [33] | 2023 | Benin | Logistic | 2/10 | Rice |
| Azumah et al [34] | 2019 | Ghana | Probit | 4/7 | FD |
| Hussaini et al [35] | 2020 | Nigeria | Logistic | 3/8 | Maize |
| Aye Moe San [36] | 2021 | Mayanmar | ESR | 8/21 | Rice |
| Winter et al [37] | 2011 | Indonesia | Probit | 5/16 | Corn |

ESR-Endogenous switching regression model; GC- Groundnut & chill; FFG-Fresh fruits & vegetables DHM-Double hurdle model; FD- more than two food crops; TEM- Treatment effect model; (S/T)- “S” stands for significant variables “T” stands for total explanatory variables

3.2. Contract Farming Practice

Contract farming is practiced in different developing countries. However, contract farming adoption particularly in the crop subsector was mostly practiced in the following 15

countries in the last decades (Figure 3). Although rice and maize contract farming were highly adopted in low and lower-middle-income countries, soybean contract farming was also practiced in the last decades as indicated in the below figure (Figure 4).

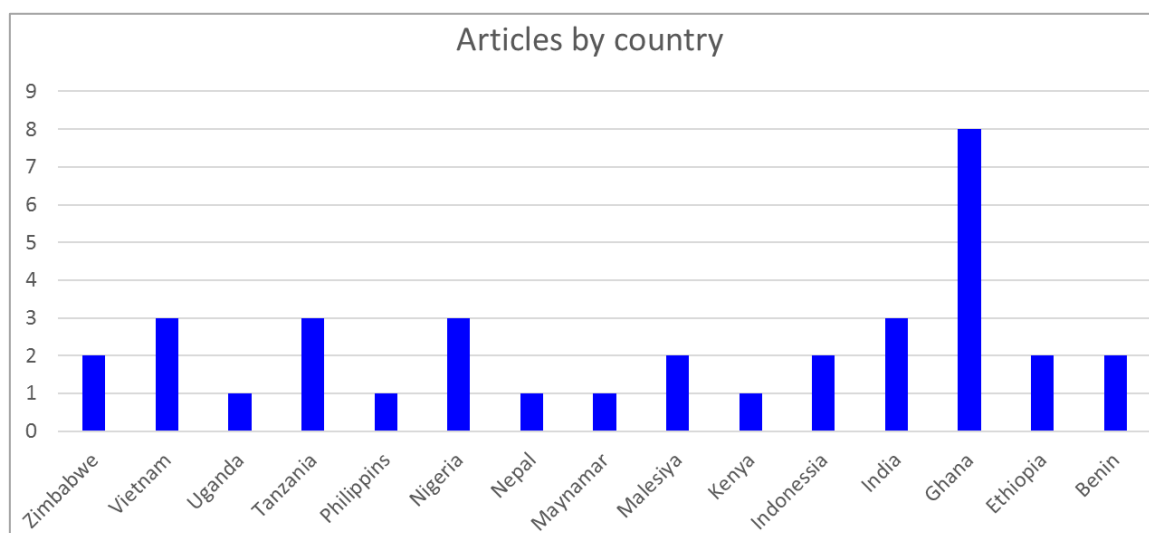


Figure 3. Articles by country.

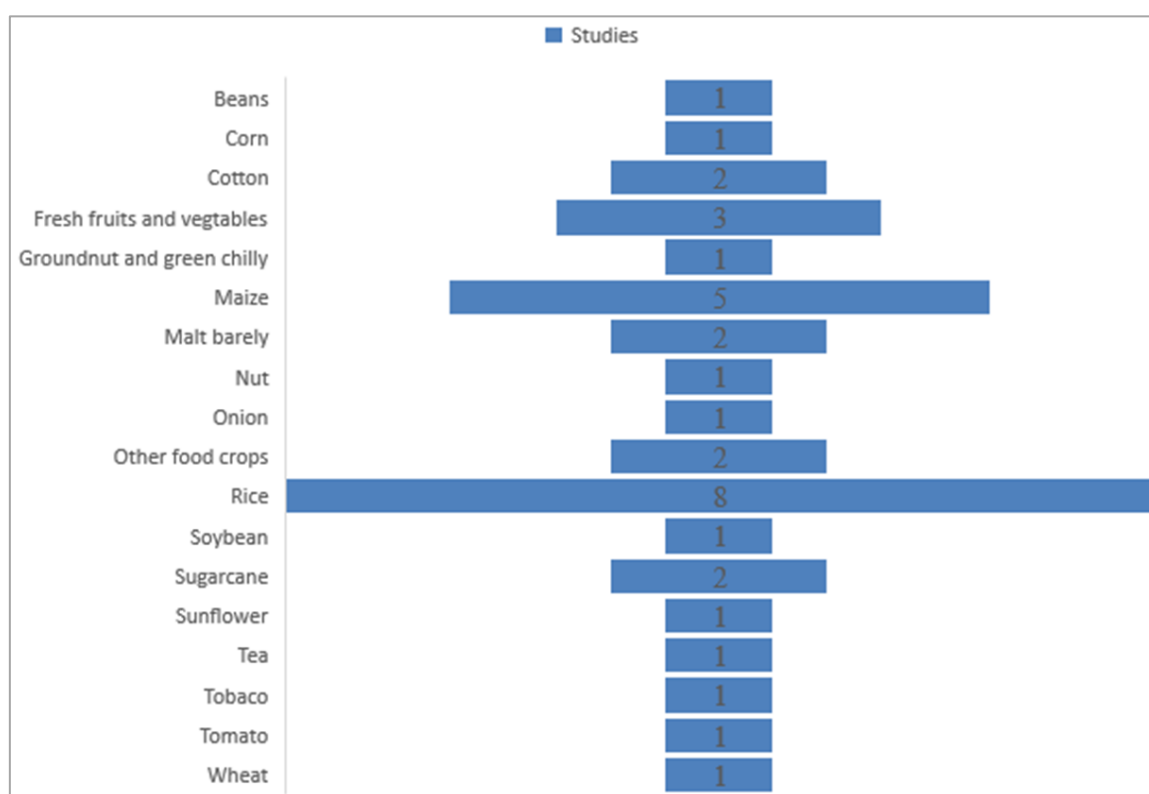


Figure 4. Articles across agricultural products.

3.3. Meta-regression Analysis

Major determinants of contract farming participation

Based on the values of model regression ($I^2 = 0.00$, $H = 1$), it seems like a good idea to proceed with further analysis in this meta-analysis. Because $I^2 = 0.00$ indicates no statistically significant heterogeneity between the studies in this regression analysis. $H = 1$: Higgins' statistic (H) complements I^2 . A value of $H = 1$ coincides with no heterogeneity, further sup-

porting the I^2 result. The test of residual homogeneity ($\text{Prob} > Q_{\text{res}} = 1$) also suggests that the study fails to reject the null hypothesis of residual homogeneity. Based on this test, we can assume that the variances of the effect sizes are relatively similar across the studies included in the meta-analysis. This strengthens the validity of the random-effects model, which assumes some degree of heterogeneity between studies. Generally, proceeding with further analysis using a random-effects model seems reasonable. A good sign for proceeding with further analysis using the random-effects model

(Table 2).

Table 2. Meta-regression outputs for determinants of contract farming participation.

| Effect-size label: Log odds-ratio Effect size: $_meta_es$ Std. errs.: $_meta_se$ Random-effects meta-regression Method: REML | | Effect-size label: Log odds-ratio Effect size: $_meta_es$ Std. errs.: $_meta_se$ Number of obs = 14 Residual heterogeneity: $\tau^2 = 1.4e-07$ I^2 (%) = 0.00 $H^2 = 1.00$ R-squared (%) = 100.00 Model F (3,10) = 10898 Prob > F = 0.000 | |
|---|-------------|--|------|
| $_meta_es$ | coefficient | Std. err | P> t |
| Educ | -1.10 | .006 | 0.00 |
| landsize | 0.77 | .004 | 0.00 |
| hsizeor | -0.10 | .001 | 0.00 |
| -cons | 0.33 | .001 | 0.00 |

Test of residual homogeneity: $Q_{res} = \chi^2(10) = 0.74$ Prob > $Q_{res} = 1.0000$

Contract farming participation in the crop subsector by smallholder farmers in low and lower-middle-income countries is affected by various factors. From the meta-regression analysis, it was observed that smallholder farmers' level of education in low and lower-middle-income countries had a negative and significant effect on their rate of technology adoption. Smallholder farmers who were considered educated with some form of formal or informal education adopt new technologies lower than uneducated smallholder farmers. When the farm household head has an educational background, they can get more information as well as modern agricultural inputs like extension services, chemical fertilizer, and others without being contract farming participant to increase their production in the farming area. This result is consistent with the findings of [1, 9, 10]. Likewise, smallholder household size was noted to affect their contract farming participation decisions. As farmers' household size increases, the level of contract farming participants decreases contrary to [5, 6, 12]. The meta-regression analysis shows that a one-number increase in smallholder farmers' household size;

leads the probability of being a contract farming participant to be decreased approximately by 0.1 unit while the remains are constant. On the other hand, the land size of the smallholder farmer is also identified as a measure of contract farming participation decision. The larger the smallholder farmer's land size, the higher the smallholder farmer's probability of being a contract farming participant [2, 9, 12, 23]. The same is true in this meta-regression analysis; one hectare of additional land leads to an increase in the small-holder farmers' probability to be contract farming participants by 7.7 units while the remains are constant.

3.4. Factor Analysis

This reviewed study reported varying levels of contract farming participation among small-holder farmers in low income and lower-middle income countries.

Factor Analysis: The principal component analysis showed four significant variables explaining 73% of the overall variation in the factors (Table 3).

Table 3. Factor Analysis Results.

| Determinants | Factor1 | Factor2 | Factor3 |
|----------------|---------|---------|---------|
| Household size | 0.86 | 0.33 | 0.39 |
| Land size | -0.99 | 0.07 | -0.14 |
| Age of hhd | -0.36 | -0.66 | 0.66 |

| Determinants | Factor1 | Factor2 | Factor3 |
|----------------|-------------------------|------------------------|---------|
| Marital status | 0.34 | -0.34 | 0.01 |
| Extension | 0.42 | -0.53 | 0.74 |
| Education | 0.87 | 0.39 | -0.22 |
| Factor | Description Eigenvalue | Variance Explained (%) | |
| Factor 1 | Financial values | 4.23 | 21.15 |
| Factor 2 | Technical Support | 3.87 | 19.35 |
| Factor 3 | Trustworthy Partnership | 3.14 | 15.70 |

Contract is defined as an agreement by which, on the one side, the producer undertakes to produce agricultural commodities, to deliver them in accordance with the contractor's specifications, and on the other side, the contractor undertakes to acquire the product for a price and generally to supply the producer with different inputs and technical advice. This review study aimed to investigate the underlying determinants determining small-holder farmers' decisions to participate in contract farming arrangements in low and lower-middle income countries.

Factor 1: Financial values (household income, Price offered): Contract farming participation can be evaluated through farmers' financial indicators, in this case household income and price. Smallholder farmers are more likely to participate in contract farming when farmers have relatively large household size and being educate one. However, owning a relatively large land size has a negative effect on contact farming participation.

Factor 2: Technical Support (training and input provision): This factor highlights the training on improved farming practices and access to inputs. Age of the household head and access to extension for rural farmers discourages access of technical support from responsible bodies. However, education can enhance technical support positively.

Factor 3: Trustworthy Partnerships (social capital, trust): This factor focuses on the relationship with the contractor. While not the primary driver, a positive relationship with the contracting company seems to be important for some farmers. Age of the household head, access of extension services and having of large household size have an advantage for small-holder farmers to be contract farming participant through this dimension of contract farming.

Generally, based on this review paper, smallholder farmers' contract farming participation decision was affected by various factors. The meta-analysis investigated household size, farm size and education were the major factors that affect contract farming participation. However, the factor analysis based on clustering of contract farming participation dimensions revealed the above factors had different implications on the dependent variable. Therefore, we can conclude that contract farming participation dimensions have been influenced

by various variables. Simply asking farmers whether they participate or not and using contract farming participation dimension as a dependent variable have different results.

4. Conclusion and Recommendation

The meta-analysis shows that small-holder farmers' contract farming participation in the crop sub-sector of low and lower-middle-income countries is affected by a combination of farmer and farm characteristics. The meta-analysis shows that small-holder farmers' contract farming participation results suggest that contract farming arrangements may be more attractive to farmers with smaller landholdings and lower education levels in low and lower-middle-income countries. However, the factor analysis identified factors that affect contract farming participation which differs in length and dimension from meta-analysis outputs. The combined analysis shows the importance of both market-level and farmer-level factors for successful contract farming. To encourage broader participation, policymakers, and program designers could consider targeted outreach and support services for these specific demographics. Additionally, exploring contract models that offer flexibility or accommodate family labor needs could enhance inclusivity for farmers with larger households. Further research investigating the specific reasons behind the education-participation link would provide valuable insights for tailoring interventions and maximizing the benefits of contract farming for all potential participants.

Abbreviations

| | |
|--------|--|
| Dr. | Doctor |
| ESRM | Endogenous Switching Regression Model |
| N/A | Not Available |
| PRISMA | Preferred Reporting Items for Systematic Reviews and Meta-Analyses |

Author Contributions

The authors approve their contribution to the paper as follows: Getahun Abreham and Yordanos Sete contributed to problem identification, article selection, data extraction, and writing a report under the supervision of Dr. Zemen, Dr. Essa, and Prof Mammo.

Statements and Declarations

All authors of this study read and agreed on this manuscript.

Data Availability Statement

The raw data of this paper is available and the researchers can send it wherever it is needed.

Conflicts of Interest

The authors declare no conflicts of interest.

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