



# Fostering positive food system outcomes with midstream actors in informal supply chains

A pragmatic approach for identifying opportunities for action

E. Termeer, V. Vernooij, Y. Dijkxhoorn and B. de Steenhuijsen Piters



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This study was carried out by Wageningen Social & Economic Research and Wageningen Food & Biobased Research and was commissioned and subsidised by the Dutch Ministry of Agriculture, Fisheries, Food Security and Nature within the context of the 'Food and Water Security programme' research theme of the Knowledge Base (project number KB-35-104-008).

Wageningen Social & Economic Research  
Wageningen, March 2025

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REPORT  
2025-061

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Termeer, E., V. Vernooij, Y. Dijkxhoorn, B. de Steenhuijsen Piters, 2025. *Fostering positive food system outcomes with midstream actors in informal supply chains; A pragmatic approach for identifying opportunities for action*. Wageningen, Wageningen Social & Economic Research, Report 2025-061. 26 pp.; 5 fig.; 3 tab.; 22 ref.

This report presents a 4-step approach to support midstream actors in informal food sectors in achieving food system outcomes and broader societal goals. Traditional formalisation efforts often fell short, excluding many informal actors. This approach offers alternative interventions, engages diverse stakeholders, and fosters innovation. The aim is to identify (dis)incentives that influence public objectives and steer actions accordingly. The four steps include: (1) defining scope, (2) mapping the system, (3) analysing (dis)incentives, and (4) identifying opportunities. Further case-based learning and real-world testing will refine and validate this framework.

Dit rapport presenteert een 4-stappenaanpak om actoren actief als tussenschakels in informele voedselketens te ondersteunen bij het bijdragen aan voedseluitkomsten en bredere maatschappelijke doelen. Traditionele formaliseringstrajecten schoten vaak tekort en sloten informele actoren uit. Deze aanpak biedt alternatieve interventies, betreft diverse belanghebbenden en stimuleert innovatie. Het doel is het identificeren van (dis)incentives die publieke doelstellingen beïnvloeden en acties hierop afstemmen. De vier stappen zijn: (1) het bepalen van de scope, (2) het in kaart brengen van het systeem, (3) het analyseren van (dis)incentives en (4) het identificeren van kansen. Verdere praktijkgerichte casestudies en testen in de praktijk zullen dit raamwerk verfijnen en valideren.

Key words: action-perspective, intervention, approach, incentive, informal, midstream, food system

This report can be downloaded for free at <https://doi.org/10.18174/689356> or at <http://www.wur.eu/social-and-economic-research> (under Wageningen Social & Economic Research publications).

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Wageningen Social & Economic Research Report 2025-061 | Project code 2382900003

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# Summary

## S.1 Main research question: How can informal sector actors be supported to contribute more effectively to food system outcomes?

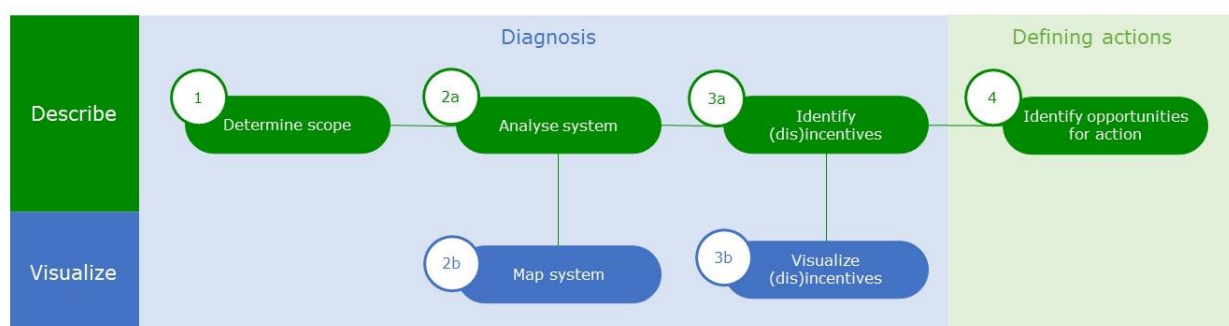
Past efforts to meet food system outcomes such as food and nutrition security and food safety, often relied on formalisation processes. These are only partially effective and often exclude actors operating in the informal economy, who play a significant role in food systems. In this study we therefore aim to answer the question: 'How can informal sector actors be supported to contribute more effectively to food system outcomes?'

## S.2 Message: Apply our 4-step approach to support informal midstream actors to achieve food system outcomes

This document provides a pragmatic 4-step approach to support midstream actors operating in informal sectors to achieve food system outcomes and thereby contribute to public and societal development goals. This is developed for researchers and development practitioners who want to include informal midstream actors in their work on food systems. The core motivation is to identify opportunities for action to steer efforts toward achieving public objectives by identifying the (dis)incentives that support and hamper these goals.

The four steps are visualised in Figure S.1 and consist of diagnosis and visualisations (steps 1-3) to identify opportunities for action (step 4):

1. Determine the scope
2. Analyse the system, map the system
3. Identify (dis)incentives, visualise (dis)incentives
4. Identify opportunities for action



**Figure S.1** Step-by-step approach to informal context analysis

We conclude that to maximise the effectiveness of opportunities for action with and for informal food sector contributions to food system outcomes, it is important to clearly define the goal (scope), such as enhancing food and nutrition security (FNS) or reducing post-harvest losses. Next steps include further case-based learning from the application of this approach, and testing and learning from promising interventions in practice.

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## S.3 Methodology: Incentives framework and case studies

To develop this 4-step approach, we built on the incentives framework (de Steenhuijsen Piters et al., 2025). This analytical framework was applied in four cases, and the lessons from this application are translated to this 4-step approach. This approach is thereby a first pragmatic translation of the incentives framework (*ibid.*). Table S.1 presents the overview of included cases.

**Table S.1** Overview of cases

Country	Value chain(s)	Focus actor(s)	Objective
Tanzania	Tomato	Midstream traders	Reducing post-harvest losses in the tomato value chain
Nigeria	Onion	Midstream traders	Innovative post-harvest solutions to reduce food loss and improve food safety
Philippines	Mango, cabbage, tomato	Midstream traders	Innovative post-harvest solutions to reduce food loss and improve food safety
Kenya	Dairy	Milk ATM operators	Understanding how the innovation of milk ATMs has taken shape in Kenya's dairy sector



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# 1 Introduction

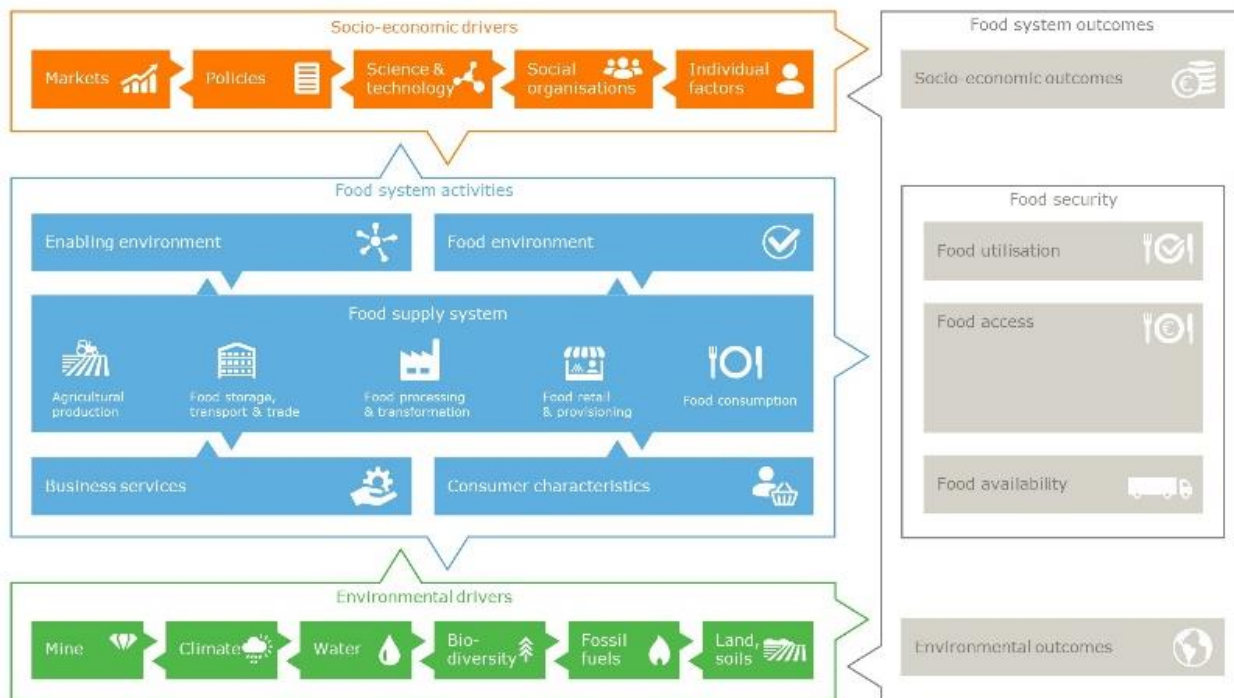
## 1.1 Current situation: Strategies to engage with the informal sector are not effective for positive food system outcomes

### **Food businesses in the informal sector are crucial for food security and livelihoods, but face numerous challenges**

Informal businesses play a crucial role in enhancing food and nutrition security, particularly for low-income households in developing countries. These businesses improve the availability, accessibility, and utilisation of nutritious foods by operating in local markets and street settings, where they offer affordable food options. This is vital for low-income households, as income from informal employment enhances their purchasing power and access to food (Reardon, 2015). Studies show that a significant portion of food consumed by low-income families comes from informal vendors, who also offer diverse and nutritious options (Battersby et al., 2016; Patel et al., 2014; Steyn et al., 2013). These vendors are especially important in areas where formal food retail options are limited. However, the informal sector faces challenges related to food safety and quality control, largely due to inadequate regulatory systems, low literacy among food traders, and insufficient infrastructure (Grace et al., 2019). There is a pressing need for better food safety standards and education to ensure that these vital food sources remain safe and accessible, while also protecting the livelihoods of those who rely on them (*ibid.*). Moreover, informal businesses suffer from a lack of acknowledgement from the government, resulting in a lack of engagement in decision-making processes.

### **Current strategies to engage with the informal sector are not inclusive and therefore not effective for positive food system outcomes**

The regulatory environment often fails to align with the realities of the informal food sector, leading to inefficiencies and missed opportunities for improving food system outcomes (Figure 1.1). For example, in Kenya's milk sector, regulations emphasise pasteurisation and licensing, yet consumers and producers prefer raw milk and informal distribution channels, which have been shown to have comparable safety and quality to formal chains (Blackmore et al., 2022). Government attempts to confine trading to designated markets often do not reduce informal street trading (Kazembe et al., 2019). To support the informal food sector, interventions should focus on facilitating rather than restricting informal sector activities, recognising their critical role in food trade and urban food security (Tawodzera, 2019; Liverpool-Tasie et al., 2020). Engaging with informal traders and understanding why businesses choose informality can lead to better policies that reduce vulnerabilities and enhance cooperation (Hidalgo et al., 2022). More broadly, it is important to consider that transitions towards more sustainable food system outcomes (van Berkum et al., 2018) in highly informal contexts require a different approach than in contexts where formalisation and a central role for the government is the norm. In informal contexts, people rely more heavily on community and family relationships, as the state is often unreliable, ill-functioning, contested or personalised (Ramos-Mejía et al., 2018).



**Figure 1.1** The food system, and food system outcomes (in grey)  
 Source: van Berkum et al. (2018).

## 1.2 Desired situation: Informal sector is engaged to effectively contribute to positive food system outcomes

### **Engaging the informal food sector to contribute towards positive food system outcomes is key to reach sustainable development efforts**

Because informal midstream actors are a critical part of the food economy, they should be included in the efforts to advance public goals (Reardon, 2015). However, knowledge on effective approaches to reach out and include informal businesses in interventions to enhancing food system outcomes and reducing negative impacts is lacking (Termeer and Vernooij, 2024). This could result in missed opportunities in achieving zero hunger – Sustainable Development Goal (SDG) 2 – and other SDGs, as informal actors make up the majority of food traders and sellers in these regions. Past efforts to meet food system outcomes such as food and nutrition security and food safety, often relied on formalisation processes. These are only partially effective and often exclude actors operating in the informal economy, who play a significant role in food systems. Therefore, there is a need for improved understanding of the motivations, organisation, and governance of informal businesses, so policies and interventions can be adjusted to their realities, and hopefully be more effective in achieving food system outcomes.

### 1.3 Main research question: How can informal sector actors be supported to contribute more effectively to food system outcomes?

In this study we aim to answer the question: 'How can informal sector actors be supported to contribute more effectively to food system outcomes?'

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## 1.4 Message: Our 4-step approach aids in identifying opportunities for informal sector actors to contribute to food system outcomes

### **We present a pragmatic 4-step approach to identify opportunities for action that work for the informal sector, exemplified by practical cases**

To identify opportunities for action, it is important to analyse the context in which actors in the informal sector operate. We present a step-by-step approach which starts by determining the scope of your initiative or issue (step 1), followed by an analysis of the actors and system (step 2) and identification of the various incentives and disincentives that these actors receive and provide (step 3). Steps 2 and 3 can be supported with visualisations. Finally, by identifying and visualising how the incentives and disincentives related to your intended goal or desired outcome, you can identify opportunities for action to address these (step 4). The core motivation is to identify opportunities for action to steer efforts toward achieving public objectives by identifying the (dis)incentives that support and hamper these goals. This approach is a pragmatic translation of the incentives framework (de Steenhuijsen Piters et al., 2025) which was applied and tested in four cases. This is developed for researchers and development practitioners who want to include informal midstream actors in their work on food systems.

We conclude that to maximise the effectiveness of opportunities for action with and for informal food sector contributions to food system outcomes, it is important to clearly define the goal (scope), such as enhancing food and nutrition security (FNS) or reducing post-harvest losses. Next steps involve case-based learning from the application of this approach, and testing and learning from promising interventions in practice.

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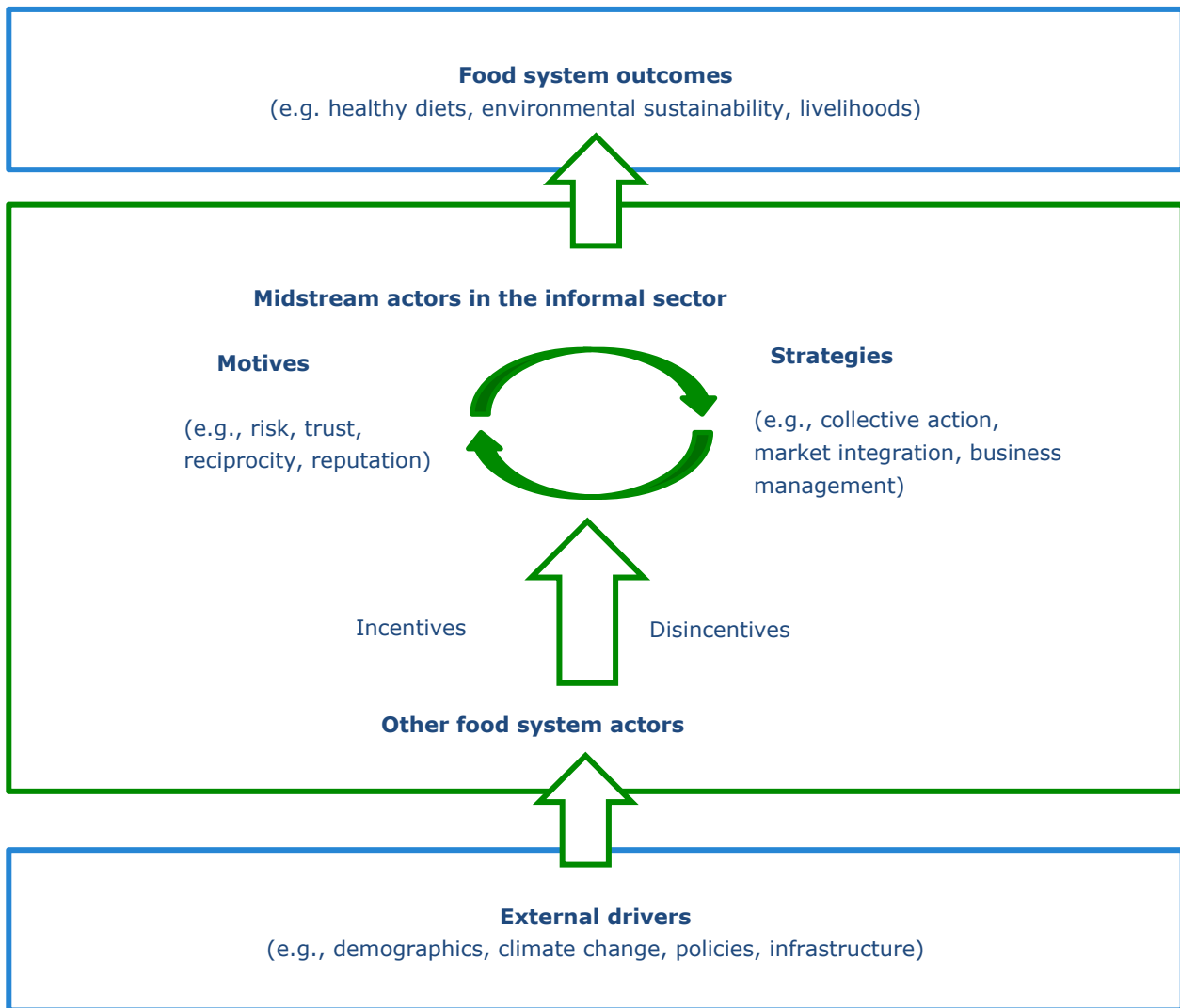
## 2 Materials and methods: incentives framework and case studies

### **The informal sector has a hybrid governance structure, which is important to take into account when working with the sector**

The informal food sector is a complex structure of self-organisation and regulation through communities, entrepreneurs, religious leaders, and trade associations. This 'hybrid governance' model acknowledges that economic regulation is shared between state and non-state entities, creating an economic order independent of formal state control (Guijt et al., 2021; Schoofs, 2015). Social networks are pivotal in shaping relationships and governance within informal markets, where trust, collaboration, and social capital are critical for business resilience and continuity. For instance, women vendors often leverage social connections to build customer trust, which is crucial for sustaining their businesses (Hidalgo et al., 2022). Vendor collaboration, such as pooling resources, can lead to improved business outcomes (Keen and Ride, 2019). There are various governance approaches to the informal sector, ranging from 'covert cooperation' where informal practices are tolerated although officially illegal, to 'overt opposition' where illegal actions are regulated via the seizure of goods, and arrests (Dai et al., 2019; Nicolini et al., 2022). Informal markets also have their own governance systems: for example in Ghana, market queens oversee operations and manage traders' associations, with access to market infrastructure sometimes influenced by social status or ethnicity (Kushitor et al., 2022). However, these systems are not without challenges, as internal conflicts and communication breakdowns can lead to governance failures (Davies et al., 2022). To engage the informal sector in food system interventions, it is important to take into account and build on existing governance structures.

### **To address our research question, we build on the incentives framework developed in earlier stages of research**

To develop the 4-step approach, we built on the incentives framework (Figure 2.1) (de Steenhuijsen Piters et al., 2025). This analytical framework examines how actors organise their businesses, mobilise resources, integrate into markets, and engage with governments. It highlights the influence of political and governance structures on food system outcomes and connects the motivations and behavioural drivers of informal sector actors with their business strategies, and it therefore very relevant to our research question. It explains that incentives must be tailored to fit these actors' specific contexts, recognising that informal economies operate under distinct rationales and governance structures, rather than imposing formal economic conditions. To effectively encourage these actors to contribute to better food system outcomes, it is essential to base the design of incentives on their own motivations and behavioural drivers.



**Figure 2.1** Visualisation of the incentives framework based on de Steenhuijsen Piters et al., (2025)

**To answer our research question, we applied the incentives framework in four cases. The lessons from this application are translated to this 4-step approach. This approach is thereby a first pragmatic translation of the incentives framework**

We draw on four case studies to illustrate our suggested approach and relate it to real-life examples of informal food sector issues and realities (see Table 2.1). This is important because informal sectors are highly contextual and approaches that work in one setting can be unfit for another. Two of the case studies we present (Nigeria and the Philippines) were aimed specifically at testing the incentives framework. The other case (Tanzania) used some of the key principles of the framework, but had a broader aim. The final case (Kenya) focused on motives, incentives and strategies around a specific innovation. Examples from these case studies will supplement each step of the approach outlined below. More case information can be found in the Appendix, and detailed case information can be found in the case documents (Talabi et al., 2024; Mvungi et al., 2024, Digal et al., 2024; Kithinji and Vernooij, *forthcoming*).

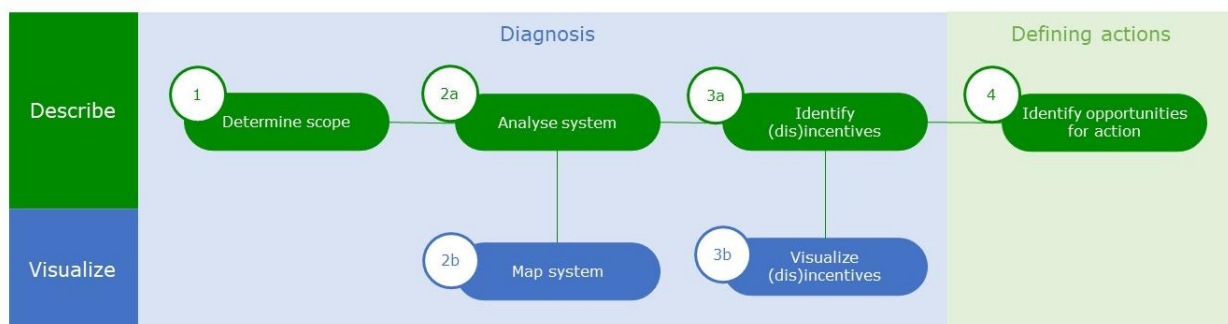
**Table 2.1** Overview of cases (see Appendix 1 for details)

Country	Value chain(s)	Focus actor(s)	Objective
Tanzania	Tomato	Midstream traders	Reducing post-harvest losses in the tomato value chain
Nigeria	Onion	Midstream traders	Innovative post-harvest solutions to reduce food loss and improve food safety
Philippines	Mango, cabbage, tomato	Midstream traders	Innovative post-harvest solutions to reduce food loss and improve food safety
Kenya	Dairy	Milk ATM operators	Understanding how the innovation of milk ATMs has taken shape in Kenya's dairy sector

# 3 A 4-step approach to identify opportunities for informal midstream actors to improve food system outcomes

Our 4-step approach is visualised in Figure 3.1. The four steps consist of diagnosis and visualisations (steps 1-3) in order to identify opportunities for action (step 4), that are further described in detail in the next sections:

1. Determine the scope
2. Analyse the system (step 2a), map the system (step 2b)
3. Identify (dis)incentives (step 3a), visualise (dis)incentives (step 3b)
4. Identify opportunities for action



**Figure 3.1** 4-step approach to identify opportunities for informal midstream actors to improve food system outcomes

## 3.1 Step 1: Determine the scope

The first step is the determination of scope and level of analysis. In this step, you decide on the issue you aim to address and whether this issue is relevant to consider at the local, national or regional level. This step is crucial to determine your next steps, as the remainder of the analysis depends on the selected scope.

For example, if your aim is to improve the food safety of road-side vegetables and fruits, you will need to engage farmers, traders, road-side vendors and consumers. Depending on the institutional context, you will need to consider any relevant food safety authorities and infrastructure institutions or developers. Intervention suggestion will likely be socio-technical. However, if you would like to focus on improving the bargaining position of road-side vendors, you will need to develop empowerment strategies or other socio-economic interventions with various actors.

Key questions:

- What is the problem?
- Who is/are the problem owner(s)?
- What is your objective?
- Which question(s) do you want to answer?
- What food system outcome are you trying to impact?
- Which product or part of the value chain will you be looking at?
- Which value chain actor(s) are you focusing on?
- What geographical scope are you focusing on (local, sub-national, national, regional level)?

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**Box 3.1: Leveraging the role of brokers in fruit and vegetable value chains in Tanzania (based on Mvungi et al., 2024) (case 3)**

Many horticultural traders for domestic consumption in Tanzania operate in the informal sector, meaning there is little monitoring across the value chain, poor infrastructure, lack of coordination and fragmentation. This limits the ability to maintain and develop an efficient informal sector to improve food safety, reduce consumer prices, and reduce food losses and waste. An interesting and often overlooked role in this system of actors is that of the broker: intermediaries that accompany buyers to the farm and negotiate terms of trade between the farmer and the buyer, or act on behalf of the buyer. Brokers can be regarded in both a positive and negative light: on the one hand, they play a key role in providing price information, sourcing produce, negotiating prices, harvesting, sorting and grading, packing and transporting produce to neighboring and distant markets, thereby contributing to providing availability of fresh produce. On the other hand, brokers are often distrusted by both farmers and traders, as they can push prices down or distort prices, and act as a barrier for direct relations between farmers and traders. Therefore, the question that is central to this case is: how can the role of brokers be leveraged towards positive food system outcomes?

## 3.2 Step 2a: Analyse the system

This step consists of a description of the value chain and its performance drivers, placed in the relevant wider food system, within the relevant scope. It includes the description of all value chain actors, as well as service supply chain actors, and other food system actors that are relevant to the objective and within the scope. Preferably, this step is conducted in close consultation with the value chain actors themselves, as they are most knowledgeable on who and what impacts their activities. It is important to distinguish between actors directly and indirectly impacting your focus actor(s) activities, for example direct trading relations between farmers and wholesalers, or the indirect influence certain regulatory bodies or NGO activities might have on the actors.

An important aspect of this systems analysis is mapping the key external drivers that influence the chain, actors and products and that are relevant for your focus. These can involve environmental drivers, such as droughts, seasonality of crops or expected changes in crop production, but also socio-economic aspects (economic dependency on the crop, profitability) or relevant policies. Together, the internal value chain relations and the external drivers make up the system.

Key questions:

- Who are the actors directly interacting with your focus-actor(s)? Why and how are they interacting directly?
- Who are the actors indirectly interacting with your focus-actor(s)? Why and how are they interacting indirectly?
- What does the product flow look like?
- What are the key external drivers influencing your focus actor(s) or focus product?

### Box 3.2a: The onion value chain in Nigeria (based on Talabi et al., 2024) (case 2)

- Who are the actors directly interacting with your focus-actor(s)? Why and how are they interacting directly?

Onion trading in Nigeria is characterised by a web of interconnected activities involving various midstream actors. Key actors include local agents, aggregators, exporters, dealers, wholesalers, and retailers collectively referred to as traders.

- Who are the actors indirectly interacting with your focus-actor(s)? Why and how are they interacting indirectly?

There are financial institutions, agricultural extension services, and input providers that influence the value chain. For example, there are a large number of local governmental organisations that provide extension services directly to farmers but also to processors. NGOs also work closely with farmers and input providers and national associations of producers, processors and marketers are active to enhance practices in the value chain.

- What does the product flow look like?

The states Sokoto, Kano and Kaduna contribute to over 80% of the national onion production. Aggregators, acting as intermediaries, purchase directly from farmers, mainly located in the North of Nigeria, in addition to engaging local sourcing agents and then distribute to dealers in Northern markets who in turn supply/sell onions to major markets in the South through the wholesalers. Sometimes, some aggregators also sell directly to wholesalers in the Southern markets. The final link in the chain involves retailers selling units of onions to end consumers. There are also activities of exporters who buy from aggregators and dealers in the Northern markets and export to neighbouring countries.

- What are the key external drivers influencing your focus actor(s) or focus product?

The favorable conditions in these regions, including well-distributed rainfall and fertile soils, result in an estimated annual onion production of over 2 million metric tons. The volume of onion production is influenced by the season of production. Onion yields are consistently higher during the dry season (November to May) compared to the wet season (May to October). The entire onion production cycle, from planting to harvesting, spans 70 to 90 days. Farmers attribute variations in yield to factors such as the selection of onion varieties, soil properties, fertiliser application, and extension services. However, the cost of inputs and labor requirements also imposes constraints on farmers' ability to expand their operations. Onion cultivation in Nigeria involves smallholder farmers as well as larger commercial farms.

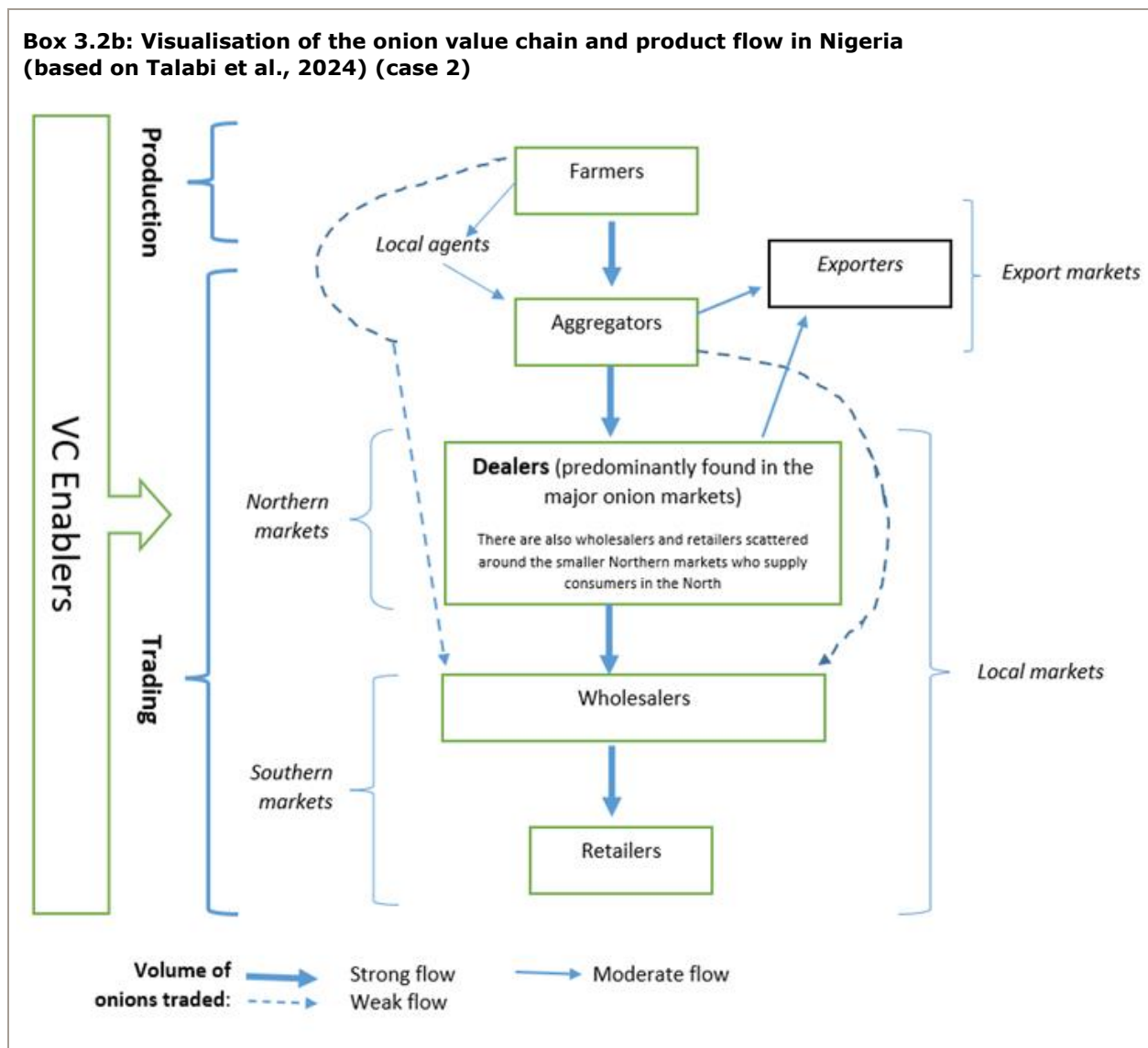


Pictures: Jimi Talabi



### 3.3 Step 2b: Visualise the system

This step visualises the system described in step 2a. This helps for an understanding of the value chain and wider food system, and it helps to communicate about the actor relations and product flows.



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## 3.4 Step 3a: Identifying (dis)incentives, motives, and strategies

This step describes (dis)incentives to your focus-actor(s) towards achieving the defined food system outcome. Understanding actors' motives and strategies is necessary for understanding the (dis)incentives, and therefore for intervention design. This step aims to briefly describe relevant political economic dynamics including unexpected relations, power of cooperatives or other network organisations, the presence and effect of monopolies, and the influence of NGOs and civil society organisations. Implementing this step translates the more 'static' system description and visualisation (Step 2a,b) to a more relational understanding of the system.

Actors that directly interact with your focus-actor(s) provide direct (dis)incentives towards achieving the food system outcome. For example, if the focus-actors are retailers, the actors that provide direct (dis)incentives are likely the wholesalers and consumers with which the retailers interact. A key motive for the consumer to interact with the retailer is to access affordable food, and his/her strategy can be to negotiate price or build a relationship with the retailer.

Actors that indirectly interact with your focus-actor(s) provide indirect (dis)incentives towards achieving the food system outcome. For example, if the focus-actors are the same retailers, supermarkets could provide indirect price-incentives to the retailers, influencing the food system outcome food availability via availing produce to low-income consumers. The underlying motive of the supermarket to indirectly interact with the retailers can be to compete for the same consumers, and its strategy can be to offer a slightly higher quality product than the retailers.

Key questions:

- Who is providing which direct (dis)incentives towards the food system goal to the focus-actor?
- Who is providing which indirect (dis)incentives towards the food system goal to the focus-actor?
- Which motives and strategies underly these (dis)incentives?

### **Box 3.3a: Incentives and disincentives for innovation to reduce post-harvest losses in the mango value chain in the Philippines (based on Digal et al., 2024) (case 2)**

In the mango value chain in Davao region in the Philippines, the food system outcome is to innovate to reduce post-harvest losses. Multiple value chain actors were included as focus actors in this case, including wholesalers and retailers. Current practices that are causing postharvest losses include rough handling causing bruises and quicker decay, fruit fly damage, and a relatively long time for the product to reach the consumer(although this has shrunk over time) causing mangos to be overripe. Innovations that can minimise these causes include loading less produce on trucks, to wash and trim the mangoes, and to use different packaging during transportation and product display arrangements for consumers.

- Who is providing which direct (dis)incentives towards the food system outcome to the focus-actor?

An example of direct incentives from value chain actors to implement these innovative practices include an improvement of product quality, for which they can charge a higher price.

- Who is providing which indirect (dis)incentives towards the food system outcome to the focus-actor?

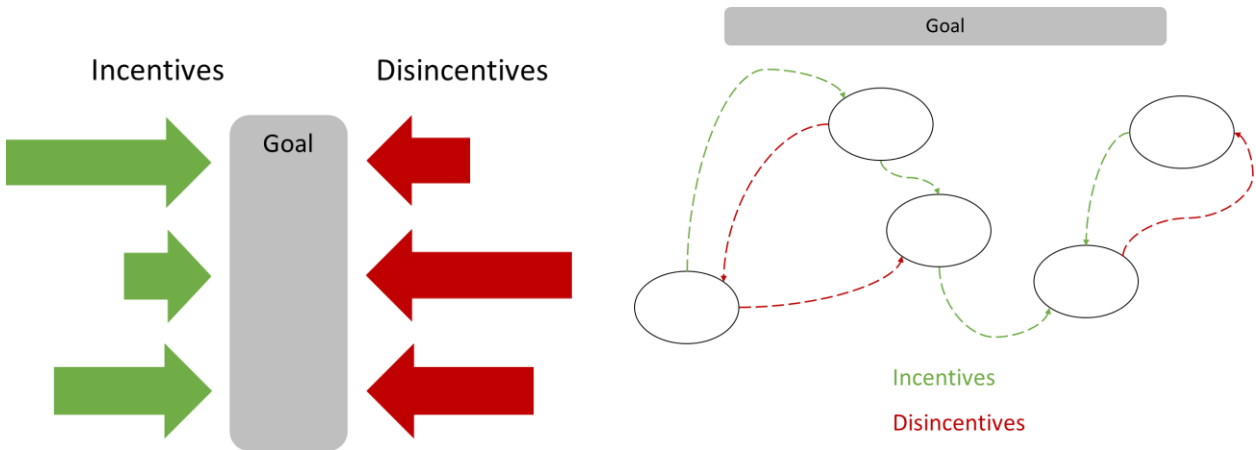
An important indirect incentive is related to seasonality and market demand: due to limited market space during peak season, wholesalers and retailers are interested in prolonging the shelf-life of mangoes so that they can sell their produce slightly after the peak season, and potentially earn a higher price. Disincentives are the limited consumer demand for higher quality mangoes and the perceived innovation investment costs. The first is a direct disincentive for retailers interacting with consumers, and an indirect incentive for producers and aggregators upstream in the value chain.

- Which motives and strategies underly these (dis)incentives?

Motives for the (dis)incentives in this case are largely economic to sustain their business practices. Examples of strategies that actors employ to receive prices for their produce that can sustain their business include improving product quality and prolonging its shelf life.

### 3.5 Step 3b: Visualise (dis)incentives

This step visualises the (dis)incentives identified in Step 3a. This helps for an understanding of potential areas of effective intervention. Examples of supporting visualisation tools include force fields (left) and causal loop diagrams (right). Alternatively, a table in which the incentives and disincentives are summarised per actor group can be useful as an overview. The incentives and disincentives should always be coupled to the actor that is experiencing and/or providing them. Also, these incentives and disincentives are typically not static, and fluctuate through time.



**Box 3.3b: Visualisation of incentives and disincentives for innovation to reduce post-harvest losses in the mango value chain in the Philippines (case 2)**

## 3.6 Step 4: Action perspectives for systems change

Moving from step 3 to step 4 demarcates a shift from 'diagnosing' to 'defining actions'. The key objective of this step is to define action perspectives towards supporting the identified food system goal. The previous steps identified the relevant socio- and political-economic contextual factors to estimate the effectiveness of interventions. Current incentives can be strengthened, potential incentives can be created, or disincentives can be addressed. Some actors are benefiting from the current status, while others can be motivated to change their practices, or relations between actors can be adjusted. The below information gives you general directions and suggestions, but each case will be different.

We argue that active inclusion of the 'unusual (informal) suspects' in the previous steps, and the identification of their contributions to food system outcomes, (dis)incentives to do so, motives, and strategies, aids the development of inclusive and therefore more effective action perspectives for achieving food system outcomes.

It is important to always consider the (dis)incentives in relation to the actors that are expressing them. Can the actor(s) be supported to strengthen current incentives, create new incentives, or resolve disincentives? Reasons for inability to strengthen/resolve the (dis)incentives, for example a lack of priority, power, or financial means, should be addressed first, or other opportunities for action should be explored.

Key questions:

- Which current incentives can be strengthened? How? By whom?
- Which potential incentives can be created? How? By whom?
- Which disincentives can be resolved? How? By whom?

To define action perspectives, it is always advised to ask those involved: 'What do you need?'. Table 3.1 presents an overview of typical instruments to provide (dis)incentives per general actor type. This always needs a translation to the relevant context and issues. Typically, public sector actors can provide (dis)incentives via subsidies and taxes, price, import and export regulations, standards, infrastructure development, information campaigns and extension services. Private sector actors can create business opportunities, build distribution channels, make investments and develop technology. Civil society organisations typically have a role in organising communities, build capacity, provide information and lobbying. Financial institutes can provide credit, loans, insurance, and influence the conditions of the access to finance. Knowledge institutes play a role in creating the knowledge needed for developing new technologies, educate and train, and provide an evidence-base for promising market innovations and policies.

**Table 3.1** Typical instruments per actor type to provide (dis)incentives in the system (authors)

Actor type	Typical instruments to provide (dis)incentives
Public sector	Subsidies, taxation, certification programmes, price controls, legal frameworks, sanitation standards, infrastructure development, information campaigns, extension services
Private sector	Distribution channels, investments, technology, price, standards, (supply) conditions, network (inclusion), business opportunities
Civil society organisations/representative, NGO's	Lobbying, information campaigns, organising people and communities/consumers, capacity building
Financial institutes	Credit and loans, insurance, conditionalities (e.g. mortgage)
Knowledge institutes	Research into new technologies, education and training, provide evidence-base for effective market innovations and policies

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See box 3.4a and Box 3.4b for examples of this step from Tanzania and Kenya.

**Box 3.4a: Developing action perspectives to reduce post-harvest losses in the tomato value chain in Tanzania (based on Mvungi et al., 2024) (case 3)**

- Which current incentives can be strengthened? How? By whom?

Traders have financial incentives to operate in the tomato business. Reducing post-harvest losses could enhance trader incomes. A defined opportunity for action in the case in Tanzania is to pilot the use of plastic crates to reduce tomato losses. This is implemented starting with traders, and moving up and down the supply chain with the actors in the network of the traders.

- Which potential incentives can be created? How? By whom?

Incentives to improve product quality can be coupled to financial incentives of the traders in the pilot.

- Which disincentives can be resolved? How? By whom?

It was found that tomato damages were particularly due to poor packaging and storage conditions during transport, and that the practice of overloading is affecting the quality of the tomatoes and is likely to increase the post harvest losses. It is expected that the pilot addresses this.

**Box 3.4b: Developing action perspectives for milk ATM operators in Kenya's dairy sector (based on Kithinji and Vernooij, 2024) (case 4)**

- Which current incentives can be strengthened? How? By whom?

ATM operators in and around Nakuru town are drawn to the ATM business because of high consumer demand for pasteurised milk, relatively ease of entry, and profitability. A market for pasteurised milk could be further incentivised with economic growth in general, allowing consumers to make choices that can include the slightly more expensive pasteurised milk compared to raw milk.

- Which potential incentives can be created? How? By whom?

To increase the accessibility of pasteurised milk to consumers, NGOs and/or government organisations could support or subsidise specific business groups, such as young people and/or women to engage in the ATM business. Also, technical training programs could involve people (ATM operators or technicians) to learn about the milk ATM machines and to be able to conduct maintenance and repairs.

- Which disincentives can be resolved? How? By whom?

ATM operators face barriers like start-up costs, seasonal milk supply fluctuations, and regulatory burdens. Examples of addressing these by actor-type are to simplify compliance requirements and provide training on regulatory adherence by the government and regulatory bodies, develop affordable loan products or credit lines tailored to ATM operators to ease start-up and operational costs by financial institutions and businesses with slightly larger economies of scale and access to formal financing, offer affordable, scalable service contracts for ATM maintenance and repair by technology providers, and to facilitate business management training by NGOs and development partners to financially overcome seasonal milk supply.

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## 4 Discussion and conclusion

### 4.1 Discussion: 4-step approach is pragmatic and needs more application

These steps provide a pragmatic approach to engaging midstream actors operating in informal sectors for achieving food system outcomes and contributing to public and societal development goals. With this approach, a pragmatic translation based on and after applying the incentives framework (de Steenhuijsen-Piters et al., 2025), we envision opportunities for finding 'unusual' intervention options, with 'new' or previously invisible stakeholders.

Engaging midstream actors operating within informal economies remains an underutilised and often undervalued approach to achieving food system outcomes. Only recently has this pathway gained recognition as a key strategy for driving food system transformation. The 4-step approach aims to maximise the effectiveness of such engagements, first, via defining the food system outcome that needs to be addressed. These may include enhancing food and nutrition security (FNS), reducing post-harvest losses, enhancing food safety, or supporting livelihoods. If there are multiple food system outcomes in focus, or a lack of clarity, it is advisable to repeat the approach for each outcome to ensure focus and effectiveness.

Understanding the evolution of incentives and disincentives over time is crucial. These factors are not static; they can shift due to seasonality, political events such as elections, or changes in the wider food system (e.g., global market disruptions). Identifying which actors, beyond public sector stakeholders, can provide or influence these incentives is particularly relevant, as their involvement can have significant implications for achieving the defined goals.

Applying our 4-step approach may reveal alternative interventions, engage alternative stakeholders, and uncover novel types of innovations. The core motivation is to steer efforts toward achieving public objectives by identifying the drivers that promote these goals and assessing their leverage potential. Past efforts to meet public objectives often relied on formalisation processes, which were only partially effective and often excluded actors operating in the informal economy. The presented 4-step approach seeks to reverse that dynamic by actively engaging the informal sector, aiming to create inclusive and impactful pathways towards positive food system outcomes.

Currently there is limited understanding of interventions that support informal midstream contributions to food system outcomes (Termeer and Vernooij, 2024). Therefore, next steps that are being taken and that are needed, are further case-based learning from the application of this approach, and testing and learning from promising interventions in practice.

### 4.2 Conclusion: The 4-step approach can be used to identify opportunities to improve contribution of informal midstream actors to food system outcomes

In this study we aimed to answer: 'How can informal sector actors be supported to contribute more effectively to food system outcomes?' Building on the lessons from the analytical incentives framework (de Steenhuijsen Piters et al., 2025) and application of the framework in four cases, we conclude that the 4-step approach developed in our study can be used to identify sector specific opportunities to improve the contribution of the informal midstream actors to food system outcomes.

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# Appendix 1 Summary of cases

## Case 1: A value chain analysis of four vegetable production hubs in the greater Arusha and Kilimanjaro area: the importance of rural brokers

**Summary:** This study is part of a wider project under the CGIAR's Research Portfolio, the Fruit and Vegetables for Sustainable Healthy Diets (FRESH) Initiative. FRESH is working with partners worldwide to address challenges to sustainable and healthy diets through an end-to-end: starting from consumers and working back through the food system to arrive at production, to increase fruit and vegetable intake for multiple impacts — improving diet quality, nutrition, and health while also improving livelihoods, empowering women and youth, and mitigating negative environmental impacts. This study falls under FRESH Work Package 4 on food loss, food safety and inclusive markets (Mvungi et al., 2024).

**Methods:** The data collection process involved conducting in-depth interviews with 14 vegetable traders and facilitating four Focus Group Discussions (FGDs) with farmers in the Arusha and Moshi regions in Tanzania between September and November 2023. Each focus group discussion was with 10 to 20 farmers from different villages connected to the hubs. The actors were related to four production hubs: Ngarenanyuki (1), Nkure (2), Mabogini (3), and Miwaleni (4) (Mvungi et al., 2024).

Reference: A case report is published as Mvungi, H., Mlowe, N., Ernest, Z., Mwambi, M., and Dijkxhoorn, Y. (2024). The role of midstream actors in vegetable value chains in Tanzania. World Vegetable Center and WUR. Arusha, Tanzania. <https://hdl.handle.net/10568/159435>.

## Case 2: Reducing post-harvest losses in the onion value chain in Nigeria

**Summary:** The onion sector in Nigeria operates within a complex informal supply chain. Internal drivers like profit maximisation influence decision-making, while external factors like seasonal variations and inadequate infrastructure create challenges. Participants employ strategies to manage risks and innovate, such as diversification and storage methods. Key strategies include cornstalk huts for storage and jute bags for transportation, which have proven effective in reducing post-harvest losses. While the informal sector offers advantages like low entry barriers, it also faces challenges like limited support and financial insecurities. Stakeholders in the supply chain, particularly midstream actors, play a crucial role in driving innovation and ensuring sustainable product availability. Their focus on profit maximisation motivates them to adopt strategies that reduce losses and improve the overall efficiency of the onion value chain (Talabi et al., 2024).

**Methods:** In total, 6 farmers, 6 aggregators, 6 dealers, 6 enablers, 4 traders and 3 retailers were interviewed from onion producing regions and main selling hubs (Talabi et al., 2024).

**Reference:** A case report is published Talabi, J., Dijkxhoorn, Y., and de Steenhuijsen Piters, B. (2024). Contributing to food system outcomes in the onion value chain in Nigeria: The potential role of midstream traders to reduce post-harvest losses and enhance food safety. <https://doi.org/10.18174/671021>.

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## Case 3: Reducing Post-harvest Losses and Enhancing Food Safety: The role of the midstream traders in the case of Mango and Vegetable Value Chains in Southern Philippines

**Summary:** There are opportunities for reducing post-harvest losses in the mango, cabbage and tomato value chains in Mindanao region in the Philippines, an area with an agri-based economy. This study sought to understand the role of informal midstream traders in these value chains in order to identify interventions for reducing post-harvest losses. Specifically, their motives, actions and strategies in dealing with risks were investigated, external factors such as policies, market requirements and competition, incentives that drive the adoption best post-harvest practices and technologies, and recommendations were formulated. Key findings are presented in the report per value chain (Digal et al., 2024).

**Methods:** Interviews with 38 key informants in total with actors from mango, cabbage, and tomato value chains, of which 31 identified themselves as being part of the informal sector.

**Reference:** A case report is published as Digal, L., Carbonell, A.K., Aguinaldo, R., Orbeta, M.L., Shuck, V., Dijkxhoorn, Y., and Pijters, B.D.S. (2024). Reducing post-harvest losses and enhancing food safety: The role of the midstream traders in the case of mango and vegetable value chains in southern Philippines. <https://hdl.handle.net/10568/159433>.

## Case 4: Tracing the (dis)incentives of milk ATM businesses in Nakuru County, Kenya

**Summary:** The milk ATM sector around Nakuru town, Kenya, balances opportunities and challenges. High demand for quality pasteurised milk, relatively easy entry, and profitability drive operators, though they face start-up costs, regulatory burdens, and seasonal milk supply fluctuations. Operational risks like spoilage and equipment breakdowns are mitigated through refrigeration and maintenance. Formalisation, spurred by 2021 dairy regulations banning raw milk sales, has seemingly affected older operators, causing high turnover but also attracting newcomers. Limited innovation and poor record-keeping hinder growth, while collaboration with suppliers and regulators is crucial despite dissatisfaction with oversight. Support in materials, maintenance, and operator-friendly regulations could strengthen the sector (Kithinji and Vernooij, *forthcoming*).

**Methods:** Nakuru town was sampled because it has a relatively high density of milk ATM's. Of the 17 total registered number of ATMs in and around Nakuru town, 14 ATM-operators were interviewed with a structured questionnaire. Three enabling actors in Nakuru's business/policy ecosystem were interviewed, and three expert interviews were conducted (Kithinji and Vernooij, *forthcoming*).

**Reference:** A case report will be published as Kithinji and Vernooij (*forthcoming*). Tracing the (dis)incentives of milk ATM businesses in Nakuru County, Kenya.



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