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Distribution, transportation, and coordination in African indigenous vegetables value chains: A scoping review

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Malnutrition continues to be a major problem with negative implications on economic and human development in many parts of the world, including in Sub-Saharan Africa (SSA). Strengthening promising underutilized crops that are nutrient dense, climate resilient, and locally adaptable is an instrumental approach to enhancing dietary diversity. Due to their nutritional and economic benefits, African Indigenous Vegetables (AIVs) have the potential to contribute to livelihoods and address challenges of food and nutrition insecurity. Despite their importance but due to their perishability, AIVs tend to suffer from high post-harvest losses (PHLs). Effective distribution systems along the value chain have the potential to reduce PHLs for AIVs. We therefore conducted a scoping review on transport systems and coordination in AIVs value chains in SSA. The objectives of this review were to summarize and analyze the focus of research in AIVs transport, to analyze the extent to which the literature synthesizes interactions of sub-components of the chains, and to identify knowledge gaps in AIVs transport literature. Based on the research foci, we categorize the reviewed articles into seven themes. Our analyses indicate that distance to agricultural market is a fundamental aspect of AIVs transportation, as it interacts with transport costs, market participation, produce quality, and profit efficiency. Results show that collective action is instrumental in the coordination of AIVs transportation and that it contributes to cost reduction. Following light exploration of determinants of choice of means of transport, we recommend further research in this area for improvement of transportation in AIVs value chains.

KEYWORDS

transportation, AIVs, logistics, collective action, distance to market, food systems, value chain, marketing

1. Introduction

Malnutrition continues to be a persistent problem with negative implications for economic and human development in many parts of the world. The state of Food and Nutrition Security Report (FAO et al., 2022) reports that about 25% of the world's population—i.e., two billion people—lack access to sufficient and nutritious food. This is

true and most frequent in Sub-Saharan Africa (SSA), where population continues to grow significantly (FAO et al., 2021). For good nutrition to be realized, there is need for consistent availability and affordability of a variety of food for the population. In past decades, intensification of agricultural production, which entails promotion of stress-tolerant and high-yielding varieties, has been widely advocated for as a strategy to enhance food and nutrition security (Bokelmann et al., 2022). The underlying principles of intensification, however, fail to ensure access to diversified diets among the population and sometimes hamper the sustainability of natural resources in the long run (FAO., 2017, 2021). Diversity in agricultural production, instead, enhances the availability of nutritional diets.

Strengthening previously underutilized crops is a useful approach in enhancing diversity of diets and thereby reducing the problem of food and nutrition insecurity (Bokelmann et al., 2022). Globally, there has been an increased recognition that underutilized crops such as African Indigenous Vegetables (AIVs) can greatly contribute to food and nutrition security, especially for vulnerable groups (Riziki, 2015; Ochieng et al., 2018; Kittipanya-ngam and Tan, 2020). African Indigenous vegetables, also called African Underutilized Vegetables (AUVs) or African Leafy Vegetables (ALVs)[1] are crops which are well adapted to local conditions in SSA and are essential sources of vitamins and minerals (Towns and Shackleton, 2018). They are also known to contain human-health-promoting properties (Odongo et al., 2018). The vegetables also contribute to economic growth and are a source of livelihoods in rural and peri-urban areas of SSA (Mayekiso et al., 2019; Fischer et al., 2020; Omotayo and Aremu, 2020; Kansiime et al., 2021).

Despite their importance, AIVs suffer from high post-harvest losses (PHLs) due to their perishable nature. This is made worse by inefficient distribution and transportation of AIVs. Against this backdrop, there is a pressing need for resilient and effective food systems to deliver nutritious and quality food (Chen et al., 2021; Fanzo et al., 2021). Post-harvest losses tend to amplify food and nutrition insecurity through both quantitative and qualitative—i.e., nutritional losses. Reduction of PHLs can contribute to SDG 12.3, which aims to reduce food waste by 2030 by half, by reducing food losses along production and value chains (Bechoff et al., 2022; Jacob-John et al., 2022).

Post-harvest losses are a persistent problem in value chains of perishable crops. Poor value chain coordination, inappropriate use of technologies, and weak institutionalization and services, for instance distribution networks and infrastructure, limit progress in reducing PHLs (Kitinoja et al., 2018; Stathers et al., 2020; Dsouza et al., 2021). The current understanding of transport and logistics in perishable crops indicates that distance to markets and means of transport influence the performance of transportation (Ahumada and Villalobos, 2011; Chitranshi et al., 2020). In addition, efficient transportation should give the best trade-off between the quality of produce and cost. There is, however, limited literature on transport in perishable crops, more so in AIVs value chains. This review therefore seeks to summarize and analyze the focus of research (themes) in AIVs transport, analyze the extent to which the literature synthesizes interactions of sub-components of the chains, and identify knowledge gaps in AIVs transport literature.

The main concepts as used in this review are defined as follows: First, value chains are sets of actors who perform a linked sequence of value-adding activities that bring a product from its raw material to the final consumer (Trienekens, 2011; Senyolo et al., 2018). Secondly, African Indigenous Vegetables (AIVs) constitute scores of vegetable species utilized in African continent for both consumption and income generation (Towns and Shackleton, 2018). These vegetables are also referred to as African Underutilized Vegetables (AUVs) due to them being neglected as well as African Leafy Vegetables (ALVs). This paper is organized as follows: Section 2 details the step-by-step approach applied to achieve the aim of the paper. Section 3 presents the results of the scoping review. The results are organized in collated themes and presented in tables and charts. Section 4 discusses key findings in Section 3 and makes recommendations for further research. Section 5 concludes.

2. Methodology

2.1. Scoping review protocol

This study applied a scoping review approach following Tricco et al. (2018) guidelines on Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping reviews (PRISMA-ScR). The scoping review sought to provide a narrative account of existing literature on transport systems in AIVs value chains. The approach entailed five major steps: (i) identification of a research question (what is the extent of knowledge on transportation and coordination in AIVs value chains in SSA?); (ii) identification of relevant studies using predetermined definitions; (iii) selection of studies; (iv) data extraction and charting; and (v) collating, summarizing, and reporting of findings.

2.2. Database and search methods

Authors developed and tested a search strategy for identifying available articles relevant to the research question. Search terms entailed variation of key terms in the research question which included: "transport or transportation," "logistics," "African Underutilized Vegetables or African Indigenous Vegetables or African Leafy Vegetables," "AUVs or AIVs or ALVs," "collective action," "commercialization or marketing," "food systems," "SSA," "nutrition sensitive," "post-harvest losses," "value chains," "supply chains," and "commodity chains".[2] The search engines used by the authors were Elsevier's Scopus, Web of Science, Science Direct, Emerald Springer online and Google Scholar.

1 It is crucial to note that not all underutilized African vegetables are indigenous. Some literature use AUVs for this reason and others use ALVs or AIVs. Our review adopts AIVs to refer to these vegetables.

2 Conceptually the concepts of value chain, supply chain and commodity chain differ although the terms are sometimes used interchangeably. This study adopts the concept of value chains following the definition as stated above. In our search strategy we include all three terms.

TABLE 1 Eligibility criteria.

Criteria	Inclusion	Exclusion
Publication type	Inclusion of peer-reviewed English academic journals	Exclusion of conference proceedings, unpublished reports.
Study design	Inclusion of quantitative, qualitative and mixed methods empirical studies	Exclusion of theoretical studies
Value chain	Inclusion of crops with special interest in AIVs value chain	Exclusion of all livestock value chains

2.3. Eligibility criteria and selection of studies

In total, 44 articles were included in the review based on the following inclusion criteria: (i) explicit reference to AIVs value chains with a few benchmark value chains; (ii) explicit reference to SSA and a few benchmark countries outside SSA; (iii) published after the year 2009; (iv) explicit reference to transport systems and coordination in AIVs; (v) published in English; (vi) no focus on other crops except AIVs and (vii) no focus on livestock value chains. Table 1 shows further inclusion and exclusion criteria.

Studies were selected in four steps. The first step entailed manual screening of titles to pick out the main elements of the study. The second step involved screening the abstracts of selected articles to exclude articles violating the inclusion criteria. In the third stage, full text screening for the selected articles was performed. The fourth stage involved identification and dropping of duplicate articles, leading to a total of ($n = 44$) studies. Figure 1 presents the study selection procedure.

2.4. Data extraction and analysis

Extracted data entailed citation details, geographic location, sample size, empirical approach, value chain, node of value chain, and key findings of interest. Extracted data was organized based on several themes under the research question and included as Supplementary material. The categorization of the themes was based on our understanding of the research focus of the included articles with relation to AIVs transportation, as stated in the objectives of the research articles and the article's results.

3. Results

3.1. Overview of included studies

The majority (89%) of the 44 studies included in this scoping review were from SSA. All the included studies were published between 2009 and 2022, with a larger proportion (52%) published between 2018 and 2022. Figure 2 shows the distribution of studies across the years, based on identified themes. We cluster the identified studies into seven themes, based on the research focus they address under the broader study topic of transportation and coordination in AIVs. These themes are: Overview of transport in horticulture; challenges in AIVs transportation; distance to agricultural market as a proxy for transport; collective action and AIVs transportation; determinants of choice of means of transport; transport and market participation; and management of transportation in AIVs. As stated earlier, for most themes, the studies were published in recent years, except studies on role of transport in market participation, for which the majority (66%) of the studies fall within the 2009–2012 timeframe; and distance to market, for which 45% of the studies were published between 2013 and 2017.

Most studies (89%) employed quantitative approaches, with 63% of the quantitative studies using a sample size of at least 100 respondents. In addition, 80% of the included studies explored AIVs as the main value chain with the rest covering other vegetables, fruits, and a few major crops for comparison purposes. Our impression is that transport in food value chains is a niche and publications are scattered across a range of journals.

The majority of the studies—i.e., 25% explored distance to agricultural market as a proxy for transport; 16% gave an overview of transport in horticulture; another 16% highlighted challenges in AIVs transportation; 11% explored management of transportation in AIVs; and 16% narrowed down to collective action and AIVs transportation. The rest of the studies covered correlates of choice

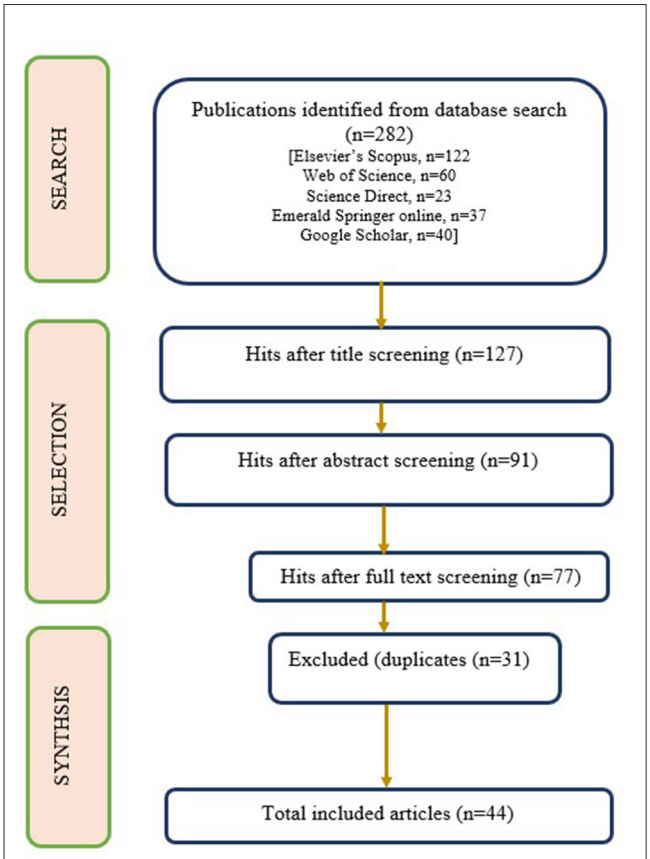

FIGURE 1
PRISMA flowchart for literature search and selection.

of means of transport (7%) and the relationship between transport and market participation (7%). Detailed results are embedded in the Supplementary material of the manuscript.

3.2. Transport in horticultural value chains and challenges in AIVs transportation

The majority of the studies identify bicycles, motorcycles, trucks, pick-ups, passenger buses, animal carts, wheelbarrows, and human porterage as available means of transport in horticulture value chains. About 38% of the studies under this theme report that in horticultural value chains, the quality of delivered produce and means of transport used during distribution and marketing are dependent on the distance to market. One of the studies (Lenn and Ward, 2010; Suraraksa and Shin, 2019) states that transportation in horticulture value chains is a key aspect in distribution and marketing from close to distant market outlets. Review results show that another 38% of the studies under this theme focused on elements of chain actors' welfare, marketing strategies, governance, and trading, with a very thin strand exclusively focusing on transportation practices in AIVs.

As shown in Table 2, it was observed that 38% of studies under this theme point out poor infrastructure, especially road networks, as a key challenge in AIVs transportation (Saghareishvili, 2021). The existence of poor road conditions contributes to increased transportation distance, time, and costs. For instance, narrow and soil or gravel roads limit the accessibility by vehicles to AIVs-sourcing locations and leads to difficulties in timely market delivery. Thirty-seven percent of these studies identified the unavailability of transport facilities as a challenge. One-quarter of the studies revealed poor connectivity and mobile networks as a hindrance to coordination of transportation activities among value chain actors. Other challenges identified include PHLs (12.5%), high transportation costs (12.5%), and bad weather, for instance excessive rain that limits distribution and leads to delays (12.5%). In addition, one study noted that timely exchange of information is significant in logistics for produce accessibility and supply to the targeted market (Issa et al., 2021).

3.3. Distance to the market and how it interacts with transport components

Review results show that 36% of the studies under this theme find distance to the market to have an association with transport costs, as shown in Table 2. Vegetable producers near market outlets spend less on transport and are likely to sell their produce at the nearby outlets. Slightly above one-quarter of the studies mention that distance to market plays a role in quality of the AIVs. Moreover, PHLs tend to increase with longer distances to agricultural markets. Two studies find that consumers are more likely to buy AIVs from nearer markets (Maruyama and Wu, 2014; Gido et al., 2017). Contrary to this, one study finds that consumers would rather source preferred AIVs from distant markets (Gido et al., 2017).

3.4. Role of collective action in AIVs transportation

We found collective action to be a crucial transport coordination mechanism. Collective action was found to interact with organization and cost of transport (Mwema and Crewett, 2019; Mwema et al., 2021). Observed review findings show that 25% ($n = 2$) of the studies exploring collective action in AIVs transportation imply that high transportation costs and

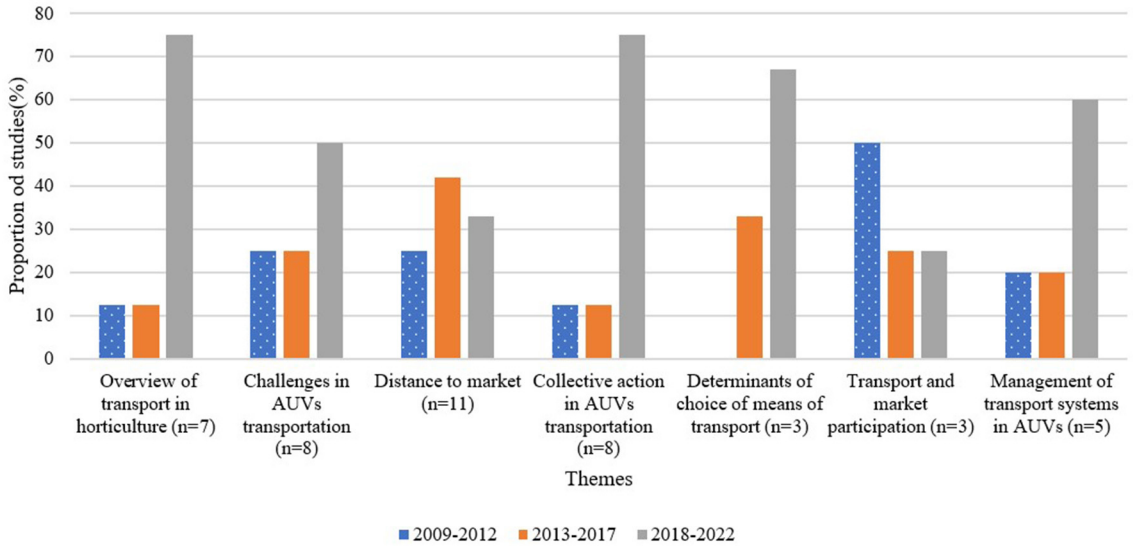

FIGURE 2
Summary of publication years of the included studies.

TABLE 2 Results for distance to the market and transportation challenges.

Share of studies	Key results
(n = 11)	*Distance to the market as a proxy to transport*
4 (36%)	Distance to the market has a direct effect on transport cost. As distance increases, transport cost tends to increase.
3 (27%)	Distance to the market affects the quality of marketable AIVs. An increase in distance to market leads to deterioration of AIVs quality, exacerbating PHLs. Distance to the market, transportation time, and means of transport contribute to AIVs transportation losses.
2 (18%)	Consumers tend to buy AIVs from nearer markets.
1 (9%)	Consumers would prefer to source complimentary AIVs from distant markets.
1 (9%)	Distance to the market and conditions of roads influence the profit efficiency of AIVs farmers and traders. Shorter distances to agricultural markets translate to low transportation costs and resulting low profit inefficiency.
(n = 11)	*Transportation challenges*
3 (37.5%)	Poor infrastructure
3 (37.5%)	Unavailability of transport facilities
2 (25%)	Limited coordination and flow of information
1 (12.5%)	Bad weather
1 (12.5%)	High transport costs
1 (12.5%)	Low processing leading to PHLs

post-harvest losses are key challenges in AIVs transportation, and that farmer associations, a proxy for collective action, are useful in coordinating transportation. One study (Abel et al., 2019) mentioned that AIVs farmer groups in peri-urban areas engage in collective action through joint transportation of vegetables to wholesale markets and supermarkets. Another study (Govindasamy et al., 2020) revealed that existence of organized systems for smallholder AIVs producers help in the process of aggregation and transportation, leading to reduced transportation costs.

3.5. Role of transport in market participation

Only three studies explored transportation and market participation in AIVs. One study (Megerssa et al., 2020) explored smallholder market participation among AIVs producers in Ethiopia and found that poor transport (lack of access to transport services), inadequate infrastructure, and transaction costs limit participation of vegetable farmers in agricultural markets. The other two studies (Salasya and Burger, 2010; Magogo et al., 2015) had similar findings, which stated that distance to the market, as a proxy for transport, is associated with market participation and choice of market outlet. Their results also showed that good roads and efficient infrastructure lower marketing costs and positively affect market participation.

3.6. Determinants of choice of transport

Review results reveal that there is scanty literature on correlates of choice of means of transport. In fact, studies under this theme ($n = 3$) account for only 7% of the total included studies. One of the studies, Ngenoh et al. (2019), noted that access to transport facilities determines choice of transport means. Value chain actors will only use means of transport that they have access to. Another study (Gogo et al., 2017) mentioned that distance to the market plays a role in the choice of means of transport. For longer distances, value chain actors choose more sophisticated or rather efficient means of transport, as compared to shorter distances where simple means are preferred (Kessy et al., 2018).

3.7. Management of transportation in AIVs

Transportation management provides effective planning and provision of transport services, resulting in reduced operational costs, time saving, and maintenance of produce quality (Gogo et al., 2018; Lipwop and Achuora, 2021). Information on how transport is managed in the AIVs value chains is however limited, compared to international or export value chains for exotic vegetables. Results show that 60% of the studies under this theme found availability of appropriate transportation infrastructures and handling facilities for AIVs reduce travel time, reducing produce losses. One study (Huber et al., 2010) mentioned that condition and type of roads have significant influence on transportation of AIVs with respect to product value, delivery time, and travel distance. In addition, it was interesting to note that awareness of specific storage conditions for AIVs and use of modern handling facilities like refrigerated vehicles and packaging materials, which maintain cooling and aeration conditions, enhance management of transportation and increase efficiency (Njenga et al., 2014; Issa et al., 2021).

4. Discussion and knowledge gap(s)

Following the review results, we summarized the literature into seven themes based on the research focus, as shown in the results section. The majority of studies (25%) addressed distance to market and its relation to transport components, while only 7% analyzed the choice of means of transport. The review shows that AIVs supply chains and transport in such supply chains is a niche topic with limited research. The few studies we found confirm the role of effective transportation in sustainable food systems and nutrition-sensitive value chains (Maertens and Swinnen, 2009; Maertens et al., 2012). At the same time, the review results explicitly indicate that AIVs value chains face substantial constraints in transportation (Gogo et al., 2017, 2018).

Our analysis shows that over 80% of the studies employed quantitative methods, with slightly more than half of the

quantitative studies using a minimum sample size of 100. There were, however, some studies with sample size as low as 50. All quantitative studies pose questions of internal and external validity. We observe that distance to the market is an underlying factor associated with most of the constraints; however, this varies with the means of transport. Increased distance leads to higher transport costs, deterioration of quality, high profit inefficiency, as well as low levels of market participation (Dolan and Humphrey, 2000; Barry et al., 2009; Gebregziabher, 2010; Gani and Adeoti, 2011). For perishable food value chains, delays in delivery are associated with longer distances to market (Weinberger and Pichop, 2009; Sibomana et al., 2016; Zivkovic et al., 2022). Effective coordination of transport services thus requires networking among actors (Issa et al., 2021). This could, however, be limited by delayed exchange of information, especially in remote areas where the accessibility to appropriate infrastructure including roads, connecting bridges, and network signals is limited (Marson, 2022). It is crucial to note that in AIVs value chains; durations for the exchange of information could be different in various geographical locations (Chagomoka et al., 2014). This implies a need for adequate and region-specific planning in order to achieve efficient AIVs transport coordination. In addition to appropriate facilities, handling of AIVs during transportation requires knowledge of suitable conditions and skills for maintaining the quality of AIVs.

Our analysis reveals that distance to agricultural market interacts with collective action, market participation, and choice of means of transport. For instance, Magogo et al. (2015) show that distance to market influences costs and market participation. This implies that for rural AIVs smallholder farmers, distance to market could play a central role in their welfare, as measured by profitability (Mphafi et al., 2019), which is embedded in transport costs (Rachmina et al., 2014), produce losses (Gogo et al., 2017), and market participation. Results also reveal that distance to market is an equally important variable for AIVs consumers, as it influences the produce quality that reaches the consumer (Gogo et al., 2018) as well as the choice of retail outlet from which to buy (Gido et al., 2017). From the literature, there are several proxies for transport, for instance, distance to the nearby transitable road, ownership of means of transport, type of road, distance to the nearest market in kilometers, and distance to the nearest market in walking minutes. However, most of the studies tend to use distance to the market and ignore other measures. Future research could incorporate multiple indicators for reliability and validity checks.

The review findings amplify the relevance of collective action as a coordinating and governance mechanism in AIVs transportation. This contributes to reduction of transportation costs and sharing of transport-related information, leading to optimization of benefits among chain actors (Weinberger and Pichop, 2009; Muriithi and Matz, 2014; Govindasamy et al., 2020). Results by Abel et al. (2019) imply that there could be differences in the levels of engagement in collective action based on geographic locations in terms of rural or urban settings, where urban farmers seem to be more advanced. A well-organized transport approach, with good infrastructure such as roads, positively influences AIVs farmers' market participation (Seidel, 2021). We also find a very thin strand of literature addressing determinants of choice of means of transport in AIVs value chains.

5. Conclusions

Our review emphasizes the role played by AIVs toward sustainable food systems and magnifies the need for effective management of transportation in AIVs value chains. The findings show that there are few studies generally exploring transport in AIVs. Furthermore, a very small proportion explore determinants of choice of means of transport, AIVs handling conditions, and skills during transportation, as well as transport and market participation. There is also a narrow link between transport and nutrition, specifically in AIVs. Methodologically, most studies are quantitative but with issues of internal and external validity; there is no clear evidence of the interaction of behavioral and social factors with transport. Further research should be directed toward these elements to provide useful information to improve transport in AIVs value chains. The limitation of this study is that literature in other languages other than English as well as gray literature was not considered.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frevc.2023.1113826/full#supplementary-material

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