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REVIEW

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A scoping review on the impacts of smallholder agriculture production on food and nutrition security: Evidence from Ethiopia context

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Abstract

Background Currently, food and nutrition insecurity are global challenges. Millions of people are still suffering from this problem in Ethiopia. Smallholder farmers that dominated the agricultural sector in most developing countries like Ethiopia are deemed as one avenue to address such challenges. The purpose of this review was, therefore, to scrutinize the impact of smallholder agriculture production on food and nutrition security from Ethiopian context. Empirical studies were retrieved through electronic databases and the backward searching mechanism in which the Preferred Reporting Items for Systematic Reviews and Meta-Analyses flowchart were used to select the empirical studies and to report the review results.

Results The finding of the review indicated that, smallholder farmer plays a decisive role in an effort towards improving food and nutrition security through either directly as sources food and/ or indirectly provides means and mechanisms to access the required food type at different level. Furthermore, it is found that, female contributed more in securing food and nutrition status of households compared to their male counterparts. Yet, both male and female smallholder farmers are faced different challenges including lack of access to agricultural infrastructures and facilities, plant and animal disease, and gender- based difference on access to and control over productive resources.

Conclusion and recommendation. Given the contributions of smallholder agriculture in Ethiopia, there is a need to strengthen capacity of female and male smallholder farmers through provision of gender responsive agricultural advisory services and credit services tailored to the local context as options in improving food and nutrition security in Ethiopia.

Keywords Smallholder farmers, Food and nutrition security, Impacts, Gender, Households, Formal and informal mechanisms.

Background and rationale to the review

The concept of food and nutritional security varies from time to time and contexts to contexts. The focus towards food and nutrition is changed with time and other situations and currently it is not only about the amount of food that individual eats rather include several interrelated issues like the time, psychical, social and economic aspects, the sources, process, and the quality and health aspect of the food that come to the end user. It is a

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complex and interactive process and affected by so many factors like climate change, political and institutional structures and system, and socio- economic factors.

Evidences indicated that ensuring the food and nutrition security is becoming critical concern as more than 800 million people in the world are in the food insecure status of which more than 50% are from African countries and more than 35% of the population in Ethiopia are under the state of the food insecurity [1, 2].

In response to such challenges, international and national communities place different policies and strategies. Agriculture which is considered an important strategy for overcoming many of the emergencies faced by rural households in developing countries is the focus area [3]. In relation to this, it is deemed that smallholder farming is the pathway to reduce prevalent poverty, enhances food and nutrition and focusing on such farm approach is thought as mechanism to address several issues. On one hand, in most developing countries in general and in Ethiopia in particular, the largest portion of agricultural sector is dominated by the smallholder farmers who produce more than 90% of the produce [4, 5]. On the other hand they are identified as resources utilizers (e.g. labour and sloppy areas). Further, it is indicated that these farmers will enable to address equity issues and efficiency as the smallholder farmers are among resources less groups and faced several challenges in which most female farmers participated in such framing approach relative to the large scale farming who focus on exporting and capital intensive technologies [6, 7]. In contrast to the above, some literature claimed that smallholder farmers are subsistent oriented and mainly produces for household consumption see for example [8]. In this respect, smallholder farmers are supposed as less visible to compute in the market and meet food demand of the rapidly growing population.

Building on the existing literatures, scoping review was conducted to gain better understandings on the impact of smallholder farms approach on food and nutrition security in Ethiopia. Hence, this particular review aimed to address the following questions. To what extent do the smallholder agricultural productions contribute in the effort towards enhancement of food and nutrition security of households and local communities in Ethiopia? Do gender matter or have any implications in the impact of smallholder agricultural productions on food and nutrition? And what are the main factors determining the food and nutrition security of smallholder agricultural production?

In doing so, this review would be an addition in the growing literature in the area of smallholder farm and their impact on food and nutrition security at the household and local community levels by showing mechanisms smallholder produces use to enhance and secure food security of households. Moreover, there is a lack of standalone reviews that systematically summarizes and provides an important source on the impact of smallholder on food and nutrition security, its determining factors and mechanisms used by smallholder farmers to enhance food and nutrition security in Ethiopia from a gender point of view in which this review aimed to fill such gap.

Review methodology

Types of review, search engines and mechanisms

Since the aim of this review was to assess the impact of smallholder farmers on food and nutrition security using secondary data, a scoping review which is one of the descriptive types of review was used. Using this review type, this particular review identified, mapped the available evidences and reported on the types of evidence that address and inform practice in a given field (for this review, food and nutrition security effect of smallholder farmers and the way the previous research has been conducted [9, 10].

Similar to the empirical study, standalone review is expected to rigorously collect source to answer the main research question of a review. To this end, this review has used different searching engines (mainly the electronic databases) and techniques. At the first instance, the topic, "The Impacts of Smallholder Agriculture Production on Food and Nutrition Security in Ethiopia" was entered directly in the electronic database. A pilot of search using this searching mechanism was resulted with 33 sources. Second, different searching phrases and terminologies were used to get more sources by adding and removing some suffixes and prefixes of the topic. Key terminologies includes; smallholder farmers, food and nutrition security, impacts of smallholder farmers, the way and mechanisms smallholder farms contribute in the food and nutrition security of households, market participation of smallholder farmer and determinates of smallholder farmers. This enables to access 205 records. Third sources that are deemed relevant but denied access through the Google and Google scholars were entered into other data bases and 3 sources were accessed using this searching. Furthermore, 5 articles were accessed through the backward searching. Finally, 246 total records were identified using the above searching engines and terminologies.

Procedures followed and criteria used to select empirical studies

In line to [11] and [12], the Preferred Reporting Items for Systematic Reviews and Meta-Analyses checklist (PRISMA) protocol was used as a guideline to choose the empirical studies and report the result of the review. Accordingly, abstract of the identified records were

readout in the first stage to understand the eligibility / relevance of studies. This technique enables to easily identify and decide whether to go through the remaining section of the retrieved sources or not. Hence, of the 246, 115 sources that did not address any of the review objectives stated above in their abstract were excluded at the first instance of the selection process. The remaining 131 sources were kept for the second screening and assessed for their temporal eligibility (published after 2014) and spatial eligibility (conducted in Ethiopia). Only 52 sources were satisfying these inclusion criteria. Taking, originality, methodological rigorous and being published in reputable journals as selection mechanism, only 16 of them were found to fulfil these criteria and considered for the review. On the other hand, the exclusion criteria include: review articles, reports, unpublished and conducted in other countries rather than in Ethiopia. Such sources were used to discuss the theoretical review and support or argue the empirical evidence from Ethiopia.

Empirical Evidences

Impacts of smallholder agriculture production on food and nutrition security

Smallholder farmers consume most of their produces at home, basing their food intake on what they grow and sell part of their produce in the market. They also exchange plots of land and food with other smallholder farmers as long as it is needed. All these enable the smallholder farmers to enhance the food and nutrition security at least at household, regional and local level. With these concepts in mind, this particular review has discussed the empirical evidence on the impact of smallholder agricultural production in enhancing the food and nutrition security.

A cross sectional study was conducted to investigate the impact of smallholder farming who participate in the small-scale irrigation on household food security in Ethiopia, Oromia region, Adamitulu Jido Komoblcha district. Primary data were collected from randomly selected 94 irrigation users and 100 non-user households. The study has applied propensity score matching model and calorie intake, crop harvest and consumption both from own production and bought from the sale of the crop harvest produced as indicator of food security. The finding of the study showed that, use of irrigation by the smallholder farm producers has a positive impact on food security through consumption of own crop harvest [13]. Other study has analyzed the role of wheat varietal diversification on the food security of smallholder farmers in Ethiopia, focusing in three major wheat-growing regions of Ethiopia (North—Wollo in the Amhara region; central—in the Tigray region; and the district of Chefe Donsa in Oromia region), where smallholder farmers are participating in the seed for need program. The study has selected 66 villages in which 18, 18 and 30 were selected from Amhara, Tigray and Oromia region on this order. The study has applied the double robust estimator to properly estimate the impact of seed for need program. Results of the study then revealed that, the effects of the seed for need initiative were positive and statistically significant on the food security by improving the yield and food provision. The finding of the study showed that, varietal diversification through the participatory approach promoted by the program has increased on-farm varietal diversity as measured by the Simpson diversity index and Margalef species richness index, and enhances households' food security among smallholder farmers in the study area. The study further revealed that, yield change (29%) is also positive and significant for beneficiary households compared to the non-beneficiary and it is estimated to reduce around 10% of food insecurity as measured via household experienced inadequate food provision and 12% via the food insecurity dummy. According to the explanation of the authors, the effect on food security of participants was mediated through the yield change associated with the increased adaptation of the new varieties and improving farmers information on the proposed varieties [14]. Though the amount of food consumption from own produce differs across context, there are empirical studies from other developing countries context that substantiate the above findings. For instance, a cross sectional study conducted in the context of Uganda with an aim to investigate the role of smallholder bean farmers in determining farm gate prices for beans revealed that, majority (67%) of households consume products from their own farms [15]. A case analysis from West and East Africa, South Asia, and Central America also supports the above findings. The data for the case analysis were gathered from 9 sites and 5,314 households and found that, smallholder households that adapt with double motivation (market and climate change adaptation) has an impressive 95.6 days of food security (i.e., 7.09 per practice changed times 13.48 changes, on average) and on average, 295.6 days of food security in a year; agricultural adaptation provides 32% of their yearly food security [16]. See also the finding of [17, 18] on the role of smallholder farming as source of food for households.

Alongside the cultivation of produces for household consumptions, smallholder farmers that have market access are able to generate cash/ income through the production of high value crops and buy the food they need and other household expenditure [19]. A study conducted in central Ethiopia, MinjarShenkora, Gimbichu and Lume-Ejere has assessed the welfare impacts of improved chickpea adoption by smallholder farmers.

A total of 700 farm households were considered by the study from the three districts. The study has employed a standardized survey instrument and calculated household welfare as annual net income per capita in constant 2005 USD purchasing power party. The finding of the study indicated that, improved chickpea cultivation contributes to significantly higher yields and this allowed the framers to sell a share of their production the market. The result from the t-test of the study indicates that, the volume of production/yield for non-adopter and adopter were 1875 kg/ ha and 2338 kg/ha in which 54.3% and 58.0% of the chickpea production was sold in the market by non-adopters and adopter households, respectively. This in turn accounts about 739 and 1727 net returns to chickpea sales (USD) and 21.6% and 38.6% chickpea sales as share of income for the non-adopter and adopter households, respectively. The result of the study also showed that a 10% increase in the area planted with improved chickpea was associated with a 12.6% increase in income per capita and a 12.3% increase in total income for poor households. The result from the fixed effects linear probability model of the study also indicated that, the increase in yield and income has reduced the probability of a household being below the $2.00 poverty line and a 10% increase in the area planted with improved chickpea reduces the probability of being below the median poverty line by 3.9% [20]. Moreover, a study conducted in Ethiopia, Oromia region, Adamitulu Jido Komoblcha district to evaluate the impact of small-scale irrigation on household food security using the propensity score matching approach and the calorie intake, crop harvest and consumptions both from own production and from the sale of the crop harvest produced through irrigation as an indicator of food security revealed that, smallholder's irrigation adoption enabled smallholder farmers to produce enough crops / yields and these crops/ yield helped irrigation user households to generate more 94,553.74 birr/ income than non-users. According to the author's explanation, this income in turn enables to buy food items which are rich in calories and to complement the food requirements in addition to what they produce including meat, barley, chicken, yogurt, and avocado and egg. Furthermore, the result from nearest neighbour and calliper matching estimator of the study showed that, irrigation by the smallholder farm has increased the daily per capita caloric intake of user households by 643.76 kilocalories than non-user households which is statistically significant at 1% significance level and it increased to 596.43 kcal and 591.74 kcal with radius and kernel matching estimators, respectively [13].

Another corss-sectionl study was coundcted by Tamirat (2020) to assess the adoption of row planting of '*Teff* 'crop and its impact on smallholder farmer welfare and food consumption expenditure in Ethiopia, South Nations, Nationalities, People's Region Hadiya Zone, Duna district. The study has gathered data from a sample of 355 (200 non adopters and 155 adopters) '*Teff*' producing smallholder famers selected from six kebeles to represent major '*Teff*' producers of the row planting '*Teff*' crop. The study employed propensity score matching approach to evaluate the impact of row planting '*Teff*' crop on welfare and food consumption expenditure. The finding of the study showed that, row planting technology has significant and positive effect on household welfare as evidenced by the significantly higher yields for adopters by 6.20 quintals/ha, higher per capita consumption expenditure and annual income resulting from adoption at $p < 0.01$. The finding of the study also indicated that, food consumption expenditure and income accounts on average 6,559.75 Birr and 9,168.55 Birr for the adopters, respectively [21]. See also [22] which confirms the above finding Furthermore, a case study by [23] was conducted to measure the impact of subsistence agriculture on household diets. Household consumption and expenditure survey collected by central statistical agency of Ethiopia that covered the entire country except for some nomadic pastoralists in the eastern region was utilized by the study. Data for the study were collected from 10,322 rural households. Food availability in each sample household was measured in terms of the number of calories consumed per capita and day and dietary diversity was calculated using the household dietary diversity score in which twelve food groups consumed by the households during the 7-day recall period was considered. The finding of the study showed that, subsistence production accounts for 58% of rural households' calorie consumption in which over 80% of the food diversity is purchased in the market with farm cash income playing a larger role than off-farm cash income [23]. Analysis on Ethiopian smallholder coffee producers using the food insecurity reported by household as a function of share of income coming from coffee also showed that, share of coffee in the total income portfolio by 25% is associated with 0.10 unit of standard deviation decrease in food insecurity and the instrumental variable estimator indicated that increasing the share of coffee in a household's income portfolio by 25% decreases the household food insecurity score on average by 0.35 units of standard deviation ($p = 0.039$) [24].

Another study that analyzes the food security effects of smallholders' participation in apple and mango value chains in North-Western Ethiopia using the nearest neighbour matching also found that the calorie intake of the apple participants was 2889.04 kcal and that of the non-participants was 2103.86 kcal, while the calorie intake of the mango participants was 3096.31 kcal

and that of the non-participants was 2778.64 kcal. Using kernel-based matching approaches (0.01 bandwidth), the study indicated that apple participants consumed 2868.32 kcal per adult equivalent per day, which is approximately 7.03% higher than the corresponding non-participants and the calorie intake (mean food consumption) was about 3042.33 kcal for mango participants, while the corresponding figure for non-participants was 2870.41 kcal [25]. More specifically, a study from the East Hararge zone of Oromia regional state, Haramaya and Girawa district using the endogenous switching regression and score matching showed that, the adoption of improved maize varieties positively and significantly increased consumption expenditure per adult equivalent that ranges from 14.4 to 19.2% [26]. This particular finding is confirmed by another study conducted in the East Haraghe zone Oromia regional state, Ethiopia aimed to measure the impact of adopting agricultural technologies on household food consumption and dietary diversity. The study has applied 5-nearest neighbour matching and a one-to-one matching algorithm to measure the food consumption score and household dietary diversity score, respectively. The study showed that, households using improved agricultural technologies had an average of 8.97 higher food consumption score and a 1.22 higher household dietary diversity, respectively, [27] and reduces the likelihood of households being in the chronically poor situation or enable them to move to a better welfare situation [22]. See also the finding form Tanzania [28]. From the above discussion, it is possible to infer that smallholder agricultural production has significant and positive impact in enhancing food and nutrition with varying status and intensity across cases and context in Ethiopia.

Unlike the large scale farming that basically relied on the formal market, smallholder farmers use different mechanisms and channels to enhance the food security status of their family and other consumers. With respect to this it is stated that, almost all (99%) and (96%) of the smallholder farmers in Ethiopia relied in the informal and local markets, respectively, to sell their produce [29] and some farmers uses barter as mechanism to improve their produce and food security. This idea is confirmed by the empirical studies form other developing country context. As it is indicated in the finding of Palmioli, neighbour farmers create sort of synergy in which one of the farmer give 1 ha of his land to cultivate corn, and the other in turn gets 1 ha of land to grow potatoes. In this way, both farmers produce and enhance food and nutrition security of their household. The authors also reported the data extracted from the interview as; in exchange for olive oil and wine he/she receives meat, which accounts for about 90% of the household's meat consumption [17]. These mechanisms often play a key role in ensuring smallholder livelihood, their neighbours and local community's food and nutrition security [18]. Even though such strategies are important from the smallholder food and nutrition security point of view, their important role in enhancing food security status of the large portion of the communities particularly for the poor households get less to no attention from the academicians and agricultural interventions.

Gender, smallholder agriculture production and food and nutrition security

Given the gender-based difference on access and control towards productive resources and opportunities, and limited appreciation of gender roles in implementation of strategies towards realization of food security, sustainable agriculture, economic growth and food security are undermined [30] and most women faced the persistent hunger and malnutrition problem globally. There is strong relationship between gender inequality and food and nutrition insecurity and the reverse is true. Women's and girls' own food security and nutrition needs are being neglected at the household level, they eat the least and after male members of the family especially in countries where discriminatory social and cultural norms prevail [31] like Ethiopia. This gendered food insecurity also contributes to increasing the risk of child malnutrition, as food insecurity affects diet quality of children's and women's, and health in different ways [2].

However, if they get the opportunity to do so and access to productive resources as do men, it is deemed that women are interested and ready to accept and adopt agricultural technologies and have better contribution on household food securities compared to their men counterpart. In Ethiopia, women are the primary decision-makers regarding household healthcare and daily activities including the type and component of food to be consumed by the household and children which are important issues in the battle against food and nutrition insecurity in the country.

Of the selected articles, only two of them have addressed the gender aspect while they analyze the impact of smallholder farmers on food and nutrition security. Accordingly, in a panel study that have used a three waves of farm household survey collected from 390 households that are drawn from the 2012 nationally representative baseline survey conducted by the International Food Policy Research Institute (IFPRI) and Agricultural Transformation Agency (ATA) in the four main regions of Ethiopia; Tigray, Amhara, Oromia and Southern Nations Nationalities and Peoples (SNNP) and applied the seven day recall period revealed that, gender of the household head was

negatively associated with food consumption. The study showed that, male-headed households have 15% less consumption than female-headed households indicating that female-headed households takes care about the amount and type of food consumed in the household relative their male counter parts [22]. This finding confirms with the finding of previous study that revealed, female farmers' product is first for household consumption and they can sell when they produce enough relative to men who would prefer to sell rather than keeping his products for self-consumption [17].

Contrary to the above finding, another study that analyzed the gender gaps in food security among male, female, and joint decision-making farm households using primary data collected from 560 farm households in Dawuro zone, southern Ethiopia showed that, the mean probability of being in the food-secure category among female decision-making households is 12.1% lower than male decision-making households and the mean probability of being in the transitory and chronic food- insecure categories among females is 6.0% and 6.1% higher, respectively, than that among males. As per the explanation of the author, these gaps are explained by difference in resource endowment between male and female-headed households. Hence, if females had the same amount of resources as males, their probability of taking the food- secure position would increase by 4.6% and if females had the same returns from their resources as males, their probability of being in the food-secure category would increase by 11.6% [32]. This finding is confirmed by cross-sectional study on women empowerment, land tenure and property rights, and household food security among Nigerian smallholders. This study revealed that, female achievement in the asset and group membership has increased the dietary intake of diverse food groups among the farming households given their access to and control over productive resource are enhanced as male farmers do [33].

From the discussion on gender, smallholder agriculture and food security, it is possible to infer that, the result is mixed. It is also possible to deduce that, the difference in food and nutrition security of male and female-headed household smallholder farmers is attributed to gender different in access to and control over productive resources in most of the case. Moreover, empirical evidences on nexus between gender, smallholder agriculture production and food security are scant which is an indication for further investigation on what explains the difference on food and nutrition security of male and female-headed household smallholder farmers in Ethiopia.

Factors that determine the impact of smallholder agriculture production on food and nutrition security

With respect to the factors that determine the impact of smallholder produce on food and nutrition security, one study revealed that, sex, education and family size of household, livestock holding, use of credit, extension services, access and attending farmers' training centre were found to be significantly and positively associated with households' adoption decisions with marginal effects ranging from 1.1 to 22.7% on average. That means these factors may indirectly influence the food security of smallholder farms positively [21]. Similarly, other study indicated that age, education, land size, access to extension service, and participation in off or non-farm activities have positive impacts on participation in irrigation and then food security status of smallholder farmers [13]. See also on the impact of education and off-farm activity from Nigeria [33]. Strong social capital [7], knowledge and information on the crop varieties [14] were also found as enabling condition to increase the probability of being food secure for smallholder. It is also found that, certain level of strengthening market participation or specialization to generate cash income as key element in strategies to improve diets and nutrition in the small-farm sector [23]. Another study that assessed the contribution of crop diversification in improving household food security among wheat dominated rural households in Sinana District, Bale Zone, Ethiopia also found that asset holding, access to road and agricultural information and crop diversification have a positive influence on dietary diversity and a negative influence on household food insecurity access scale [3].

On the other hand, the main factors that limit smallholder's productivity and food and nutrition security include; lack of connection between farm produce and local market [3], distance from farm plot to water source [13], lack of access and control over agricultural inputs and output markets, plant and animal diseases, household expenditure and large family size [7].

From the gender point of view, one study that has applied gender disaggregated T-test mean comparison and Tobit regression model to analyze gender deference found that, male-headed household possesses on average 1.25 and 0.96 hectares of non-coffee and coffee land, respectively, whereas female-headed households have on average 1.11 and 0.59 hectares for non-coffee and coffee land, respectively, in which these households have on average a farm physical capital valued for 6673 ETB, and 3022 ETB, respectively [7]. Another study from Bilo Nopa district of Ilu Aba Bor zone, Oromia region Ethiopia using the chi-square test result also showed that, sex of household head was found statistically significant at 1% significance level indicating that, participation

of female-headed household in maize output market was very low [8]. Such difference is mainly attributed to gender-based difference in access to and control over resources and opportunities and less emphasis to such difference has contributed female-headed households to be poor and food insecurity comparing to male counter parts [22, 27]. From the above discussion, it is possible to deduce that determinant factors of smallholder produce vary across studies and context. The most common enabling factors are social capital, asset holding, education level, crop diversification with relative market participation whereas the common hindering factors are lack of access to infrastructures, land and agricultural input and output markets and lack of attention to take the gender difference into consideration by agricultural intervention. Hence, enhancing the productivity of smallholder agriculture through provision of gender sensitive agricultural input and advisory services can positively contribute in the food and nutrition security.

Conclusions and implications

The purpose of this review was to assess the impact of smallholder farming on food and nutrition security. The literature indicated that, currently ensuring food security is a critical challenge by the international communities and regional governments where the situation is severe in developing countries like Ethiopia that lack resources to respond and lessen it.

The discussion on the finding of the selected studies indicated that, smallholder farm has played pivotal role in the effort towards improving food and nutrition security by directly supplying the necessary food and/or by being sources of income that helps to purchase the required food and other requirements. In the smallholder farm approach, it was also found that given women are provided equal access to and control over productive resource e.g., land and agricultural inputs as do men, they can play greater role in enhancing household food consumptions relative to men who mainly focus on market participation and income generation. Yet, the potential role of both male and female farmers is negatively affected by shortage of land and lack of access to input and output facilities. In most of the cases, gender and its implication on household food and nutrition security status was overlooked by previous studies. Moreover, most previous studies have focus on market participation of smallholder farming approach as a mechanism of enhancing food security and give less attention to the importance of informal mechanism such as the barter and temporary small land exchange used by the smallholder farmer to enhance food availability and access.

Accordingly, the review recommends the following main points:

With the increased food and nitration insecurity, rapid population growth, shortage of land and the agricultural sector is dominated by the smallholder farmers in Ethiopia, focusing on smallholder agriculture and introducing more friendly institutions, input and output markets and strengthen their product and productivity capacity in such a way to contribute household food and nutritional security is not an option rather a priority chooses. Since gender difference has its own implication in the food and nutrition security through the smallholder farming, an independent investigation is needed on gendered gaps to have clear picture on the gendered roles, gendered access to and control over productive resources, to understand the implication of such difference on food and nutrition security among household members and then to take strategic and corrective actions. Furthermore, encouraging and strengthening the practices of informal mechanism (like bartering) by the smallholder farmer are an important avenue to enhance the food and nutrition security at least at the household and community level.

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HT has drafted the full manuscript. HT and CSA has reviewed, assessed the overall work of the review including its conceptual coverage, technical and language editing. Both of the authors have read and approve the final review manuscript.

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