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A scoping review of market links between value chain actors and small-scale producers in developing regions

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Sustainable Development Goal 2 aims to end hunger, achieve food and nutrition security and promote sustainable agriculture by 2030. This requires that small-scale producers be included in, and benefit from, the rapid growth and transformation under way in food systems. Small-scale producers interact with various actors when they link with markets, including product traders, logistics firms, processors and retailers. The literature has explored primarily how large firms interact with farmers through formal contracts and resource provision arrangements. Although important, contracts constitute a very small share of small-holder market interactions. There has been little exploration of whether non-contract interactions between small farmers and both small- and large-scale value chain actors have affected small farmers' livelihoods. This scoping review covers 202 studies on that topic. We find that non-contract interactions, de facto mostly with small and medium enterprises, benefit small-scale producers via similar mechanisms that the literature has previously credited to large firms. Small and medium enterprises, not just large enterprises, address idiosyncratic market failures and asset shortfalls of small-scale producers by providing them, through informal arrangements, with complementary services such as input provision, credit, information and logistics. Providing these services directly supports Sustainable Development Goal 2 by improving farmer welfare through technology adoption and greater productivity.

The past two decades have seen tremendous growth in developing regions. Urbanization has soared, diets have diversified and food supply chains have expanded. This growth has created huge markets for farmers, along with employment in various supply-chain segments^{1,2}, including food processors, wholesalers and logistics firms. They are referred to as the 'hidden middle' because, though they constitute 40% of the average food supply chain, they are often missing from policy debates³. Their rise is important to small-scale producers because they are the farmers' proximate interface with the market, through which farmers sell their products, receive logistics and intermediation services and buy farm inputs. The potential role of these value chain actors in assisting farmers to adopt sustainable practices and attain higher incomes is especially notable in light of Sustainable Development Goal 2 (SDG 2), which aims to end hunger, achieve food and nutrition security and promote sustainable agriculture by 2030. This requires that small-scale producers benefit from the growth and transformation under way in food systems.

The midstream and downstream of the food output and input supply chains have emerged as a growing field of research⁴⁻⁶. However, this literature has largely focused on the contracting of farmers by value chain actors, and in particular the formal provision of resources within contract arrangements with large processors and supermarkets⁷⁻¹⁰. Yet just a very small share of small-scale

producers sell under contract directly to large firms³. Largely missing from the literature is evidence on (1) whether and how much value chain actors provide resources and services to farmers when the relation does not involve a formal contract and (2) whether interactions with these enterprises benefit small-scale producers in the absence of a formal contract. These questions pertain mostly to small and medium enterprises (SMEs) as they typically do not formally contract with farmers.

Here we present the findings of a protocol-driven scoping review that explores whether transactions without formal contracts with value chain actors improve the welfare of small-scale producers in developing regions. We filtered for studies that consider supply-chain transactions by value chain actors involving small-scale producers (that is, non-credit input purchase, logistics service purchase and output sales by farmers to/from value chain actors) that are not governed by formal contracts. This yielded a set of studies largely focused on SMEs. Then we analysed whether the outcomes of these economic relations were positive for small-scale producers, as well as what explained any positive or negative outcomes (Fig. 1). See the Methods for full details and Box 1 for a summary.

A key contribution of this review is to show that, contrary to expectations, it is common for SMEs in non-contract relations to undertake complementary resource provision similar to that observed among large companies in contract schemes^{11,12}.

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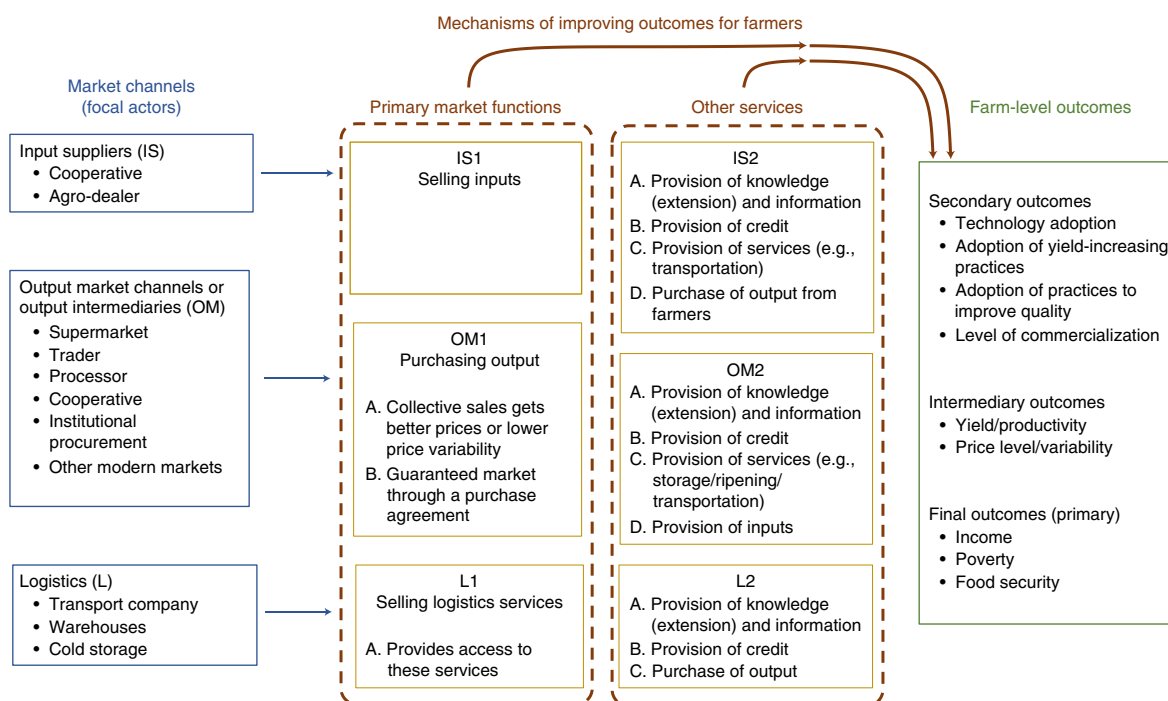


Fig. 1 | Conceptual framework of transactions. Focal actors are categorized on the basis of their 'transactional' role as a supplier of farm inputs (for example, chemical fertilizer: IS1) or service (for example, warehouse rental: L1) or a buyer of farm output (OM1). Focal actors can take on roles beyond their transactional role in the provision of complementary services such as transport or credit (which would be IS2, L2 or OM2 for input suppliers, logistics providers and output markets, respectively). Outcomes of the transactions for the farmer are determined by the terms and conditions of the transactional role plus any complementary services. The primary outcome (increased income or lower poverty or food security) can arise through adopting a new practice or technology (secondary outcome) that increases yields or attracts a higher price (intermediary outcome).

In addition, when SME value chain actors provide these services that are beyond their core activities, it is correlated with technology adoption and higher productivity among farmers. These findings are instrumental towards achieving the goals of SDG 2. Particularly in developing countries in Africa and South Asia (where small-scale producers dominate), the growth and transformation of food systems drives a proliferation of midstream SMEs which, our results show, can be a force inclusive of, and beneficial to, small-scale producers.

Results

Figure 2a presents the distribution of the included studies by publication type. A majority of the included studies (73%) are peer-reviewed journal articles. Ten percent are working papers published in grey-literature outlets, 7% are conference papers, and book chapters and theses/dissertations each account for 5% of the included studies. Most studies were scored as being of 'high quality' using the criteria explained in the Methods; just 15.5% (quantitative) and 20% (qualitative) of the studies were scored as being of low quality, usually because the study lacked sufficient details on its methodological approach.

There has been a dramatic increase in research interest in the relationship between small-scale producers and our focal actors in the past ten years. Over 40% of our selected studies were published within the past four years and over 80% in the past ten years (Fig. 3). Across all studies, 33% are of settings in Asia, 49% in Africa and 21% in Latin America. Thus, less attention has been given to measuring the impacts of small-scale producers' engagement with these focal actors in Asia or Latin America compared with Africa. This might reflect more funding opportunities and/or the prevalence of small-scale agriculture in Africa.

While 77% of the included studies focused on crop production, just 18% focused on livestock production (with the remaining studies having a dual focus). This reveals a gap in the literature, particularly given rising animal-protein consumption and the associated supply response in developing countries. More studies on livestock will be important to improve the likelihood of small-scale producers' successful participation in value chains with sustainable agricultural practices^{1,13,14}. We also find more emphasis on high-value crops in 55% of the studies, compared with 39% that look at staple crops (Fig. 2b).

There is an extremely limited gender and environmental focus in the literature. Only 24 (12%) of the 202 studies include a focus on gender, and 17 (9%) focus on the extent to which marketing channels promote the adoption of environmentally sound agricultural practices. This demonstrates a mismatch between rhetoric and reality in policy debates (which highlight gender mainstreaming and sustainability) and development research. Further research on gender-related issues and how SMEs in the midstream of value chains could increase farmer adoption of environmentally safe practices is needed to guide efforts to promote sustainable agricultural practices in line with SDG 2.

Few studies consider a primary outcome (such as income, poverty or food security) alongside a secondary or intermediate outcome (such as technology adoption or increased yields). This indicates that the final welfare effect of farmers' interactions with market channels is a gap in the literature.

Non-contract SME market channels provide key services. A key finding of this review is that value chain actors across the midstream segments of trade, processing and logistics provide a wide set of complementary services to farmers, outside the vehicle of

Box 1 | Abridged methods

We developed a comprehensive search strategy to identify all relevant studies that assess the impacts of interactions between small-scale producers and our focal actors in the midstream and downstream of the food-product and input supply chains. See Supplementary Methods for the search strategy used in CAB Abstracts and the Methods for a more detailed description of our methods. All of the search strategies used, including a list of databases and grey-literature sources, are available on the Open Science Framework⁶⁸.

After deduplication across searches, a total of 12,320 search results were screened in three phases. First, additional metadata tags were added to each study record using a machine-learning model, which facilitated an initial accelerated title-screening phase. The records were then imported into the screening tool Covidence for screening of titles and abstracts by two independent reviewers. Studies in which insufficient information was available to determine whether our criteria for inclusion were met were passed on to a final full-text screening phase. A total of 202 studies met the criteria for inclusion. Extended Data Fig. 1 presents the number of studies included and excluded at each step of the screening process.

Criteria for inclusion were determined a priori and are provided in detail in a pre-registered protocol available on Open Science Framework⁶⁸.

Briefly, a study was included if:

- It included explicit reference to small-scale producers.
- It was published in 2000 or later and in English.
- It was experimental or observational (case studies, survey-based studies, participant observation).
- The study location was in a low- or middle-income country in Asia, Africa or Latin America.
- It made clear reference to a link/interaction or potential link/interaction in terms of exchange (physical and/or monetary) between small-scale producers and the study's focal actors (value chain actors across the midstream segments of agri-food trade, processing and logistics).
- It explicitly evaluated at least one of the following farm-level outcomes: income, food security, technology adoption, practices that improve yields or quality, level of commercialization, yield or price variability.

Studies not meeting any of the above criteria were excluded. In addition, a study was excluded if:

- The methodology provided was insufficiently clear to evaluate quality and potential biases.
- It focused on the effect of contract farming on small-scale producers.
- It focused on efficacy of a technology or service.
- It focused on any government and/or non-governmental organization programme/activity that involves an exchange of a good or service for free or at a subsidized rate. We also excluded government programmes that provide inputs at market rate, extension services or the development of information systems, as well as those about cooperatives that have been established by governments.
- It focused on the effect of certification on welfare, including fair trade and organic certification, or on the relationship between certification and market channel access.
- It focused on changes in perception, confidence or attitude, but with no reference to the outcomes listed in the preceding.
- It lacked sufficient information to enable us to characterize the mechanisms regarding the link between our focal actors and smallholder farmers.

Relevant information from each included study was extracted by at least one review author and included an assessment of the quality of the studies' methodology description and justification. Supplementary Table 1 is the data extraction form, which includes details about the information extracted from each study. A list of all studies that met the inclusion criteria can be found in Supplementary Table 2. The extracted data were summarized on the basis of emerging themes and with the aim of providing recommendations to donors and policymakers.

Why is this method so important?

Unlike a typical narrative review, a scoping review strives to capture all of the literature on a given topic and reduce authorial bias. Other forms of evidence synthesis such as systematic reviews are less suitable for addressing the kinds of open-ended, exploratory questions that are often appropriate in agriculture. Scoping reviews offer a unique opportunity to explore the evidence in agricultural fields to address questions relating to what is known about a topic, what can be synthesized from existing studies to develop policy or practice recommendations and what aspects of a topic have yet to be addressed by researchers.

formal resource provision contracts. More surprisingly, this is not restricted to large enterprises but is widespread among SMEs. We categorized the focal actor cases in the included studies by whether they were identified as being small and find that the value chain actors (that is, traders, processors and logistics companies) in an overwhelming majority of the included studies are not large multinational companies but SMEs. Small enterprises comprised 75% of the cases for traders and almost 90% for processors. This is probably because we excluded formal contract arrangements, typically conducted by larger enterprises.

Finding that SME value chain actors provide complementary services shifts the debate on their role in markets. These findings show that SMEs directly improve the market context for small-scale producers and promote inclusion, while such improvements were previously attributed mostly to large companies using contract arrangements. Thus, SMEs (which are more accessible to small-scale producers than are formal contract arrangements) play an important role in facilitating inclusive growth as food systems transform in developing regions.

Table 1 disaggregates the kinds of services (beyond purchasing) provided by output market channels. The main complementary service provided by SME processors (also the second most common for traders) is credit provision. Credit was provided in 22% and 31% of farmer interactions with traders and SME processors, respectively (OM2B in Fig. 1). This links to the traditional tied-output credit market literature of the 1970s focused on SME traders, which cast them as exploitative actors who offered advances of credit to farmers and then gouged them with exorbitant implicit interest rates extracted at harvest from the sale price¹⁵.

Our findings differ from the traditional tied credit-output literature in that we find that credit provision is provided not only by traders but also by other value chain actors and is actually more likely to be provided by SME processors even in the absence of contracts. We also find that the majority of outcomes of the transactions are beneficial to small farmers, not exploitative as suggested by the old literature.

Processors and cooperatives also provide extension services and inputs to farmers. In 35% of interactions with cooperatives

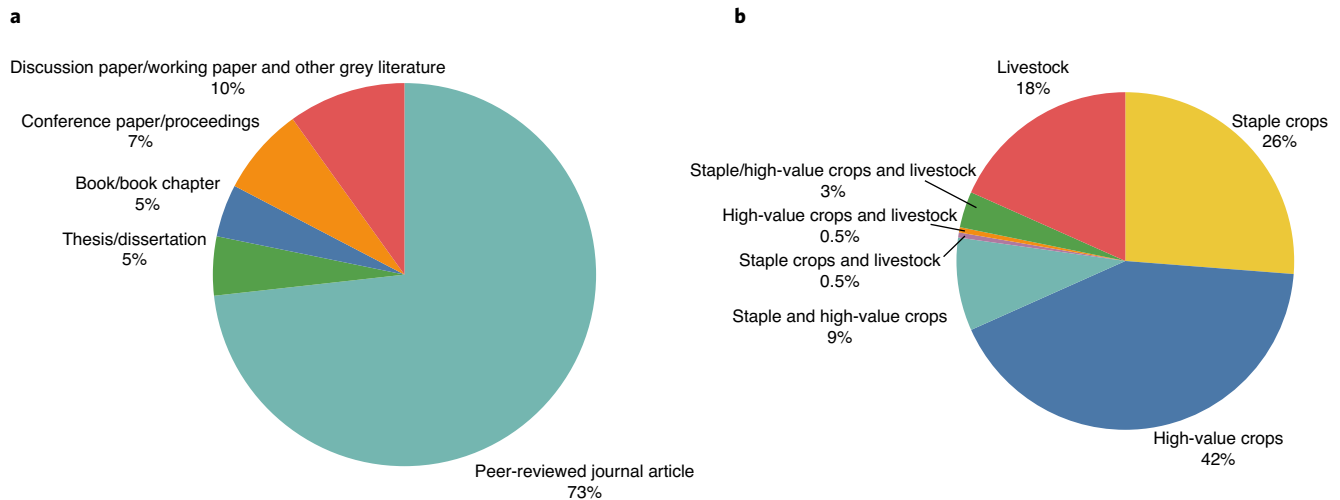


Fig. 2 | Distribution of included studies. a,b, Studies can be classified either by type of publication (a) or by product category (b). The observation level is the included study; thus, $N=202$. High-value crops are defined here to include horticulture and cash crops.

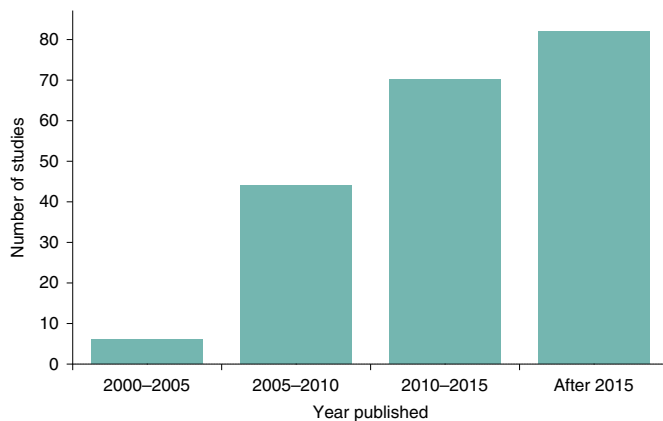


Fig. 3 | Distribution of studies by year published. The observation level is the included study; thus, $N=202$.

(19% for processors) that purchased products from small-scale producers, the buyer also offered some sort of training (OM2A in Fig. 1), while in 25–30% of interactions with these focal actors, inputs were provided.

Compared with traders and cooperatives, supermarkets are less likely to provide credit and inputs but not less likely to arrange for transportation of the product. We refer to these logistics services (such as transport) as OM2C in Fig. 1. Purchase agreements can involve farmers being included on a buyer's lists or, less formally, repeated transactions between a farmer and an output market channel (Table 3). For supermarkets and traders, the provision of purchase agreements (informal but consistent interactions) was prevalent, provided in 50% and 25% of links with farmers, respectively. This indicates that there is some effort to formalize the relationship and guarantee repeated interactions in these market channels.

We consider that three levels of formality can govern relations between output market channels and farmers. The first includes written contracts and/or contract farming arrangements—which we exclude from this scoping review. The second includes oral or unwritten contracts such as a farmer being included on a supplier's lists, which suggests some degree of formality. The third includes repetition of transactions between a farmer and buyer. For traders,

we assume that purchase agreements fall into category 3 (the least formal interaction). For processors, since over 90% of them were identified as small, we also consider purchase agreements to be in category 3. For supermarkets and government programmes captured in this scoping review, we consider purchase agreements to be in category 2 or 3. These less formal arrangements are quite common in modern value chains in developing countries.

The 'other modern' market channels (agro-export companies, marketing platforms and high-value chains) also tend to provide services for farmers in addition to an output market. Inputs were provided to farmers in 38% of links with these modern market channels. Extension and credit were provided in 25% and 19% of the interactions, respectively. Almost 31% of these interactions involved a purchase agreement, while transportation arrangements (OM2C) were made in 19% of these interactions. These modern market channels are therefore similar to the main output market channels in providing these additional services.

Although our sample size is limited for input suppliers, we find that they also provide additional services, such as credit and training (Extended Data Table 1). In over 40% of interactions with cooperatives (where their primary role was as an input provider), training/extension was offered. This was also the case for 31% and 33% of farmer interactions with other input suppliers and logistics service providers, respectively (IS2A and L2A in Fig. 1). Finally, logistics service suppliers (in 44% of their interactions with farmers) and cooperatives (in 25% of their interactions as input provider) purchased output from farmers. This is consistent with studies that have documented that some truckers also serve as wholesalers or purchase output from farmers on behalf of traders^{6,16}, and this underscores how the provision of complementary services in the midstream and downstream of input and output value chains is well recognized in the private sector.

Across product types, the share of focal actor cases where complementary services were provided is higher for links with livestock farmers compared with crop farmers (Extended Data Table 2). Among crop farmers, the particular type of assistance varies between interactions dealing with high-value crops compared with staple crops. For example, the percentage of cases where an output buyer provided a purchase agreement is much higher for high-value crops (34%) compared with staple crops (22%). However, provision of warehouse services is higher (at 6%) for staple crops than for high-value crops (at 2%).

Table 1 | Types of assistance provided to farmers

Type of assistance	Share of links that are characterized by a given type of assistance for farmers (%)							
	Traders	Processors	Cooperatives	Supermarkets	Other modern channels	Government ^a	Market	Other buyers
Arrange for transport	12	19	9	11	19	0	6	17
Provide credit	22	31	14	7	19	0	6	17
Provide inputs	16	25	30	7	38	0	11	0
Provide extension	12	19	35	7	25	0	11	50
Purchase agreements	25	19	18	50	31	50	44	0
Storage on farm	2	0	0	0	0	0	0	0
Warehouse	4	13	5	4	0	0	0	0
Irrigation	0	0	0	4	0	0	0	0
Observations	51	16	57	28	16	12	18	6

Assistance to farmers is disaggregated by the type of buyer. Included studies were coded to tabulate the focal actor linkages captured within the study. An individual study could consider multiple focal actors (for example, traders and processors). This yielded 241 linkages or 'focal actor cases'. Of these 241 linkages, 204 are with output buyers. Thus, $N=204$. Source: authors' calculations. ^aThis category includes one observation of a non-governmental organization operating as a buyer.

Table 2 | Focal actor cases with positive impact (%)

	All	Asia	Africa	Latin America	Livestock farmers ^b	Crop farmers ^b	Staple-crop farmers ^c	High-value crop farmers ^c
All focal actor cases	83	87	86	76	87	83	88	83
Buyers/processors	81	85	83	75	85	80	83	82
Input suppliers	96	100 ^d	100 ^d	80 ^d	100 ^d	96	100 ^d	94 ^d
Logistics	100 ^d	100 ^d	100 ^d	100 ^d	100 ^d	100 ^d	100 ^d	100 ^d
Observations (all) ^a	241	79	115	54	55	195	89	133

The share of cases with some positive outcomes was disaggregated by location of study and product type. The 202 included studies were coded to tabulate the focal actor linkages that were captured within each study. For this table, $N=241$. Source: authors' calculations. ^aObservations (all) refers to the number of focal actor cases in the first row. The number of observations varies when disaggregating by type of focal actor in the rows below. ^bRefers to both crop-only farmers (or livestock-only farmers) and cases with farmers producing both crops and livestock. ^cRefers to farmers that produce only staple crops (or only high-value crops) and cases with farmers producing a mix of staple and high-value crops. Thus, some cases can be found in both columns. ^dThese cells contain fewer than ten observations.

Government agencies provide fewer services. Contrary to what we find for non-government output market channels, we do not see much evidence of complementary service provision by government agencies. Instead, the agencies tend to focus on their primary role of buying farmers' output (OM1). However, they are similar to supermarkets and traders in the high likelihood of using purchase agreements (50%), which we also refer to as a primary market function (an OM1 activity) since it may be somewhat more consistent (guaranteed) than the spot market (Fig. 1).

Non-contract market channels improve farmers' welfare. Another main finding of this scoping review is that a majority of the recorded interactions between small-scale producers and value chain actors are positive. Specifically, 83% of cases exhibit a positive result for at least one outcome assessed in the study. This value is 81% for output intermediaries, 96% for input suppliers (largely cooperatives and agro-dealers) and 100% for providers of logistical services (although there are just nine cases in the latter group).

Table 2 displays the outcome patterns by geographical location and product type. It is less common for engagement between market channels and small-scale farmers to result in a positive outcome for farmers in Latin America compared with other continents. While interactions are generally positive, the share of total interactions with a positive outcome is higher for studies looking at livestock (87%) compared with crops (83%). Among crops, it is higher for staple-crop farmers (88%) than for farmers of high-value crops (83%).

Among all outcomes assessed in these studies, the study focal actors produced a positive outcome for farmers in 77% of the

cases (Extended Data Table 3). Across the three outcome categories illustrated in Fig. 1, this value is 77% for primary outcomes such as income and food security, 67% for intermediary outcomes such as yield and 84% for secondary outcomes such as technology adoption. Because so many of these observations are of buyers, the values for buyers alone are very similar (at 77%, 63% and 82% for primary, intermediary and secondary outcomes, respectively). For input suppliers alone, these values are 88%, 93% and 94% ($N=64$ in total).

The provision of complementary services appears to be instrumental in fostering a positive outcome from farmers' interactions with these input and output market channels. Table 3 presents information on the links that lead to either positive or negative/inconclusive outcomes for farmers. Among output intermediaries (columns 1 and 2), it is more common for positive outcomes to follow from exchanges that include arrangements for transportation, the provision of credit or inputs, and the provision of extension. For example, 12% of cases with positive impacts involve the buyers extending some sort of logistical assistance to arrange for transportation of the agricultural products, while this value is just 8% for cases with negative or inconclusive impacts. This pattern is consistent with the mechanism (OM2 in Fig. 1) laid out in the conceptual framework. For input suppliers, a higher percentage of cases with a positive impact involve the suppliers also purchasing output from the farmers. The provision of marketing services alongside input supply (IS2D in Fig. 1) is consistent with the rise of farmer aggregator services that supply farmers with inputs but also procure their outputs or link them with buyers¹³.

Table 3 | Positive or negative outcomes with different characteristics of the link (%)

Characteristic of the link	Buyers		Input suppliers	
	(1)	(2)	(3)	(4)
	Positive impact	Negative or inconclusive impact	Positive impact	Negative or inconclusive impact
Arrange for transport	12 ^a	8	0	0
Provide credit	19	13	29	20
Provide inputs	24	18	N/A	N/A
Provide extension	20	13	39	40
Purchase agreements	37	39	0	0
Purchase output	N/A	N/A	8	0
Storage on farm	1	0	0	0
Warehouse	5	4	0	0
Irrigation	0.002	0	8	0
Observations	351	119	59	5

Positive or negative outcomes for farmers from value chain interactions are disaggregated by the kind of complementary service provided during the interaction. For each of the 241 linkages, outcomes (Fig. 1) were recorded for small-scale producers that the study considered. Since some studies looked at multiple outcomes (for example, income as well as poverty), this resulted in 555 records of outcomes of an interaction between a farmer and a focal actor; 534 relate specifically to output buyers or input suppliers. There were too few observations of outcomes of interactions with logistics providers to include them here. Thus, for this table, $N=534$. Source: authors' calculations. ^aThe percentages reported in each column can sum to more than 100. These numbers reflect the percentage of outcomes in the column that follow from a link with each characteristic.

Overall, these results shed light on a set of activities undertaken by focal actors that tend to yield additional benefits for farmers. These services appear to fill gaps in what small-scale producers require to undertake transactions, including arranging transport and providing credit and inputs, private extension, storage and warehousing, and even irrigation services. In the great majority of cases, the interaction with these midstream enterprises benefits the farmers, and this benefit tends to be greater for men than for women in the limited studies with gender considerations.

Contrary to our expectations, it is not more common for cases with positive outcomes to include informal purchase agreements compared with cases that have negative or inconclusive outcomes. The difference between positive and negative outcomes seems to derive from the complementary services that output intermediaries provide for farmers beyond buying their products. These include the provision of training, credit and logistics services. This is extremely important as it indicates that the provision of complementary services by output intermediaries tends to be key for the interaction to be positive for small-scale producers, even conditional on the existence of pseudo-contracts.

Facilitators of positive outcomes. One hundred eighteen of the 202 included studies mention at least one condition that enables interactions with our focal actors to have a positive effect on small-scale producers. These conditions can be grouped into three broad categories. (1) Complementary services and activities provided by focal actors can bolster the positive effect of the interaction with small-scale producers. These activities—IS2, OM2 and L2 in Fig. 1—refer to additional services provided by input suppliers, output market channels and logistics service providers, alongside their main role of input or output intermediation (IS1, OM1 or L1, respectively). (2) Positive outcomes can derive from access to infrastructure. (3) A conducive policy environment can facilitate mutually beneficial interactions between farmers and the focal actors.

The provision of complementary services is a key condition supporting positive outcomes of small-scale producers' interactions with focal actors. This was noted in 65% of the instances where positive enabling conditions were mentioned. The services most frequently cited were capacity building and training (extension) for farmers (mentioned in 23% of the included studies) and the provision of credit (mentioned in 16%). Other important complementary

services include the availability of multistakeholder market platforms (mentioned in 14%) and market information (mentioned in 12%) (Extended Data Fig. 2).

The included studies demonstrate that training and capacity building can support small-scale producers as they upgrade their production to satisfy the requirements of modern market channels^{17–21}. Market information increases the speed of farm product sales while allowing farmers to bargain more effectively and obtain better prices^{22–24}. Providing timely access to affordable credit also supports the adoption of modern technologies^{25,26}, and platforms that facilitate interactions among stakeholders improve the performance of value chains^{27,28}.

The availability of rural infrastructure, including irrigation, transportation, processing, storage and communications, was noted as a facilitating condition in 23% of the studies. In addition to easing the provision of complementary services, access to transportation (road infrastructure) enables farmers to gain better price terms from both informal and formal market channels^{29,30}, and cold storage infrastructure, which reduces food wastage, has been found to increase producers' sales and generate higher prices in the off season^{17,31,32}.

A stable policy environment, characterized by enforcement of regulations and the enactment of enabling policies, was mentioned as a facilitating condition in 18% of the studies. Strong regulations can help protect farmers from exploitation by output intermediaries³³. Furthermore, supportive marketing and trade policy reforms (liberalization of input and maize markets) have been found to lead to increased input use and crop productivity³⁴.

Factors associated with negative outcomes. Forty-six of the 202 studies (23%) explicitly discussed challenges that impede the ability of value chain actors to upgrade producers' practices or improve their welfare. In order of importance (that is, the number of studies that mentioned a factor), the main inhibitors were capacity constraints, lack of trust between farmers and the focal actors, high transaction costs, non-inclusiveness, financial constraints and market power (Extended Data Fig. 3).

The low technical capacity of cooperatives and traders (the two major focal actors documented in the literature) limits their ability to support farmers^{6,35–38}. Inadequate managerial and organizational skills can lead to collective action failure, and poor coordination in

fulfilling agreements with buyers can limit market opportunities for the entire group^{39–41}.

The detected lack of trust might reflect the prevalence of informal contract arrangements in the included studies. Low trust coupled with an unstable market environment, as well as information asymmetry due to weak institutional arrangements, creates room for opportunistic behaviour by all parties^{42–44}. Moreover, a lack of trust between cooperative members and their leadership could result in failure to deliver on agreements^{28,45–48}.

High transaction costs are generally driven by additional risks or monitoring costs both parties incur during the interaction^{24,40,49–51}. Buyers fear side selling while farmers fear product rejection^{52–54}. In addition, transaction costs and capacity constraints can be exacerbated when infrastructure is poor and the relationship involves the poorest and most marginalized producers^{36–38,55–61}.

Financial constraints limit buyers' ability to provide farmers with services *ex ante* and thereby help them to upgrade^{40,62}. This closely aligns with the finding that focal actors' provision of complementary services was instrumental for their successful interaction with farmers. However, buyers' market power can substantially reduce the benefits farmers derive from interactions with them, as they can transfer demand shocks to remote farmers with few market options^{63,64}.

Discussion

This review confirms that there has been a rapid development of the midstream and downstream actors in output value chains—processors, traders and cooperatives—that buy crops and livestock products from small-scale producers. Moreover, there has also been a proliferation of value chain actors in input supply chains (agro-dealers) that supply inputs as well as services (such as training and logistics arrangements) to small-scale farmers. These value chain actors and the complementary services they provide help small-scale producers upgrade their practices, raise their productivity and subsequently improve their welfare.

The importance of these actors has been recognized with a rapid increase in the number of studies on these intermediaries in the past decade. However, the available literature is heavily tilted towards crop value chains rather than livestock, and towards high-value crops rather than staple crops. Farmer interactions with market channels and across both kinds of value chains (crop and livestock) and across crop types tend to have a positive effect on small-scale producers.

Contrary to the articulated focus by policymakers and governments on gender equality and environmental sustainability, we find extremely limited emphasis on these issues in the literature. We thus note a dearth of empirical evidence on the role that SMEs in the midstream and downstream of input and output value chains can play in the adoption and dissemination of agricultural practices that will preserve the environment or increase small-scale producers' resilience to climate change. To promote the SDGs, particularly SDG 2, additional research on how value chain actors can increase farmers' knowledge and adoption of environmentally safe practices would be valuable. Similarly, more evidence is needed on the conditions that allow both women and men small-scale producers to benefit from SMEs. Private-sector platforms that serve as one-stop shops for farmers to secure inputs, training, credit and a guaranteed market are emerging in developing countries. Further studies on whether and how these platforms could support the adoption of sustainable agricultural practices in crop and animal production are necessary.

Given the study findings of abundant midstream enterprise activity that is generally supportive of small-scale producers, we question whether governments need to directly provide these services. It appears to us that direct public provision would crowd out these midstream enterprises and waste public resources. These

Box 2 | Policy recommendations

We find that midstream and downstream enterprises, even when not in formal contract relations and even when they are SME firms, are generally helpful to small-scale producers. Thus, our main recommendation is that these value chain actors be considered as allies of governments (not as 'competitors' or 'missing') in the provision of key rural services. Governments and donors should facilitate their success through investments in hard and soft infrastructure. Governments should promulgate policies and regulations that reduce the SMEs' transaction costs for both start-up and operation and that increase their capacity to manage supply-chain risks^{13,70}. Governments and donors should also incentivize SMEs' continued provision of complementary services that benefit small-scale producers.

More specifically, we recommend the following:

1. Provide SMEs with incentives to offer complementary services to small-scale producers facing market failures and to expand their operations to reach remote farmers (with even higher transaction costs), with special attention to youth, women and disadvantaged castes and ethnic groups.
2. Expand access to finance to improve SME performance. This will enhance their ability to support small-scale producers with the relevant complementary services to enable them to upgrade their practices and improve their welfare.
3. Provide SMEs with incentives to encourage small-scale producer adoption of environmentally beneficial practices. This can support the diffusion of these technologies to safeguard food security, both now and in the future.
4. Reduce double taxation policies and numerous redundant certifications and registrations, known as 'red tape', that constrain SMEs.
5. Improve transport infrastructure and conditions to help traders and logistics firms; reduce road-related corruption (via illegal roadblocks) and high fines, as well as costs of electricity, fuel and vehicle imports. Improve trucking regulations to promote safety, and ease constraints on transport investment. Implement policies that reduce the costs of energy and equipment import and increase property rights and the ease of registration and certification.
6. Reduce cell phone and Internet connection costs that often constrain SMEs, limiting their access to information and money.

midstream enterprises serve as allies to governments in the provision of key rural services. Thus, efforts to support their operation and their continued and expanded provision of complementary services to small-scale producers should be considered (Box 2).

These intermediaries can directly support zero hunger and improved welfare through the inclusion of small-scale producers that otherwise would have been excluded. They have the potential to expand small-scale producers' access to knowledge and provide incentives to adopt sustainable agricultural practices. Thus, they can be instrumental towards achieving the objectives set forth by the United Nations' Sustainable Development Goal of zero hunger by 2030.

Methods

A scoping review identifies trends, concepts, theories, methods and knowledge gaps across a broad range of literature⁶⁵, while highlighting key areas for future research and engagement⁶⁶. A scoping review comprises five steps: (1) articulating the research question, (2) searching published and grey literature for relevant studies, (3) selecting studies on the basis of pre-defined criteria, (4) extracting and charting the data and (5) collating, summarizing and reporting the results. In this review, we made use of the Preferred Reporting Items for Systematic Reviews and

Meta-Analyses (PRISMA) extension for Scoping Reviews⁶⁵ and guidance provided by Peters et al.⁶⁷ in designing and reporting the methods. This review leverages a data science framework to accelerate the work within each of the individual steps as described in the following. A protocol for this study was developed before data collection and was registered on the Open Science Framework⁶⁸.

Search methods for identifying relevant studies. We developed a comprehensive search strategy to find all relevant studies that assess the impacts of interactions between small-scale producers and our focal actors in the midstream and downstream of the food-product and input supply chains. The Supplementary Information presents the search strategy used in CAB Abstracts, and all of the search strategies used are available on the Open Science Framework⁶⁸.

We searched the following electronic databases: CAB Abstracts (Clarivate Analytics), Web of Science Core Collection, Scopus, EconLit (Ebsco), Dissertations & Theses Global (ProQuest), Africa Theses and Dissertations (<http://datad.aau.org/discover>) and AgEcon Search (<https://ageconsearch.umn.edu>). In addition, over 15 sources of grey literature were searched⁶⁸ using custom web-scraping scripts. The results from the databases and the grey-literature searches were combined and deduplicated. Additional studies were included through consultation with experts in this field of research and on the basis of the authors' previous knowledge.

Study selection. The studies were then screened in three phases. In a first step, each citation was analysed using a machine-learning model that added over 30 metadata fields such as the studies' populations, geographies, interventions and outcomes of interest. This accelerated our identification of articles for exclusion, in which records were excluded by a single screener when they clearly did not meet our criteria (for example, published before 2000, not in a low- or middle-income country or focused on a non-food product).

The remaining records were imported into Covidence (<https://www.covidence.org>) for title/abstract and full-text screening. In both steps, studies were screened by two independent reviewers, and conflicts were resolved by a third reviewer. Studies in which insufficient information was available to determine whether our criteria for inclusion were met were passed on to the full-text screening phase. Extended Data Fig. 1 presents the number of studies included and excluded at each step of the screening process.

Selection criteria. We included studies that assessed impacts on small-scale producers of food crops, fish, dairy and livestock in low- and middle-income countries in Africa, Asia and Latin America. Studies were included if they made a clear reference to a link or interaction between small-scale producers and the study's focal actors in terms of a physical and/or monetary exchange. Focal actors were defined on the basis of the functional role that they play as an intermediary in the midstream and downstream of output and input supply chains (Fig. 1). Importantly, we did not include credit as an input here. We also did not include certification and its impacts on welfare effects, or contract farming between large enterprises and small farms, because they have been explored in two separate and recent systematic reviews^{10,69}. The systematic review by Ton et al.¹⁰ reports that contract farming may increase farmer incomes substantially, but this is largely restricted to larger farmers. Included studies measured at least one of our primary, secondary or intermediate outcomes, as shown in Fig. 1.

We focused on farmers' output production and sale and not on their household labour supply as our focus is the farm enterprise. It is possible that value chain actors could affect labour supply and subsequently labour choices in farm enterprises, thus indirectly affecting farmer practices, but this was not part of our study.

Regarding study design, both experimental and observational studies were considered, including quantitative and qualitative work. However, studies were excluded if they lacked clear objectives or had small sample sizes and lacked a justification for this limitation. Studies using data collected before 2000 were excluded from the review, given our focus on modern marketing channels. Due to time constraints and limited expertise on the team, studies in any language other than English were also excluded from the review. We recognize this as a limitation and encourage the inclusion of this literature in future iterations on this work. For a detailed explanation of selection criteria, see the scoping review protocol in Open Science Framework⁶⁸.

Data extraction and analysis. Relevant information from each included study was extracted by at least one review author. The extracted data included bibliographic information, information about the study design, sample size, producer characteristics and information about the focal actors and their interactions with producers. Information on the nature of the interactions, the outcomes measured and the effects on small-scale producers were recorded. In addition, we noted whether a study addressed issues of climate change, environmental sustainability or gender. While an assessment of study quality is not typically carried out as part of a scoping review⁶⁷, we conducted a general methodological assessment on the basis of three questions related to the appropriateness of the methods used. Bibliometric data were examined to identify publishing and research trends. Journal impact factors for studies published in peer-reviewed journals were retrieved from Journal Citation Reports (Clarivate Analytics).

The quality of each study's 'methodology description' and 'methodology justification' was assessed to be high, low or uncertain/questionable. 'High' meant there was a clear description of the sampling methods used (for methodology) and a clear justification of the selection of the research site(s), research design and/or methods used to collect and analyse the data used (for methodology justification). Studies that clearly did not meet this were considered to be of low quality. Studies for which the reviewer remained uncertain after applying the criteria were labelled as uncertain. Overall subjective quality assessment for each study was based on how convinced a reviewer was of the quality of the methodology and its justification from the two previous questions. Papers were ranked as low, medium or high using the following guide. If the responses to the two previous questions were both high, then it received a high assessment overall. If they were both low/uncertain, then this was a study of low/uncertain quality. If the responses were high and then low or low and then high, then this was a study of medium quality.

The extracted data were summarized on the basis of emerging themes and with the aim of providing recommendations to donors and policymakers.

Data availability

The data that support the findings of this study (that is, the data extracted from the 202 studies, as described in the Methods) are available from the corresponding author on request.

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Author contributions

S.Y. and N.G. led the search process and contributed to the title and abstract screening. S.Y. also contributed to the writing. L.S.O.L.-T. identified the overall research question and liaised with S.Y. and N.G. on the search process; coordinated the research process and paper writing; contributed to screening at all stages; contributed to the development of the data extraction framework, data extraction and data analysis; and led the writing. A.W. contributed to screening at all stages, contributed to the development of the data extraction template and to data extraction, led the data cleaning and analysis and contributed to the writing. J.T. and G.S.A. contributed to screening at all stages and contributed to data extraction, data analysis and writing. C.V. contributed to screening at all stages and developed the data extraction tool. T.R. contributed to the writing, evidence interpretation and link to the literature. L.B. and A.G. contributed to screening, data extraction and data analysis. J.P. contributed to the methodology and writing, and A.C. contributed to screening and data extraction.

Competing interests

The authors declare no competing interests.

Additional information

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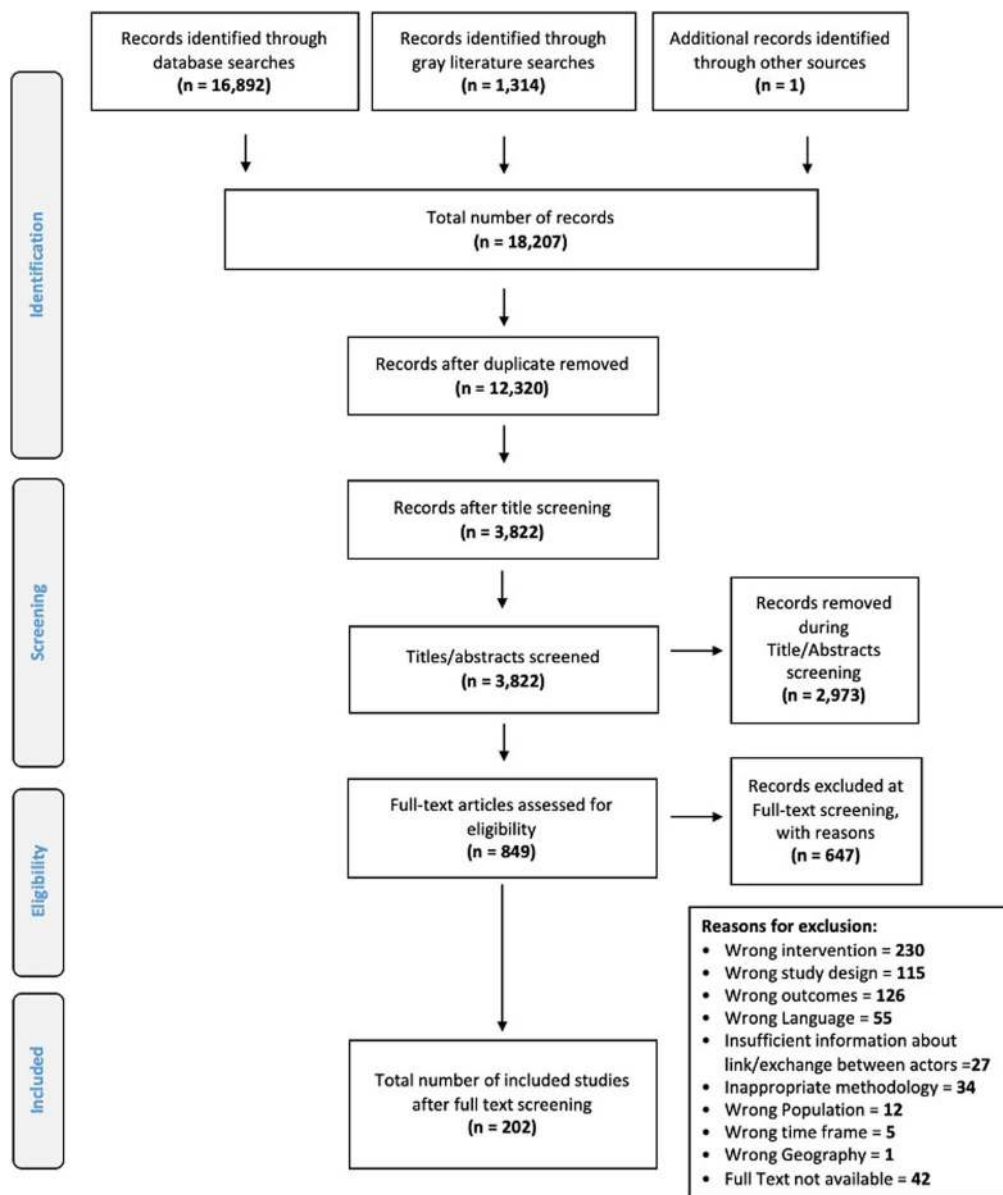
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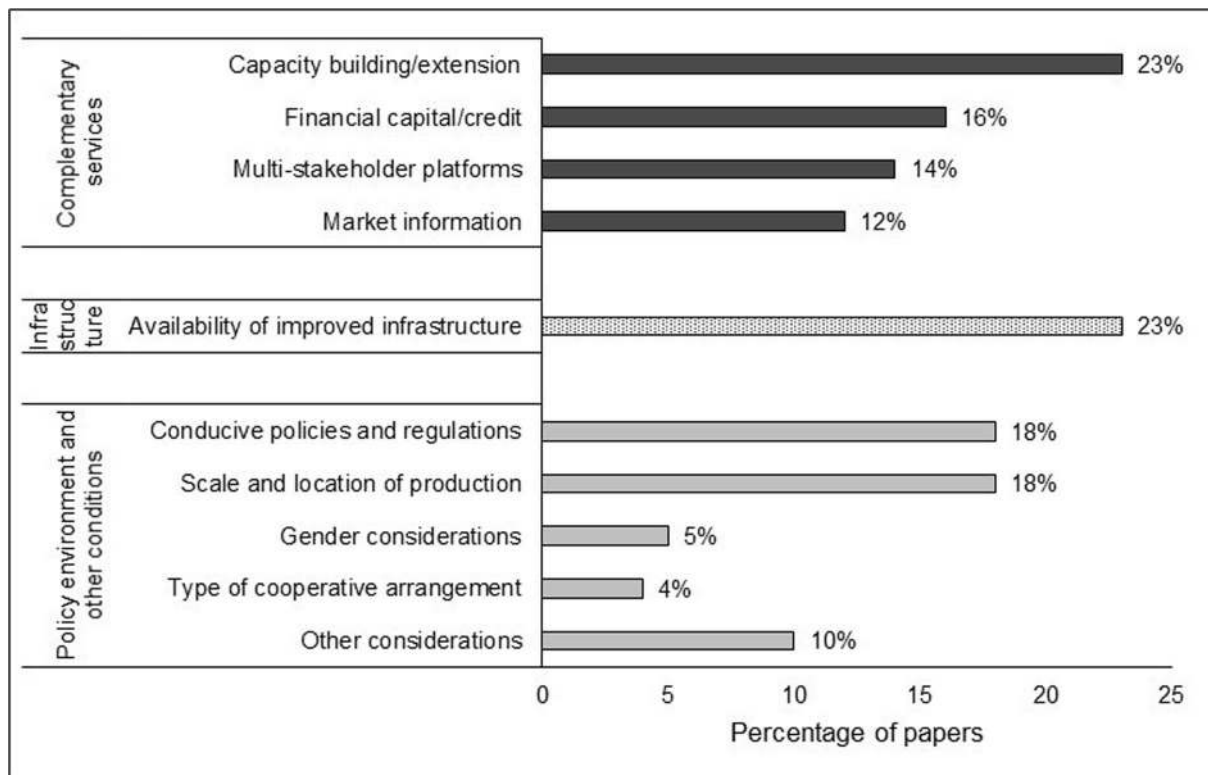


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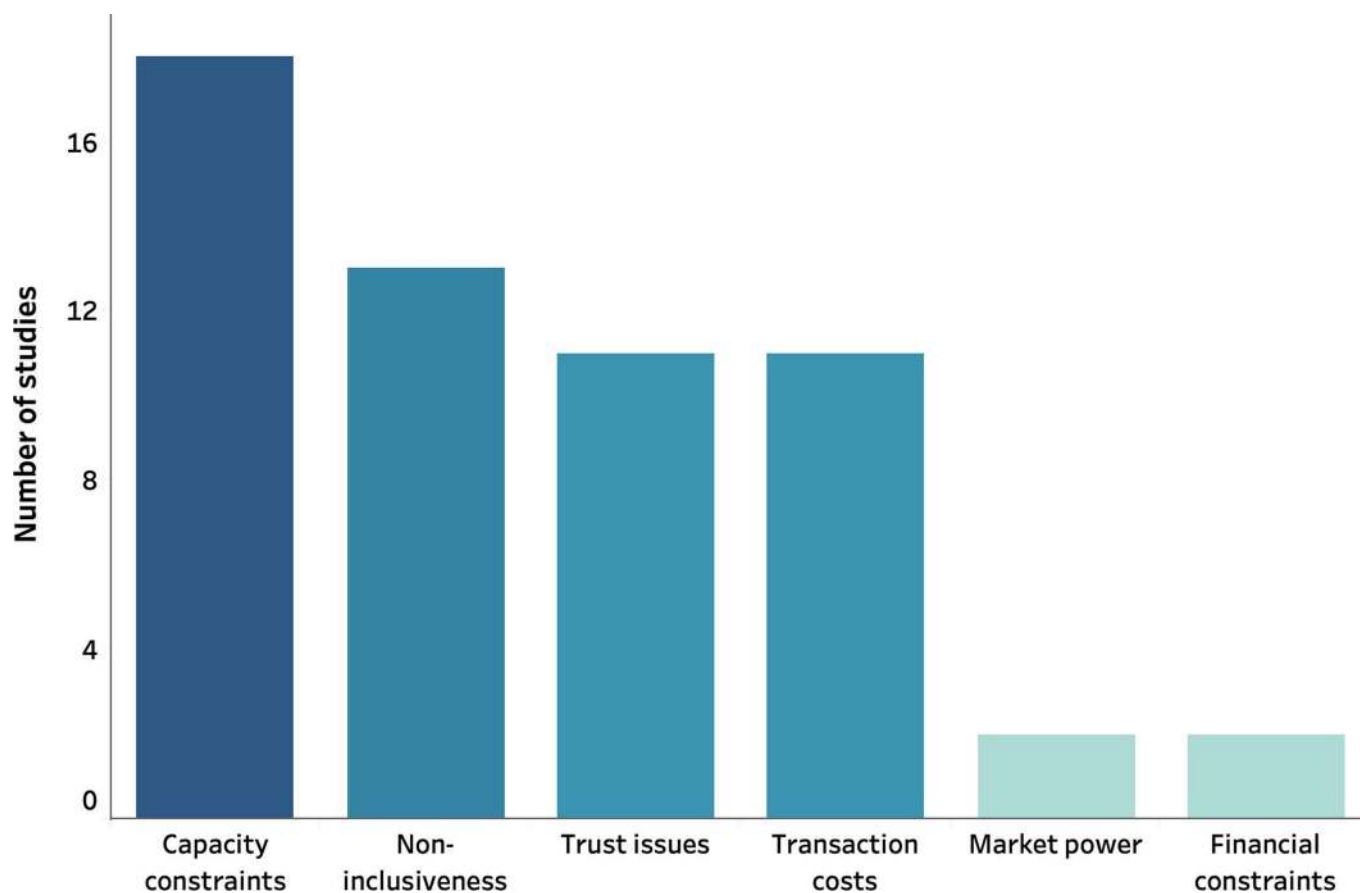
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Extended Data Fig. 1 | PRISMA flowchart of screening. The number of articles retrieved in the searches and passed each subsequent stage of screening is shown.



Extended Data Fig. 2 | Main facilitators of positive interactions. Source: Authors' calculations. The facilitators of positive interactions between focal actors and small-scale were classified into ten different groups. The observation level is the included study that mentioned a facilitating condition for a transaction between a small-scale producer and a value chain actor. There were 118 mentions; thus, N=118.



Extended Data Fig. 3 | Main challenges in focal actor interactions with farmers. Source: Authors' calculations. The main challenges impeding the successful interaction between study focal actors and small-scale producers were categorized into 6 groups. The observation level is the included study that mentioned a challenge affecting the transaction between a small-scale producer and a value chain actor. Thus, $N = 57$.

Types of assistance	Share of links that are characterized by a given type of assistance for farmers (%)		
	Input suppliers		Logistics service providers
	Cooperatives	Other input suppliers	
Arrange for transport	0	0	0
Provide credit	17	25	22
Provide inputs	N/A	N/A	22
Provide extension	42	31	33
Purchase agreements	0	0	11
Purchase output	25	13	44
Storage on farm	0	0	0
Warehouse	0	0	33
Irrigation	0	6	0
Provision of capital	0	0	0
Other	0	0	11
Observations	12	16	9

Extended Data Table 1 | Types of assistance provided by input suppliers and logistics service providers. Source: Authors' calculations. The type of assistance provided to farmers is disaggregated by input suppliers and logistics service providers. Included studies were coded to tabulate the focal actor linkage that was captured within the study. An individual study could look at multiple focal actors (for example traders and processors). This yielded 241 linkages or 'focal actor cases'. Of the 241 linkages, 204 were output buyers and 37 were input suppliers or logistics providers. This table presents the distribution of services provided for input suppliers and logistics providers only; thus, N=37.

Links between buyers/processors and small-scale producers			
Types of assistance	Staple crop farmers	High-value crop farmers	Livestock farmers
Arrange for transport	8	11	11
Provide credit	9	14	23
Provide inputs	15	16	32
Provide extension	20	20	19
Purchase agreements	22	34	32
Storage on farm	0	1	0
Warehouse	6	2	4
Irrigation	0	1	0
Observations	65	114	47

Extended Data Table 2 | Types of assistance provided by product type of farmer. Source: Authors' calculations. Type of assistance is disaggregated by product type of farmer. The 202 included studies were coded to tabulate the focal actor linkage that was captured within the study. An individual study could look at multiple focal actors (for example traders and processors), this yielded 241 linkages or 'focal actor cases'. Of those 241 focal actor cases, 204 are with output buyers. This table presents the distribution of these 204 focal actor linkages for output buyers. Observations can overlap across the three columns, as some farmers produce more than one type of agricultural product (see Fig. 2b). Thus N=226.

Outcome category	Impact on farmers (%)			Obs. ^a
	Inconclusive	Negative	Positive	
Primary	13	9	78	174
Intermediary	21	12	67	170
Secondary	12	4	84	211
Total % in column	15	8	77	

Extended Data Table 3 | Impacts on farmers by outcome category. Source: Authors' calculations. The impacts of interacting with value chain actors is disaggregated by outcome type (primary, intermediary or secondary). ^a The unit of analysis in this table is the outcome evaluated in a given study and by a given focal actor. 555 outcomes were evaluated in the 202 included studies.