Peer review history for:

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HOW TO CITE:
Extension models in sustainable agriculture adoption in South Asia and sub-Saharan Africa [peer review history]. S Afr J Sci. 2025;121(7/8), Art. #20578. https://doi.org/10.17159/sajs.2025/20578/peerreview

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Reviewer 1: Round 1
Date completed: 13 February 2025
Recommendation: Accept / **Revisions required** / Resubmit for review / Resubmit elsewhere / Decline / See comments
Conflicts of interest: None

Does the review fall within the scope of SAJS?
Yes/No
Is the review written in a style suitable for a non-specialist and is it of wider than only specialist interest?
Yes/No
Do the Title and Abstract clearly and accurately reflect the content of the review?
Yes/No
Does the review provide a significantly novel perspective or significant recent advances in the field?
Yes/**No**
Is the objective of the review concisely stated?
Yes/No
Is appropriate and adequate reference made to other work in the field?
Yes/No
Do current debates and points of contention receive appropriate coverage?
Yes/No/**Not applicable**
Are gaps in the literature adequately identified?
Yes/No/Not applicable
Does the review provide direction for future research?*
Yes/No/Not applicable
Are the methodology and statistical treatment appropriate?
Not applicable/**Yes**/No/Partly/Not qualified to judge
Are the interpretations and recommendations aligned with the objective?
Yes/Partly/No
Please rate the manuscript on overall contribution to the field
Excellent/**Good**/Average/Below average/Poor
Please rate the manuscript on language, grammar and tone
Excellent/**Good**/Average/Below average/Poor
Is the manuscript concise and free of repetition and redundancies?
Yes/No
Is the supplementary material relevant and separated appropriately from the main document?
Yes/No/**Not applicable**
Please rate the manuscript on overall quality
Excellent/Good/**Average**/Below average/Poor
If accepted, would you recommend that the article receives priority publication?

Yes/**No**

Are you willing to review a revision of this manuscript?

Yes/No

With regard to our policy on 'Publishing peer review reports', do you give us permission to publish your anonymised peer review report alongside the authors' response, as a supplementary file to the published article? Publication is voluntary and only with permission from both yourself and the author.

Yes/No

Comments to the Author:

This was an interesting paper to read. The topic is relevant to the current research in the adoption of sustainable agricultural practices (SAP) by smallholder farmers. The title of the study was very vague and I made some suggestions on how to improve it. The authors need to define SAP well and provide examples of it in the introduction. The structure of the review is different from the aims given. I think the results and discussion should first start off with the factors influencing adoption rates of SAP and this should be well emphasised. Then the pro's and con's of the different conventional extension models can be discussed. The author could make some subheadings for pro's and cons for each extension model. I would also advise that some figures be added in the results and discussion. I also think that a section is needed on the way forward to provide suggestions on how we can improve the adoption rate of SAPs by smallholder farmers.

[See Appendix 1 for Reviewer 1's comments made directly on the manuscript]

Author response to Reviewer 1: Round 1

The title of the study was very vague and I made some suggestions on how to improve it.
The authors need to define SAP well and provide examples of it in the introduction.
You need to write out SAP in full. And also define SAP. Also provide examples of SAPs.

AUTHOR: The title has been changed to "The impact of extension models in the adoption of sustainable agricultural practices in South Asia and Sub-Saharan Africa: A systematic literature review." See the title page copy.
SAP was defined and examples given in the introduction. Lines 33-42.

The structure of the review is different from the aims given. I think the results and discussion should first start off with the factors influencing adoption rates of SAP and this should be well emphasized. Then the pros and cons of the different conventional extension models can be discussed. The author could make some subheadings for pros and cons for each extension model.

AUTHOR: Factors influencing adoption of SAPs were included and discussed. Lines 133-197.
The subheadings for the pros and cons for each extension model were added. Lines 203-314.

I would also advise that some figures be added in the results and discussion.
I'm thinking you can put in figures where you compare the countries and the type of extension services they use, as well as adoption rates.

AUTHOR: Figures 3 and 4 were added.

I also think that a section is needed on the way forward to provide suggestions on how we can improve the adoption rate of SAPs by smallholder farmers.
I think you should add a section where you provide some ideas of these innovative approaches.

AUTHOR: A section with the heading "Strategies to enhance adoption rates of SAPs among smallholder farmers," has been added. Lines 394-417.

Which regions?
This should be alphabetical, so start with Adoption first.
Rephrase these to sentences to clarify what you are trying to say.

AUTHOR: The regions have been included. Line 12.
Keywords were aligned. Line 22.
The sentences have been rephrased accordingly. Lines 75-78.

Your tables should be numbered in order of first mention and appearance. You first mentioned table 2 in line 85, so I would make that table 1 instead and this one table 2.

AUTHOR: Tables were numbered as suggested starting with the first mentioned one accordingly.

What is CA, write this out in full first before using the abbreviation.

Reviewer 2: Round 1
Date completed: 20 February 2025
Recommendation: Accept / Revisions required / **Resubmit for review** / Resubmit elsewhere / Decline / See comments
Conflicts of interest: None

Does the review fall within the scope of SAJS?
Yes/No
Is the review written in a style suitable for a non-specialist and is it of wider than only specialist interest?
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Yes/No/Not applicable
Are gaps in the literature adequately identified?
Yes/No/**Not applicable**
Does the review provide direction for future research?*
Yes/**No**/Not applicable
Are the methodology and statistical treatment appropriate?
Not applicable/Yes/No/**Partly**/Not qualified to judge
Are the interpretations and recommendations aligned with the objective?
Yes/**Partly**/No
Please rate the manuscript on overall contribution to the field
Excellent/Good/**Average**/Below average/Poor
Please rate the manuscript on language, grammar and tone
Excellent/**Good**/Average/Below average/Poor
Is the manuscript concise and free of repetition and redundancies?
Yes/No
Is the supplementary material relevant and separated appropriately from the main document?
Yes/No/Not applicable
Please rate the manuscript on overall quality
Excellent/Good/**Average**/Below average/Poor
If accepted, would you recommend that the article receives priority publication?
Yes/No
Are you willing to review a revision of this manuscript?
Yes/No
With regard to our policy on 'Publishing peer review reports', do you give us permission to publish your anonymised peer review report alongside the authors' response, as a supplementary file to the published article? Publication is voluntary and only with permission from both yourself and the author.
Yes/No
Comments to the Author: Overall comments The relationship between the research topic, aim and content (results) is poor. Again, there is no information about the efficacy of extension models in improving the adoption of sustainable agricultural practices. Therefore, the research topic, aim and objectives must be changed to reflect the information presented. The following topic is suggested: The impact of extension model in the adoption of sustainable

agricultural practices in selected developing countries. Impact is suggested because it differs from efficacy. I suggest that you do more reading to differentiate the two when revising the research topic.

(i) Materials and methods

The inclusion for the research papers reviewed only focuses on utilization of conventional agricultural extension models in SA and SSA. There is no mentioning of Sustainable Agricultural Practices (SAP) used by farmers even though the manuscript is about the efficacy of extension models in SAP. Therefore, the inclusion criteria must be revised to cater for all variables related to the study e.g. extension approaches, efficacy/impact etc. How was the efficacy/impact of extension models measured/identified in literature?. The limitations of the study must be added because literature sources not published in English were excluded in the study; thus, the findings cannot be generalised to non-English speaking countries without articles published in English. Moreover, the study delimitations must be added because not all Asian and SSA countries were included in the study. The study delimitations must also specify all publications years for articles included in the study (e.g. 1998-2024).

Data analysis must be added because all the literature sources reviewed were analysed before the presentation of the results. The section about the description of the included studies must be moved from results and discussion to materials and methods. It is part of the inclusion criteria.

(ii) Results and discussions

It is suggested that the following heading “Significance of conventional extension models on SAP adoption” must be changed to Impact of extension models on SAP adoption. Most of the information under “Significance of conventional extension models on SAP adoption” is mostly on the adoption rate of SAP and it is not linked to extension models investigated in the research. The results presented in Table 2 shows SAPs and adoption rates which is very important for the study. However, the interpretation of the results is not linked to what is presented in Table 2. It is suggested that the section about “Significance of conventional extension models on SAP adoption” must be linked to the results in Table 1. For example, focusing on the extension model and how they have promoted the adoption of SAP. In Table 1, it shows that T&V has led to the adoption of organic farming in Bangladesh, Ethiopia and India; however, the impact was low in two countries, but medium in the other. The above approach can be used to interpret the results of association between SAP and extension models. At the end, conclusion can be made about extension model that is dominant in the adoption of SAP. This is because there are extension models used to promote the adoption of various SAPs, meaning they are widely used to promote adoption. One of the important aspect is the definition of low, medium, tardy, and disadoption. What is low, medium and tardy adoption?

(iii) Conclusion

Most of the information covered under conclusion is important. Nonetheless, the section must be improved after the manuscripts has been revised.

(iv) References

In general, the referencing style is consistent. There are minor errors in the referencing for some journal articles whereby the journal volume and number, page numbers, article number etc., are omitted. Again, some journals are written in abbreviations (E.g. Reference 48, 73, etc.). In general, authors must align the referencing style for all sources cited with the journal requirements.

(v) General comments

In general, there manuscript has a potential to be published if major corrections can be made to improve it. The corrections will ensure that the research topic, and aim are aligned with the content provided in the results section. The description of conventional and traditional extension models must be provided somewhere in the introduction and methodology. What is the different between the two? This is important because some scholars argue that Farmer Field Schools are not conventional extension models because they are participatory in nature.

the research topic, aim and objectives must be changed to reflect the information presented. The following topic is suggested: The impact of extension model in the adoption of sustainable agricultural practices in selected developing countries. Impact is suggested because it differs from efficacy.

AUTHOR: The title has been changed to "The impact of extension models in the adoption of sustainable agricultural practices in South Asia and Sub-Saharan Africa: A systematic literature review." See the title page copy.

Materials and methods

The inclusion for the research papers reviewed only focuses on utilization of conventional agricultural extension models in SA and SSA. There is no mentioning of Sustainable Agricultural Practices (SAP) used by farmers even though the manuscript is about the efficacy of extension models in SAP. Therefore, the inclusion criteria must be revised to cater for all variables related to the study e.g. extension approaches, efficacy/impact etc.

How was the efficacy/impact of extension models measured/identified in literature?

The limitations of the study must be added because literature sources not published in English were excluded in the study; thus, the findings cannot be generalized to non-English speaking countries without articles published in English.

AUTHOR: The inclusion criteria has been revised with the inclusion of the SAPs utilized by the farmers and the extension models. Lines 101-106.
The measurement method for the extension model impact and how it was identified in literature was added. Lines 106-108.
A subsection for the limitations of the study was included. Lines 118-124.

Moreover, the study delimitations must be added because not all Asian and SSA countries were included in the study. The study delimitations must also specify all publications years for articles included in the study (e.g. 1998-2024). 1984-2023

Data analysis must be added because all the literature sources reviewed were analyzed before the presentation of the results. The section about the description of the included studies must be moved from results and discussion to materials and methods. It is part of the inclusion criteria.

AUTHOR: The delimitation of the study was added to the exclusion criteria. Lines 109-117.
A subsection for data analysis was added. Lines 125-131.
The section about the description of the included studies was moved from the results and discussion section to the materials and methods section. It was moved to the inclusion criteria. Lines 97-99.

Results and discussions

It is suggested that the following heading "Significance of conventional extension models on SAP adoption" must be changed to Impact of extension models on SAP adoption.

AUTHOR: The title has been changed to "impact of extension models on SAPs adoption" as suggested. Line 315.

Most of the information under "Significance of conventional extension models on SAP adoption" is mostly on the adoption rate of SAP and it is not linked to extension models investigated in the research. The results presented in Table 2 shows SAPs and adoption rates which is very important for the study. However, the interpretation of the results is not linked to what is presented in Table 2. It is suggested that the section about "Significance of conventional extension models on SAP adoption" must be linked to the results in Table 1.

AUTHOR: The results have been linked to the tables and figures as suggested. Lines 320-325, 327-331, 337-343, 349-357, 372-377.

The above approach can be used to interpret the results of association between SAP and extension models. At the end, conclusion can be made about extension model that is dominant in the adoption of SAP. This is because there are extension models used to promote the adoption of various SAPs, meaning they are widely used to promote adoption.

AUTHOR: The dominant extension models part was added. Line 320-322.

One of the important aspect is the definition of low, medium, tardy, and disadoption. What is low, medium and tardy adoption?

References

In general, the referencing style is consistent. There are minor errors in the referencing for some journal articles whereby the journal volume and number, page numbers, article number etc., are omitted. Again, some journals are written in abbreviations (E.g. Reference 48, 73, etc.). In general, authors must align the referencing style for all sources cited with the journal requirements.

General comments

The description of conventional and traditional extension models must be provided somewhere in the introduction and methodology. What is the different between the two? This is important because some scholars argue that Farmer Field Schools are not conventional extension models because they are participatory in nature.

Conclusion

Most of the information covered under conclusion is important. Nonetheless, the section must be improved after the manuscripts has been revised.

AUTHOR: The definition of low, medium, tardy and disadoption were explained as relative terms. Lines 322-325.

The reference section was modified as suggested though some journals did not have the specific information that is needed.

The description and differences of conventional and traditional extension models was done in the introduction. Lines 51-67.

The conclusion was revised. Lines 418-424.

Reviewer 2: Round 2
Date completed: 06 May 2025
Recommendation: Accept / Revisions required / Resubmit for review / Resubmit elsewhere / Decline / See comments
Conflicts of interest: None

Does the review fall within the scope of SAJS?
Yes/No
Is the review written in a style suitable for a non-specialist and is it of wider than only specialist interest?
Yes/No
Do the Title and Abstract clearly and accurately reflect the content of the review?
Yes/No
Does the review provide a significantly novel perspective or significant recent advances in the field?
Yes/No
Is the objective of the review concisely stated?
Yes/No
Is appropriate and adequate reference made to other work in the field?
Yes/No
Do current debates and points of contention receive appropriate coverage?
Yes/No/Not applicable
Are gaps in the literature adequately identified?

Yes/No/**Not applicable**

Does the review provide direction for future research?*

Yes/No/Not applicable

Are the methodology and statistical treatment appropriate?

Not applicable/**Yes**/No/Partly/Not qualified to judge

Are the interpretations and recommendations aligned with the objective?

Yes/Partly/No

Please rate the manuscript on overall contribution to the field

Excellent/**Good**/Average/Below average/Poor

Please rate the manuscript on language, grammar and tone

Excellent/**Good**/Average/Below average/Poor

Is the manuscript concise and free of repetition and redundancies?

Yes/No

Is the supplementary material relevant and separated appropriately from the main document?

Yes/No/Not applicable

Please rate the manuscript on overall quality

Excellent/**Good**/Average/Below average/Poor

If accepted, would you recommend that the article receives priority publication?

Yes/No

Are you willing to review a revision of this manuscript?

Yes/**No**

With regard to our policy on 'Publishing peer review reports', do you give us permission to publish your anonymised peer review report alongside the authors' response, as a supplementary file to the published article? Publication is voluntary and only with permission from both yourself and the author.

Yes/No

Comments to the Author:

Old title: Efficacy of extension models in sustainable agricultural practices in developing countries.
New title: The impact of extension models in the adoption of sustainable agricultural practices in South Asia and Sub-Saharan Africa: A systematic literature review.

Title

The comments about changing the title was addressed satisfactorily. From grammatical perspectives, the author must check whether is impact "on" or "in. Is it impact of extension model on the adoption " or "impact of extension model in the adoption ".

Introduction

The introduction has improved significantly after new information was added. The author is commended for addressing the comments raised by the reviewers.

Materials and methods

All the comments raised about inclusion criteria, study limitations and delimitations, and data analysis were addressed satisfactorily.

Results and discussion

The new information added in the results and discussion has improved the quality of the manuscript. The following comments are made:
In line 148-149, the word" factors" must not me repeated under each factors. The fact that in the beginning of the sentence it is mentioned, there is no need for the repetition. On the results of socio-economic factors, it is important to indicate whether factors correlated with SAP adoption were also statistically significant. If there are non-significant factors, it will be important to mention them. The same applies to negative and significant socio-economic factors. The above comments applies to quantitative studies that used correlation and regression to analyse data. As for qualitative studies, mentioning the factors without indicating their significant impact is acceptable. The above comments applies to biophysical, institutional,

financial and technical factors.

Inder institutional factors, the following is mentioned:" as well as the agroecological factors of the farm's location all influence SAPs adoption". The above statement contradict the heading because is about biophysical not institutional. For example, under biophysical, it was mentioned that distance from the nearest town or market as crucial in SAPs adoption. The statement must be moved to the relevant section.

In figure 4, Low/disadoption is used for Zambia and Zimbabwe, again medium/disadoption is used for India. This creates a confusion between if farmers did not adopt SAP, it means there a no adoption. Again, how can medium/disadoption be use together. The above comments must be addressed to avoid the confusion.

Conclusion

The conclusions and recommendations are aligned with the new research topic.

Overall comments

After revising the research topic and providing additional information, the quality of the manuscript has improved significantly. If the minor comments raised in this review, the manuscript will be of good quality. I suggest that the alternative word be found for disadoption. The reason being that it is highlighted in red colour, meaning the computer cannot validate the use of disadoption in English language.

Author response to Reviewer 2: Round 2

From grammatical perspectives, the author must check whether is impact "on" or "in. Is it impact of extension model on the adoption " or "impact of extension model in the adoption ".

AUTHOR: The title has been changed to "The impact of extension models on the adoption of sustainable agricultural practices in South Asia and Sub-Saharan Africa: A systematic literature review." See the title page copy.

I suggest that the alternative word be found for disadoption. The reason being that it is highlighted in red colour, meaning the computer cannot validate the use of disadoption in English language.

AUTHOR: "Disadoption" has been replaced with "Abandonment."

In line 148-149, the word" factors" must not me repeated under each factor. The fact that in the beginning of the sentence it is mentioned, there is no need for the repetition.

AUTHOR: The word 'factors' has been deleted under each factor.

Under institutional factors, the following is mentioned:" as well as the agroecological factors of the farm's location all influence SAPs adoption". The above statement contradict the heading because is about biophysical not institutional.

AUTHOR: The sentence has been deleted and replaced by 'as well as information and technical advice provided in various training programs all influence SAPs adoption.' Lines 129-130.
It has not been replaced under bio-physical for 'household location already represents it.' Line 122.

On the results of socio-economic factors, it is important to indicate whether factors correlated with SAP adoption were also statistically significant. If there are non-significant factors, it will be important to mention them. The same applies to negative and significant socio-economic factors. The above comments applies to quantitative studies that used correlation and regression to analyze data. As for qualitative studies, mentioning the factors without indicating their significant impact is acceptable. The above comments applies to biophysical, institutional, financial and technical factors.

AUTHOR: The significant factors from quantitative studies have been revised and those from the qualitative studies have been maintained. Lines 111, 123,130, 140

In figure 4, Low/disadoption is used for Zambia and Zimbabwe, again medium/disadoption is used for India. This creates a confusion between if farmers did not adopt SAP, it means there a no adoption. Again, how can medium/disadoption be use together. The above comments must be addressed to avoid the confusion.

AUTHOR: Figure 4 has been revised accordingly.

Appendix 1: Reviewer 1's comments on original manuscript (Round 1)

Efficacy of Agricultural Extension models in adoption of Sustainable Agricultural Practices in Developing Countries in Africa?

Commented [A1]: The title is very vague and broad.

Abstract

Using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology, this study rigorously analyzes the characteristics, strengths, and limitations of various extension models, including Fee-For-Service, Farmer Field Schools, Training and Visit, and Farmer-to-Farmer approaches. The review identifies persistent barriers to the widespread adoption of SAPs, such as limited access to resources, inadequate training, and the lack of tailored solutions for diverse farming contexts, which stem from the inherent limitations of conventional agricultural extension models. Also, it discussed a hybrid approach that integrates conventional and emerging participatory, demand-driven models, customized to smallholder farmers' unique needs and constraints. This integrative strategy is suggested to enhance the dissemination and adoption of SAPs, thereby contributing to sustainable development and food security in these regions. The paper concludes by emphasizing the need to leverage the complementary strengths of diverse extension models to address existing challenges and drive effective policy interventions.

Commented [A2]: Which regions?

Significance of the main findings

- To assist policymakers and practitioners to prioritize the development of agricultural extension strategies that are economically viable and tailored to the specific needs and constraints of smallholder farmers.
- To help foster greater engagement from policymakers, enhancing communication channels, and implementing robust feedback mechanisms to ensure that agricultural extension services are responsive and adaptable.

Keywords: Innovation; Transfer of Technology; Public Extension System; Diffusion; Adoption

Commented [A3]: This should be alphabetical, so start with Adoption first.

Figures and tables are located at the end of the document.

Introduction

Agricultural development is essential for sustainable development and reducing poverty in South Asia (SA) and Sub-Saharan Africa (SSA) [1,2]. Agricultural extension services are crucial for spreading technological advancements and tackling the challenges that farmers encounter at the local level [3,4]. Despite their significance, smallholder farmers in these regions often face substantial barriers, including limited access to critical knowledge, information, and resources to improve their agricultural practices and achieve agricultural progress. Effective extension models are crucial for successfully disseminating SAPs to farmers. However, smallholders in rural areas of developing countries frequently encounter difficulties in accessing SAPs [5]. To sustain their livelihoods, these farmers need a diverse range of reliable and precise information, as agricultural advancement depends on the ability to generate, share, and utilize knowledge effectively [6,7].

Providing effective and efficient agricultural extension services remains a complex challenge, particularly for smallholder farmers. Information on knowledge intensive SAPs in SA according to Ali [8] and SSA according to Davis [9] is provided by publicly financed agricultural extension services, which have historically struggled to cope with the changing demands of smallholder farmers. Notwithstanding the recognized benefits of SAPs and significant efforts by national and international organizations to promote their adoption, uptake remains low in rural areas [10–13] and low adoption rates are primarily due to gaps in farmers' knowledge [13,14].

The slow adoption of SAPs has raised concerns about the effectiveness of existing agricultural extension models, which have sometimes led to suboptimal outcomes [15,16]. The knowledge gaps in agricultural practices translate to yield discrepancies [17]. Hence, a large proportion of smallholder farmers in SA and SSA frequently utilize substandard practices in agriculture owing to a lack of awareness, expertise, and management [18]. This review acknowledges the complex array of factors influencing the adoption of innovations generally and SAPs specifically among smallholder farmers. It specifically examines the effectiveness of conventional extension models in promoting SAPs in SA and SSA, evaluating their strengths, weaknesses, and overall impact on the adoption of these practices.

Materials and methods

This study conducted a thorough literature analysis to examine the primary obstacles to the diffusion and adoption of SAPs among smallholder farmers in SA and SSA in the context of existing conventional agricultural extension models (i. Fee for Service, ii. Farmer Field Schools,

Commented [A4]: You need to write out SAP in full. And also define SAP. Also provide examples of SAPs

Commented [A5]: Rephrase these to sentences to clarify what you are trying to say.

Commented [A6]: In your text, you first start off with the strengths and weaknesses of the conventional extension services and then go into the factors influencing adoption of SAP. I think you need to restructure the text, and start of with the first point as described here in the aim of your review.

Commented [A7]: Im thinking you can put in figures where you compare the countries and the type of extension services they use, as well as adoption rates.

iii. Training and Visit, and iv. Farmer to Farmer). A systematic review aims to examine empirical evidence by extracting quantitative and qualitative aspects from original research [19,20]. The PRISMA method, in contrast to the traditional review, adopts well-defined protocols [20]. The method has been utilized in several disciplines [19,21] including agriculture research [20]. This study employed a four-phase flow diagram to conduct a systematic review. These include identifying studies, screening studies, examining study eligibility, and selecting studies for inclusion in this review (see Fig. 1).

Literature search strategy

The articles reviewed in this study were identified by searches on Springer, Scopus, Web of Science, Science Direct, PubMed, and Google Scholar. The keywords utilized in the search for literature were based on previously published empirical studies such as "SAPs," "agricultural extension models," and "innovation diffusion models in agriculture."

Inclusion criteria

The following criteria were used to choose papers: (i) empirical research articles and conference proceedings; (ii) studies published in English; and (iii) articles highlighting the utilization of conventional agricultural extension models in SA and SSA.

Exclusion criteria

Articles that were not accessible in full text or not published in English were excluded. Furthermore, studies that focused on locations other than SA and SSA, as well as non-conventional agricultural extension models, were excluded.

Results and discussions

Description of the included studies

Through a literature search, 750 articles were identified; nevertheless, after the exclusion of duplicates, titles, abstracts, and full-text screening, a total of 46 studies were considered relevant and thus were included in this study (see Fig. 1). All the reviewed countries in SSA show low adoption rates of SAPs among smallholder farmers as depicted in Table 2.

Conventional agricultural extension models

Fee-For-Service Extension Models

Private sectors provide the fee-for-service (FFS) extension model, in which farmers pay for extension services to make services more accessible. Generally, farmers hire extension workers to provide particular information and services [22–24]. This model provides current and relevant information to the farmers by establishing a demand-driven extension service platform that is economical, reliable, and outstanding [22]. According to studies conducted in Tanzania [25], Bangladesh [26], and Nepal [27], farmers were eager to pay for agricultural extension services. In Zimbabwe, requiring payment for extension services ensured that these services were delivered to farmers who were genuinely interested in acquiring knowledge and implementing the practices [28].

Research conducted in Zimbabwe by Foti et al., [28], as well as in Rwanda and Zambia by Ogunmodede et al., [26], found that farmers had a very low interest in FFS extension. Additionally, most governments in developing countries tend to oversupply free but ineffective extension services, leading to a lack of willingness especially among smallholder farmers, to pay for commercial extension services [28]. Additionally, smallholder farmers are unable to hire services due to their low incomes [9,16,24]. This model is more capitalistic, favoring wealthy farmers over others who cannot afford to pay for services. The majority of the farmers targeted for SAPs adoption are smallholders who are still battling with breaking the poverty cycle and are unable to pay for extension services, hence impeding the practices' adoption and diffusion.

Farmer Field Schools

The Farmer Field School (FFS) agricultural extension model emerged during the rice mono-cropping agricultural era. In the 1980s, Indonesia and the Philippines implemented this approach to spread knowledge-intensive Integrated Pest Management (IPM) [17,22]. FFS is an unstructured school within the farmers' neighborhood, a school without a building, community-driven training in which a similarly minded group of 20-25 neighboring farmers meets regularly with instructors amid the crop and animal cycles [22,29–31]. Farmers are encouraged to undertake independent research, identify and investigate challenges, and develop solutions.

Commented [A8]: Do not start a sentence with an abbreviation.

The success of FFS in Nigeria is due to farmers' engagement in identifying their challenges, deciding, testing, and assessing potential solutions [32]. FFS programs encourage cost-sharing to maintain sustainability as well as promote a sense of ownership and responsibility [9]. The earlier study suggests that the FFS model should be prioritized to enhance the dissemination of SAPs

aimed at enhancing average crop yields and improving the well-being of farming communities [33]. When appropriately integrated, FFS has been found to strengthen supply chain actors, farmers, and agribusiness champions' behavior related to climate change adaptation at a lower training cost [34,35].

Myriad obstacles (see Table 1) impede the implementation of FFS in SA and SSA, notably insufficient exposure of staff to FFS tenets and operations; gender disparities; and a low level of engagement of policymakers [24,31,36,37]. In Nigeria, the model's sustainability without outside financial backing was a significant obstacle [32]. Farmers who complete the FF school have been reported to have little success in disseminating the innovations among their neighbors [38]. This implies that the strategies for instruction and curriculum need to be rethought to make an impact on the intended users of the innovations being propagated.

Commented [A9]: Your tables should be numbered in order of first mention and appearance. You first mentioned table 2 in line 85, so I would make that table 1 instead and this one table 2.

Training and Visit Model

The training and visit (T&V) extension model has been extensively used as the main technology transfer approach in SSA and SA [30]. The model was envisioned to develop a group of extension experts competent in steering farmers toward increasing productivity and revenue through ideal, viable, and reliable planning [9,22,36,39]. The T&V model was remarkably successful and effective in disseminating Green Revolution technologies in irrigated areas of Asia, particularly India, where farming systems are more homogeneous [9,17,38,39,45,61].

Although the T&V model enhanced linkages with research by promoting highly specialized packages, studies revealed that it is unreliable, ineffective, devoid of equity, financially untenable, and ultimately led to many countries being burdened with insurmountable levels of debt [36,38,62,63]. In India, the withdrawal of the World Bank culminated in long-term financial commitments for state governments [38]. In Ethiopia, Kenya, Rwanda, Côte d'Ivoire, Cameroon, and Nigeria, the communication system between contact farmers and the rest of the community did not operate as intended; the model was eventually declared unsatisfactory [9,36,38,40,41].

Studies in India by Ferroni and Zhou [17] and Zambia by Mitti et al., [43] contend that, as a supply-driven system, the T&V model supported ideas developed by researchers with minimal input from farmers, and genuine technology adopters. Furthermore, it has been argued that in Nepal the model focused primarily on production, neglecting postharvest and agribusiness operations such as value addition, credit, and marketing; frequent monitoring; and communication infrastructure [1,42]. In Zambia as highlighted by Mitti et al., [43], the model was expensive to operate, inflexible, lacking appropriate feedback mechanisms, gender insensitive, and personnel tended to lack

focus. Overall, it is concluded that the T&V model did not fulfill its promises and expectations [17,64]. However, the T&V approach could be more effective in Tanzania if it were more participative and demand-driven [44].

Farmer-to-Farmer Extension Model

Farmer-to-farmer extension (F2FE) is based on the principle of voluntarism, often through establishing a network of farmer promoters and trainers, who are expected to educate and share information with other farmers [46–49,56]. Studies conducted in the Democratic Republic of Congo and Mozambique [15] and Rwanda [51] found that under F2FE, volunteer farmers are recruited, trained, and then mentored by other farmers on improved agricultural practices. Due to their numerous tasks, farmer trainers are often known as lead, innovative, volunteer, master, model, or community knowledge workers [14,31,47–49,58]. The F2FE model's popularity was influenced by flaws identified in previous models, such as the engagement of contact farmers in the T&V model [47]. F2FE is the prominent model for extension and advisory services in SSA [49]. When the fundamental principles are upheld, F2FE is an effective model for extension delivery [34,46,47,57].

F2FE has proved to be more viable in regions with strong social asset, minimal social strata, and strong community confidence [46,47,55]. Studies highlighted that the F2FE model was cost-effective, had improved accountability, and enabled marginalized communities who are frequently excluded from mainstream assistance to have greater access to extension services [52,59]. F2FE in Ethiopia was more valuable in farmers' adoption of SAPs and advocated for the continued use of model farmers in innovation dissemination [50]. Model farmers, on the other hand, associate the benefits of their role with an enhanced reputation, personal fulfillment, and the opportunity to receive various incentives [14,46,47,49].

The F2FE model has been proven to be ineffective when model farmers are chosen only on their abilities, without regard for their capacity to communicate and transfer their knowledge to others [16,46,47,55,60]. Additionally, a study conducted in Pakistan by Baloch and Thapa [54] found that providing an insufficient large number of field-based extension workers, each responsible for 2000-2400 households, proved ineffective despite the workers being well-equipped with the necessary knowledge. In other circumstances, as observed in Ethiopia, follower farmers often find it difficult to confidently replicate the practices of model farmers, as technology may remain exclusive or be predominantly utilized by early adopters [46]. The lead farmers were in conflict with the farmers under their leadership owing to the incentives benefited; ultimately prompting others to disadopt or not even adopt SAPs [14,65]. F2FE's success is further hampered by ineffective model

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farmer selection procedures, marginalization of smallholder farmers, and a lack of widespread support [46,47]. The F2FE model in Nepal lacks a clear pro-poor focus in agricultural extension and decentralization strategies [52]. Due to some of these identified challenges, a study found that only 43% of the sampled farmers in Zimbabwe utilized the F2FE extension approach which was below the expected target [53].

Significance of conventional extension models on SAP adoption

The central focus of extension services is the adoption of technologies and improved practices like ~~the~~ SAPs. In agricultural extension programmes, the acquired knowledge and information is an output whereas the adoption of technologies is an outcome and the ultimate impact is the change in productivity [45]. The reviewed conventional agricultural extension models have been employed to promote SAPs to farmers (see Table 2). Notwithstanding their benefits, profound global concerns, and the desire to achieve SDGs by 2030, the adoption rate and extensive utilization of SAPs is still low in rural regions of developing countries [11,29,65–69]. Research in Nigeria by Oyetunde-usman et al., [13] found that the adoption of SAPs (improved seed varieties) was low (14%). Similarly, in Tanzania Tenge et al., [10] reported that the adoption of SAPs (conservation of soil and water) is low, and soil erosion persists as a threat. The primary cause for low SAPs (agroforestry) adoption in Kenya is a lack of knowledge regarding farmers' adopting behaviour towards the technique [70]. Despite the national promotion of SAPs, the idea of SAPs (organic farming) was new to Bangladesh farmers, and adoption rates remained low [71].

Farmers in Rwanda expressed concern about the inadequate availability of extension services, and practical knowledge to sustain them, resulting in low SAPs (terrace) adoption rates [72,73]. SAPs have been promoted through FFS in the Democratic Republic of the Congo and Mozambique, notably CA, nevertheless adoption rates are low [15,16]. Despite the benefits of CA its adoption in Mozambique has been tardy and low due to farmers' lack of vital skills, knowledge, and equipment, as well as inadequate extension services and poverty [12]. In Ethiopia Teklewold et al., [66] noted that SAPs adoption rates remained lower than expected. Furthermore, research done in Zambia revealed low SAPs (CA) adoption rates despite being promoted for over fifteen years [14,67,74,75]. Similarly, the SAPs (agroforestry) were not widely adopted in Cameroon [76]. Although CA holds great potential, its adoption by farmers in Malawi remains low, and some basin-based CA abandonment has been documented [59].

The quest for widespread SAPs (Climate-smart agriculture) adoption was found to be complicated in Pakistan [69]. In Nepal Kumar et al., [77] found that KISAN recipient farmers adopted SAPs (climate

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resilient technologies) instead of KISAN non-beneficiary farmers. SAPs (organic farming) are progressively more widespread with low to medium adoption and are stable in India [2,78,79]. However, smallholder farmers continue to cultivate less than 1 hectare of land under SAPs [78]. Similarly, a study in Zambia by Habanyati et al., [14] revealed that smallholder farmers who had adopted CA were cultivating tiny portions of land while larger portions were under conventional agriculture.

Unfortunately, in Zambia Arslan et al., [75] and Habanyati et al., [14] found that there were high levels of disadoption (around 95%) of SAPs among smallholder farmers, with anecdotal evidence indicating that most "adoption" was in anticipation of receiving free inputs and that once these incentives were no longer delivered, disadoption occurred. Pedzisa et al., [80] observed significant levels of CA disadoption in Zimbabwe, arguing that such disadoption does not occur in conventional agriculture. Brown et al., [16]'s study in Africa showed that a lot of farmers adopt CA because they have a mindset that they will receive some incentives to do that. But when the perceived incentives are not provided, they lag behind. A significant number of respondents depended on project support to implement conservation agriculture-based sustainable intensification [60]. However, their adoption of this approach ceased when the support was withdrawn.

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Conclusions

This review highlights the limitations of conventional agricultural extension models in effectively promoting the adoption of SAPs among smallholder farmers in SA and SSA. Traditional models such as Fee-For-Service, FFS, T&V system, and F2FE have shown variable success but often fall short of the transformative impacts in disseminating SAPs. Persistently low adoption rates and frequent disadoption of SAPs underscore the need for a more integrated and context-sensitive approach to extension services. To overcome these challenges, it is essential to combine conventional extension models with innovative, participatory, and demand-driven approaches. Enhancing the participatory nature of FFS and T&V models by involving farmers can increase their relevance and effectiveness. Policymakers and practitioners should prioritize the development of extension strategies that are economically viable and tailored to the specific needs and constraints of smallholder farmers. This includes fostering greater engagement from policymakers, enhancing communication channels, and implementing robust feedback mechanisms to ensure that extension services are responsive and adaptable.

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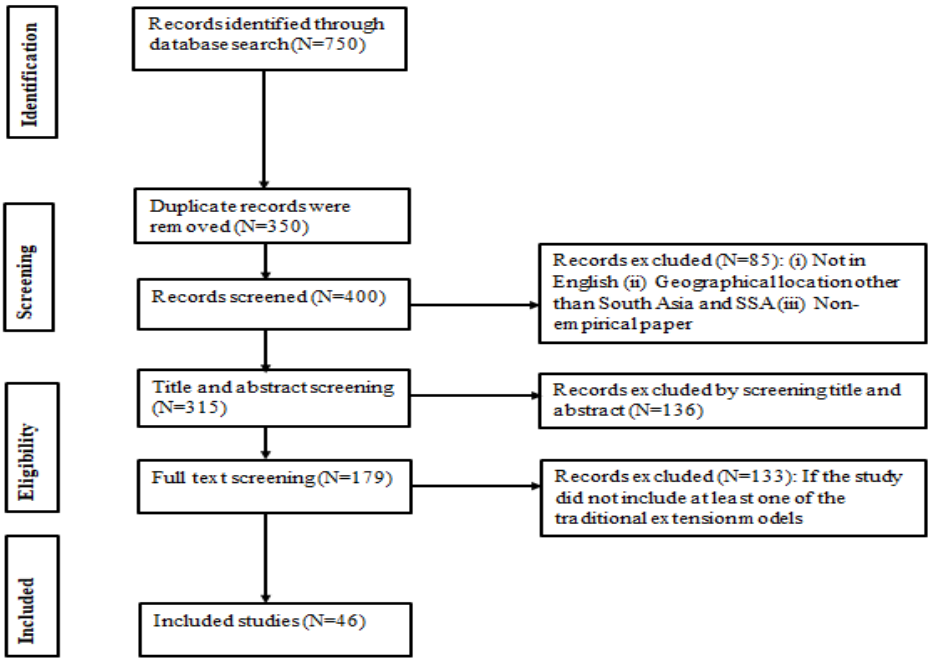
Figures and Tables



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504 **Fig. 1** PRISMA Flow chart

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506 Table 1: Comparative analysis of conventional extension models employed in SA and SSA

Model	Characteristics	Strengths	Weaknesses	Country	Selected references
Fee-For-Service	Demand driven	Farmers pay for the service Farmers contract extension workers Cost effective service system High quality services	Smallholder farmers fail to purchase the service due to low income	Tanzania Bangladesh Nepal Rwanda Zambia	Davis [9] Foti et al., [28] Shausi et al., [25] Ogunmodede et al., [26] Paudel et al., [27] Brown et al., [16] Brown et al., [23]
Farmer Field Schools	Demand driven	Discovery learning Direct links between farmers and scientists Critical thinking and creativity Encourage cost sharing High levels of ownership Intensive training activities Democratic and participatory Client centered Community-based learning	Extension staff are not adequately exposed to FFS FFS activities are not coordinated at national level Gender disparities Low degree of engagement and collaboration of policymakers Financially unsustainable	India Pakistan Kenya Nigeria DRC Gambia Niger Cameroon Togo Uganda Namibia Tanzania Zimbabwe	Anandajayasekeram et al., [36] Davis [9] Ferroni and Zhou [17] Abdullah et al., [33] Ajani and Onwubuya [32] Cipriano et al., [15] Maulu et al., [31] Mapiye et al., [30]
Training and Visit	Supply-driven system	Increased geographical coverage Improved linkages with research Promotes very specific packages Aiding farmers to enhance output and income	Lack appropriate feedback mechanisms Financially unsustainable Extension agents lack communication skills Too rigid and costly One way of information flow Farmers are passive Too hierarchical	Kenya Rwanda Ethiopia Cameroon Nigeria Mozambique India Nepal	Anandajayasekeram et al., [36] Cunguara and Moder [39] Davis [9] Ferroni and Zhou [17] Buehren et al., [40] Ekumankama and Anyanwu [41] Jamison and Moock [42] Dhital [1] Mitti et al., [43]

		Extension officers are knowledgeable and up to date	Gender insensitive	Zambia Tanzania	van den Ban and Mkwawa [44] Maulu et al., [31] Mapiye et al., [30] Taye [45]
F2FE	Demand driven	Model farmers train and share local information Low costs and effective Wide coverage Improved sustainability and accountability Inclusive of marginalized farmers Farmers are active High credibility Harness the indigenous leadership Participatory Principle of voluntarism Enhanced feedback mechanisms from farmers to extension staff	Model farmers lack communication skills Conflicts between lead farmers and their followers Biasness in selecting model farmers Gender imbalance Inadequate backing from local institutions Absence of relevant training resources Limited technical expertise among farmers High expectations from farmers regarding financial and non-financial rewards Elevated dropout rates among participants	Ethiopia Zambia Kenya Nepal Zimbabwe Pakistan Rwanda India Malawi Uganda Bangladesh Cameroon Congo DR Mozambique	Hailemichael and Haug [46] Kiptot and Franzel [47] Scarborough et al., [48] Simpson et al., [49] Habanyati et al., [14] Tessema et al., [50] Kiptot et al., [51] Shrestha [52] Dube [53] Baloch and Thapa [54] Sah et al., [55] Cipriano et al., [15] Brown et al., [16] Maulu et al., [31] Kansiime et al., [56] Meena et al., [57] Meena et al., [58] Fisher et al., [59] Chaudhary et al., [60] Martini et al., [34]

511 Table 2: SAPs and adoption rates

Selected references	Country	SAPs	Adoption rates	Conventional extension model used
Oyetunde-usman et al., [13]	Nigeria	Improved seed varieties	Low	FFS T&V
Tenge et al., [10]	Tanzania	Soil and water conservation technologies	Low	Fee-for-Service T&V
Hammond et al., [72] Nahayo et al., [73]	Rwanda	Terraces	Low	Fee-for-Service T&V F2FE
Cipriano et al., [15]	Democratic Republic of the Congo	CA	Low	FFS
Nkala et al., [12] Cipriano et al., [15]	Mozambique	CA	Low and tardy	T&V
Teklewold et al., [66]	Ethiopia	Organic farming	Low	T&V F2FE
Habanyati et al., [14] Arslan et al., [75] Ng'ombe et al., [67] Nkomoki et al., [74]	Zambia	CA	Low Disadoption	Fee-for-Service T&V F2FE
Nkamleu and Manyong [76]	Cameroon	Agroforestry	Low	T&V
Mazhar et al., [69]	Pakistan	Climate-smart agriculture	Low	FFS F2FE
Kumar et al., [77]	Nepal	Climate resilient technologies	Medium	Fee-for-Service T&V F2FE
Singh and Sharma [79] Brown et al., [23] Chaudhary et al., [60]	India	Organic farming	Medium Disadoption	FFS T&V
Pedzisa et al., [80]	Zimbabwe	CA	Low Disadoption	Fee-for-Service F2FE
Mwaura et al., [70]	Kenya	Agroforestry	Low	F2FE FFS T&V
Sarker and Yoshihito [71]	Bangladesh	Organic farming	Low	Fee-for-Service

Fisher et al., [59]	Malawi	CA	Low	F2FE

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