A Meta-analytic Review of the Link between Market Access and Contractual Crop Production in Ethiopia[1]

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Abstract

This systematic review and meta-analysis introduces a new perspective for measuring open market access to examine how it influences the success of contract farming initiatives in Ethiopia. It addresses the types of associations that exist between contract farming and open market access and fills the existing empirical and knowledge gaps. The review uses thirty studies published between 1990-2024.The findings show there is a notable effect between contract farming earnings and open market access, with a considerable difference across the regional states in Ethiopia. Mainly, high market access has a better effect on contract farming proceeds compared to other levels. Moreover, Amhara emerges as a more favorable working environment for contract farming stakeholders, while Tigray and Sidama show less favorable situations. Farmer characteristics, including training (education), closeness to market centers, and household head's age, encourage the contract farming system. In contrast, access to extension services reveals a counterproductive association with contract farming success, suggesting that its delivery requires re-evaluation, especially in less supportive areas. To promote national agricultural growth, this study advocates for facilitating cross-regional agreements that link experienced farmers and contractors to new areas. There is a need for policy prioritization for farmer empowerment and regional-level market opportunities for contract farmers. This can be realized by providing field-based training focused on contract management directly to farmers, and by facilitating cross-regional agreements that link experienced farmers and contractors to low-experienced areas in the country.

Keywords: Crop contract farming, Ethiopia, Open market access, Meta-regression analysis

JEL Classification: Q13

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1. Introduction

Owing to better market access and lower marketing costs, contract farming has emerged as a promising way to improve the lives of farmers in developing countries (Ganewo et al., 2022). Currently, contract farming is considered a solution for agricultural marketing problems (Ganewo et al., 2022a) in Ethiopia. Due to problems with market access, the government of Ethiopia has been forced to directly interfere in output markets via means such as price controls, marketing boards, and strategic stockholding (Girma & Kuma, 2022). Subsequently, contract farming is often considered an institutional innovation (Li & Wang, 2024) to address market limitations or market failure (Bezabeh et al., 2022), with the expectation of increasing agricultural productivity (Ganewo et al., 2022) and improving the livelihoods of smallholder farmers (Yusuf et al., 2021; Li & Wang, 2024).

However, the current empirical research has not thoroughly investigated how existing open market access affects the success of contract farming in Ethiopia. While researchers have investigated the impact of contract farming on farmers' integration into agricultural value chains (e.g., Bezabeh et al., 2020; Paul Jr Tabe-Ojong & Abay, 2023), a clear understanding of how the comprehensive market situation, notably the degree of open market, influences contract farming success is elusive. Specifically, there is limited evidence on whether open market access influences contract farming, which dimensions of market access matter most, and which Ethiopian regions are more conducive to contract farming success.

In addition to this knowledge gap, there is also a contextual gap in the agricultural literature, where the concept of open market access remains poorly defined and operationalized. This can be addressed by clearly defining and operationalizing it within the Ethiopian context as a market environment characterized by the absence of governmental or third-party intervention and the absence of pre-existing contractual arrangements. This definition, informed by market liberalization and transaction cost economics, focuses on the key dimensions of physical, information, and economic access. The study aimed to fill additional research and conceptual gaps. Specifically, this study sought to address the existing gap in the agricultural literature, where the concept of market access remains poorly defined and operationalized. To this end, the study introduced the concept of "open market access," which characterizes a market situation free from government or any third-party intervention and free from any prior market contract agreements. Although

open market access is a complex concept, this study focused on three main dimensions: physical access (the proximity of farmers to market centers), information access (farmers' ability to obtain timely and accurate market information), and economic access (farmers' financial capacity to engage in market activities, particularly their access to agricultural credit). By considering such issues, this review paper categorized open market access as low, medium, or high according to the study's predefined criteria.

To provide a more comprehensive understanding, this review paper incorporates results from various studies across various Ethiopian regions and contexts, focusing on the three main dimensions of open market access – physical, information, and economic – categorized as high, medium, or low based on predefined criteria, to recognize overall associations with contract farming success and offer more generalizable insights for policymakers and practitioners.

A recent study by Abreham et al., 2025 examined how contract farming is influenced by market access in developing countries and found that market access has a moderate and positive effect on contract farming. However, while this study provides a preliminary, general perspective, focusing broadly on developing economies, it doesn't capture the specific institutional, socio-economic, and policy realities of Ethiopia's agricultural sector, which is dominated by smallholder farmers facing challenges such as poor infrastructure and highly fragmented landholdings.

Therefore, a more focused investigation is essential to generate actionable insights and tailored policy recommendations directly relevant to Ethiopian farmers and stakeholders. Such research must go beyond general trends to address the specific "where, why, and what" of contract farming's effectiveness in the Ethiopian context.

2. Review Methodology

2.1. Identifying the Appropriate Studies, Screening, and Data Extraction

Search strategy: This systematic review and meta-analysis used scientific procedures for selecting relevant articles. We used the following scientific databases to obtain articles: Dimensions, PubAg, Taylor & Francis, and Scopus, applying specifically developed search strings using search words and Boolean operators (e.g., AND, OR, NOT). The search was designed to retrieve studies published between 1990 and 2024 focusing on the association between market access and contract farming in Ethiopia. To broaden our search, this study also incorporated Google Scholar in its search approach to reduce the risk of missing important studies. The

study also aimed to incorporate grey literature (organizational websites) because that kind of literature often reflects real-world applications, policy implications, and practical experiences that may not be fully captured in regular studies. The full search activities for Scopus are shown in the supplementary files.

Study Selection: A multi-stage screening process was employed based on predefined inclusion and exclusion criteria to identify relevant articles. First, duplicate records were removed. Next, titles and abstracts were screened for significance to the research question. Full texts of potentially relevant articles were then evaluated against the inclusion and exclusion criteria. These procedures, guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram (Figure 1), generated a final set of thirty articles, all from peer-reviewed journals.

Inclusion Criteria: Peer-reviewed journal articles that explored the influence of market access on contract farming in Ethiopia and unpublished (grey) literature were considered. Published studies were required to be original research articles written in English and to provide essential quantitative data on the Ethiopian farming population. The review considered evidence across different crop subsectors.

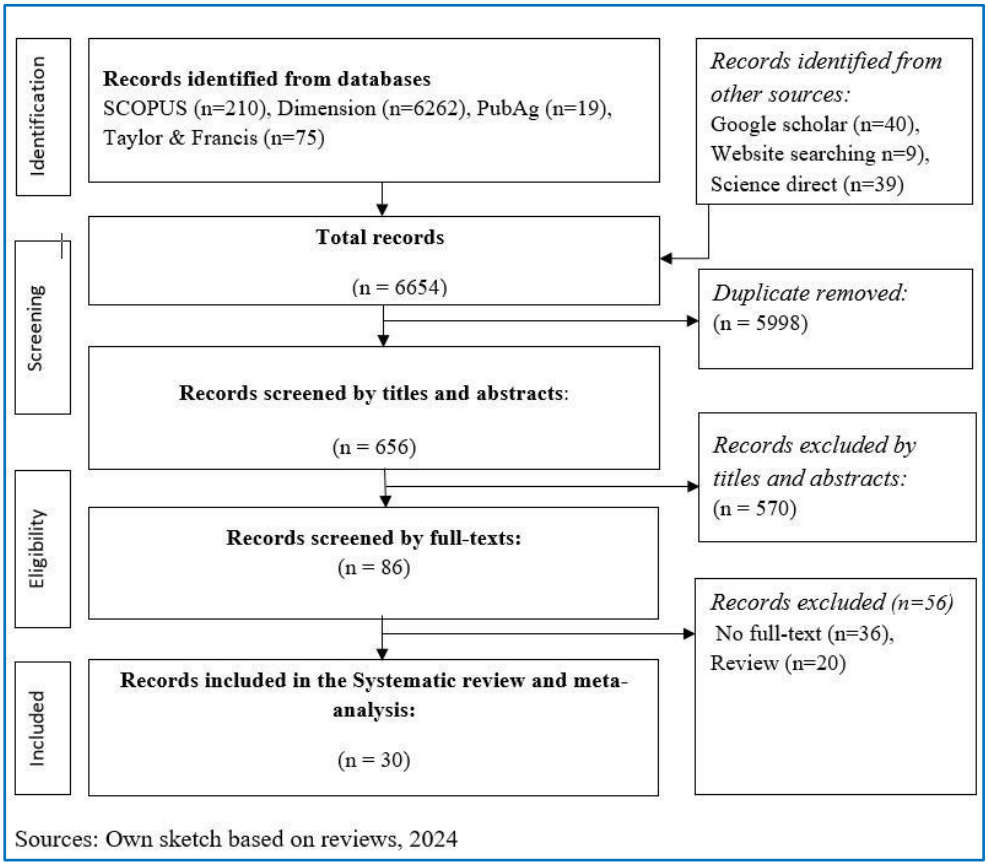
Exclusion Criteria: Studies were excluded if they were not published in English, did not provide data on the focus of this review, and if there is no clear and defined objectives, samples, target populations, study areas, and if it failed to fulfill the inclusion criteria of this review (Figure 1).

Data extraction and critical appraisal: Data from the included studies were extracted for this study using a standardized protocol. A study was conducted to assess the reliability of the extracted data to increase the level of accuracy and consistency. Any discrepancies were recognized through in-depth discussions among the authors. Furthermore, the accuracy of the removed data records was rigorously examined.

Quality assessment: The quality of the included studies was independently evaluated by two researchers based on the Cochrane Handbook's Risk of Bias Assessment Tool in the following areas: outcome evaluators, selective reporting of study results, completeness of outcome data, and other biases (Zhao et al., 2023). A third reviewer discussed and resolved any disagreements encountered (Zhao et al., 2023). The Joanna Briggs Institute Critical Appraisal Checklist for Studies (Johnny EG et al., 2019) was applied to further evaluate the risk of bias in each article (Von Hippel, 2015; Lucyk et al., 2019). For each investigation, a quality score between 0 and 9

was assigned, which was used to determine the probability of bias. Articles with a score lower than 5 were considered to have a higher probability of bias, while those with scores between 5 and 8 indicated moderate bias, and scores between 8 and 9 were evaluated as having low bias (Table A1).

Figure 1: Flow diagrams of article selection for review analysis



5.2. Model for Meta-analysis

The concept of using findings from multiple research studies, what we now call meta-analysis, began with Karl Pearson in 1904. Later, Gene Glass formally announced the term "meta-analysis" in 1976. He clarified it as "the analysis of analyses"—a systematic technique to combine results from multiple research studies. An important concept in meta-analysis, developed by statisticians like Larry Hedges and Ingram Olkin (1982), is the precision-weighted average of estimated effects, as shown in the

equations below. This study assesses the results of different studies, denoted by "D." Each article has its real effect measured by "," with a true standard error measured by "D" = 1…," D." Following established meta-analytic methods (e.g., Hedges & Olkin, 1985), across articles, the simple average of the true effects E is assessed by the precision-weighted average of the estimated effects:

$$\mathcal{B}_D = \frac{\sum_{D=1}^{D} \delta^2{}_D \mathcal{B}_D}{\sum_{D=1}^{D} \delta^{-2}{}_D}$$

The variance of the evaluated effects is partly due to the heterogeneity $V(\mathcal{B}_D) = T^2$of the true effects and partly due to the standard errors δ_D:

$$V(\mathcal{B}_D) = V(B_D) + \sum_{n=1}^{\infty} (\delta^2{}_D) = T^2 + \delta^2{}_D$$

Note that the variance $V(\mathcal{B}_D)$ is heteroskedastic because each included study has a different standard error δ_D. To visibly define fractions of variance, Higgins and Thompson (2004) first made the simplifying assumption that the standard errors are all equal, i.e., $\delta_D = \delta$. Then, $V(\mathcal{B}_D) = T^2 + \delta^2$ (Higgins & Thompson, 2004) and the fraction of variance that is due to heterogeneity (Hodder et al., 2017) is

$$I^2 = \frac{T^2}{T^2 + \delta^2}$$

Heterogeneity was predicted to be assessed using (I^2 = 0, no heterogeneity; I^2 = 0–50%, low; I^2 = 50%–75%, medium; and I^2= >75%, high heterogeneity) (De Cassai et al., 2023). On this basis, our study found that the fixed effect model is appropriate for the given data set in this systematic review and meta analysis paper because of the existence of insignificant heterogeneity (Vesterinen et al., 2014). Data analysis was performed using STATA version 17 software.

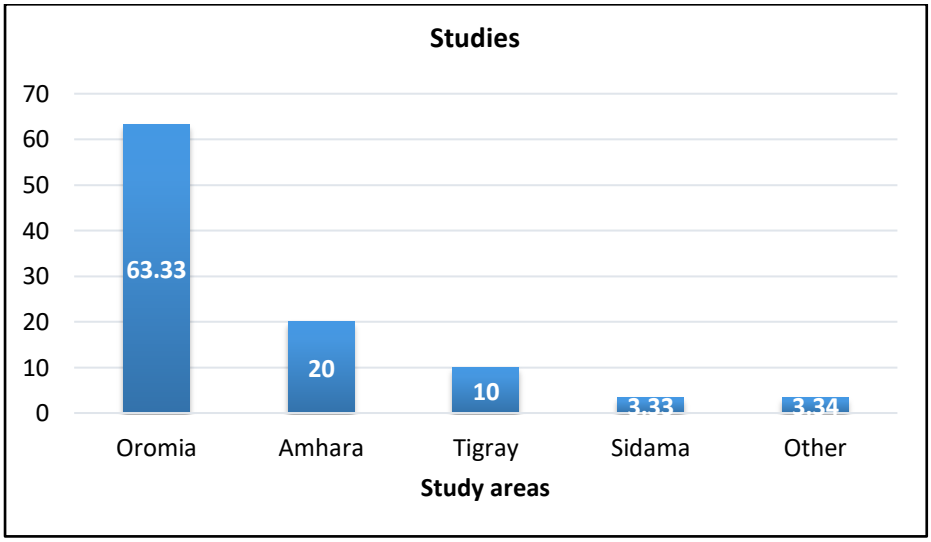
6. Results and Discussion

3.1. Overview of the Geographical Locations of the Included Studies

This systematic review and meta-analysis, performed in Ethiopia, mapped the distribution of the included articles. Figure 2 shows that articles focusing on contract farming, particularly in the crop subsector, between 2003 and 2024 were mostly concentrated in the Oromia, Amhara, and Tigray regions. Notably, the Amhara

region displayed the second-highest attention in these studies, next to the Oromia region. The combination of government support, a conducive policy environment, agricultural significance, research infrastructure, and the existence of agribusiness industries has resulted in the Oromia and Amhara regions being favorable for contract farming research.

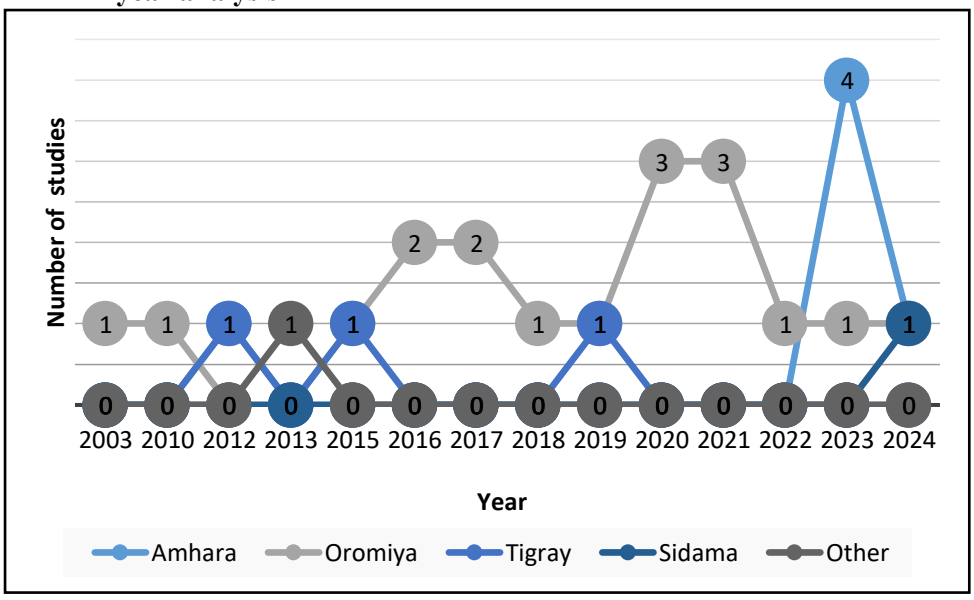
Figure 2: Distribution of studies across regions in Ethiopia



3.2. Spatial Patterns of Crop Contract Farming Research Outputs

As shown in Figure 3, the Oromia regional state is better at paying attention to contract farming studies and can use this opportunity to enhance contract farming earnings. In the two regions (Oromia and Tigray), there has been a consistent flow of studies over the years, highlighting the importance of contract farming research in these areas. However, in the Amhara regional state of Ethiopia, although the number of studies initially was insignificant, there has been a recent increase in contract farming investigation activity in this region, especially in 2023. Universities in these regions had a significant influence on the number of studies conducted, while security issues became constraints to performing research, particularly primary data-based research in the area of contract farming.

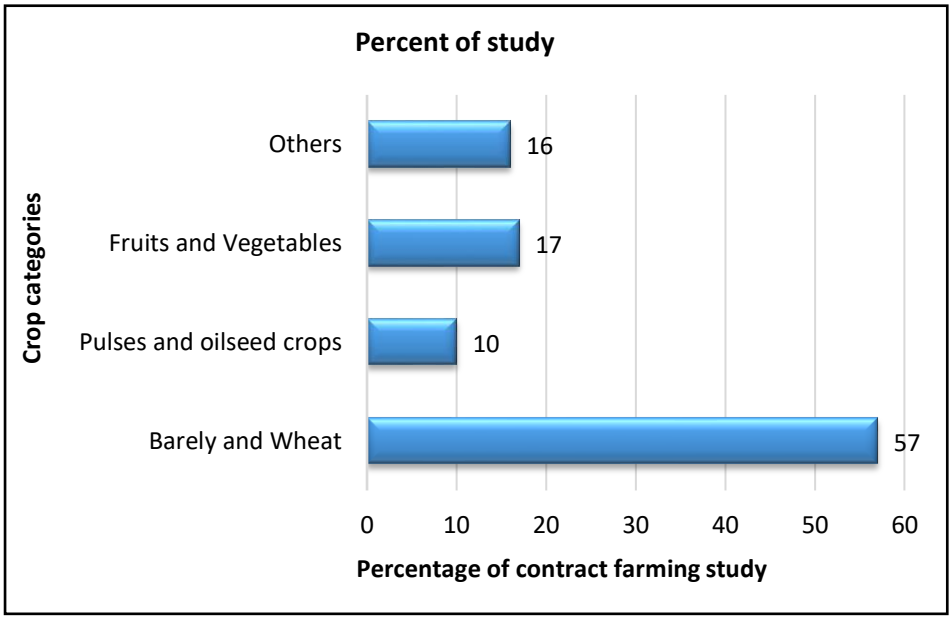
Figure 3: Spatial patterns of crop contract farming research outputs: A 21-year analysis



3.3. Study Distribution Across Crop Types

Figure 4 shows the proportion of contract farming research conducted on various crop groups in Ethiopia. In particular, oilseeds and cereals accounted for the highest percentage of the research focus, making up 67% of the total. This important consideration of cereals and oilseeds highlights their vital role in improving the livelihoods of citizens, particularly in terms of food security and income, in Ethiopia. While other crops also receive research consideration, their share is comparatively lower in contract farming research than that of oilseeds and cereals. This might be due to several reasons, such as government policies, the perceived profitability of different crops, and market demand.

Figure 4: Study distribution across crop types

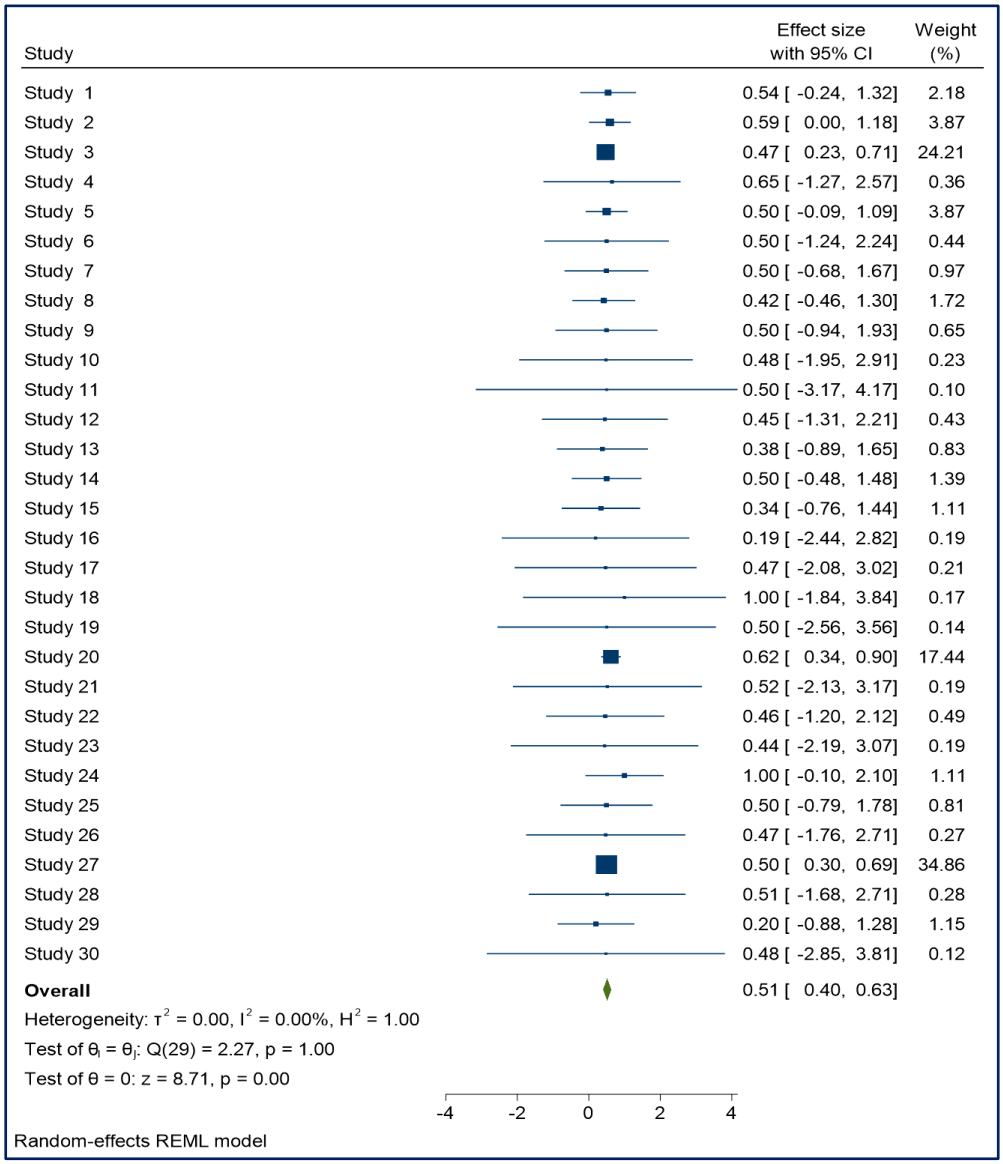


3.4. Evaluating and Modeling Heterogeneity in Meta-Analysis

Visual inspection of the forest and Galbraith plots (Figure 5 and Figure 6) revealed that there was no considerable heterogeneity among the included articles. Moreover, the statistical diagnosis for heterogeneity, I^2, and Q, did not provide significant results, further supporting the conclusion of homogeneity. Accordingly, the fixed effects model was considered the most appropriate model among the fixed, random, and combined effects models for this meta-analysis.

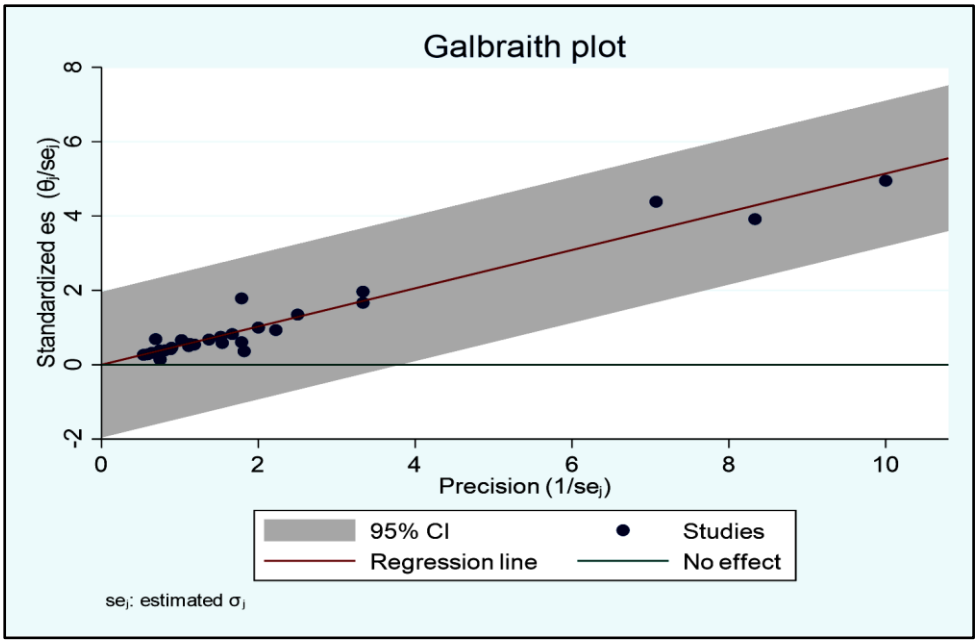
Forest plot: The forest plot in Figure 5 explains the results of a meta-analysis conducted on the effect of market access on contract farming. The $I^2 = 0.00\%$ indicates that the observed variability in effect sizes across studies is likely due to chance rather than true differences in the underlying effect. This result suggests a moderate positive effect, and the low heterogeneity encouraged us to use the fixed-effects model in this meta-analysis. Further diagnostic evaluations, including a visual review of the Galbraith plot (Figure 6), which displayed no evidence of significant asymmetry ($p = 0.00$ for Egger's test), indicate the robustness of the combined effect size to the exclusion of any single study, further strengthening the reliability of these results.

Figure 5: Forest plot



As shown in the Galbraith plot (Figure 6), the data points were distributed around the regression line without significant variation. It also suggests that the data are relatively homogeneous and that there is no strong evidence of publication bias, which is consistent with the results of the statistical test, i.e., the Egger's test.

Figure 6: Galbraith plot for publication bias



Publication Bias: Egger's test evaluation: The publication bias test was also performed using Egger's test. Since the P value of the bias coefficient is greater than 0.05 (p = 0.206), there is no detection of publication bias issues in this study (Table 1).

Table 1: Eager test for publication bias

Egger's test for small-study effects:
Regression of the standard normal deviation of the intervention
effect estimates against its standard error

Number of studies = 23 Root MSE = 17.87

Std_Eff	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
Slope	5.26	1.49	3.53	0.002	2.16	8.36
bias	1.16	5.18	0.22	0.83	-9.61	11.92

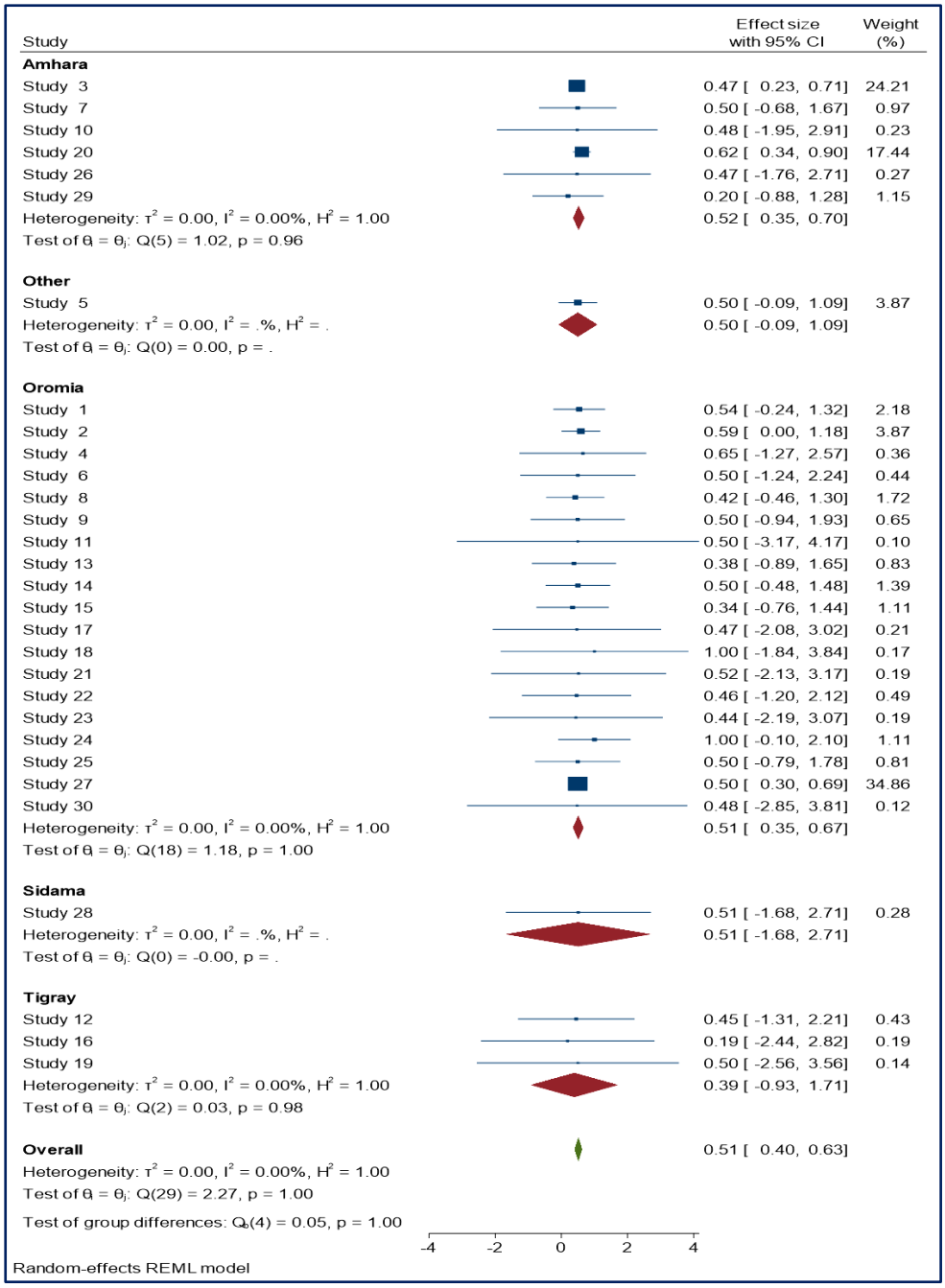
Test of H0: no small-study effects P = 0.826

3.5. Examining Regional Variations in Contract Farming in Ethiopia

The subgroup analysis of this systematic review and meta-analysis (Figure 7) reveals what contract farming strategies look like across Ethiopian regional states. The combined effect shows that contract farming has a reasonably positive result across different regional states of Ethiopia. This analysis indicates that the practice of contract farming and its effects on various outcomes are moderate in the Amhara and Oromia regions. In particular, the modest effect size of 0.52, 95% CI: 0.35–0.70, suggests that contract farming strategies have been valuable in the Amhara regional state of Ethiopia. The main reasons may be the existing security challenges in some areas of different regional states of Ethiopia, which have interrupted agricultural activities and discouraged investments more than what researchers have observed in the Amhara regional state. In addition, the land tenure system of Amhara, mostly in certain areas, has been more conducive to large-scale farming and commercialization than in other regions.

However, the influence of contract farming strategies in the Tigray and Sidama regional states of Ethiopia is less certain (Figure 7). The wide confidence intervals for these regions suggest that the effect sizes could range from negative to positive, as shown by their statistical effect sizes (0.51 (95% CI: -1.68, 2.71) and 0.39 (95% CI: -0.93, 1.71)). This problem may be due to various factors, including the socioeconomic context of the region, the specific characteristics of the contract farming arrangements, and the quality of the available research within the region.

Figure 7: Subgroup analysis of contract farming by the regional state of Ethiopia



3.6. Subgroup Analysis of Contract Farming Earnings by Market Access

This systematic review and meta-analysis uses both subgroup analysis and meta-regression to review contract farming earnings, a well-established activity in a quantitative way of analysis when reviewing multifaceted concepts like market access.

Market access, which can be defined as farmers' ability to effectively engage in market transactions (Barrett, 2008), is categorized into low, medium, and high levels based on predefined criteria: information access (access to communication technology and availability of market price information), physical access (road conditions and distance to the nearest market center), and economic access (access to credit, household income, and transaction costs). Low market access (LAM) is characterized by significant limitations across these dimensions. On the other hand, it is marked by significant remoteness, substantial economic constraints, limited information availability, and poor infrastructure (Gebre et al., 2016). High market access (HAM) is considered when a farmer is significantly better positioned for the predefined market futures. In other words, it is characterized by abundant information availability, proximity to markets, fewer economic constraints, and well-developed infrastructure, which are associated with enhanced outcomes (Svensson, 2021). Medium market access (MAM) refers to intermediate situations, with some restrictions in one or more of these factors (e.g., some information gaps, moderate remoteness, or moderate financial constraints).

Initially, the meta-regression analysis aims to explore the significant indicators that contribute to market access, such as market distance and market information. Secondly, by identifying market access as a main variable, a subgroup analysis is conducted to recognize how different levels of market access, defined previously by the combination of different indicators, moderate the combined effect on contract farming proceeds, as shown in Table 2.

Therefore, using variables that contribute to market access in both analytical methods is a valid and insightful approach. This allows for the evaluation of the specific effect of each indicator through meta-regression analysis, while simultaneously investigating the overall contextual effect of market access levels through subgroup analysis, ultimately providing a comprehensive understanding of the main factors driving contract farming proceeds.

Table 2: Effect of open market access on contract farming success

Effect-size label: Effect size
Effect size: CFProceeds
Std. err.: cfpse
Subgroup meta-analysis summary Number of studies = 26
Fixed-effects model
Method: Inverse-variance
Group: MaktAcc[5]

Study		Effect size	[95% conf.	interval]	% weight
Group: RAM	Zerhun et al. 2022	9.23	8.64	9.81	4.05
	Mario et al., 2015	3.34	-0.32	7.00	0.10
	Getachew et al., 2016	10.09	7.56	12.64	0.22
	Negasi et al., 2019	2.00	-1.05	5.05	1.05
	Hailes et al., 2024	0.00	-0.28	0.27	18.30
	Dawit et al., 2012	9.79	8.72	10.88	1.21
	theta	2.17	1.93	2.41	
Group: MAM	Abebe et al., 2023	0.56	.33	0.79	25.40
	Gemechu et al., 2017	0.00	-1.92	1.92	0.38
	Delelegne et al., 2021	10.06	9.18	10.95	1.81
	Abebe et al., 2015	7.79	6.03	9.56	0.45
	Alemayehu et al., 2017	8.29	7.02	9.56	0.87
	Getachew et al., 2016	4.00	1.35	6.64	0.20
	Tibebu et al., 2024	9.75	7.55	11.93	0.29
	theta	1.57	1.35	1.78	
Group: HAM	Fikadu et al., 2020	8.88	8.09	9.67	2.29
	Gumataw et al., 2013	4.28	3.69	4.86	4.06
	Dawit et al., 2020	4.27	2.53	6.02	0.46
	Abebe et, al, 2023	8.81	7.64	9.99	1.02
	Addisu et al., 2023	0.000	-1.43	1.43	0.69
	Dawit et al., 2021	5.45	2.60	8.29	0.17
	Abdisa, 2024	10.86	9.20	12.52	0.51
	Addisu et al., 2020	0.00	-1.29	1.29	0.84
	Abebe et al., 2023	10.63	8.40	12.86	0.28
	Bezabih et al., 2023	10.78	10.58	10.97	36.45
	theta	9.64	9.47	9.81	
Overall	theta	5.50	5.38	5.62	
Heterogeneity	**summary**				

Group	df	Q	P>Q	% I2
RAM	5	1019.25	0.000	99.61
MAM	6	641.06	0.000	99.22
HAM	9	891.19	0.000	98.99
Overall	22	6712.78	0.000	99.67

Test of group differences Q b = chi2(2) = 4 161.06 Prob > Q_b = 0.000

Source: Own analysis result, 2024

[5] Refers open market access which is expressed in terms of three dimensions such as economic access, physical access, and information access.

As an earlier description, this study focused on the associations between open market access and contract farming in Ethiopia. In particular, the part of this study here (the subgroup analysis) shown in Table 2 displays the effect size results of each open market access indicator's effect on contract farming outcomes (contract farming proceeds) in Ethiopia.

Although all three market access categories presented a positive influence, the level of certainty and the extent of the effect across each market access level varied. The low market access group revealed a greater positive and significant effect than the medium market access group, but a lower effect than the high market access group.

The pooled effect size for high market access (HAM) is 9.65; CI 9 (47--9.81), signifying a strong and significant effect on contract farming outcomes. These findings are consistent with Megesa's report (Magesa et al., 2014). This market level consistently displays a meaningfully advanced effect size compared with the other types of market access levels (MAM 1.57 (CI: 2.17--1.93) and RAM 1.35 (CI: 1.35--1.78)), confirming that there is a strong, significant, and positive association between higher levels of market access and contract farming.

3.7. Meta-Regression Analysis for Drivers of Contract Farming in Ethiopia

The very low p-value (Prob > chi2 = 0.00) shows that the overall model fitness is good, and the explanatory variables, as a group, meaningfully predict the difference in contract farming proceeds. The given meta-regression model addresses the effect of open market access on contract farming.

indicates that, on average, studies showing farmers with access to information reported around 4.18 units higher contract farming proceeds compared to studies reporting farmers without such access, while the remaining variables are constant. This demonstrates a positive and significant association between access to information and contract farming outcomes. On the other hand, the positive coefficient (0.85, $P < 0.01$) for the level of education and contract farming outcome shows a direct and significant relationship, contrary to Al-Hassan and Abdulani's findings (Al-Hassan et al., 2016). As the level of education increases by one unit, the level of contract farming income increases by approximately the same unit, whereas other variables remain constant, which is consistent with the findings of Mounirou (2020) and Legesse et al. (2024).

Similarly, the results indicate that younger individuals are less likely to participate in contract farming successfully than older farmers. The result is consistent with

Mounirou and Yebou (2023). This may be due to several reasons, such as having less life experience, poor social networks, and lower access to resources compared with older farmers (Bidzakin et al., 2019). However, the coefficient of access to credit (accscredit) at a one percent significance level (Table 3) indicates increased economic access; in this case, access to credit is directly associated with lower contract farming earnings under Ethiopian contract farming strategies. This counterintuitive finding might be due to several reasons, such as increased debt burdens and income diversification. A farmer who has a high level of credit decreases their contract farming earnings by reducing contract farming participation decisions.

Table 3: Driving Factors of Contract Farming in Ethiopia

meta_es	Coefficient	Std. err.[6]	Z	P>|z|	[95% conf. interval]	
dismkt	0.18	0.03	5.6	0.00	0.122	0.252
accscredit	-0.36	0.031	-11.6	0.00	0.430	-0.306
infomob[7]	4.18	0.14	28.2	0.00	3.89	4.472
extension	-1.86	0.09	-20.26	0.00	2.044	-1.68
educ[8]	0.85	0.06	13.20	0.00	0.731	0.986
Age	0.20	0.01	17.46	0.00	0.184	0.232
_con[9]s	3.11	0.45	6.89	0.00	2.229	4.00

Effect-size label: Effect sizeFixed-effects meta-regression
Effect size: CFProceeds Method: Inverse-variance
Std. err.: cfpse; Number of obs = 20 Wald chi2(6) = 3878.05; Prob > chi2 = 0.0000
Sources: Own analysis results, 2024

Likewise, the coefficient of extension at -1.86 with a p-value < 0.01 shows that access to extension services is inversely linked with contract farming outcomes, contrary to the findings of Rokhani et al. (2020). This could be due to several justifications, such as the quality of services and the importance of the messages provided by the extension agents. On the other hand, farmers with improved loan availability may be allowed to diversify their income sources, reducing their reliance on contract farming. The same is true for market distance (dismkt). The value of dismkt (0.18, p < 0.01) suggests that higher contract farming earnings, in our case,

[6] Standard error-a measure of uncertainty
[7] Access to mobile phone
[8] Farmer's level of education
[9] Constant term which refers a value that remains fixed throughout the analysis.

contract farming proceeds, have been affected by increased distance from the nearest market center, which is consistent with Mounirou (2020). The main reason is that the farmer is far from the market center, which could increase transaction costs and uncertainty. To minimize the cost of transactions and the level of risk associated with market uncertainty, farmers might be pushed to participate in contract farming, resulting in a direct and significant relationship between distance from the market and contract farming earnings.

***Limitations*:** The conclusions drawn from this study are limited by the heterogeneity of the studies included and dependence on existing literature. Further research should be prioritized to investigate the impact of specific market access interventions, explore power imbalances in contract farming, and use primary data collection to overcome these limitations.

4. Conclusion

This review showed that open market access improves both contract farming involvement and farmers' earnings, potentially through expanded market opportunities. Local disparities in contract farming favor the Amhara regional state. Individual influences like education, market proximity, and age foster participation. The undesirable association with extension services requires a re-evaluation toward innovation-driven methods to effectively leverage contract farming for Ethiopia's agricultural progress. Facilitate national agricultural growth by connecting experienced regional farmers and contractors with other areas through cross-regional agreements.

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Appendices

Table A1: List of articles included in the meta-analysis

No.	Code	Author	Publication year	Area	Focus area
1.	144	(Bezabeh et al., 2020)	2020	Oromia	Malt barely
2.	145	(Ganewo et al., 2022b)	2022	Oromia	Malt barely
3.	149	(Dagnew et al., 2023a)	2023	Amhara	Malt barely
4.	150	(Mulatu et al., 2017)	2017	Oromia	Vegetable
5.	152	(Abebe et al., 2013)	2013	Other (Eth)	Potato
6.	153	(D. Alemu et al., 2021)	2020	Oromia	Malt barely
7.	159	(Dagnew et al., 2023b)	2023	Amhara	Malt barely
8.	1	(Tefera & Bijman, 2021)	2021	Oromia	Malt barely
9.	2	(Bezabeh et al., 2022)	2022	Oromia	Malt barely
10.	3	(Dagnew et al., 2023b)	2023	Amhara	Malt barely
11.	4	(Biggeri et al., 2018)	2015	Oromia	Wheat
12.	5	(A. E. Alemu, 2015)	2015	Tigray	Other
13.	6	(Dagne, 2017)	2017	Oromia	Coffee
14.	7	(Haji, 2010)	2010	Oromia	Vegetable
15.	8	(Wendimu et al., 2016)	2016	Oromia	Sugarcane
16.	9	(A. E. Alemu & Bauer, 2012)	2012	Tigray	Malt barely
17.	10	(Getachew & Engdawork, 2019)	2016	Oromia	Malt barely
18.	11	(D. Alemu et al., 2021)	2021	Oromia	Malt barely
19.	12	(Negasi & Mebrahatom, 2019)	2019	Tigray	Sugarcane
20.	13	(Hailu & Kidu Mezgebo, 2024)	2024	Amhara	Sesame
21.	14	(Getachew & Engdawork, 2019)	2019	Oromia	Sesame
22.	15	(Neme et al., 2024)	2024	Oromia	Vegetable
23.	16	(Seba et al., 2018)	2018	Oromia	Chickpea
24.	17	(Bati Fedi et al., 2022)	2021	Oromia	Sugarcane
25.	18	(Bezabeh et al., 2020)	2020	Oromia	Malt barely
26.	19	(Dagnew et al., 2024)	2023	Amhara	Malt barely
27.	20	(Ali & Mohammed, 2024)	2003	Oromia	Malt barely
28.	21	(Legesse et al., 2024)	2024	Sidama	Avocado
29.	22	(Tsegaye, 2012)	2012	Amhara	Wheat
30.	23	(Megerssa G., 2019)	2019	Oromia	Malt barely

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