

# The interplay between food market access and farm household dietary diversity in low and middle income countries: A systematic review of literature

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## ABSTRACT

A significant share of undernourished people are smallholder farmers in low and middle-income countries. Recent studies advocate improving market access as an important pathway towards improving the dietary diversity of farm households over increasing farm production diversity. A systematic review of five databases using *Priori* criteria identified 28 original studies from 14 low and middle income countries by screening 786 articles using different indicators of market access, diets, and nutrition. Most of the studies reported a consistent positive association between access to markets and dietary diversity, and few studies reported positive or negative association. However, findings are context-specific from several countries in Africa and Asia. Further research is needed to conclude that improving market access is an effective pathway to improve a farm household's dietary quality. Eight research priorities are identified based on the gaps in the existing research literature.

## 1. Introduction

A significant share of the undernourished population live in rural Asia and Africa, and many of them are smallholder farm households that largely depend on agriculture for their livelihoods (Muller, 2009; Pinstrup-Andersen, 2007; Qaim, 2017). Typically, smallholder farmers consume a considerable share of what they produce; hence, increasing on-farm diversity with different types of crops and livestock species is frequently seen as a promising way to improve household dietary diversity (Fanzo et al., 2013; Jones, 2016; Jones et al., 2014; Powell et al., 2015). Dietary diversity is often used as a proxy to indicate people's broader nutritional status because diverse foods facilitate the balanced intake of all essential nutrients. Dietary diversity is currently considered one of the main indicators of nutrition in the Sustainable Development Goals (SDGs) (Webb, 2014).

Although it is often presumed that diversifying farm production is a logical and direct way to improve dietary diversity for the subsistence farm households, an empirical examination of the relationships between farm production diversity and the level of household/individual dietary diversity revealed mixed results, which are context-specific. Most of the studies found that increased farm production diversity had a positive influence on dietary diversity (Dillon et al., 2015; Fanzo et al., 2013;

Hirvonen and Hoddinott, 2017; Jones et al., 2014; Koppmair et al., 2017; Pellegrini and Tasciotti, 2014; Powell et al., 2015; Sibhatu et al., 2015a; Sibhatu and Qaim, 2018a; Snapp and Fisher, 2015; Zanello et al., 2019). A recent review article reported that out of 21 original studies, 19 reported a positive relationship between production diversity and dietary quality (Jones, 2017).

In developing countries, small landholdings, limited access to technologies, unorganized markets that are geographically scattered, and agro-climatic and soil biophysical conditions (Hirvonen and Hoddinott, 2017) hinder households from diversifying farm production. Encouraging smallholders' farms to increase crop diversity could have adverse effects, mainly when production diversity is already high. It may expose them to the risk of losing benefits from specialized and economically viable crops and gaining a competitive advantage (Sibhatu and Qaim, 2018b). Most smallholder farm households are neither strictly subsistence-oriented nor market-oriented (Jones et al., 2014; Mondiale, 2008; Qaim, 2017). Therefore, the need is to identify options for diversifying farm production better suited for different farm households such that they gain all the nutrients needed. Should they be encouraged to diversify on-farm production or take advantage of market incentives to grow profitable cash crops or mono-crops, and use the income generated from their sale to buy more nutritious and diverse food from

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the markets?

Recent empirical studies have highlighted the relative importance of markets for farm household dietary diversity and reported that markets are critical for dietary diversity than subsistence production (Qaim and Sibhatu, 2018). That market access has significant positive effects on dietary diversity, compared with increased farm production diversity (Sibhatu et al., 2015a). Studies have also reported that in the presence of better agro-ecological conditions, better market access, and where markets function well, farm production diversity plays a lesser role for rural farm households dietary diversity (Kissoly et al., 2018; Sibhatu and Qaim, 2018a). The food purchased from the market contributed more to household nutrition than self-produced food (Luckett et al., 2015). Thus, the literature has begun to debate the relative importance of markets on dietary diversity compared with farm production diversity.

The authors acknowledge a corpus of literature on the links between market access/market participation and farm household income and poverty. This large body of theoretical and empirical evidence about the role of markets for human well-being is important and well recognized. The present systematic review focuses on understanding the relative importance of markets as sources of food (accessibility and availability of diverse food in diverse markets) impacting a farm household's dietary diversity and nutrition with farm production diversity. A panorama of existing studies in rural areas of low- and middle-income countries are screened for arriving at this understanding. Previous review articles have summarized existing studies of the association between production diversity and farm households dietary diversity (Jones, 2017; Sibhatu and Qaim, 2018b); they have not explicitly assessed the market dimension. The review studies by Jones (2017) and Sibhatu and Qaim (2018b) identified and summarized only six and seven of the existing studies, respectively, against 28 studies in our current systematic review.

The review will add to the knowledge on the role of markets in farm household dietary diversity, which has been gaining research interest during the past few years and provide a qualitative summary of existing studies. Section 2 of this paper presents the structured approach adopted in this analysis - a systematic review of the published results using PRISMA guidelines (Moher et al., 2009) and a quality assessment using the Yosef 18-point scale (Yosef et al., 2015). An elucidation of the results/interpretations from the review is presented under four different dimensions - a. the interplay between consumer markets and household dietary diversity; b. the supplementary effects of other factors on market access to improve farm household's nutrition; c. market access v/s on-farm production for better household's nutrition; and d. research/-knowledge gaps and future priorities. The paper ends with broad conclusions for influencing policy.

### 1.1. Theoretical background: farm household's production and consumption decision

The farm household decision to produce their food on-farm or purchase from the markets has important implications for their nutrition, and they pose great complexity in assessing household nutrition. This complexity is shown in the conceptual framework (Fig. 1), and it is elucidated from the interplay among the three facets of diversities, namely i). farm production diversity, ii). the dietary diversity, and iii). the diversity of food products purchased from the markets or market food diversity. In a situation where markets are poorly functioning (or there is no market), household's decisions are *non-separable* as they cannot separate their decision of farm production from their consumption decisions. In such a situation, production decisions depend upon consumption decisions (i.e., Households have to produce what they want to consume). In contrast, when markets are well functioning, households can *separate* their production decision from the consumption decision and move towards specialization to achieve higher income from the production. In subsistence farm households, diversifying farm production is a direct way to improve dietary diversity. However, the

recent literature has reported that increased crop diversity on small-holder farms could have adverse effects, mainly when production diversity is already high (Sibhatu and Qaim, 2018b). The stated relationships are very contextual and need further investigation, especially in low and middle-income countries. Influencing relationships among the three diversities mentioned above (illustrated in Fig. 1) can transform local food systems through better pathways (Gómez et al., 2013).

## 2. Material and methods

### 2.1. Literature search

The literature search was conducted from August to November 2019 on five databases: Web of Science, PubMed, MDPI, CAB Abstracts, and AGRIS. We applied a combination of keywords relating to the search concepts about the association between farm household dietary diversity and markets. Each set of terms was initially applied without specifying a country and then narrowed down to developing countries. We also screened the reference lists of the relevant articles we found. The intention was to survey the range of research articles on the topic; however, it is possible that not every relevant article was identified.

The keywords searched in the databases produced a broad set of results for the first stages of title and abstract screening. These words were also searched under the overall topic, abstracts, and keywords, and not just in the article's title. The search terms used are listed in Table 1. The preliminary searches involved a broad set of searches around the theme using different combinations of words. The database searches were confined to literature published in English with no restriction on the year of publication and author. We included peer-reviewed publications, including research reports, policy notes, discussion/working papers, conference papers, and case studies during the initial article screening. Finally, we considered only peer-reviewed publications. The process of systematic review and article screening is, as shown in Fig. 2.

The database search was completed on November 8, 2019. Following the initial title screening, shortlisted titles and abstracts were screened. Relevant studies for which full-text documents were not publicly available were requested through the ICRISAT Library; authors were also contacted and requested to share their original papers and additional details. Twenty-eight studies are included (Table 2) and discussed in this review.

### 2.2. Inclusion/exclusion criteria

We included studies that explicitly attempted to investigate the association between farm household dietary diversity and markets, and used at least one indicator of markets, dietary diversity, dietary quality, or associated nutrition outcome at the farm household or individual level in developing countries. A study is considered if it attempted to investigate the association of at least one indicator of market access<sup>1</sup> with at least one indicator of dietary diversity.<sup>2</sup>

Of the 28 studies, 24 were published in peer-reviewed academic journals, two in conference papers, one in a discussion paper, and a book chapter (Table 2). Among the excluded studies were: those not in

<sup>1</sup> Distance to the nearest market, market participation, time taken and cost to reach the nearest market, market food diversity, market diversity, frequency of visits, proportion of food purchased, ownership of mode of transport and mode of transport to reach market to buy food and market food availability index.

<sup>2</sup> Household/individual/women dietary diversity score (HDDS/IDDS/WDDS), Food Variety Score (FVS), Nutrition Functional Diversity (NFD), Food Consumption Score (FCS), Household Food Insecurity Access Score (HFIAS), Hunger Index (HI), Household Food Diversity Score (HFDS), Minimum Dietary Diversity (MDD), Monthly Food Expenditure (MFE), Dietary Quality (DQ), indicator of calorie and nutrient intake or an indicator of nutrition outcomes.

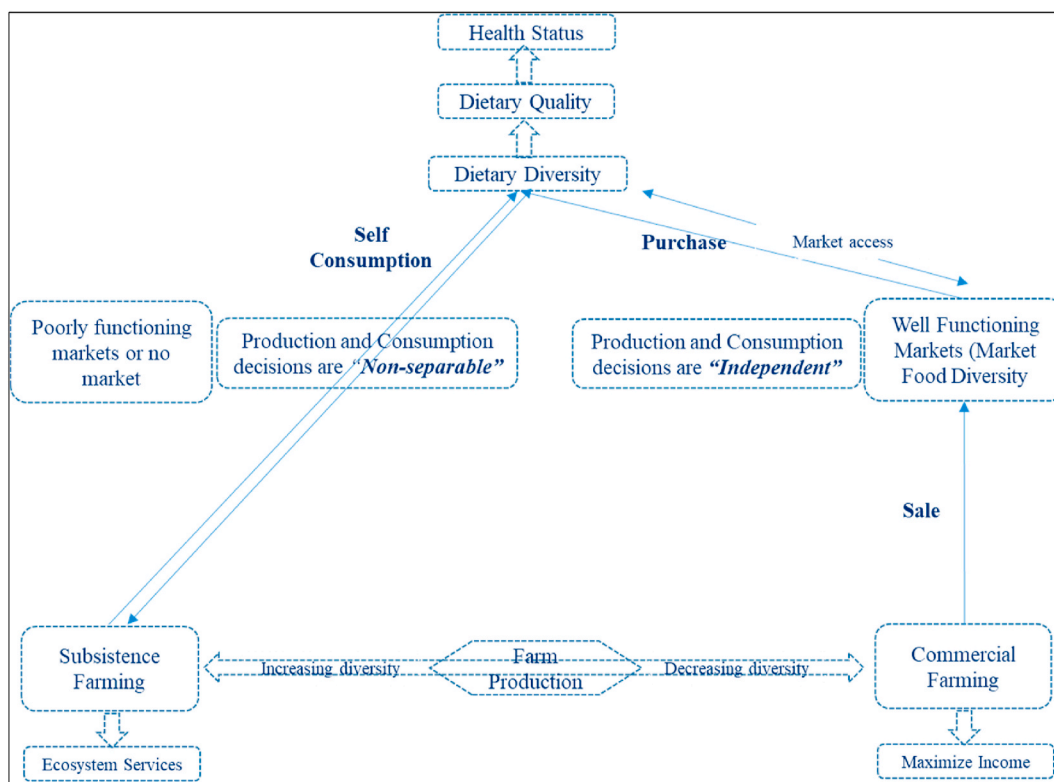


Fig. 1. Conceptual framework showing the links between production diversity, dietary diversity and market access (Authors’ construction based on Bellon et al. (2016).

Table 1  
Search topics and terms used in the systematic review.

Topic	Search terms
Nutrition	Diet; diet diversity; dietary diversity; diet quality; dietary quality; consumption; quality consumption; food consumption; food variety; food security; nutrient consumption; nutrient intake; nutrition
Market	Markets; food markets; food access; market access; market source; food availability in markets; market participation; market food diversity; market proximity

English, grey literature, opinion pieces, review articles, those attempted to investigate the association between farm production diversity and household dietary diversity without mentioning market access indicators, and those with a similar focus but confined to urban households and developed countries.

2.3. Data extraction and quality assessment

The systematic review included 28 studies representing 14 low and middle-income countries; 21 of these studies are new ones that have not been included in previous review articles, and most of them were published in recent years. The limited size of the published empirical work on the topic, and the need for a review of the literature examining the magnitude and nature of association, factors, mechanisms, and context-specific market-based approaches, justifies the inclusion of all of the studies published to date. Information on the study objectives, author/s, type and year of publication, country of research, type of data, and sample size used for each study were extracted. Furthermore, indicators used for market access and diet or nutrition were extracted. Each study’s key findings on the interplay between market access and dietary diversity were extracted. Considering the diverse indicators used in the original studies, a qualitative and descriptive approach is employed to compare the studies and summarize their key findings, instead of a

quantitative meta-analysis.

Most of the reviewed studies assessed market access using simple proxies such as distance, time taken, and cost to reach the nearest market. Only a few studies assessed market food diversity, market diversity, frequency of visits, proportion of food purchased, ownership of transport, and transport mode. Most of the studies assessed dietary diversity as a proxy for dietary quality, and only two studies directly measured diet quality by measuring specific nutrient intakes.

Our systematic review identified and included quantitative and qualitative research studies, which are summarized in Table 2. Considering their heterogeneity, quality assessment and comparing study outcomes presented a significant challenge. This is because qualitative studies do not commonly focus on measurable outcomes, which are traditionally important in systematic reviews. In addition, the Department for International Development (DFID) framework (DFID, 2014) has been used in this systematic review with necessary adaptations (Yosef et al., 2015). As shown in Table 3, greater emphasis was placed on internal validity by study design; points were given to studies based on the study design adopted. Therefore, quantitative studies using a randomized controlled trial (RCT) design or quasi-experimental designs received higher points than studies that used descriptive, longitudinal or cross-sectional designs. The quality criteria developed by Yosef et al. (2015) were adapted for the study to assess the quality of the selected articles.

3. Results

The search criteria returned 786 articles from across the five databases, and 28 relevant articles were included in the analysis, as shown in the PRISMA flow diagram (Fig. 2). The year-wise publications are presented in Fig. 3, clearly indicating the relevance of the articles included in the review and analysis.

Details of the methods used, indicators used, magnitude and nature of the association between dietary diversity and markets, factors,

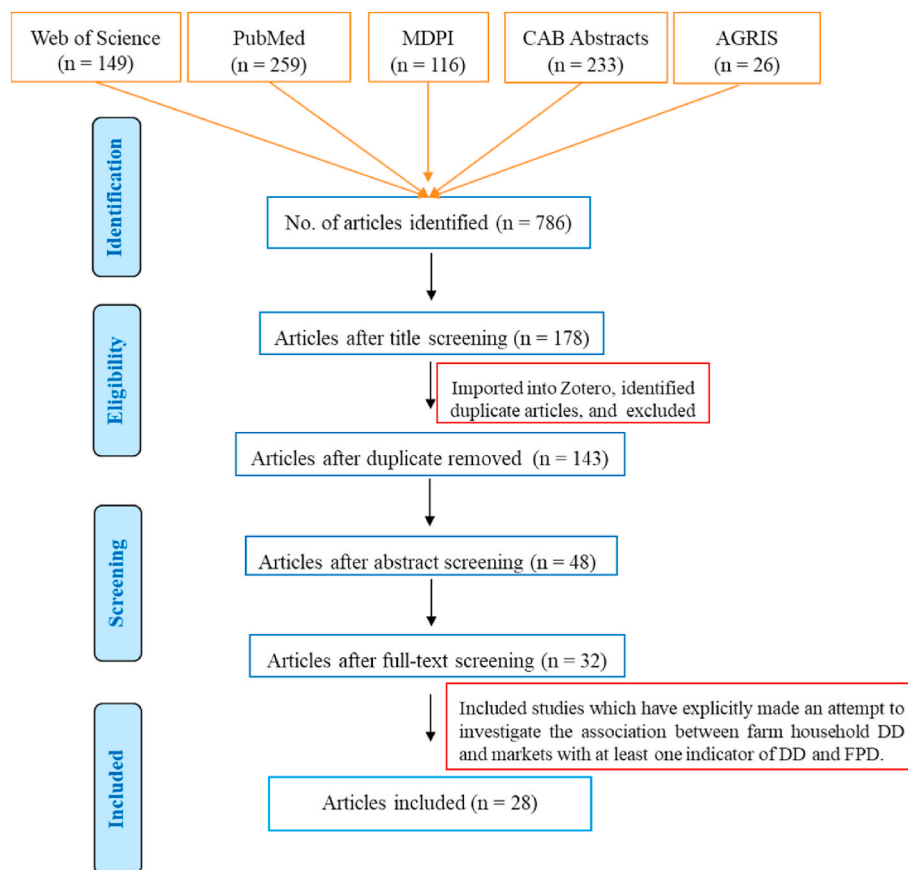


Fig. 2. The PRISMA diagram showing the systematic screening process.

mechanisms and context-specific market-based approaches in the 28 studies are given in Table 2. These 28 studies, five from Asia and 23 from Africa, provide evidence from 14 countries. The countries and number of studies are: Ethiopia – seven; Malawi – four; Ethiopia, Kenya, Malawi, and Indonesia together – three; India and China – two each; Afghanistan; Bangladesh; Benin, West Africa; Ethiopia and Tanzania; Indonesia, Kenya, and Uganda; Zambia; Uganda; Tanzania; South Nigeria and Rwanda – one each. Five studies reported results from two or more countries. Of the 28 studies, 16 employed quantitative methods, and nine used quasi-experimental methods (Ayenew et al., 2017; Bellon et al., 2016; Davidson and Kropp, 2017; Hirvonen et al., 2017; Hirvonen and Hodinott, 2017; Huang and Tian, 2019; Onyeneke et al., 2019; Ntakyio and van den Berg, 2019; Zanello et al., 2019); only three used mixed methods, and none used a RCT. Regarding the type of data, 23 studies used cross-sectional data (of which four studies were cross-sectional and nationally representative) and five studies used longitudinal datasets (of which one was longitudinal and nationally representative) for analysis. The number of households or individuals surveyed in each study varied from 135 households/individuals (India) to 24,542 adults (China).

There is a lack of evidence to state the reason for not employing RCT based designs while studying the impact of market access indicators on nutrition outcomes. Meeker and Haddad (2013) opine that Randomized Controlled Trials (RCT) are the most robust methodology to determine attribution between agriculture and nutrition. However, this is difficult in agriculture (exception: yield) as concerns about cross-contamination of treatment and control are big, and the causal chains between agriculture and nutrition are lengthy and complicated. The majority of the studies reviewed in this systematic review are context-specific. In these studies, to measure market access indicators, simple proxies such as presence of market in the community, distance, time, mode of transport,

and cost to reach the nearest market are used (Hoddinott et al., 2015; Jones et al., 2014; Sibhatu et al., 2015a). The association between market access and market structure is affected by several factors. Due to data limitations, this association's validity is hardly ever tested (Chamberlin and Jayne, 2013). Multi-dimension nature of market access which may not be easily aggregated to all-purpose indicator or single index. Therefore, an empirical challenge common to all studies that estimated the impact of market access on various nutrition outcomes is that the causal relationship among market access indicators and the obvious outcomes of such access are difficult to differentiate (Stifel and Minten, 2017).

The quality assessment of each article was made based on the Yosef 18-point criteria: eight studies scored 14 points; seven studies scored 13 points; four studies scored 15 points; three studies scored 16 points; two studies scored 17 points; another three studies scored 12 points, and one study scored eight points. As per the Yosef 18-point quality criteria, studies that scored between 13 and 18 points are marked as 'I', of high quality; those scoring between seven and 12 are marked as 'II', of medium quality; and those scoring less than six points are marked as 'III', of poor quality (Table 2).

### 3.1. The interplay between food markets and household dietary diversity

We found that 20 studies (72%) reported a consistent positive association between households' access to consumer markets (place where consumer buy food) and farm household dietary diversity. Of these, four studies (14%) reported that market access had a more significant positive effect on dietary diversity than farm production diversity (Luckett et al., 2015; Ludwig, 2018; Qaim et al., 2016; Sibhatu et al., 2015a). Only one study reported that market access and production for self-consumption complemented rather than replaced each other in

**Table 2**

An overview of studies included in the review of the literature to examine the interplay between market access and household dietary diversity (HDD).

#	Author(s), year and country of research	Study objective(s)	Data type	Sample size	Indicator(s) of market access	Nutritional indicator (s)/Nutrition data*	Key findings (Interplay between market access and HDD)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	<a href="#">Takeshima and Nagarajan (2012)</a> Tamil Nadu, India	To test minor millet's market participation may encourage the exchange of new varieties at local markets and higher returns from varieties already grown	CS	135 HHs	Distance to market	HDDS (15)/24 h	<ul style="list-style-type: none"> <li>Market participation improved in less fertile dryland plains with on-farm varietal diversity of minor millets and resulted in increased net revenue</li> <li>However, market development had no effect on varietal diversity in the fertile hill ecosystems</li> </ul>
2	<a href="#">Sibhatu et al. (2015a)</a> Ethiopia, Kenya, Malawi and Indonesia	To test what other factors in addition to crop diversity influence farm HDD	CS	5114 HHs	Distance to nearest market	HDDS (12), FCS (9)/7 d	<ul style="list-style-type: none"> <li>Market access had positive effects on DD, which were greater than those from increased farm production diversity</li> <li>A 10-km decrease in distance to the market had a similar effect on DD as did increasing FPD by one additional livestock or crop species</li> <li>Earnings from off-farm activities improved households' ability to purchase a variety of foods from the market, and the effect was significantly greater than the effect from increasing FPD</li> <li>Increasing on-farm diversity is not always the most effective way to improve DD in small-holder households</li> </ul>
3	<a href="#">Luckett et al. (2015)</a> Malawi	To assess the relative contribution of farm production and purchase from the market in providing nutritional diversity to farm households	CS	11,814 HHs	Distance to market	NFDS/7 d	<ul style="list-style-type: none"> <li>Food purchased from the market contributed more to household nutritional diversity than home-produced food</li> <li>Household market proximity is inversely related to overall dietary diversity</li> <li>The lowest diversity in nutrition was recorded during the growing season when farmers plant crops</li> </ul>
4	<a href="#">Snapp and Fisher (2015)</a> Malawi	To examine how agricultural subsidy policies and the promotion of modern crop varieties affect smallholder farm production and household diet	CS & NR	9291 HHs	Distance to the road (km); household ownership	HDDS (12), FCS/7 d	<ul style="list-style-type: none"> <li>Crop diversity was positively associated with DD</li> <li>Market access, education, income, and access to improved storage technologies had a higher influence on DD than crop diversity</li> </ul>
5	<a href="#">Kumar et al. (2015)</a> Zambia	To analyze: the association between household FPD and child DD; and the association between households' FPD and child nutritional status	CS	3340 HHs (children aged 24–59 months)	Household ownership of mode of transport	HDDS (7)/24 h	<ul style="list-style-type: none"> <li>Households with their own mode of transport and households within the village with access to public transport facilities have better access to nearby markets</li> </ul>
6	<a href="#">Qaim et al. (2016)</a> Ethiopia, Kenya, Malawi and Indonesia	To analyze the role of production diversity and market access for farm HDD	CS	8000 HHs	Distance to market (km)	HDDS (12)/7 d	<ul style="list-style-type: none"> <li>Market proximity had positive effects on DD, and these effects were stronger than those from FPD; selling farm produce significantly improved dietary quality</li> <li>The effect of FPD on household diets declined with higher levels of market integration</li> <li>The average effect of commercial sales on HDD was five times greater than that of producing one additional crop or livestock species on the farm</li> </ul>

*(continued on next page)*

Table 2 (continued)

#	Author(s), year and country of research	Study objective(s)	Data type	Sample size	Indicator(s) of market access	Nutritional indicator (s)/Nutrition data*	Key findings (Interplay between market access and HDD)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
7	Bellon et al. (2016) Benin, West Africa	To test the extent to which market participation, diversity of plant species grown and the variety of foods mothers purchase are associated with their DD	CS	954 HHs	Travel time to market; market diversity (purchases, 7-day recall)	HHDS (10)/24 h and 7 d	<ul style="list-style-type: none"> <li>Off-farm income was significantly associated with higher DD</li> <li>Self-production on the farm and food purchases complement rather than replace each other in their contribution to DD</li> <li>Seasonality is a significant factor contributing to DD</li> </ul>
8	Lenjiso et al. (2016) Ethiopia	To examine the effects of smallholder milk market participation on household and intra-household DD	CS	164 HHs	Household distance from milk collection centre	HHDS (12); IDDS (9)/24 h	<ul style="list-style-type: none"> <li>Households that participated in the milk market had significantly higher levels of milk production, household income, DD and nutritional status of young children</li> <li>Household participation in the market was positively related to food security and the nutritional health of small farm households</li> </ul>
9	Jones (2016) Malawi	To determine the association of crop species' richness with the diversity and quality of household diets via both subsistence- and market-oriented pathways	LD & NR	3000 HHs	Distance to nearest town	HHDS (10); daily energy, protein, iron, zinc and vitamin A intake per adult equivalent/7 d	<ul style="list-style-type: none"> <li>Households that had more market-oriented production and greater earnings from sold produce consumed a similar proportion of foods compared with households that had lower earnings from production and less market-oriented production</li> </ul>
10	Koppmair et al. (2017) Malawi	To analyze the role of other factors that may influence DD, such as market access and agricultural technology in addition to crop diversity	CS	1482 HHs (408 small HHs; 519 children and 408 mothers)	Walking hours to district-level market	DDS (12); household, children under 5 years and mothers/24 h	<ul style="list-style-type: none"> <li>Household access to the village and closeness to district markets had larger positive effects on DD than diverse on-farm production</li> <li>FPD was more important for household diets in locations far away from the market</li> <li>Crop sales and the use of purchased inputs had larger positive effects on DD than increasing FPD</li> </ul>
11	Hirvonen et al. (2017) Ethiopia	To study the effect of caregivers' nutrition knowledge and its complementarity with market access	CS	775 HHs	Transportation costs (Birr/quintal)	DD/24 h	<ul style="list-style-type: none"> <li>Nutrition knowledge with relatively good market access led to considerable improvements in children's DD</li> <li>No evidence that better nutrition knowledge alone increased the diversity of children's diet in the most remote areas</li> </ul>
12	Stifel and Minten (2017) Ethiopia	To analyze the relationship between household/individual well-being, nutrition, and market access	CS	850 HHs	Average travel time to market; transport cost to market	HHDS (12)/24 h	<ul style="list-style-type: none"> <li>Remote households were more food insecure, consumed less and had less diverse diets than who resided close to the market</li> </ul>
13	Abay and Hirvonen (2017) Ethiopia	To quantify the seasonal fluctuations in children's weights in relation to crop diversity	LD	2387 HHs	Distance to market; seasonality	HHDS (12)/7 d	<ul style="list-style-type: none"> <li>Children located closer to local food markets consumed more diverse diets and were better nourished compared with their counterparts who resided farther away, but the content of the diet varied across seasons</li> </ul>
14	Davidson and Kropp (2017) Bangladesh	To investigate the effect of production and market participation on food group consumption, and to explore the relationship between markets, crop production, and DD	CS	1000 HHs	Market participation (buying/selling in the market)	HFIAS (15)/24 h & 7 d	<ul style="list-style-type: none"> <li>Households that had greater market participation consumed more micronutrient-rich foods compared with their counterparts</li> </ul>
15	Hirvonen and Hoddinott (2017) Ethiopia	To examine the relationship between pre-school children's food consumption and household agricultural production	CS	3448 children (aged 6–59 months)	Distance to nearest market (km)	Children's DDS (7)/7 d	<ul style="list-style-type: none"> <li>The diets of children residing near markets were more diverse than those of children without market access; to achieve the same level of DD, more remote households needed to produce a wider variety of foods</li> </ul>
16			LD			DDS (12)/24 h	

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Table 2 (continued)

#	Author(s), year and country of research	Study objective(s)	Data type	Sample size	Indicator(s) of market access	Nutritional indicator (s)/Nutrition data*	Key findings (Interplay between market access and HDD)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Wang et al. (2017) China	To investigate dietary changes in China from the perspective of DD		24,542 adults (over 18 years)	Accessibility to food (market)		<ul style="list-style-type: none"> <li>DD was unequally distributed among regions and families; urban residents had a significantly more diverse diet compared with their rural counterparts</li> <li>DD was positively associated with food access and was affected by socioeconomic factors</li> </ul>
17	Ayeneu et al. (2017) Ethiopia and Tanzania	To investigate the role of production diversification for DD in smallholder agriculture	CS & NR	1994 HHs	Distance to population centre; food purchase proportion	HDHS (12); food poverty/actual calorie intake	<ul style="list-style-type: none"> <li>Smallholder household's improved market access and market integration would play a vital role in food and nutrition security in sub-Saharan Africa</li> </ul>
18	Qaim and Sibhatu (2018) Ethiopia, Kenya, Malawi and Indonesia	To analyze the link between FPD and farm HDD	CS & NR	8230 HHs	Distance to market (km)	FVS, HDHS (12)/24 h	<ul style="list-style-type: none"> <li>Market access was more important for DD than subsistence production</li> <li>Increasing production diversity may have positive effects on smallholder diets in specific contexts, but may have no effects or even negative effects in other contexts</li> </ul>
19	Kissoly et al. (2018) Tanzania	To assess the relationship between smallholder FPD and DD with contrasting agro-ecological and market contexts in rural Tanzania	CS	900 HHs	Distance to nearest paved road (km); access to market information	HDHS (12); FVS/7 d recall;	<ul style="list-style-type: none"> <li>FPD had a minor role in the presence of better market access and agro-ecological characteristics</li> <li>FPD had a positive role for food consumption diversity in districts with relatively negative agro-ecological and climatic characteristics and poor access to markets</li> </ul>
20	Sibhatu and Qaim (2018a) Indonesia, Kenya and Uganda	To compare different indicators of FPD and DD, in order to better understand some of the underlying linkages	CS	1482 HHs	Distance to market (km)	HDHS (12, 10)/7 d	<ul style="list-style-type: none"> <li>Markets were more important for farm household nutrition than production diversity in situations where markets functioned properly and were accessible</li> <li>Diverse subsistence production often contributed less to DD than cash income generated through market sales</li> <li>FPD measured as a simple count of species was positively related with almost all dietary indicators, but when compared with the number of food groups grown, the relationship becomes insignificant in many cases</li> </ul>
21	Ludwig (2018) India	To test the hypothesis that with improving market access, the relationship between FPD and DD diminishes	CS	1324 HHs	Distance to next market;	DD (10)/24 h	<ul style="list-style-type: none"> <li>Market access was important to improve nutrition, mainly in the case of food groups that were not necessarily produced on the farm</li> <li>Higher-income groups benefited from market access</li> <li>Market access had a greater positive effect on DD than production diversity for higher-income groups and only for some food groups</li> </ul>
22	Zanello et al. (2019) Afghanistan	To understand the relative importance of markets versus their own production in providing DD by considering their relationship in the context of seasonality	CS & NR	21,000 HHs	MFAI; transport cost to market	FCS (from own production, from market purchases and from other sources e. g. gifts and aid)/7 d	<ul style="list-style-type: none"> <li>The diversity of foods available in the market was positively related to DD</li> <li>Improved crop diversity was positively associated with DD in the regular season; however, during the lean season, market transport costs and food availability in the market</li> </ul>




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Table 2 (continued)

#	Author(s), year and country of research	Study objective(s)	Data type	Sample size	Indicator(s) of market access	Nutritional indicator (s)/Nutrition data*	Key findings (Interplay between market access and HDD)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
23	Ambikapathi et al. (2019) Ethiopia	To describe market access using MFD and estimate the effect of MFD, crop diversity and livestock diversity on DD among women	CS	2117 women (aged 15–49 years)	MFD	MDD/24 h & 7 d	<ul style="list-style-type: none"> <li>became particularly important for diets</li> <li>Food availability varied in local markets across seasons and agro-ecological zones</li> <li>MFD had the potential to mitigate the impact of the environment on women's DD; women who had access to higher MFD in the highland agro-ecological zone had better DD</li> </ul>
24	Headey et al. (2019) Ethiopia	To examine how rural markets vary in their diversity, competitiveness, frequency, and food affordability, and how such characteristics are associated with diets	LD	4395 children	Market proximity; MFD	DDS (10)/24 h	<ul style="list-style-type: none"> <li>Children with access to nearby markets selling more non-staple food groups had more diverse diets, but the relationship was small in absolute terms</li> </ul>
25	Weatherspoon et al. (2019) Rwanda	To determine food intake patterns, DD, socioeconomic risk, and protective factors, and quantify their influence on stunting in rural Rwandan children	CS	820 children (under 5 years)	Distance to market (m); distance to main road (m); road to market accessible	Monthly food expenditure/not mentioned	<ul style="list-style-type: none"> <li>Stunting in rural children was related to multiple factors, including the child's gender, weight &amp; age, DD, marital status, education of the head of the household, mother's height and family garden/livestock if available. Besides, environmental factors such as altitude, soil fertility, market access and location relative to a market</li> <li>It was less clear whether rural markets are capable of supplying diverse and nutritious foods at affordable prices consistently</li> </ul>
26	Huang and Tian (2019) China	To study whether food access in rural China helps to alleviate the deviation between farmers' diet patterns and the recommended diet	LD	6775 adults (aged 20–59 years)	Distance to market (km)	Dietary quality (10)/24 h	<ul style="list-style-type: none"> <li>Market development contributed to better dietary quality for rural households that did not work in agriculture; no significant effect was detected for people engaged in agriculture</li> </ul>
27	Onyeneke et al. (2019) South Nigeria	To assess caregivers' nutrition knowledge and access to the market on the DD of pre-school children	CS	400 HHs	Distance to market	DD (12)/24 h	<ul style="list-style-type: none"> <li>Caregivers' nutrition knowledge together with access to markets in remote areas improved pre-school children's DD</li> </ul>
28	Ntakyio and van den Berg (2019) Uganda	To assess the effect of market-oriented production on household food consumption using the case of rice, where rice is a major cash crop	CS	1137 HHs	Distance to market (km); Market Production Index	HDDS (10); HFIAS/7 d	<ul style="list-style-type: none"> <li>Market-oriented production had significant negative effects on household calorie consumption</li> <li>Commercial farm households were more likely to consume less than the required calories/adult equivalent/day</li> </ul>

Abbreviations: CS = Cross Section data; LD = Longitudinal data; NR = Nationally Representative data; DD = Dietary Diversity; DDS = DD Score; FCS = Food Consumption Score; FPD = Farm Production Diversity; FVS = Food Variety Score; HHs = Household; HDDS = Household DD Score; IDDS = Individual Dietary Diversity score; MDD = Minimum DD; MFAI = Market Food Availability Index; MFD = Market Food Diversity; NFDS = nutritional functional diversity score.

\* Numbers in parentheses are the maximum number of food groups used for the indicator. The description of indicators is provided in Appendix 1.

# Quality rank on the Yosef 18-point scale (Adapted): 13–18 points = I ; 7–12 points = II ; 0–6 points = III .

contributing to household dietary diversity (Bellon et al., 2016). The most often used market access indicator was the distance to the market; farm households closer to markets had higher dietary diversity than households in distant and remote areas. Sibhatu et al. (2015a) revealed that decreasing distance to the market by 10 km had a similar effect on dietary diversity as increasing farm production diversity by one additional livestock or crop species. Similarly, Qaim et al. (2016) reported that the average effect of market participation through commercial sales

on farm household dietary diversity was five times greater than producing one additional crop or livestock species. Five research studies have used distance to the market and time to reach the market as indicators of market access and reported a positive relationship between farmer's market participation and dietary diversity (Jones 2016; Koppmair et al., 2017; Lenjiso et al., 2016; Qaim et al., 2016; Sibhatu and Qaim 2018a). Kissoly et al. (2018) reported that better access to markets enables farm households to purchase diverse foods and generate



**Table 3**  
Quality assessment criteria (Adapted from Yosef et al., 2015).

Does the study ...	Score
Acknowledge existing research?	1 point
Have a conceptual framework?	1 point
Have an enquiry question?	1 point
Present a hypothesis?	1 point
Link to raw data?	1 point
Recognize limitations?	1 point
Identify research design?	1 point
Identify research method?	1 point
Explain why it uses a specific design or method?	1 point
Use a well-suited indicator?	1 point
Outline results that are generalizable?	1 point
Use instruments that are reliable for measuring aspirations? (The authors considered the subsequent to be generally reliable)	1 point
Contain signposting (the text clarifies key aspects, such as aim, structure and conclusion, and shows connections between sentences and paragraphs)?	1 point
End with a logical conclusion?	1 point
<b>Is the study internally valid</b> (up to a maximum of four points)?	
Internal validity was based on the study design used:	
Randomized controlled trials	4 points
Quasi-experimental studies	3 points
Longitudinal studies	2 points
Descriptive or cross-sectional studies	1 point
High-quality/detailed ethnography	3 points

higher incomes from agricultural activities that create a comparative advantage to produce and sell cash crops. These studies concluded that better market access through the reduced distance to markets, better transport facilities, increased ownership of mode of transport, more frequent visits to the market, and reduced travel time and transport costs could contribute to higher dietary diversity. Market food diversity is a new market indicator (Ambikapathi et al., 2019), revealing that market food diversity is affected by seasonal variability of food available in the market, which affects the dietary diversity of households close to the market.

3.2. The supplementary effects of other factors on market access to improve farm household's nutrition

Most of the reviewed studies considered market access as an explanatory variable in the farm household dietary diversity models and suggested that several other factors combined with market access and farm production diversity can potentially influence dietary diversity. Agricultural extension and rural advisory services, off-farm income, agro-ecology, seasonality, ownership of transportation, nutrition knowledge, community infrastructure, technologies, and other socio-economic factors vis-à-vis farm households have the potential to influence dietary diversity in specific contexts. Hirvonen et al. (2017) and Onyeneke et al. (2019) reported that mothers' nutrition knowledge leads to improvements in children's diets but only in the presence of relatively good market access. A remote community's nutrition knowledge, combined with household proximity to markets, improved dietary diversity among school children. A study from Tanzania reported that farm production diversity plays a minor role in dietary diversity in the presence of better agro-ecological and market access characteristics (Kissoly et al., 2018). A study from India reported on the effect of market access in two different agro-ecological contexts with contrasting results. In the less fertile dryland plains, market participation improved on-farm varietal diversity of minor millets and increased household revenue. By contrast, market access did not affect varietal diversity in the fertile hill ecosystems (Takeshima and Nagarajan, 2012). Similarly, Ambikapathi et al. (2019) reported that local markets' food availability varied across seasons and agro-ecological zones. Qaim et al. (2016) and Sibhatu et al. (2015a) reported that farm households' off-farm economic activities that increased cash earnings enabled them to buy diverse foods from the market, and this effect was more significant than that from farm production diversity. In India's study, higher-income groups benefited from market access; in such situations, the associated positive effects exceeded those from farm production diversity (Ludwig, 2018). Similarly, studies from Afghanistan and Benin revealed that seasonality significantly influenced dietary diversity. One of these studies reported that improved crop diversity was positively associated with dietary diversity during the regular season, but not during the lean season (Bellon et al., 2016; Abay and Hirvonen 2017; Zanello et al., 2019). These findings suggest that other factors should be considered along with promoting farm production diversity and market access to obtain effective nutritional outcomes for farm households.

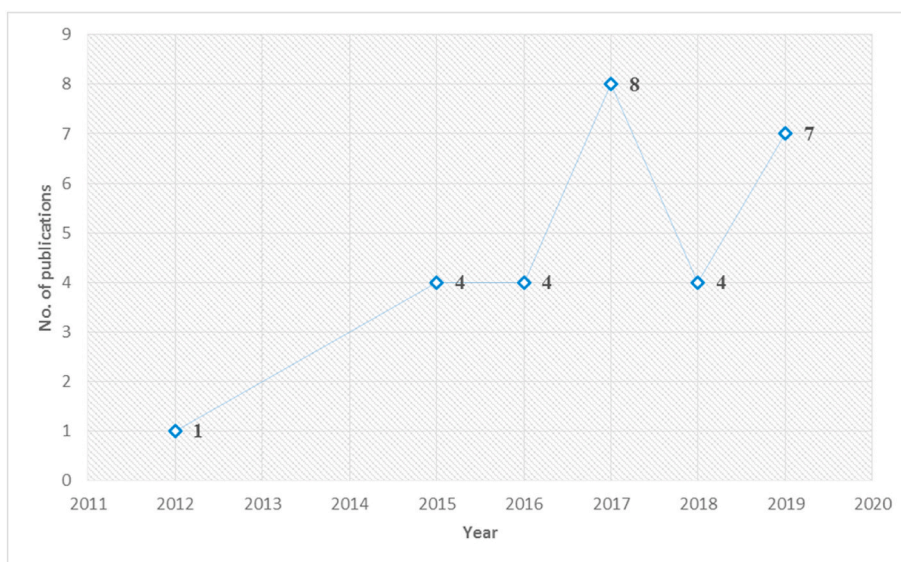


Fig. 3. The year of publication of the identified research articles.

### 3.3. Market access v/s on-farm production for better household nutrition

A third point that emerged from the review is understanding market access vis-vis on-farm production for better nutrition outcomes. 93% of the studies included in the review reported a consistent positive association between a household's access to markets (input, output, and consumer market) and farm household dietary diversity. Four studies reported that market access had a more significant positive effect on dietary diversity than farm production diversity (Luckett et al., 2015; Ludwig, 2018; Qaim et al., 2016; Sibhatu et al., 2015a). Several studies empirically examined the linkages between farm production diversity and the level of household/individual dietary diversity. Most of them found that increased farm production diversity had a positive relationship with dietary diversity, which substantiates similar findings from other recent studies (Dillon et al., 2015; Fanzo et al., 2013; Hirvonen and Hoddinott, 2017; Jones et al., 2014; Koppmair et al., 2017; Pellegrini and Tasciotti, 2014; Powell et al., 2015; Sibhatu et al., 2015a; Sibhatu and Qaim, 2018a; Snapp and Fisher, 2015; Zanello et al., 2019).

Sibhatu et al. (2015a) suggested that market access is more important than farm production diversity for improving farm household dietary diversity, and that emphasis should be placed on improving market access rather than on increasing farm production diversity. Smallholders often buy more than half of all the food they consume from the market (Bellon et al., 2016; Jones, 2017; Sibhatu and Qaim, 2017). Farm households in Ethiopia and Malawi acquire 55% and 61% of the foods they consume from the market, respectively (Sibhatu et al., 2015a). Further, limited access to markets and non-availability of diverse foods are among the foremost reasons for the high rate of poverty and undernutrition in remote areas, suggesting the need to strengthen market functions to provide economic incentives for the production and consumption of diverse foods. Moreover, they agreed that a mix of interventions needs to be targeted to specific contexts, such as extension services along with improved market access for better dietary quality. Qaim et al. (2016) indicated that farm production diversity might contribute to income growth, but beyond a certain point, it may reduce household incomes because benefits from crop specialization cannot be realized. Therefore, a context-specific mix of interventions such as farm production diversity, improved market access, extension services, technologies, and other complementary interventions will help to achieve better nutrition outcomes in remote areas.

### 3.4. Measurement of nutrition outcomes and market access indicators

The indicators and the data used to calculate the indicators vary (heterogeneous) among the articles included in this review. Seven, nine, 10, 12, and 15 food groups are considered to measure farm household dietary diversity. The most common being 12 food groups, followed by seven food groups. Among the 28 studies, 15 used dietary data based on a 24-h recall period, and 13 used a 7-day recall period. The dietary diversity recall period, assessment method, and definition of food group diversity may have influenced the observed associations. Data is based on 7-day recall periods rather than on 24-h recall periods may be misleading and inflate diet diversity scores (Swindale and Bilinsky, 2006). Longer recall periods may also limit variation in observed data. Food groups selection also alters the observed association between diet diversity and market-related indicators, particularly when the selected food groups do not align with those used to define Market Food Diversity or Food Variety Score. On the contrary, Thorne-Lyman et al. (2014) reported arguments against short recall period indicating random within-person error associated with short recall period while estimating usual diet, stating some foods are not frequently consumed in low and middle-income countries that leads to day-to-day variation in food intake that leads to measurement error.

Similarly, simple proxies such as distance, time taken, and cost to reach the nearest market were used to measure market access. The use of

proximity alone as an indicator of market access is unlikely to give an accurate picture. The complex construct of market access as an indicator, even measured rigorously, does not necessarily equate to market participation. The myriad ways of measuring market access indicators pose great difficulty in measuring them. In their study, Chamberlin and Jayne (2013) observed a low correlation among market access indicators. Also, considerable variation in the correlation between market access indicators over time. The varying degree of correlation among the market access indicators may be very problematic to use a single indicator to measure market access. Therefore, it is quite challenging to determine one or two indicators that represent the overall market access. It may also not be easy to develop a single index by aggregating multiple variables or developing all-purpose indicators. Therefore, information on multiple market access indicators in a specific context may help to conceptualize market access.

Berti (2015), in his comment to Sibhatu et al. (2015b), argued that the failure to find an association between production diversity and dietary diversity might have been because they were measured using different scales. In response, Sibhatu et al. (2015b) agreed that they did not measure farm production diversity using the same food groups as those considered for dietary diversity. Further, Sibhatu et al. (2015b) agreed that this inconsistency might affect the results in specific contexts. Particularly in subsistence farm households where food is only produced for self-consumption, the association between farm production diversity and dietary diversity would increase if both were measured using the same scales.

### 3.5. Research/knowledge gaps and future research priorities

The association between production diversity and dietary diversity has been studied extensively in recent years. However, the market's role in farm household dietary diversity in developing countries and the depth of analysis are lacking. There has been progress in research and documentation of markets' role in moderating dietary diversity and farm production diversity in developing countries in recent years. An analysis of the available studies reveal that much remains to be studied about how, and in what contexts, market access can contribute to farm household dietary diversity and nutrition in the developing world. Although ongoing studies will improve understanding of the associations between farm production diversity, market access, and dietary diversity, the following research gaps, limitations, and future research areas need to be addressed:

- Of the 28 studies considered in this systematic review, ~75% are from nine countries in Africa and ~25% from five countries in Asia, and their results may not necessarily apply to other regions in those countries and other developing countries. Future research should focus on analyzing specific country or regional contexts, particularly in a diverse country like India, where agro-climatic, biophysical and socioeconomic conditions, consumption behaviour, food habits, and other factors vary. More importantly, as some regions specialize in producing certain crops commercially, market access can play an important role in farm household dietary diversity.
- Most of the studies (75%) based on cross-sectional data used proxy indicators (which are highly error-prone) to study the associations. Thus, results should not be generalized in a causal sense. Future studies should consider using longitudinal data, comparative surveys, and experimental and quasi-experimental studies across different regions.
- Close to 93% of the studies used dietary diversity as a proxy indicator for dietary quality, and only two studies (Bellon et al., 2016; Jones, 2016) used actual diet quality in terms of micronutrient intakes. The nutritional status mainly depends on adequate intake of macro and micro-nutrients in the diets, and it does not necessarily depend on the consumption of diverse food alone. Therefore, collecting data on actual diet quality in terms of macro and micronutrient intake is a

better option than using proxy indicators such as dietary diversity. The cost of collecting such a quality data on micronutrient intake may be a costly exercise. However, it is worth to consider for future studies to assess diet quality using standard, validated approaches (e. g., minimum dietary diversity for women indicators and minimum dietary diversity for children aged 6–23 months, as recommended by WHO) that estimate nutrient intake from specific food groups, particularly in more market-dependent communities.

- Most of the studies highlighted that market access improves dietary diversity. However, none of the studies addressed how safe and hygienic foods are sourced from markets compared to their farms' food. Also, buying foods from markets may be associated with unhealthy diets such as higher fat, additives/preservatives, more sugar, chemical residues etc. Health impact studies comparing subsistence farm households and market-oriented farm households are warranted.
- The majority of the previous studies considered the distance as the major proxy indicator (e.g. self-reported travel time, distance to the nearest market, time taken, and cost to reach the nearest market). This proxy indicator may not accurately measure the construct of market access and also may not necessarily equate to market participation. Thus, assessing farms' market orientation would be a more direct proxy indicator of a farm household's market participation. Only three studies used a new market indicator: market food diversity/market food availability (AmbikapathiHeadey et al. (2019) et al., 2019; Headey et al. (2019); Zanello et al., 2019).
- The study by Ludwig (2018) in India revealed that the positive association of market access could outdo the positive association of production diversity only in higher-income groups, and only for some food groups. As food prices could be an important criterion for farm households, the use of market food price as an indicator might provide valuable insight into the roles of markets in dietary diversity and market price as an indicator, which was not considered in any of the studies reviewed here. Besides, it is also essential to know how different socioeconomic groups benefit from different market access.
- The importance of markets for diets depends on the type of market and how well it is working. Markets are very diverse and governed by very different governance structures, social norms, and social relationships that shape consumer preferences and knowledge transfer. It is a challenge to generalize recommendations for one type of market to another (Ickowitz et al., 2019). Therefore, a study is needed to understand how different markets types and environments [input, output, consumer markets and local/village markets (weekly/daily markets, online markets, regional markets, supermarkets, grocery shops, fairs, neighborhood shops, etc.)] and households' access and opportunities to participate as consumers, input buyers and sellers influence the relationships between farm production diversity, dietary diversity and market access in developing countries.
- Markets are a vital component in a food system. The type of food and its movement vary with connectivity, seasonality, infrastructure, and cultural norms. For example, some foods are abundantly available during specific festivals (such as Eid, Ramadan, Diwali, and Shivarathri in India), though they may not be produced in the local area. In this context, it is vital to know how markets respond to community and cultural norms that potentially influence diet and nutrition quality and quantity.
- Seasonality is key in farm production and food availability in the market, affecting farm household dietary diversity. Only five studies (BellonAbay and Hirvonen (2017) Headey et al. (2019) et al., 2016; Abay and Hirvonen (2017); Sibhatu and Qaim, 2017; Headey et al. (2019); Zanello et al., 2019) addressed seasonality in the context of Afghanistan, Benin, and Ethiopia, revealing that seasonality significantly influences dietary diversity. Therefore, more studies analyzing household dietary diversity's seasonal differences must consider both own-farm production and markets as food sources.

#### 4. Conclusions

The role of markets in moderating production diversity and dietary diversity has gained researchers' attention in recent years, particularly market access for farm households' diet and nutrition. This paper provides a deeper understanding of the interplay of market access and diet diversity through a structured, systematic review of the literature. Several conclusions emerge from this review. It is evident from this review that a farm household's market access to buy food is positively associated with dietary diversity. This association has the potential to mitigate the negative effect of low-farm production diversity on dietary diversity. It is to be noted that the degree of this association is context-specific and depends on a combination of other factors like access to resources, technologies, nutrition knowledge, and own farm production. The above argument is not against farm-production diversity, in fact, market access complements production diversity in improving the quality of diets. As opined by Gupta et al. (2020), a policy emphasis should be on the role that markets can play in complementing own production, more so in the future where food and nutrition security is an important development goal.

This paper also provides some methodological contributions. The concept of non-separability of production and consumption is presented through a conceptual framework that links all elements in the production pathway and the market access and food environment pathway leading to improved nutrition outcomes. The framework implicitly elucidated with findings from the review of literature.

Important gaps for future research are identified for a more robust understanding of the linkages between market access, production, and consumption. Notable among these are - a regional focus for context specificity; development of new and innovative simple to use metrics and indicators for a holistic measurement of market access, diet diversity, and production diversity; market functioning and governance under diverse socio-cultural, structural, and policy environments; and agro-ecological, climate variability and seasonality influences, dietary patterns and cultural norms concerning food consumption. More research on these lines needed for a complete understanding of the interplay of market access and diet quality for improved nutritional status.

Lastly, it is recognized that food that goes onto the plate and is consumed matters for better nutritional outcomes. Therefore, a final thought is to focus on nutrition-sensitive agricultural interventions that enable market integration as well as an effective mechanism for promoting production diversity and reducing malnutrition.

#### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix 1. A description of the dietary diversity and market access indicators

Indicator	Description
<b>Dietary Diversity Score (DDS)</b>	Number of food groups consumed.
<b>Food Poverty</b>	Food poverty (food insecurity) is a situation when an individual does not meet his/her nutritional requirements. It is often measured in its extremes as a form of undernourishment. Food poverty exists when caloric intake is below the minimum dietary energy requirement (Joint, 1985).
<b>Food Consumption Score (FCS)</b>	This continuous variable is calculated on the basis of the frequency of consumption of the nine food groups consumed by a household's members during a 7-day recall. The constructed FCS is a continuous variable taking values between 0 and 12 (Kennedy et al., 2011). It is meant to reflect the quantity and quality of food access at the household level.
<b>Food Variety Score (FVS)</b>	The variety of food items eaten during a specific period (Hatley et al., 1998).
<b>Household Dietary Diversity Score (HDDS)</b>	HDDS is calculated by a simple count of the number of food groups consumed. Food items are grouped into 12 different categories, and each food group is counted for the household score if an item from the group has been consumed in the past 24 h/7 days by a household member (Swindale and Bilinsky, 2006). HDDS is most commonly constructed with 12 food groups as it does not focus solely on the most nutrient-rich foods (Kennedy et al., 2011). The Food and Agriculture Organization (FAO) uses a list of 16 food groups, which have been aggregated into the 12 food groups of the FANTA indicator.
<b>Household Food Insecurity Access Score (HFIAS)</b>	A measurement of the access component of household food security. It uses a set of questions that represents universal domains and sub-domains of experiencing household food insecurity and more specifically lack of access to food. It asks for the occurrence of increasingly severe experiences of food shortage. If an affirmative response is given to any of the nine questions, the frequency of occurrence in the past 4 weeks/30 days is asked: the score is 1¼ if rarely (once or twice); 2¼ if sometimes (3–10 times); and 3¼ if often (more than 10 times).
<b>Individual/Women Dietary Diversity Score (IDDS/WDSS)</b>	This is a measure of an individual's access to a variety of foods (which is meant to reflect micronutrient adequacy of the diet), and is used for those over 2 years old. It was initially developed for use in women of reproductive age to reflect the mean probability of micronutrient adequacy. The calculation is a simple count of the number of food groups consumed.
<b>Market Food Availability Index (MFAI)</b>	The availability of a basket of food items, excluding pulses, at the regional level that make up a large proportion of the diets of local households, measured at the time the respondents were surveyed.
<b>Market Food Diversity (MFD)</b>	The availability of foods and food groups across seasons and agro-ecological zones, which is collected through physical visits to markets or from traders and development agents.
<b>Market Production Index (MPI)</b>	The value of total household sales divided by the value of total production. All production, including the share retained for home consumption, is valued at farm gate prices.
<b>Minimum Dietary Diversity for Women (MDD-W)</b>	A population-level dichotomous indicator of diet diversity validated for women (aged 15–49 years) based on 10 food groups; it is considered the standard for measuring population-level dietary diversity in women of reproductive age (FAO, 2016).
<b>Nutritional Functional Diversity Score (NFDS)</b>	NFDS is the level of functional differences within the foods that prevail on a farm or in a market or are consumed in an individual's diet. Mentioned functional differences are based on the nutrient profile of every food (amount of energy and 17 different nutrients in a standard amount of each food). NFDS is a relative measure: higher scores indicate a more diverse diet (Luckett et al., 2015).

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