Barriers to commercialise produce for smallholder farmers in Malawi: An interpretive structural modelling approach

Abstract

Smallholder farmers are among the most vulnerable communities in Sub-Saharan Africa, relying on agriculture for subsistence and employment. The transition from subsistence towards commercial agriculture is a focus area to improve the living conditions of farmers in several African countries, including Malawi. However, a number of barriers still prevents the commercialisation of produce by smallholder farmers. This work aims to identify the key barriers faced by Malawian smallholder farmers to commercialise their produce and to identify their root causes in order to prioritise areas of improvement to facilitate market participation for smallholder farmers.

Using Interpretive Structural Modelling (ISM), the opinions of experts in the field were captured to establish causal and hierarchical relationships among the thirteen identified barriers, which holistically address on-farm and off-farm elements across multiple disciplines, such as agriculture, entrepreneurship, supply chain management, micro- and macro-economy.

A causal mapping method is applied for the first time in the context of smallholder farming. This work is novel in identifying in a structured manner and comprehensively analysing barriers to commercialisation of produce for smallholder farmers in the context of Sub-Saharan Africa, offering a causal hierarchical mapping of the relationships between barriers in Malawi.

The findings show that 'Poor farmers' group organisation' and 'Lack of market knowledge and understanding' are the most significant barriers, having the highest driving power and aggravating the

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other barriers. The findings of this work can have a notable contribution to practice. Policy makers and other related actors can have more clarity on the key barriers that affect all others as well as on their impact pathway, thus being able to prioritise their efforts to effectively address them.

Keywords: Smallholder farmers, Market participation, Rural Development, Sub-Saharan Africa

1 Introduction

Malawi is one of the poorest countries in the world, consistently ranked in the bottom ten countries in the world in terms of GDP at purchasing power parity per capita (CIA World Factbook, 2018a; International Monetary Fund, 2017; The World Bank, 2018) and in terms of Human Development Index (United Nations Development Programme, 2019). Malawi is one of the least developed countries in the world, suffering from several developmental issues, including low life expectancy and malnutrition (African Health Observatory, 2016; FAO, 2014).

Poverty and food insecurity are disproportional in rural Malawi (Darko et al., 2018), where 80% of the population lives and developmental issues are more widespread (CIA World Factbook, 2018b). Rural population in Malawi has limited access to education (Nordhagen and Pascual, 2013) and women are particularly disadvantaged (Simpson et al., 2012). Rural population lacks access to basic water and sanitation (United Nations, 2018), is exposed to risks of waterborne diseases due to open defecation (United Nations, 2018) and has limited access to health care (United Nations, 2018). Furthermore, only 3.2% of the rural population has access to electricity and biomass is often the only available energy supply (United Nations, 2018). Several villages remain isolated and inaccessible due to poor rural infrastructure (Radchenko and Corral, 2018; Ragasa and Mazunda, 2018), resulting in a lack of access to information for a share of the rural communities, a limited accessibility to public services and an underdeveloped private sector (Radchenko and Corral, 2018; United Nations, 2018). The majority of rural population practice agriculture, predominantly in a subsistence setting (Koppmair et al., 2017; United Nations, 2018), and agriculture is key for the livelihood of rural areas, being a major channel to lower poverty and food insecurity (Darko et al., 2018).

Agriculture plays a key role in the rural economy and society, employing 80% of the national workforce, contributing to over 30% of the GDP and 90% of export revenues (CIA World Factbook, 2018b; Darko et al., 2018; FAO, 2018, 2014; United Nations, 2018). As a result, agriculture is central

to the national and household food security (CIA World Factbook, 2018b; Graeub et al., 2016). Small family farms dominate Malawian agriculture, with 75% of population involved in farming activities working in small family farms. Yet, 59% of smallholder farmers live below the national poverty line (FAO, 2018) and reducing rural poverty was identified as a strategic objective identified by FAO in 2014.

Despite the paramount position of agriculture within the Malawian economy, the primary sector suffers from several issues. These were detailed in the Agricultural Sector Wide Approach (ASWAp) 2011-2015 documents developed by the Malawian Government (FAO, 2014). Three key focus areas that "will require a significantly enhanced research and development programme" were identified in the ASWAp (Government of Malawi, 2011): Food Security and Risk Management; Commercial Agriculture, Agro-processing and Market Development; Sustainable Agricultural Land and Water management. The need for a progressive shift from a pure subsistence agriculture towards some form of commercial agriculture was recognised as a country priority by the Malawian government in order to increase agricultural income of the rural population (Government of Malawi, 2011). This is even more urgent for small family farms, since the amount of smallholder farmers selling their produce ranges from 25% to 40% depending on the season (Malawi Government National Statistical Office, 2020), yet only 8% to 13% of the overall agricultural output by smallholders is sold on the market, leading to a minimal contribution towards the livelihood of families (FAO, 2018; Jones, 2017; Koppmair et al., 2017). This need was also recently confirmed by United Nations in 2018 that identified the creation of agriculture value chain and the enabling of the environment for agricultural entrepreneurship, agro-processing and commercialisation as key aspects to improve the Malawian primary sector. This would not only contribute to the livelihood of families, but would be also functional to reduce post-harvest losses, thus helping towards the objective of food security (African Health Observatory, 2016; United Nations, 2018).

While some barriers impeding small farmers to participate in output markets are embedded in the country's low development, there is a need to understand what are the key barriers preventing smallholder farmers to develop from the subsistence-oriented agriculture to commercial agriculture and to investigate the current market participation constraints (United Nations, 2018). Evidence-based decision making is required in Malawi and this can be done only by "strengthening availability and access to data, information and statistics", a key priority identified by FAO (2014) for the nation. Aspiring to contribute towards informed decision making in the transition from subsistence towards commercial agriculture, this work aims to identify the main barriers preventing smallholder Malawian farmers from commercialising their produce and to identify the root causes of such barriers in order to prioritise areas of improvement to facilitate market participation for smallholder farmers in the country. This work contributes to the literature at the intersection of sustainable development and smallholder farming by identifying and prioritising barriers to commercialisation for smallholder farmers in Malawi and establishing structural relationship among such barriers. This work can offer important insights to policy makers and other actors involved in rural development in Malawi on the impact pathway of existing barriers, which need to be overcome to achieve inclusive rural growth.

The remaining part of this paper is structured as follows. Section 2 reviews the literature on smallholder farmers in Sub-Saharan Africa, with a specific focus on Malawi, while Section 3 further investigates the barriers associated to commercialisation of produce within the Malawian context. Section 4 illustrates the principles of Interpretive Structural Modelling (ISM) approach and the step-by-step development of the method in this study. Results arising from the application of ISM in the specific case of barriers preventing Malawian smallholder farmers to commercialise their produce are presented and discussed in Section 5. Finally, Section 6 concludes this paper by highlighting the main contribution to the knowledge and to the society, as well as by identifying future research directions.

2 Smallholder farmers in Sub-Saharan Africa

Smallholder farmers produce 80% of the food consumed in Africa (ASFG, 2013), yet they are among the most vulnerable communities due to poverty and social exclusion, being often marginalised from provisioning systems, relying on agriculture as a source of subsistence, income and employment (ASFG, 2013; Grasseni, 2014; Jayne et al., 2010; Ogutu & Qaim, 2019; Wiggins et al., 2010). Smallholder farmers face common "biophysical and socio-economic challenges" across different countries (Mpandeli and Maponya, 2014; Stringer et al., 2008). Sub-Saharan Africa, including Malawi, is no exception to this trend, with several issues determining the disadvantaged conditions of many smallholder farmers (Jayne et al., 2010).

Farmers are facing growing environmental threats due to climate change (Hazell et al., 2010; Nordhagen and Pascual, 2013), with Sub-Saharan Africa being identified as "one of the regions most vulnerable to the impacts of climate change" (Nordhagen and Pascual, 2013). Climate change is affecting biodiversity, landscape and vegetation (Stringer et al., 2008; Wilk et al., 2013) and is increasing the frequency of extreme natural events (Nordhagen and Pascual, 2013), which present a higher risk for smallholder farmers due to their vulnerability to the consequences of such events (FAO, 2018; Mpandeli and Maponya, 2014). Among extreme natural events, droughts represent the major threat for farmers as they heavily affect the harvest (Mpandeli and Maponya, 2014; Wilk et al., 2013) and can lead to a progressive desertification of the land (Stringer et al., 2008).

This, coupled with decreasing land availability per capita due to population growth (Jayne et al., 2010; Jones, 2017; Tione and Holden, 2020), is causing an increased migration to urban areas, posing questions about generation renewal in certain areas (Amekawa, 2016; Grasseni, 2014; Jayne et al., 2010; Sibande et al., 2017; Stringer et al., 2008). Additional social issues are found in the health and educational domains. The impact of HIV was mentioned as an Africa-specific challenge, potentially threatening the existence of entire rural communities in Sub-Saharan Africa (Hazell et al., 2010; Jayne et al., 2010). Moreover, Wilk et al. (2013) identified a two-layers problem regarding knowledge and

education, with a general issue related to the overall knowledge and education of rural communities and a more specific challenge related to the access to the agricultural know-how, agricultural research and innovative agricultural techniques. This is exacerbated by the difficulty for small farmers to consistently access extension services to receive support in this area (Abdi, 2004). Rural growth centres and rural farmer service centres have been identified as critical to expand the services provided to rural communities (Ragasa and Mazunda, 2018; Snapp et al., 2018).

The limited access to agricultural know-how is also imputable to the limited support that government offer to smallholder farmers, due to a progressive withdrawal of the public sector from an active role within the primary sector, meaning that weaker agricultural policies are implemented (Government of Malawi, 2011; Graeub et al., 2016; Wilk et al., 2013). Moreover, policies are often heavily influenced by political decisions aiming to maintain consensus and achieving short-term support but offering limited long-term planning opportunities for farmers (Dionne and Horowitz, 2016; Mpanza, 2015).

Smallholder farmers' ability to invest is further hampered by their financial situation, due to capital constraints and limited access to credit (FAO, 2018; Graeub et al., 2016; Mpanza, 2015). This, coupled with traditional agricultural techniques adopted, limited use of irrigation and limited access to improved cultivars, is a key factor preventing smallholder farmers from increasing their productivity (FAO, 2018; Graeub et al., 2016; Jayne et al., 2010; Mpandeli and Maponya, 2014; Wiggins et al., 2010). The low productivity along with the limited size of average farms results in low produced volumes, which do not allow generating sufficient food surplus to commercialise the produce on a regular basis (FAO, 2018; Graeub et al., 2016; Mpandeli and Maponya, 2014; Wiggins et al., 2010). Consequently, smallholder farmers face large uncertainty in the economic domain, with a detrimental effect on their family income and social security (Graeub et al., 2016; Wilk et al., 2013).

Improved market participation and a progressive shift towards commercial agriculture have been mentioned among the solutions to tackle challenges faced by African smallholder farmers and as

strategies to concurrently address food security, poverty alleviation, economic growth and climate change (ASFG, 2013; Barrett, 2008; FAO, 2009; Gold et al., 2012; Muriithi & Matz, 2015; Wiggins, 2014), as "it is widely accepted that small farmers' participation in markets is one of the most important factors necessary for economic growth and poverty reduction in developing countries" (Sibande et al., 2017) and a "positive association between commercialization and household welfare" has been identified (Muriithi and Matz, 2015).

Nevertheless, multiple barriers still prevent smallholder farmers specifically from participating to output markets and commercialising their produce. These include uncertain rights to land and natural resources (ASFG, 2013; Jones, 2017; Wiggins et al., 2011); lack of access to adequate production inputs, such as fertilizers, herbicides and improved seeds variety, to boost productivity and increase low production volumes (ASFG, 2013; Gold et al., 2012; Mpandeli & Maponya, 2014; Muriithi & Matz, 2015; Wiggins, 2014); lack of economies of scale (Hazell et al., 2010; Wilk et al., 2013); lack of access to credit and financial services (ASFG, 2013; Wiggins, 2014; Wiggins et al., 2011); lack of planning and management skills (Wilk et al., 2013); inadequate support from extension services (ASFG, 2013); insufficient market information and market access (Mpandeli and Maponya, 2014); high transaction costs due to poor rural infrastructure, high transport costs and larger players downstream along the supply chain acting as price-setters due to monopolistic power (ASFG, 2013; Gold et al., 2012; Handschuch and Wollni, 2016; Jones, 2017; Mpandeli and Maponya, 2014; Muriithi and Matz, 2015; Wiggins, 2014; Wiggins et al., 2011); competition from larger groups in the agri-food supply chain, which are able to offer lower prices (Graeub et al., 2016; Hazell et al., 2010).

While several of the barriers identified in the literature are shared among Sub-Saharan African countries, differences exist due to regionally-specific features. With this respect, Malawi is an interesting case as several barriers are exacerbated in the country due to its features. First, Malawi is a small country, which implies a smaller internal market compared to other larger African countries (The World Bank, 2008). Second, Malawi is a landlocked country and, as such, displays higher barriers

to trade due to the impact of transport costs (Government of Malawi, 2011; Hazell et al., 2010; The World Bank, 2008). These are on average 50% higher than in coastal countries, and significantly impact the prices of imported products, such as fertilizers, as well as limiting export opportunities due to the risks associated to the fluctuations of transport costs (The World Bank, 2008). Third, Malawi is the 5th most densely populated Sub-Saharan African country and the rural demographic evolution with increased rural population density is increasing pressures on available land (Anseeuw et al., 2016; Jayne et al., 2014), thus calling for holistic agricultural sustainable strategies. Finally, Malawi's primary sector is heavily subsidized through the Farm Input Subsidy Program (FISP), which is "widely perceived as being a test case for possible broader implementation elsewhere in Africa" (Lunduka et al., 2013; Ricker-Gilbert et al., 2011): a secondary objective of the program was to increase commercialisation by farmers (Sibande et al., 2017), thus strengthening the case for the choice of Malawi as a country-case to explore barriers to commercialise the produce for smallholder farmers.

3 Barriers to commercialise the produce for smallholder farmers in Malawi

The production system of Malawian smallholder farmers can be labelled, as in the majority of Sub-Saharan countries, as a "low-inputs low-outputs" system (Ortega et al., 2016). The performance of the agricultural sector in Malawi is still considered poor and this stems from the "multiple risks associated with production and marketing processes" (Sibande et al., 2017) and the potentialities of commercial agriculture for smallholder farmers are largely untapped (United Nations, 2018), due to the multiple barriers that limit the ability of the majority of the population to enter the agricultural market economy (United Nations, 2018).

Barriers were identified through a literature search, combining a structured initial search with a backward and forward snowball approach to maximise the comprehensiveness of the review (Martins and Pato, 2019). This approach was adopted due to its flexibility and fitness-for-purpose, as

a dedicated literature on the topic is scarce and barriers are often identified in papers where the focus is on the wider smallholder farming topic. Scopus database was adopted for the initial search, as it is the largest peer-reviewed database in the management field (Tuni et al., 2018). Only sources in English were included. The initial search adopted the following keyword combination: ("Malawi" AND ("smallholder farm*" OR "small farm*")). This initial set of papers was scanned for relevance to the aim of this work. The resulting set of articles was then integrated by additional sources through a backward and forward snowball approach (Martins and Pato, 2019), allowing to enhance the focus of the literature search and to further investigate the work of key authors in the field (Ridley, 2012; Trivyza et al., 2022). The final set of core sources (16) thus included also non-academic sources, such as working papers (2) as well as governmental (1) and intergovernmental (1) reports, on top of journal articles (12). The following paragraphs illustrate the barriers to commercialise the produce for smallholder farmers in Malawi, organised by thematic clusters.

On the production side, the reliance on rain fed agriculture is a significant issue (Ortega et al., 2016), making the agriculture vulnerable to the impacts of climate change (United Nations, 2018) and concurring to the low productivity by Malawian smallholder farmers (Bhatti et al., 2021; Nordhagen and Pascual, 2013; Ragasa and Mazunda, 2018; Sibande et al., 2017; United Nations, 2018). This ultimately cascades to the overall produced quantities (Bhatti et al., 2021; Macharia et al., 2018; Ortega et al., 2016; Sibande et al., 2017), which, combined with the variable quality of produce (Macharia et al., 2018; Sibande et al., 2017), are a significant barrier for farmers to be connected to more structured and profitable markets (Macharia et al., 2018). This issue is particularly critical in the dry season, when the reduced quantities of seasonal agricultural produce are mostly used for self-subsistence and to guarantee food security (Macharia et al., 2018). Several causes contribute to the low produced quantities. These include the limited land available in each farm, which is typically less than 1ha in size (Branca et al., 2021; Jayne et al., 2014; Ortega et al., 2016; Snapp et al., 2018), with an increased fragmentation of land due to growing population (Government of Malawi, 2011; Tione and Holden, 2020), as well as the lack of technical skills by farmers, which is coupled with the lack of

production technologies, low mechanisation levels, and a limited development and transfer of production technologies (Branca et al., 2021; Government of Malawi, 2011; United Nations, 2018). A major cause of limited adoption of innovative techniques and technology is the lack of coordination in training among governmental and non-governmental providers with ineffective outcomes at the farm level (Government of Malawi, 2011; Ragasa and Mazunda, 2018). Finally, the low soil fertility due to continuous monoculture of maize across centuries also contributes to low production quantities (Ortega et al., 2016; Snapp et al., 2018), inducing public authorities to heavily subsidise fertilisers in the country to maintain acceptable levels of yield (Snapp et al., 2018). However, access to fertilisers and other production inputs, such as seeds, keeps being a significant barrier for smallholder farmers (Branca et al., 2021; Ortega et al., 2016; Radchenko and Corral, 2018; Sibande et al., 2017), either because of the availability or because of the cost of such inputs (Nordhagen and Pascual, 2013; United Nations, 2018), despite the fact that the Malawi's FISP was introduced in 2005 to increase smallholder farmer access to improved farm inputs (Pace et al., 2018; Sibande et al., 2017). While it has been recognised that the program was functional to improve productivity and food security across the country (Chibwana et al., 2012; Nordhagen and Pascual, 2013; Sibande et al., 2017), FISP has also attracted criticisms as it does not adequately target the most vulnerable farmers (Shively and Ricker-Gilbert, 2013) and it achieved marginal effects on market participation by farmers (Chibwana et al., 2012; Nordhagen and Pascual, 2013; Sibande et al., 2017), calling for a strengthening of the current regulatory framework (Bhatti et al., 2021; Ragasa and Mazunda, 2018; Sibande et al., 2017).

The limited access to farming inputs is also linked to the lack of agricultural financing and the lack of access to capital by farmers (Branca et al., 2021; Chirwa, 2006; Government of Malawi, 2011; Nordhagen and Pascual, 2013; Radchenko and Corral, 2018), a barrier that not only has an impact on the production side, but also on the distribution side. Delays in payments to farmers are widespread even in the presence of supply contracts, meaning that farmers are less likely to engage in such distribution channels as they would not otherwise be able to finance their farming operations and

livelihoods (Macharia et al., 2018). Without an access to finance, farmers are often forced to turn down potentially more lucrative options to sell instead to middlemen at the farm gate, who are likely to exploit them thanks to asymmetric market information (Chirwa, 2006; Government of Malawi, 2011; Macharia et al., 2018). Moreover, smallholder farmers, unlike buyers, have a lack of understanding and knowledge about the market dynamics (Bhatti et al., 2021; Branca et al., 2021; Chirwa, 2006), in terms of demanded crops and volumes, quality specifications and, most noticeably, "the prices prevailing at different levels of the marketing chain" (Macharia et al., 2018), meaning that farmers are price-takers (Macharia et al., 2018) and suffer the competition from large farmers who can offer lower prices (Chirwa, 2009). Finally, "smallholder agriculture is associated with lack of value addition in agricultural products" (Government of Malawi, 2011), as farmers mostly sell raw agricultural produce without any value addition, resulting in lower prices being paid by buyers (Government of Malawi, 2011; Macharia et al., 2018).

The lack of business skills among smallholder farmers further emphasises the disadvantaged position of farmers in comparison to more knowledgeable and business-oriented buyers, as farmers are not familiar with basic business practices such as bookkeeping and pricing (Chirwa, 2006; Macharia et al., 2018), and ultimately contributes to a competitive-oriented approach among different actors of the agricultural value chains, which display low levels of integration and coordination (Branca et al., 2021; United Nations, 2018). This has been exacerbated by poor farmers' organisation and cooperation due to the low number of efficient farmers' organisations (Government of Malawi, 2011), which determines a low coordination among farmers in the production and a low bargaining power with traders (Macharia et al., 2018). Consequently, the potential for produce aggregation remains largely unexploited due to the lack of coordination among smallholder farmers (Macharia et al., 2018).

On the distribution side, additional barriers prevent the commercialisation of produce, such as the high transaction costs (Government of Malawi, 2011; Jones, 2017; Radchenko and Corral, 2018;

Ricker-Gilbert et al., 2011; Sibande et al., 2017) and high transport costs (Chirwa, 2006; Government of Malawi, 2011; Ricker-Gilbert et al., 2011; United Nations, 2018) due to the underdeveloped infrastructure (Branca et al., 2021; Chirwa, 2006; Jones, 2017; Ortega et al., 2016). An additional barrier to the distribution of produce is the lack of post-harvest management and technology, which limits the shelf-life of products (Macharia et al., 2018). This is due to both a lack of post-harvest handling skills and adequate storage facilities (Macharia et al., 2018; United Nations, 2018). The combination of limited post-harvest management and logistic barriers coupled with distance to the market means that smallholder farmers in certain areas lack a consistent and reliable access to markets (Bhatti et al., 2021; Government of Malawi, 2011; Macharia et al., 2018; Ortega et al., 2016; Radchenko and Corral, 2018; United Nations, 2018).

While several barriers to the commercialisation of produce by Malawian smallholder farmers were mentioned in the literature (Table 2), they have been mostly addressed in isolation, lacking a holistic approach to understand the relationship among such barriers. This work aims to holistically identify the main barriers faced by smallholder Malawian farmers to commercialise their produce and to identify the root causes of such barriers in order to prioritise areas of improvement to facilitate market participation for smallholder farmers in the country.

4 Materials and Methods

4.1 ISM Methodology

Interpretive Structural Modelling (ISM) is an iterative and structured method belonging to the causal mapping family of methods, which allows studying complex problems, by adopting an interpretive approach based on the judgements of experts (Azevedo et al., 2019; Raut and Gardas, 2018; Sage, 1977; Warfield, 1974). ISM has been adopted to tackle a variety of complex problems in agri-food supply chains, such as causal factors of post-harvesting losses and logistic barriers in horticultural supply chains (Gardas et al., 2017; Raut and Gardas, 2018), enablers of sustainable initiatives (Mangla et al., 2018) and challenges of Indian agricultural supply chains (Gardas et al., 2018).

ISM helps in understanding the relationship among different related variables of an issue or a problem (Mangla et al., 2018; Sage, 1977; Warfield, 1974), imposing order and direction in the complexity of relationships among variables of an issue or a problem as well as identifying indirect associations among them (Azevedo et al., 2019; Raut and Gardas, 2018; Sage, 1977). ISM decomposes a complex system into several sub-systems and facilitates the generation of a multi-level structure from a complex set of variables, which can be depicted in a graphical model (Azevedo et al., 2019; Raut and Gardas, 2018; Warfield, 1974). As such, it transforms "unclear and poorly articulated models of systems into visible and well-defined models", which offer improved support for decision-making (Diabat and Govindan, 2011; Sage, 1977).

The following steps are required to perform an ISM study (Figure 1), which are developed for the application of this work throughout Section 4.2:

1. Identify the barriers faced by Malawian smallholder farmers towards commercialisation of their produce (Section 4.2.1);
2. Rank the barriers listed in the previous step, in order to identify the key barriers to be included in the subsequent steps of the methodology (Section 4.2.2);
3. Establish contextual relationship among the key shortlisted barriers by developing a pair-wise comparison between barriers and develop a Structural Self-Interaction Matrix, based on the contextual relationship identified among barriers (Section 4.2.3);
4. Develop the Reachability Matrix, by firstly transforming the Structural Self-Interaction Matrix into a matrix with binary values, thus generating the Initial Reachability Matrix and subsequently incorporating transitive links into the matrix, thus obtaining the Final Reachability Matrix (Section 4.2.4);
5. Partition the Final Reachability Matrix into different levels (Section 4.2.5);

Following the partition of the Final Reachability Matrix, an initial version of the digraph is generated, which is reviewed and checked for conceptual inconsistencies by the panel of experts. Should any

inconsistency be identified, the experts are required to modify accordingly the contextual relationships among the misplaced barriers in the digraph (Step 3). Subsequently, steps 3-5 are repeated and another version of the digraph is generated. This process is repeated recursively until there is a consensus in the panel of experts that the digraph adequately depicts the relationship among variables and that the hierarchical structure of variables is accurate. Finally, the two main outputs of ISM are obtained, which are the Power Matrix, based on the MICMAC analysis, and the final digraph, which is the ISM Model.

ISM requires the judgement of experts as a key data input: a workshop, facilitated by the authors, was held in Lilongwe, Malawi in June 2019 in order to prioritise barriers faced by Malawian smallholder farmers and to identify areas of potential improvements to facilitate commercialisation by smallholder farmers in the future. Ten experts were selected to form the panel to conduct the ISM study, which took the form of a two-days' workshop. The panel of experts was informed about the aim of the study, to ensure that responses would be relevant to the study (Azevedo et al., 2019). Experts were selected to match objective inclusion criteria in order to avoid a non-representative sample (Reefke and Sundaram, 2017). Experts needed to meet the following criteria to be part of the panel:

1. Have a current involvement in the areas of rural development, smallholder farming and/or agribusiness through professional and/or academic practice;
2. Have a minimum of 10 years' experience in the areas of rural development, smallholder farming and/or agribusiness;
3. Demonstrate professional interest in the areas of rural development, smallholder farming and/or agribusiness, to guarantee the willingness of participants to be engaged in the study.

Table 1 summarises the profile of the experts part of the panel, which represents a mix of background expertise, in-line with ISM requirements (Gardas et al., 2017) and averages 16.8 years of

experience in the agricultural supply chain field. E1-E7 were involved in all steps of the methodology, while E8-E10 did not take part to the identification of the barriers and to the ranking of the barriers, but were only involved in the subsequent stages, with a particular focus on the identification of conceptual inconsistency of the preliminary results, a process that was completed in July 2020, leading to the final formulation of the ISM model.

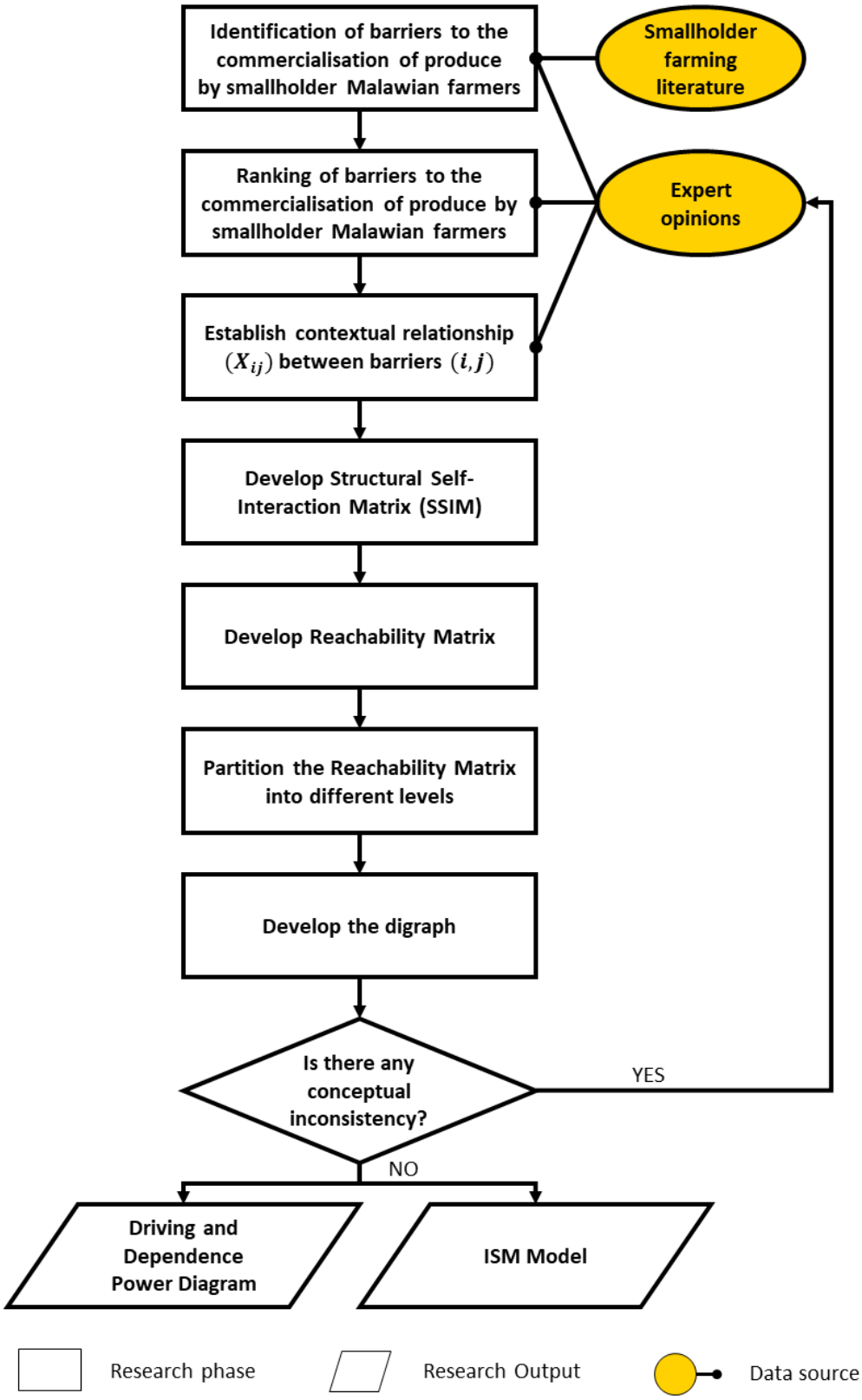

Figure 1: Interpretive Structural Modelling approach

Table 1: Profiles of experts

Code	Organisation	Organisation type	Area of expertise	Years of experience
E1	LUANAR	Academia	Agronomy, Environmental Science, Irrigation and Water Management	15
E2	Catholic Relief Services (CRS)	NGO	Community Development, Rural Development	17
E3	Challenges Worldwide	Consultancy	Agribusiness, Marketing, Value Chain Development	15
E4	Ministry of Agriculture	Government	Agronomy, Extension Services, Food Security	12
E5	Ministry of Agriculture	Government	Agriculture, Extension Services, Farmers Association	17
E6	LUANAR	Academia	Agribusiness, Business Development, Entrepreneurship	15
E7	LUANAR	Academia	Agriculture, Irrigation, Water Resources Management	20
E8	Farm Concern Worldwide	NGO	Agribusiness, Commercialisation, Farmers Association, Irrigation, Value Chain Development	15
E9	NASFAM	Farmers association	Agronomy, Extension Services, Farmers Association	20
E10	NASFAM	Farmers association	Cooperatives, Extension Services, Marketing	22

4.2 ISM Model Development

The steps to perform an Interpretive Structural Modelling analysis illustrated in Section 4.1 were applied to the case of the barriers to the commercialisation of the produce for smallholder farmers in Malawi. The following sub-sections describe in detail the steps leading to the formulation of the ISM model for the specific case.

4.2.1 Identify barriers to commercialise the produce in Malawi

The identification of the barriers was based on the results of the literature review, illustrated in Section 3, which was integrated with the opinions of the experts. Overall, 25 barriers were identified from the literature, while 77 concepts were identified by experts during a brainstorming session, including duplicates (Table A.1, available in the Appendices). The concepts were later clustered into 19 barriers by keyword analysis and similarity of scope (Tuni et al., 2018). The full list of barriers is

displayed in Table 2: a good alignment of the experts' opinion to the literature review barriers was identified, with the 19 barriers identified by experts matching relevant barriers obtained from the literature. However, some of the barriers emerging from the literature were not judged as significant by the experts for the case of Malawian smallholder farmers. Only barriers that were both identified in the literature and mentioned by experts were considered in the subsequent stages.

Table 2: List of barriers to commercialise the produce for smallholder farmers in Malawi: summary of the literature and panel of experts' opinions

Barrier	Source	Experts
Inadequate value addition to produce	(Government of Malawi, 2011; Macharia et al., 2018; United Nations, 2018)	✓
Inputs costs and availability	(Branca et al., 2021; Chirwa, 2006; Nordhagen and Pascual, 2013; Ortega et al., 2016; Radchenko and Corral, 2018; Sibande et al., 2017; Snapp et al., 2018; United Nations, 2018)	✓
Lack of access to finance	(Branca et al., 2021; Chirwa, 2006; Government of Malawi, 2011; Nordhagen and Pascual, 2013; Radchenko and Corral, 2018)	✓
Lack of access to reliable markets	(Bhatti et al., 2021; Government of Malawi, 2011; Macharia et al., 2018; Ortega et al., 2016; Radchenko and Corral, 2018; United Nations, 2018)	✓
Lack of business skills	(Chirwa, 2006; Macharia et al., 2018; United Nations, 2018)	✓
Lack of coordination in training	(Government of Malawi, 2011; Ragasa and Mazunda, 2018)	✓
Lack of market knowledge and understanding	(Bhatti et al., 2021; Branca et al., 2021; Chirwa, 2006; Government of Malawi, 2011; Macharia et al., 2018)	✓
Lack of post-harvest management and technology	(Chirwa, 2006; Macharia et al., 2018; United Nations, 2018)	✓
Lack of production technologies	(Branca et al., 2021; Government of Malawi, 2011)	✓
Lack of technical skills	(Government of Malawi, 2011)	✓
Limited land availability	(Branca et al., 2021; Chirwa, 2006; Government of Malawi, 2011; Jayne et al., 2014; Jones, 2017; Nordhagen and Pascual, 2013; Ortega et al., 2016; Sibande et al., 2017; Snapp et al., 2018)	✓
Limited value chain coordination	(Branca et al., 2021; Macharia et al., 2018; United Nations, 2018)	✓
Low level of produce aggregation	(Macharia et al., 2018)	✓
Low level of quality of produce	(Government of Malawi, 2011; Macharia et al., 2018; Sibande et al., 2017)	✓
Low prices of competitors	(Chirwa, 2009)	✓

Low production quantities	(Bhatti et al., 2021; Macharia et al., 2018; Ragasa and Mazunda, 2018; Sibande et al., 2017)	✓
Poor farmers' organisation	(Government of Malawi, 2011; Macharia et al., 2018; United Nations, 2018)	✓
Reliance on rainfed agriculture	(Government of Malawi, 2011; Nordhagen and Pascual, 2013; Ortega et al., 2016; United Nations, 2018)	✓
Weak enforcement of regulatory framework	(Bhatti et al., 2021; Ragasa and Mazunda, 2018; Sibande et al., 2017)	✓
High transaction costs	(Government of Malawi, 2011; Jones, 2017; Radchenko and Corral, 2018; Ricker-Gilbert et al., 2011; Sibande et al., 2017)	
High transport costs	(Chirwa, 2006; Government of Malawi, 2011; Ricker-Gilbert et al., 2011; United Nations, 2018)	
Lack of infrastructure	(Branca et al., 2021; Chirwa, 2006; Jones, 2017; Ortega et al., 2016)	
Low productivity	(Bhatti et al., 2021; Government of Malawi, 2011; Nordhagen and Pascual, 2013; Ragasa and Mazunda, 2018; Sibande et al., 2017; Snapp et al., 2018; United Nations, 2018)	
Low soil fertility	(Ortega et al., 2016; Snapp et al., 2018)	
Low technological development	(Government of Malawi, 2011; United Nations, 2018)	

4.2.2 Rank barriers to commercialise the produce in Malawi

In order to use ISM effectively, the number of variables, i.e. barriers, required to be reduced to the most important ones (Azevedo et al., 2019). This was performed by asking the experts to vote for the five most critical barriers and to rank them. Table 3 records the vote count of each barrier as well as the weighted vote count associated to each barrier based on the ordinal ranking assigned by experts to the top-five barriers. E8, E9 and E10 did not take part to the voting. In order to keep the number of variables manageable to establish contextual relationship in the following phase, a cut-off criterion was introduced, as in Azevedo et al. (2019): only barriers that received votes were forwarded to the pairwise comparison and subsequent stages.

Table 3: Ranking of barriers based on experts' preliminary voting

	Barrier	E1	E2	E3	E4	E5	E6	E7	Vote count	Weighted vote count
B1	Poor farmers' organisation	5	5	4	4	5			**5**	**23**
B2	Low production quantities		3	5	5	2	4	2	**6**	**21**

B3	Lack of market knowledge and understanding	2	2				2	5	**4**	**11**
B4	Low level of produce aggregation		4	3	2				**3**	**9**
B5	Lack of access to finance			2			5		**2**	**7**
B6	Limited land availability	4						3	**2**	**7**
B7	Lack of post-harvest management and technology				3	3			**2**	**6**
B8	Limited value chain coordination	3	1		1				**3**	**5**
B9	Weak enforcement of regulatory framework	1				4			**2**	**5**
B10	Lack of production technologies						3	1	**2**	**4**
B11	Lack of access to reliable markets							4	**1**	**4**
B12	Inadequate value addition to produce			1		1			**2**	**2**
B13	Lack of business skills						1		**1**	**1**
-	Inputs costs and availability								**0**	**0**
-	Lack of coordination in training								**0**	**0**
-	Lack of technical skills								**0**	**0**
-	Low level of quality of produce								**0**	**0**
-	Low prices of competitors								**0**	**0**
-	Reliance on rain fed agriculture								**0**	**0**

4.2.3 Establish contextual relationship between barriers and develop Structural Self-Interaction Matrix

The set of barriers shortlisted by experts in Section 4.2.2 was adopted in the subsequent stages. Experts were asked to provide their judgement on the relationship between barriers by the mean of pairwise comparison, facing the opportunity to pick from four options to record the relationship between each pair of barriers. The Structural Self-Interaction Matrix (SSIM) is developed to capture the type of relationship among the thirteen key barriers identified in the previous stages and is presented in Table 4. Four symbols were used to capture the relationship:

- V: barrier i aggravates barrier j;
- A: barrier j aggravates barrier i;
- X: barriers i and j aggravate each other;
- O: no relationship between barriers i and j;

In Table 4, i refers to the barriers in rows and j to the barriers in columns

Table 4: Structural Self-Interaction Matrix

Barrier	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
B1	V	V	V	V	0	V	V	V	V	V	X	V	-
B2	A	0	V	A	A	0	0	A	A	V	A	-	
B3	V	V	V	V	0	V	V	V	V	V	-		
B4	A	0	V	A	A	A	A	A	A	-			
B5	A	V	V	V	0	V	V	X	-				
B6	0	0	V	V	0	0	0	-					
B7	A	0	V	0	0	A	-						
B8	A	0	V	0	0	-							
B9	0	0	0	0	-								
B10	A	0	V	-									
B11	A	A	-										
B12	A	-											
B13	-												

4.2.4 Develop Reachability Matrix

The entries of the Structural Self-Interaction Matrix are transformed into binary form, generating the Initial Reachability Matrix (Table 5), based on the following rules:

- If the (i, j) entry in the SSIM is V, then the (i, j) value in the Initial Reachability Matrix is 1 and the (j, i) value is 0.
- If the (i, j) entry in the SSIM is A, then the (i, j) value in the Initial Reachability Matrix is 0 and the (j, i) value is 1.
- If the (i, j) entry in the SSIM is X, then the (i, j) and the (j, i) values in the Initial Reachability Matrix are both 1.

- If the (i, j) entry in the SSIM is O, then the (i, j) and the (j, i) values in the Initial Reachability Matrix are both 0.

Table 5: Initial Reachability Matrix

Barrier	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13
B1	1	1	1	1	1	1	1	1	0	1	1	1	1
B2	0	1	0	1	0	0	0	0	0	0	1	0	0
B3	1	1	1	1	1	1	1	1	0	1	1	1	1
B4	0	0	0	1	0	0	0	0	0	0	1	0	0
B5	0	1	0	1	1	1	1	1	0	1	1	1	0
B6	0	1	0	1	1	1	0	0	0	1	1	0	0
B7	0	0	0	1	0	0	1	0	0	0	1	0	0
B8	0	0	0	1	0	0	1	1	0	0	1	0	0
B9	0	1	0	1	0	0	0	0	1	0	0	0	0
B10	0	1	0	1	0	0	0	0	0	1	1	0	0
B11	0	0	0	0	0	0	0	0	0	0	1	0	0
B12	0	0	0	0	0	0	0	0	0	0	1	1	0
B13	0	1	0	1	1	0	1	1	0	1	1	1	1

The Final Reachability Matrix (Table 6) is developed by incorporating transitive links into the Initial Reachability Matrix, thus ensuring that indirect relations, which were missed in the Initial Reachability Matrix, are adequately captured; i.e. if barrier A aggravates barrier B and barrier B aggravates barrier C, then barrier A aggravates C. Floyd-Warshall's algorithm was adopted to perform the transitivity check using MATLAB software. Moreover, the Final Reachability Matrix also includes the driving power and the dependence power of each barrier. The driving power of each barrier represents the number of barriers, including itself, which it aggravates, whereas the dependence power corresponds to the total number of barriers, including itself, that aggravate it (Azevedo et al., 2019). Driving and dependence power of barriers feed into the MICMAC Analysis and the Power Diagram, which is one of the outputs of the ISM (Section 5.1).

Table 6: Final Reachability Matrix

Barrier	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	Driving power
B1	1	1	1	1	1	1	1	1	0	1	1	1	1	**12**

B2	0	1	0	1	0	0	0	0	0	0	1	0	0	**3**
B3	1	1	1	1	1	1	1	1	0	1	1	1	1	**12**
B4	0	0	0	1	0	0	0	0	0	0	1	0	0	**2**
B5	0	1	0	1	1	1	1	1	0	1	1	1	0	**9**
B6	0	1	0	1	1	1	1*	1*	0	1	1	1*	0	**9**
B7	0	0	0	1	0	0	1	0	0	0	1	0	0	**3**
B8	0	0	0	1	0	0	1	1	0	0	1	0	0	**4**
B9	0	1	0	1	0	0	0	0	1	0	1*	0	0	**4**
B10	0	1	0	1	0	0	0	0	0	1	1	0	0	**4**
B11	0	0	0	0	0	0	0	0	0	0	1	0	0	**1**
B12	0	0	0	0	0	0	0	0	0	0	1	1	0	**2**
B13	0	1	0	1	1	1*	1	1	0	1	1	1	1	**10**
Dependence power	**2**	**8**	**2**	**11**	**5**	**5**	**7**	**6**	**1**	**6**	**13**	**6**	**3**	**75**

1: entries updated from the initial reachability matrix to incorporate transitivity, i.e. indirect relationship among barriers*

4.2.5 Partition the Reachability Matrix into different levels

The Final Reachability Matrix was then partitioned into different levels, as per the ISM methodology (Warfield, 1974). Partitioning was conducted to determine the hierarchical structure of barriers, leading to the generation of an initial version of the directed graph (digraph), which is the base of the final ISM model. From the Final Reachability Matrix, for each barrier, the reachability set and the antecedent set were obtained. The reachability set of each barrier includes the barrier itself and the other barriers it aggravates, whereas the antecedent set of each barrier consists of the barrier itself and the other barriers which aggravate it (Azevedo et al., 2019; Diabat and Govindan, 2011; Warfield, 1974). For each barrier, the intersection set of the reachability set and antecedent set was also derived (Table 7). The intersection set contains all elements that are common in both sets. The barriers, whose intersection set coincide with the reachability set, are given the highest hierarchical position (labelled as 'I', see Appendix A.2 and Table 7) in the structural model, as these barriers are driven by all other barriers but do not affect any other barrier (Kumar and Dixit, 2018; Mangla et al., 2018; Warfield, 1974).

The partitioning of the Final Reachability Matrix is continued iteratively. At every iteration the barriers allocated to the previous level are discarded from remaining sets and the process is

repeated, by identifying barriers whose reachability and intersections sets coincide. The process is repeated until the level of every barrier is found. Table 7 summarises the outcome of the partitioning activity, highlighting for each barrier the reachability set, the antecedent set, the intersection set as well as the level the barrier is allocated in the ISM model, while full details about partitioning of levels is available in the Appendices (Table A.2-Table A.8). B11 'Lack of access to reliable markets' was given the top hierarchical position, as shown in Table 7, thus being placed at the top of the ISM model, while B1 'Poor farmers' group organisation' and B3 'Lack of market knowledge and understanding' are the only level-VII barriers, thus being at the base of the ISM model.

Table 7: Level partitions of the reachability matrix: Iterations I to VII

Barrier	Reachability set	Antecedent set	Intersection set	Level
B1	1,2,3,4,5,6,7,8,10,11,12,13	1,3	1,3	VII
B2	2,4,11	1,2,3,5,6,9,10,13	2	III
B3	1,2,3,4,5,6,7,8,10,11,12,13	1,3	1,3	VII
B4	4,11	1,2,3,4,5,6,7,8,9,10,13	4	II
B5	2,4,5,6,7,8,10,11,12	1,3,5,6,13	5,6	V
B6	2,4,5,6,7,8,10,11,12	1,3,5,6,13	5,6	V
B7	4,7,11	1,3,5,6,7,8,13	7	III
B8	4,7,8,11	1,3,5,6,8,13	8	IV
B9	2,4,9,11	9	9	IV
B10	2,4,10,11	1,3,5,6,10,13	10	IV
B11	11	1,2,3,4,5,6,7,8,9,10,11,12,13	11	I
B12	11,12	1,3,5,6,12,13	12	II
B13	2,4,5,6,7,8,10,11,12,13	1,3,13	13	VI

5 Results and Discussion

This section introduces the two main outputs of the ISM Model Development, namely the MICMAC Analysis, which leads to the development of the Power Matrix (Section 5.1), and the ISM model, which is the ultimate output of ISM and illustrates the hierarchical relationship among the identified barriers (Section 5.2). The results were validated with the SmartISM graphical software (Ahmad and Qahmash, 2021). Finally, Section 5.3 discusses the results against the relevant literature.

5.1 MICMAC Analysis

The MICMAC (Matrix of Cross Impact - Multiplications Applied to Classification) analysis supports the identification of the most critical barriers for commercialisation of produce for Malawian smallholder farmers, based on the driving and dependence power of each barrier, as displayed in the Final Reachability Matrix (Table 6). The MICMAC analysis is graphically depicted as the Driving and Dependence Power Diagram (Figure 2), also referred as Power Matrix, which is the first output of the ISM. The barriers plotted on the Power Diagram (Figure 2) based on their relative driving and dependence power can be clustered into four categories:

1. Autonomous barriers: factors with weak driving power and dependence power. These barriers lie close to the origin in Figure 2 and are comparatively disconnected to the entire system (Mangla et al., 2018). They have limited link with the overall system because of their weak linkage with other barriers or due to their limited influence on the entire system (Kumar and Dixit, 2018). Four barriers fall within this category, namely B8 'Limited value chain coordination', B9 'Weak enforcement of regulatory framework', B10 'Lack of production technologies' and B12 'Inadequate value addition to produce'. Particularly B9 'Weak enforcement of the regulatory framework' appears to be more disconnected from the whole system owing to its low driving power and the lowest dependence power value among all barriers.
2. Dependent barriers: factors with weak driving power and high dependence power. These barriers are the ultimate desired outcomes and typically occupy the top position of the ISM model (Mangla et al., 2018). Dependent barriers require other key barriers to be addressed first in order to showcase improvement and therefore need to be handled with attention, owing to their strong dependence from other barriers (Kumar and Dixit, 2018; Mangla et al., 2018). Four barriers fall within this category, namely B2 'Low production quantities', B4 'Low level of produce aggregation', B7 'Lack of post-harvest management' and B11 'Lack of access

to reliable markets', which is the single barrier displaying the lowest driving power and the highest dependence power.

3. Linkage barriers: factors with high driving power and high dependence power. These barriers are unstable in nature, so any action taken on these barriers will affect other barriers, and may also have closed-loop impact on them (Kumar and Dixit, 2018; Mangla et al., 2018). No such barriers have been identified in this work.
4. Driving barriers: factors with high driving power and weak dependence power, also referred as independent barriers. Driving barriers are key barriers, typically occupying the bottom position of the ISM model (Kumar and Dixit, 2018; Mangla et al., 2018). Five barriers fall within this category namely B1 'Poor farmers' group organisation', B3 'Lack of market knowledge and understanding', B5 'Lack of access to finance', B6 'Limited land availability' and B13 'Lack of business skills'. Overcoming such barriers is critical to address other barriers identified in this work, therefore these barriers need to be prioritised by policy makers, owing to their high influence to the overall system.

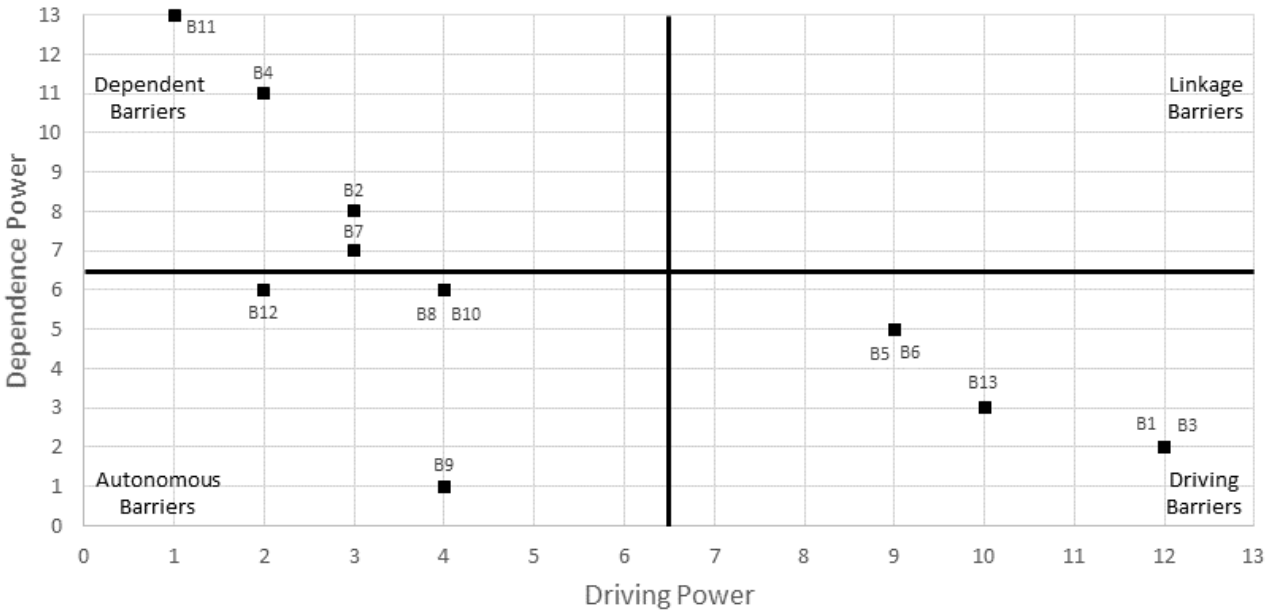

Figure 2: MICMAC analysis

5.2 ISM Model

The partition of the reachability matrix into different levels (Section 4.2.5) led to the formulation of the initial digraph to show the contextual relationship among different barriers. Once all conceptual inconsistencies and the transitive links are removed from the digraph and the barriers' codes are replaced with the linguistic terms of the barriers (Raut and Gardas, 2018), the final ISM model is generated (Figure 3). This is the main output of ISM, and represents the relationship among barriers preventing Malawian smallholder farmers to commercialise their produce.

Figure 3 displays that 'Poor farmers' group organisation' (B1), i.e. in the form of cooperative or farmers' associations, and 'Lack of market knowledge and understanding' (B3) are at the base of the model, meaning that they are the most significant barriers to address other barriers included in the model. Increased farmers' group organisation creates favourable conditions for obtaining market information and responding to changing market and consumer demands, as already identified by Macharia et al.(2018). At the same time, an increased understanding of market dynamics is functional to understand the importance of basic business skills in order to commercialise the product, such as understanding the value and implications of contracts, evaluating the profitability of different crops/offers and considering the possibility to invest to yield higher returns in the future.

The 'Lack of business skills' (B13) followingly aggravates the 'Lack of access to finance' (B5) and 'Limited land availability' (B6), two barriers showing a bi-directional relationship. On one hand, smallholder farmers either have uncertain rights over land and/or own limited size of land. This means that farmers do not have sufficient collateral to offer as a security for the repayment of credit received, leading to annual rate of interests that can reach up to 40%, thus discouraging them to take a financially risky decision, and even prohibiting access to credit. On the other hand, the lack of access to finance prevents making investments and increasing average land holding size. This is particularly critical as households with more land were identified as more likely to sell maize (Chirwa, 2006; Sibande et al., 2017).

The lack of access to finance has a pivotal role, hindering the purchase of more advanced production technologies (B10); affecting the value addition of produce (B12) and consequently the profitability farmers can achieve by selling their products; and limiting the value chain coordination (B8), as smallholder farmers are often unable to be part of more structured supply chains as they face financial constraints, which push them to sell the produce as quickly as possible, typically to middlemen. This has a cascading effect on the 'Lack of post-harvest management' (B7), which is currently a major weakness of Malawian smallholder farmers and is one of the barriers contributing to the 'Low level of produce aggregation' (B4), due to the lack of post-harvest technologies and knowledge. Moreover, a major barrier to the aggregation of produce are the 'Low production quantities' (B2) as smallholder farmers often struggle to generate enough produce surplus beyond the quantities needed for subsistence to be able to commercialise their produce. The 'Lack of production technologies' (B10) impacts on their productivity and, coupled with the limited land availability, has a detrimental effect on the supply side, i.e. smallholder farmers being unable to generate a supply-driven market. The 'Low production quantities' (B2) are further exacerbated by the 'Weak enforcement of regulatory framework' (B9), with existing regulatory framework currently being unable to generate appropriate mechanisms to act on the demand side and stimulate a demand-driven market for food produce from smallholder farmers.

The limited quantities farmers are able to sell also means that they are incentivised to find an outlet for their produce locally or through middlemen, rather than engaging in produce aggregation with other local smallholder farmers (B4). The limited value addition of produce (B12) coupled with the uncoordinated production with limited produce aggregation (B4) are the final barriers impeding farmers to consistently access a reliable market (B11), which was considered by the panel of experts as the ultimate obstacle to remove for Malawian smallholder farmers to commercialise their produce.

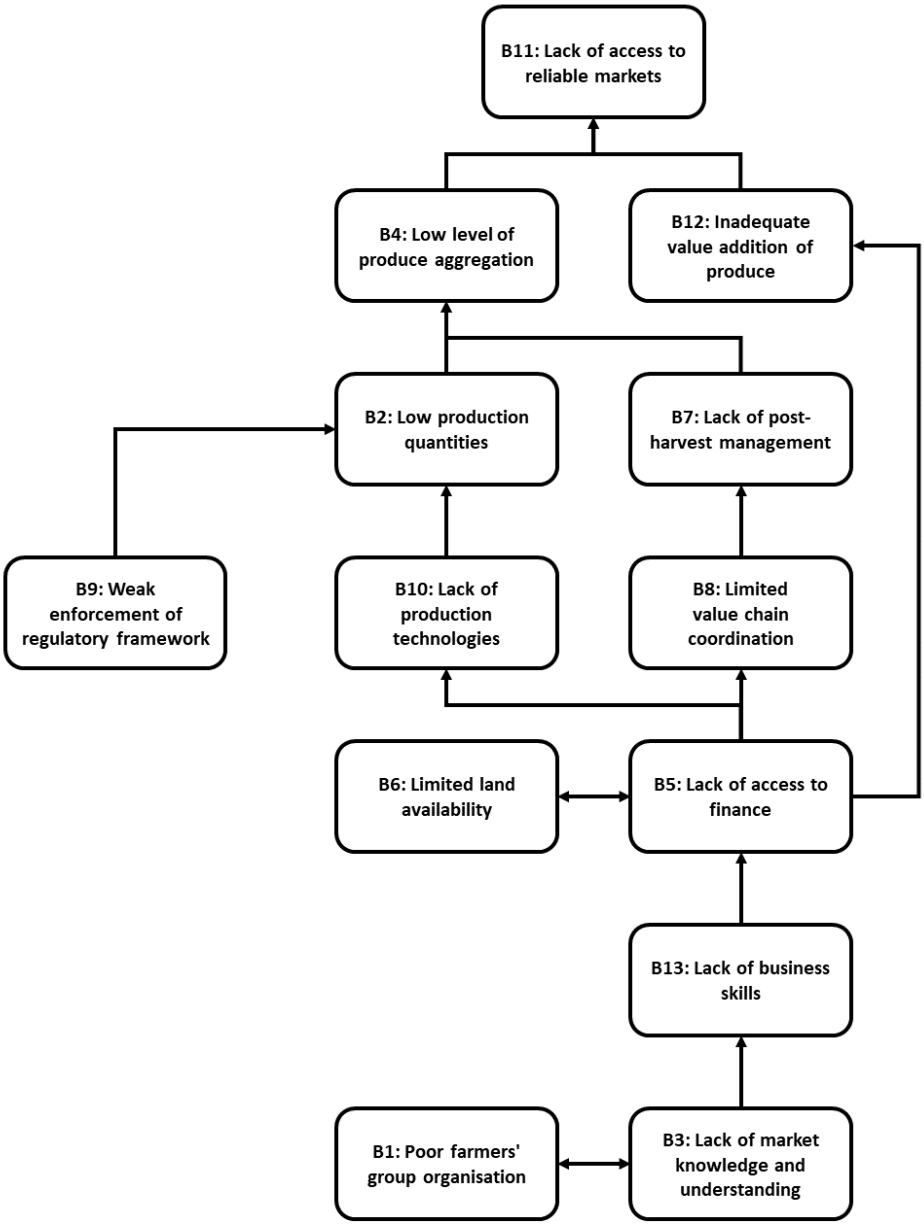

Figure 3: ISM model

Overall, 75 direct and indirect contextual relationships were identified among the 13 barriers according to the ISM model, providing a holistic identification of causality links among barriers and their impact pathway. The ISM model thus contributes to theory building by identifying 69 new structural and hierarchical relationships among barriers, as only 6 out of 75 relationships had been previously identified for smallholder farming in Malawi, namely: B1 aggravating the lack of market information and understanding, as well as the lack of trust and coordination along the value chain (Macharia et al., 2018); B2 and B3 aggravating the lack of access to reliable urban (Macharia et al.,

2018) and local (Chirwa, 2009) markets respectively; B5 aggravating the limited value chain coordination due to the limited capability of farmers to finance agricultural operations (Macharia et al., 2018); B6 aggravating the low adoption of agricultural technologies (Chirwa, 2006). Finally, two contextual relationships identified in this study contradict previous observations in the literature, both related to B8, 'Limited value chain coordination'. The lack of post-harvest management (B7), including the lack of storage facilities, and the lack of access to structured markets (B11) had previously been identified as determinants of the limited value chain coordination (B8) forcing smallholder farmers to sell the produce immediately, often accepting low prices from more powerful buyers (Koppmair et al., 2017; Macharia et al., 2018), whereas this study suggests a more central role of value chain coordination among barriers to commercialise the produce, as the B8 occupies an intermediate level in the ISM model, aggravating B4, B7 and B11.

5.3 Discussion

Malawi's smallholder agricultural sector is heavily relying on the FISP, which is recognised as the flagship among Sub-Saharan Africa national subsidy programs targeting smallholder farmers (Ragasa and Mazunda, 2018). The evaluation of FISP remains controversial (Chibwana et al., 2012). On one hand, FISP has been praised for agricultural growth (Government of Malawi, 2011), increased maize production (Chibwana et al., 2012; Lunduka et al., 2013; Nordhagen and Pascual, 2013) and for paving the way to an African Green Revolution (Lunduka et al., 2013; Ortega et al., 2016; Ragasa and Mazunda, 2018). On the other hand, FISP has been criticised for unclear targeting of beneficiaries (Sibande et al., 2017), limited support to the most vulnerable farmers (Chibwana et al., 2012; Lunduka et al., 2013; Nordhagen and Pascual, 2013), narrowing crop diversification (Chibwana et al., 2012; Nordhagen and Pascual, 2013), inconsistent impact on food security and poverty reduction (Lunduka et al., 2013; Ragasa and Mazunda, 2018) as well as for its unsustainable costs (Chibwana et al., 2012; Lunduka et al., 2013; Ragasa and Mazunda, 2018). Furthermore, subsidised inputs stimulate crop production and drive down prices, which negatively affects surplus-producing farmers who do not receive the subsidy (Kagin et al., 2018).

The overall improvement of the performance of the primary sector in Malawi since FISP was introduced in 2005 ultimately "did not cascade to the commercialisation of agricultural produce by smallholder farmers questioning the effectiveness of the policies developed in this area" (Sibande et al., 2017). Instead FISP may have even counteracted to some extent the development of commercial agriculture by subsidizing specific crops, which display limited marketability (Sibande et al., 2017).

The results, illustrated in sections 5.1 and 5.2, highlighted that several barriers to commercialisation for smallholder farmers exist, which cannot be addressed solely through input subsidy programs, but require a more holistic approach. Results show that only three barriers (B2 'Low production quantities', B6 'Limited land availability' and B10 'Lack of production technologies') are related to farming production, whereas the majority of barriers preventing Malawian smallholder farmers to commercialise their produce are found in non-farm domains, touching areas such entrepreneurship, marketing and value chain management. The key barriers, identified at the bottom of Figure 3, are also found in non-farm domains, namely the limited extent farmers are formally organised in associations and/or cooperatives and an overall lack of knowledge of business dynamics, and more specifically the lack of market knowledge and understanding.

This shortcoming is exacerbated by the fact that extension services, affected by high vacancy rates with shortages of staff reaching up to 50% (Mudege et al., 2015) are mostly focused on technical agricultural production topics (Mudege et al., 2015; Ragasa and Mazunda, 2018). This approach completely disregards marketing and commercial topics (Ragasa and Mazunda, 2018). According to the latest Household Survey, only 0.5% of farmers received advice from extension services about sales of produce, whereas 1% of farmers received advice on storage and dedicated post-harvest management (Malawi Government National Statistical Office, 2020). Farmers provided with access to extension services have successfully increased the adoption of inorganic fertilizer and hybrid seeds, and high-quality extension services have also been identified as a key variable to improve productivity and food security in the country (Ragasa and Mazunda, 2018). Therefore, increased

focus on extension services as well as broadening the scope of extension services to enhance farm management knowledge, as already noted by Lunduka et al., (2013), and to progressively include managerial topics, such as farmers organisation, cooperativism, basic business skills and an enhanced understanding of market requirements and dynamics, could be a key direction for policy makers to complement the scope of the FISP program. This is particularly true for the government, which currently "remains the main provider of extension and advisory services in Malawi" (Ragasa and Mazunda, 2018). Rural growth centres and rural farmer service centres are institutions that require to be strengthened to expand the services provided to rural communities, as already noticed by Ragasa & Mazunda (2018) and Snapp et al. (2018), in order to provide a more balanced approach to agricultural growth, which cannot be achieved through input subsidies only. This approach could potentially exploit a cascading logic with a combination of "train the trainer" and "farmer-to-farmer" schemes to increase the number of farmers and communities being reached by these services. This logic has already been successful in the case of sustainable land management and can be particularly useful in a context of low resources and limited extension services staffing (Kansanga et al., 2021). Appropriate policies are required to support these schemes to become more widespread in Malawi.

A progressive organisation of smallholder farmers into collective groups, such as cooperatives or farmers' associations, is also key to generate cascading positive effects on other barriers, as it counteracts several issues associated to the small scale and the lack of economies of scale encountered by Malawian smallholder farmers. Improved organisation of smallholder farmers has already showed promising results within Malawi in improving access to services and credit (B5) as well as to production inputs, such as hybrid seeds and hired labour (Ragasa and Mazunda, 2018) and can also lead to improved value chain coordination (B8) to access higher value urban markets (Macharia et al., 2018). Improved organisation of smallholder farmers showed significant improvement in market performances, household income and asset holdings in other Sub-Saharan African countries, along with increased technological innovation adoption and more efficient marketing information flows (Bachke, 2019; Fischer and Qaim, 2012; Mojo et al., 2017; Mutonyi,

2019; Orsi et al., 2017; Wossen et al., 2017). The bi-directional relationship between 'Poor farmers' organisation' (B1) and 'Lack of market knowledge and understanding' (B3) at the base of the ISM model confirms the reinforcing loop that can be obtained by addressing these barriers in combination.

Overcoming the current lack of market knowledge and understanding can "empower farmers with a more accurate perception of what quality and quantity of a given vegetable is in demand and at what price, therefore avoiding exploitation by market intermediaries" (Macharia et al., 2018). The role of market information services was highlighted as a key element to complement FISP to pursue the goal of reducing poverty in rural areas of Malawi (Lunduka et al., 2013). With this respect, new information technologies are increasingly available in developing countries, offering unprecedented opportunities to smallholder farmers to obtain market information, such as points of sale, market trends and updated market prices (Flores et al., 2019), thus facilitating the flow of information between smallholder farmers and relevant markets and increasing the bargaining power of smallholder farmers (Zanello et al., 2014).

The need to obtain increased information about the market naturally leads to the question on which market to target. Currently, smallholder farmers equally adopt farm-gate, village markets and district markets as an outlet for their produce (Koppmair et al., 2017). As elsewhere in Sub-Saharan Africa, the domestic market is still more promising than the export market for smallholder farmers, as it displays larger demand, looser marketing requirements and reduced non-tariff barriers on aspects such as food quality and safety standards, which can prove to be costly to comply with for smallholder farmers (Muriithi and Matz, 2015; Wiggins, 2014). With this respect, Malawi is at the initial stages of a structural economic transformation, which is likely to lead to a more diversified and inclusive economy in the near future (United Nations, 2018). This, coupled with the progressive urbanisation, can act as a stimulus to commercialisation, as an increasing number of urban households is displaying a growing and diversified food demand (Wiggins, 2014). Moreover, the

urbanisation process is in some instances reducing the physical distance from farmers to the market as former rural centres expand into proper towns (Wiggins, 2014). Finally, urbanisation is also linked to an increased number of final customers being willing to pay a premium price for high-value crops, such as horticulture, which is among the fastest growing sub-sectors in Sub-Saharan Africa (Muriithi and Matz, 2015; Wiggins, 2014). Whether the extra revenues are to be distributed along the supply chain and benefit smallholder farmers is a critical point, which stresses the importance of having more coordinated downstream supply chains to avoid middlemen eroding farmers' profits and to provide farmers with higher returns (Muriithi and Matz, 2015).

An increased market participation by Malawian smallholder farmers is critical to the rural development in the country, as commercialisation is positively associated to improved food security (Ragasa and Mazunda, 2018), dietary diversity (Jones, 2017; Koppmair et al., 2017), agricultural productivity (Ragasa and Mazunda, 2018), asset ownership (Muriithi and Matz, 2015), sustainable agricultural practices, including crop diversification (Ortega et al., 2016), hired labour opportunities (Wiggins, 2014) and income (Wiggins, 2014), therefore significantly contributing to the reduction of poverty (Sibande et al., 2017) and stimulating inclusive rural growth. Policy actions should focus on the key barriers identified at the bottom of the ISM model, as they have a cascading positive effect on other barriers and have the highest potential to deliver impact.

6 Conclusions

This work aimed to identify the main barriers preventing smallholder Malawian farmers to commercialise their produce and to understand direct and indirect relationships among such barriers, thus aiming to identify the root causes of such barriers in order to prioritise areas of improvement to facilitate market participation for smallholder farmers in the country. This is functional to contribute towards informed decision making in the required transition from subsistence towards commercial agriculture in Malawian smallholder agricultural sector. Interpretive

Structural Modelling, adopting as data inputs the opinions of multiple experts from various domains active in the context of smallholder farming in Malawi, was used to identify direct and indirect relationships among such barriers as well as to determine a hierarchical model of such barriers, which can offer support to policy makers involved with Malawian smallholder farmers. Thirteen key barriers were identified, with two being recognised by experts as the key barriers that are critical to be addressed as they would help to address other barriers: these were 'Poor farmers' group organisation' and 'Lack of market knowledge and understanding'. Therefore, such barriers need to be prioritised by policy makers, in order to equip Malawian smallholder farmers with a set of basic business skills beyond the technical agricultural knowledge usually delivered by extension services, in order to empower them in the transition towards commercial agriculture.

This study is the first work comprehensively analysing barriers to commercialisation for smallholder farmers in the context of Sub-Saharan Africa. It is also the first work to specifically address such barriers within Malawi. This is achieved by adopting a holistic approach to capture the complexity of the situation, which encompasses areas such as agriculture, entrepreneurship, supply chain management, micro- and macro-economy, and by systematically exploring the relationships among such elements.

By doing so, this work manages to provide a novel perspective within the debate on commercialisation for smallholder farmers, presenting the first application of a causal mapping method in the context of sustainable development for smallholder farmers. Methodologically, ISM offers a more complete and multi-disciplinary approach compared to the dominant regression model-based and survey-based literature, which typically limits the focus to the relationship among a narrower subset of variables, while at the same time offering more generalisable findings compared to the case study-based stream of the literature in the field.

As a result, this work contributes to the literature at the intersection of sustainable development and smallholder farming in two ways. First, it provides a structured list of barriers preventing

commercialisation and market participation for smallholder farmers within the case of Malawi, spanning multiple disciplines and addressing on-farm and off-farm elements. The list integrates barriers identified by the experts in the field with those obtained from the literature, showing an alignment between the two sets of barriers. This list can serve as a reference for other studies on market participation and commercialisation for smallholder farmers in Sub-Saharan Africa. Second, it prioritises and identifies structural relationship among barriers, as exemplified in the ISM model (Figure 3), contributing to theory building within the field, thanks to the holistic identification of causality links among barriers. Identified causal relationships could be considered as hypotheses for future research and further tested, potentially through regression models, surveys or other large-scale quantitative methods, as well as by using different data sources, including primary data collected directly from smallholder farmers. Such multi-method approach could also lead to the development of a holistic framework addressing commercialisation and market participation for Malawian smallholder farmers.

As every piece of research, this work is not immune from limitations. Some limitations are embedded in the methodology adopted. While this work adopted two sources of data for the identification of the barriers, namely secondary data from the literature and primary data collected from the experts, some barriers may still have been overlooked. With this respect, a systematic literature review could have further enhanced the rigour of the secondary data sources. Moreover, ISM relies on the subjective judgement of experts in multiple steps of the research process, including the definition of the relationships among different variables, meaning that results are not bias-free. ISM also adopts a binary-like logic, which may not always adequately capture the strengths of different relationships, thus fuzzy logic could have complemented the work. In the future, alternative methods could be adopted to further validate the developed ISM model either in isolation or in an integrated way. These include, but are not limited to, decision making trial and evaluation laboratory (DEMATEL), structural equation modelling (SEM) and total interpretive structural modelling (TISM).

Additionally, while Malawi could be considered a representative case for Southern and Eastern Africa farming systems (Nordhagen and Pascual, 2013; Snapp et al., 2018), the findings presented in this work are specific to the Malawian context and cannot be generalised to other countries or the wider Sub-Saharan Africa without appropriate validation. Further research is required to investigate what is the status regarding barriers to commercialisation for smallholder farmers in other Sub-Saharan Africa countries, in order to potentially identify country- or region-specific barriers.

Finally, this work addressed barriers to commercialisation for Malawian smallholder farmers as a whole, without addressing issues that may be associated to specific group of farmers. Some barriers may not be applicable to or additional barriers may exist for farmers cultivating specific crops or in certain geographical areas. As an example, tea supply chains are more structured compared to other supply chains, showing already a satisfactory level of coordination among the supply chain players (United Nations, 2018), differently from maize and vegetable supply chains. Additionally, this work does not provide specific insights on gender aspects, and more specifically on the barriers for commercialisation for female farmers, who are more likely to be poor and marginalised from provisioning systems (ASFG, 2013; Sibande et al., 2017; United Nations, 2018; Wiggins, 2014). Future research is recommended to investigate whether results change when they are disaggregated by gender.

Nevertheless, this work offers important insights to policy makers and other actors involved in rural development in Malawi on the main barriers associated to the transition from subsistence to commercial agriculture, adopting an evidence-based approach. With a potential target of almost 11 million smallholder farmers in Malawi, this work has the potential to contribute to an actual social impact through inclusive agricultural growth, by tackling the root causes hampering the commercialisation of produce by Malawian smallholder farmers, which are currently preventing the improvement of their livelihoods.

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Appendices

Appendix A.1 – Complete list of initial barrier concepts and clustered barriers

Table A.1: Complete list of initial barrier concepts and clustered barriers

Concept		Barrier
C1	Inadequate value addition	Inadequate value addition of produce
C2	Inadequate value addition coupled with seasonal production	Inadequate value addition of produce
C3	Low production of high value crops	Inadequate value addition of produce
C4	Availability of inputs due to seasonality	Inputs cost and availability
C5	Cost of pesticides and diseases	Inputs cost and availability
C6	Fertilizers cost	Inputs cost and availability
C7	High cost of farm inputs (i.e. fertilizers and seeds)	Inputs cost and availability
C8	High cost of farming inputs	Inputs cost and availability
C9	Seeds cost	Inputs cost and availability
C10	Weeds cost (extra seeds)	Inputs cost and availability
C11	High incidents of default	Lack of access to finance
C12	Lack of access to finance	Lack of access to finance
C13	Lack of financing mechanisms	Lack of access to finance
C14	Limited access to credits and loans	Lack of access to finance
C15	Limited sources of revenue to keep produce when prices are low	Lack of access to finance
C16	Low access to finance	Lack of access to finance
C17	Non-availability of agricultural loans	Lack of access to finance
C18	Poor access to loans to finance production	Lack of access to finance
C19	Distance to access markets	Lack of access to reliable markets
C20	Limited availability of reliable markets	Lack of access to reliable markets
C21	Lack of means of transport to reliable markets	Lack of access to reliable markets
C22	Farmers still producing mainly for subsistence	Lack of business skills

C23	Fear of commitment: risk aversion to go into market contracts	Lack of business skills
C24	Lack of business mindset and entrepreneurship	Lack of business skills
C25	Poor pricing: lack of skills to understand cost of production	Lack of business skills
C26	Lack of access to knowledge generated by universities	Lack of coordination in training
C27	Lack of access to university knowledge	Lack of coordination in training
C28	Uncoordinated farmers trainings	Lack of coordination in training
C29	Inadequate capacity to conduct market research	Lack of market knowledge and understanding
C30	Lack of access to high value markets	Lack of market knowledge and understanding
C31	Lack of knowledge about quality, quantity and supply consistency for viable markets	Lack of market knowledge and understanding
C32	Lack of knowledge of different types of market (e.g. auction/wholesale/retail)	Lack of market knowledge and understanding
C33	Lack of market understanding	Lack of market knowledge and understanding
C34	Lack of organised marketing	Lack of market knowledge and understanding
C35	Lack of skills in agriculture marketing	Lack of market knowledge and understanding
C36	Producing for unknown market	Lack of market knowledge and understanding
C37	Lack of access to storage (warehouse)	Lack of post-harvest management and technology
C38	Lack of knowledge for packaging	Lack of post-harvest management and technology
C39	Lack of packaging technology	Lack of post-harvest management and technology
C40	Poor technologies and processing methods affecting quality of produce	Lack of post-harvest management and technology
C41	Processing technology (harvest, drying)	Lack of post-harvest management and technology
C42	Weak post-harvest management capacity	Lack of post-harvest management and technology
C43	Cultivation equipment (lack of)	Lack of production technologies
C44	Farming tools (lack of)	Lack of production technologies
C45	Lack of mechanisation	Lack of production technologies
C46	Limited technology for production	Lack of production technologies
C47	Inadequate skills on quality management	Lack of technical skills
C48	No perceived benefits of some of the technologies	Lack of technical skills
C49	Land size for cultivation	Limited land availability
C50	Limited land for cultivation	Limited land availability
C51	Lack of trust between farmers and middlemen	Limited value chain coordination
C52	Poor coordination among different actors in specific value chains	Limited value chain coordination
C53	Low/lack of produce aggregation	Low level of produce aggregation
C54	Undefined and regulated rural aggregation of produce resulting in poor returns to farmers	Low level of produce aggregation
C55	Produce quality	Low level of quality of produce

C56	Exposure to international competition: lower prices of competitors	Low prices of competitors
C57	Harsh macro-economic environment	Low prices of competitors
C58	Local and global prices	Low prices of competitors
C59	Cannot meet market demand quantity	Low production quantities
C60	Low production	Low production quantities
C61	Low production	Low production quantities
C62	Low production	Low production quantities
C63	Low productivity	Low production quantities
C64	Low yield due to lack of use of local varieties	Low production quantities
C65	Produce quantity	Low production quantities
C66	Lack of cooperative management skills	Poor farmers organisation
C67	Lack of organisation among farmers to meet demand of viable markets	Poor farmers organisation
C68	Lack of organised farmers' groups to market produce as a single entity	Poor farmers organisation
C69	Poor management and governance of cooperatives	Poor farmers organisation
C70	Climate change negative effects	Reliance on rainfed agriculture
C71	Diverse and negative climate change effects	Reliance on rainfed agriculture
C72	Over reliance on rainfed agriculture	Reliance on rainfed agriculture
C73	Over reliance on rainfed agriculture	Reliance on rainfed agriculture
C74	Rainfall variability (climate)	Reliance on rainfed agriculture
C75	Government concern only for production side and not for consumption side	Weak enforcement of regulatory framework
C76	Poor regulatory framework on production and marketing	Weak enforcement of regulatory framework
C77	Regulatory framework	Weak enforcement of regulatory framework

Appendix A.2 – Partitioning of Levels of the ISM Model

Table A.2: Partition Levels - Iteration I

Barrier	Reachability set	Antecedent set	Intersection set	Level
B1	1,2,3,4,5,6,7,8,10,11,12,13	1,3	1,3	
B2	2,4,11	1,2,3,5,6,9,10,13	2	
B3	1,2,3,4,5,6,7,8,10,11,12,13	1,3	1,3	
B4	4,11	1,2,3,4,5,6,7,8,9,10,13	4	
B5	2,4,5,6,7,8,10,11,12	1,3,5,6,13	5,6	
B6	2,4,5,6,7,8,10,11,12	1,3,5,6,13	5,6	
B7	4,7,11	1,3,5,6,7,8,13	7	
B8	4,7,8,11	1,3,5,6,8,13	8	
B9	2,4,9,11	9	9	
B10	2,4,10,11	1,3,5,6,10,13	10	
B11	11	1,2,3,4,5,6,7,8,9,10,11,12,13	11	I
B12	11,12	1,3,5,6,12,13	12	
B13	2,4,5,6,7,8,10,11,12,13	1,3,13	13	

Table A.3: Partition Levels - Iteration II

Barrier	Reachability set	Antecedent set	Intersection set	Level
B1	1,2,3,4,5,6,7,8,10,12,13	1,3	1,3	
B2	2,4	1,2,3,5,6,9,10,13	2	
B3	1,2,3,4,5,6,7,8,10,12,13	1,3	1,3	
B4	4	1,2,3,4,5,6,7,8,9,10,13	4	II
B5	2,4,5,6,7,8,10,12	1,3,5,6,13	5,6	
B6	2,4,5,6,7,8,10,12	1,3,5,6,13	5,6	
B7	4,7	1,3,5,6,7,8,13	7	
B8	4,7,8	1,3,5,6,8,13	8	
B9	2,4,9	9	9	
B10	2,4,10	1,3,5,6,10,13	10	
B12	12	1,3,5,6,12,13	12	II
B13	2,4,5,6,7,8,10,12,13	1,3,13	13	

Table A.4: Partition Levels - Iteration III

Barrier	Reachability set	Antecedent set	Intersection set	Level
B1	1,2,3,5,6,7,8,10,13	1,3	1,3	
B2	2	1,2,3,5,6,9,10,13	2	III
B3	1,2,3,5,6,7,8,10,13	1,3	1,3	
B5	2,5,6,7,8,10	1,3,5,6,13	5,6	
B6	2,5,6,7,8,10	1,3,5,6,13	5,6	
B7	7	1,3,5,6,7,8,13	7	III
B8	7,8	1,3,5,6,8,13	8	
B9	2,9	9	9	
B10	2,10	1,3,5,6,10,13	10	
B13	2,5,6,7,8,10,13	1,3,13	13	

Table A.5: Partition Levels - Iteration IV

Barrier	Reachability set	Antecedent set	Intersection set	Level
B1	1,3,5,6,8,10,13	1,3	1,3	
B3	1,3,5,6,8,10,13	1,3	1,3	
B5	5,6,8,10	1,3,5,6,13	5,6	
B6	5,6,8,10	1,3,5,6,13	5,6	
B8	8	1,3,5,6,8,13	8	IV
B9	9	9	9	IV
B10	10	1,3,5,6,10,13	10	IV
B13	5,6,8,10,13	1,3,13	13	

Table A.6: Partition Levels - Iteration V

Barrier	Reachability set	Antecedent set	Intersection set	Level
B1	1,3,5,6,13	1,3	1,3	
B3	1,3,5,6,13	1,3	1,3	
B5	5,6	1,3,5,6,13	5,6	V
B6	5,6	1,3,5,6,13	5,6	V
B13	5,6,13	1,3,13	13	

Table A.7: Partition Levels - Iteration VI

Barrier	Reachability set	Antecedent set	Intersection set	Level
B1	1,3,13	1,3	1,3	
B3	1,3,13	1,3	1,3	
B13	13	1,3,13	13	VI

Table A.8: Partition Levels - Iteration VII

Barrier	Reachability set	Antecedent set	Intersection set	Level
B1	1,3	1,3	1,3	VII
B3	1,3	1,3	1,3	VII