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ENHANCING PRODUCTIVITY OF SMALLHOLDER STAPLE FOOD CROP PRODUCERS IN AFRICA WHEN INPUTS SUBSIDIES ARE NOT WORKING: WHAT OTHER OPTIONS ARE AVAILABLE?

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Abstract

Many African governments have been implementing inputs subsidy programmes (ISP) in order to turn around the low-input low-yield agricultural systems dominated by resource-constrained smallholder farmers (SHFs). In this paper we have reviewed generic from across the continent and cases from Nigeria and Zambia. The evidence shows that despite high levels of subsidies (sometimes ranging from 50% to over 80% of the market costs of inputs), the ISPs have neither triggered significant growth in average yields and output nor had much impact on reducing rural poverty. Response to the sub-optimal outcomes of ISPs has been to initiate reforms in inputs delivery systems whilst presuming that affordability is the main binding constraints facing smallholders when it comes to accessing inputs. However, a framework we adopt in the analysis in this paper (summarised in Figure 2), ineffective complementary systems contribute to this outcome. For example, extension advisory systems which offer generic (blanket) advice delinked from area-specific agroclimatic conditions does not enable the farmers to obtain optimum yields. Furthermore, there are several unaddressed pre and postharvest issues, including household liquidity constraints which limit smallholders' capacity to take up the available inputs, thereby encouraging the development of parallel inputs markets which end up transferring subsidies to better-off farmers. Lack of efficient postharvest handling facilities leads to losses which combine output marketing constraints to significantly reduce the profitability of inputs use but these issues tend to be marginalised in the design and implementation of ISPs.

Business-to-farmers (B2F) models reviewed in this paper have shown the potential of a more sustainable and inclusive way to boost the productivity and output of smallholders by enabling them take up available inputs through access to credit; increasing access to extension advice using field agents who also monitor farmers' performance under the business linkages; and assuring access to remunerative markets. Participating smallholders obtained significant boost in yield and output, reduction in postharvest losses and rise in household incomes, sometimes taking the households out of poverty. The potential can be optimised if issues such as the weak bargaining power of smallholders, limitations of extension messaging, limited supply of finance and other constraints which impact negatively on the profitability of inputs use are addressed. Further research is therefore needed to refine these models in order to ensure win-win for smallholders, agribusinesses and governments.

1. Introduction and objectives

In 2014 African governments re-committed to position agriculture as the main driver of inclusive growth and economic development by adopting the *Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods*. The Declaration builds on the continental agriculture-led growth strategy framed in the Comprehensive Africa Agriculture Development Programme (CAADP), which was launched in 2003. One of the key commitments under Malabo is to end hunger by 2025. This entails, among others, implementing actions which will double agricultural productivity by increasing access to quality and affordable inputs. It reflects the concerns policymakers have about assuring food and nutrition security whilst reducing dependence on food imports when average yields obtained by smallholder farmers (SHFs), who dominate agricultural production in most of sub-Saharan Africa (SSA), are generally low and well below global farm productivity levels.

In pursuit of the objective of boosting farm productivity and output growth, especially in staple foods value chains, many African have reverted to or continued to implement Inputs Subsidy Programmes (ISP). The ISPs involve distribution of subsidized inputs, usually including inorganic fertiliser, improved seed/planting materials, pesticides and herbicides. The main target beneficiaries are SHFs but, in some cases, access to the subsidised inputs is open to medium and even large-scale farmers. This is a turn around from the policy direction in the 1980-90s when reforms, implemented as part of structural adjustments programmes (SAPs), included discontinuation or substantial downsizing of ISPs. The expectation was that lowering inputs prices through ISPs, thereby making them more affordable to SHFs, will spur uptake and trigger a virtuous cycle by which, on one hand, growth in farm productivity and output will improve food security. On the other hand, anticipated rise in farm-based income is expected to drive sustained market demand for inputs by SHFs, making exit from ISPs feasible in the medium-term.

Contrary to the above expectations, available empirical evidence suggests that the impact of most ISPs in Africa has been rather underwhelming. Evidence from about two decades ago, which we discuss further in Section 2, shows that by the 1980s, it had become apparent that ISPs had produced limited success in raising smallholders' productivity and output (Crawford et al. 2003) and fiscally unsustainable (Denning et al., 2009). Recent reviews of ISPs are similarly quite downbeat about sustainable gains from ISPs. For instance, a review of Malawi's ISP by De Weerdt and Duchoslav (2022) concluded that maize producers in the country remain inefficient despite the support programme, making imports substantially more price-competitive. The conundrum this poses for policymakers is whether to stick with ISPs and keep trying different tweaks to programme design and implementation as have occurred in many countries or explore alternative more sustainable options in boosting smallholders' productivity and output, especially in the staple foods value chains.

1.1 Objectives of paper

In this paper we aim to contribute to the debate on the above conundrum, focusing very much on exploring options which are already showing promise in some countries where major ISPs are already being implemented by governments. It includes a review of cross-country evidence on the outcome of the ISPs. The aim, however, is not simply to add to the volumes of evidence on ISPs but to attempt to unearth some of the fundamental factors which explain their rather disappointing outcomes. This is to ensure that process of identifying alternatives is based not only on how promising various models look but also an understanding of the conceptual basis for the expectations that they can catalyse sustainable productivity growth among smallholder farmers.

One option which is emerging as having potential to boost smallholders' productivity, and in a sustainable manner, is the Business to farmers (B2F) model. It has been identified in the course of some value chain (VC) studies undertaken as par of the Value Chain for Development (VCA4D) Project, which is funded by the European Union (EU) and implemented by Agrinatura. The B2F model involves business ties between smallholders and large-scale enterprises which may be aggregators or processors. The ties are primarily for tangible, mutual benefits to the counterparties, though some welfare objectives may also be pursued. The large-scale partners usually engage in such ties in order to secure supply of food and other agricultural raw materials of consistent quality. In return the SHFs have better access to needed inputs, usually on credit, and more reliable provision of extension advisory services. The impacts of these models are analysed in Section 3 of this paper.

1.2 Methodology

The methodology adopted consists of a desk review of evidence reported in selected VCA4D studies complemented by review of relevant published literature on ISPs in Africa and other developing countries. ISPs in Nigeria and Zambia are reviewed as part of more general evidence on the design and implementation of these programmes. Three B2F models are also analysed, these being: the Ghana sorghum value chain, Nigeria's maize value chain and soya value chain in Zambia, which is linked to the egg value chain in that country. The paper will certainly be relevant to policymakers in Africa as they grapple with policy and programmatic options to boost growth in agriculture in a manner which is inclusive and also sustainable as far as public finances and the environment are concerned. It will also contribute to dialogue between governments and EUDs in framing programmes to support sustainable and inclusive growth in the sector growth.

2. Inputs subsidy programmes in Africa: justification and trends

2.1 Occurrence of ISPs

Implementation of ISPs was a key part of agricultural development programmes in most African countries in the 1960s and 1970s. A review of evidence summarised in Table 1 from over 40 VCA4D studies, which were undertaken between 2016 and 2021, shows that ISPs continue to be implemented in many African and other developing countries. It also shows that provision of subsidies is not limited to staple food crops but also include some export crops. Most of the programmes focus on distribution of subsidised inorganic fertiliser and improved seeds, especially for major staple grains like maize, rice and some legumes. More recently the list of inputs has been expanded to include pesticides and herbicides.

Typically, the inputs are procured centrally by government and, prior to the 1990s, mainly distributed by parastatal agencies and/or farmers' cooperatives. Under the early programmes SHFs were exclusively targeted but in recent cases, especially after 2010, the subsidies tend to be universal and do not exclusively target particular categories of farmers. Analysis of reported data in the VCA4D studies indicates that, even where access to subsidised inputs is universal, the predominant beneficiaries are expected to be SHFs. For instance, in the maize value chains in Nigeria and Zambia, about 70% to 75% of the respective beneficiaries are officially reported to be SHFs. In the case of the coffee VC in Angola and banana VC in the Dominican Republic, over 95% of the beneficiaries are SHFs. However, there are doubts whether the officially recorded beneficiaries actually utilise the inputs or there is "leakage" to relatively larger-scale primary producers, as noted by De Weerdt J. and J. Duchoslav (2022) in the case of Malawi's ISP.

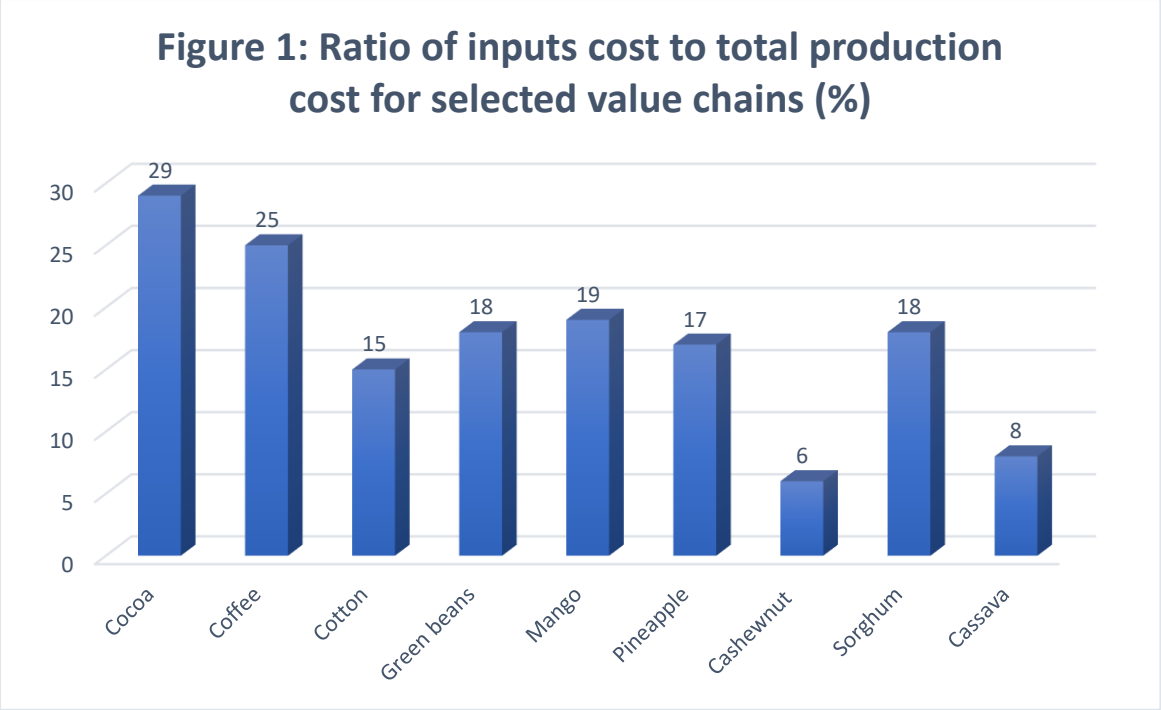
There are also cross-country differences in the level of subsidy provided. They range from about 15% in the cocoa VC in Cameroon to over 80% in cases such as the maize VC in

Zambia. Despite the substantial level of subsidy provided, it is apparent that impact on total cost of primary production may be limited. This is because data from some of the selected VCA4D studies shows that the average cost of the inputs covered under ISPs account for under 30% of the total cost of primary production as shown in Figure 1. Usually, the subsidies do not cover land preparation costs which can be quite high especially where tractor services are required as in the case of cereal production in Northern Nigeria or most parts of Zambia. Also not covered are non-family labour costs, land rent and interest on production loans (from either formal or informal providers).

Table 1: Inputs Subsidy Programmes in selected VCA4D countries

Country	Product	Subsidy
Angola	Coffee	Yes
Benin	Pineapple	No
Burkina Faso	Mango	No
Burundi	Banana	No
Cameroon	Cotton	No
Cameroon	Cacao	Yes
Côte d'Ivoire	Cassava	No
Eswatini	Beef	Yes
Ethiopia	Cotton	No
Ghana	Groundnut	No
Ghana	Sorghum	Yes
Guinee Bissau	Mango	No
Guinee Bissau	Lime	No
Honduras	Coffee	No
Kenya	Green beans	No
Mali	Cashew nut	No
Nigeria	Maize	Yes
Papua New Guinea	Cocoa	No
Papua New Guinea	Vanilla	No
Dominican Republic	Banana	Yes
Dominican Republic	Mango	No
Dominican Republic	Pina	No
Sierra Leone	Cashew nut	No
Sao Tome	Cocoa	No
Tanzania	Green Coffee	No
Togo	Pineapple	No
Zambia	Egg	No
Zambia	Maize	yes
Zimbabwe	Beef	No

Source: Various VCA4D reports.



Source: Authors based on data from various VCA4D studies

2.2 Why ISPs in Africa?

One of the main factors often cited by researchers and policymakers as constraining sustained growth in agriculture is the fact that average yields obtained by smallholders who dominate production in Africa are much lower than what is potentially achievable, creating what is termed a 'yield gap'. By yield gap we mean the difference between the potential yield if plant growth is not limited by nutrient or water deficiencies actual yield obtained by farmers. It is usually illustrated by comparing average yields obtained in various countries with global averages. For instance, for maize which is the foremost staple food crop in most African countries, average national yield is about 2.0 tonnes per hectare, which represents approximately 20% of the average yields in North America, Europe and major South American producers such as Argentina (Leitner et al. (2020). This difference does not only exist across but also within countries. For example, in Nigeria, whilst the average yields obtained by smallholders is estimated at about 1.8 tonnes per hectare whilst medium-scale farmers obtain about 3.5 tonnes per hectare and large-scale farmers get about 4.5 tonnes per hectare (Onumah et al. 2022).

The existence of a yield gap tends to have a negative impact on food security, including on household food availability, food diversity and access). It also implies that growth in agricultural output is achieved primarily by through expansion in land area under cultivation (Evenson and Gollin 2003. This results in the conversion of grasslands and forests into agricultural land as well as causing forest degradation and deforestation (Ordway et al. 2017). These land use changes are associated with loss of biomass and soil organic carbon, leading to rising greenhouse gas (GHG) emissions (Van Loon et al. 2019) increased emissions intensity (Leitner et al. (2020). Though multiple factors are responsible for the yield gap, many policymakers and researchers have attributed it to differences in the intensity of application yield-enhancing inputs, especially fertiliser (Lobell et al. 2009). We return to this as we discuss the fundamental underpinnings of ISPs in Africa.

Bridging yield gap: a focal point of policy action in agriculture

Bridging the yield gap is seen as important for policymakers in Africa, partly because it is often argued, including by researchers such as Dorward et al. (2008), that the low-inputs and low productivity equilibrium in which the predominant smallholder farmers operate reinforces a vicious cycle which hinders output growth and high incidence of rural poverty. It is apparent that several factors impact negatively on the productivity of African farmers. Box summarises some of the major risks and challenges faced by smallholder farmers in Ethiopia. Through robust quantitative analysis reported in PARM (2016) these risks and challenges were validated and shown to directly reduce yields/output obtained by farmers. This uncertainty then tends to dampen farmers' incentives to adopt new, potentially high-cost production technologies and practices. For instance, output marketing challenges (access risks and price volatility), which squeeze producer margins tend to weaken farmers' financial incentives for taking up inputs such as fertilizer by reducing the profitability of its use[1] (Sheahan et al. (2013).

Box 1: Farmers' perception of risks and constraints in Ethiopia's agriculture

During a study to assess agricultural risks in Ethiopia, a group of smallholder farmers representing three primary cooperatives were consulted during three separate focus group discussions (between 19th and 20th August 2015). The participants mentioned the following as the main risks and challenges which they face:

• Weather risks: including late/delayed rains and inadequate rainfall (drought) during the season. They added that inadequate rains often increase the incidence and severity of plant diseases and pests, which is a risk cited in particular by households growing vegetables.
• Access to inputs e.g. seeds, pesticides and fertiliser and the risk of variable inputs quality.
• Uncertain access to markets, especially when their cooperatives lack sufficient funds to procure farmers' produce and farmers lack suitable facilities for storing their crops.
• Uncertainty in output prices.
• Poor state of rural roads and lack of storage facilities, which contribute to high postharvest losses. Also contributing to high postharvest losses is lack of modern equipment for harvesting and for efficient postharvest management of produce.
• Lack of finance for procuring farm inputs and other farming activities.
• Capacity constraints facing cooperatives, which in turn affect the quality of services they provide to the farmers.

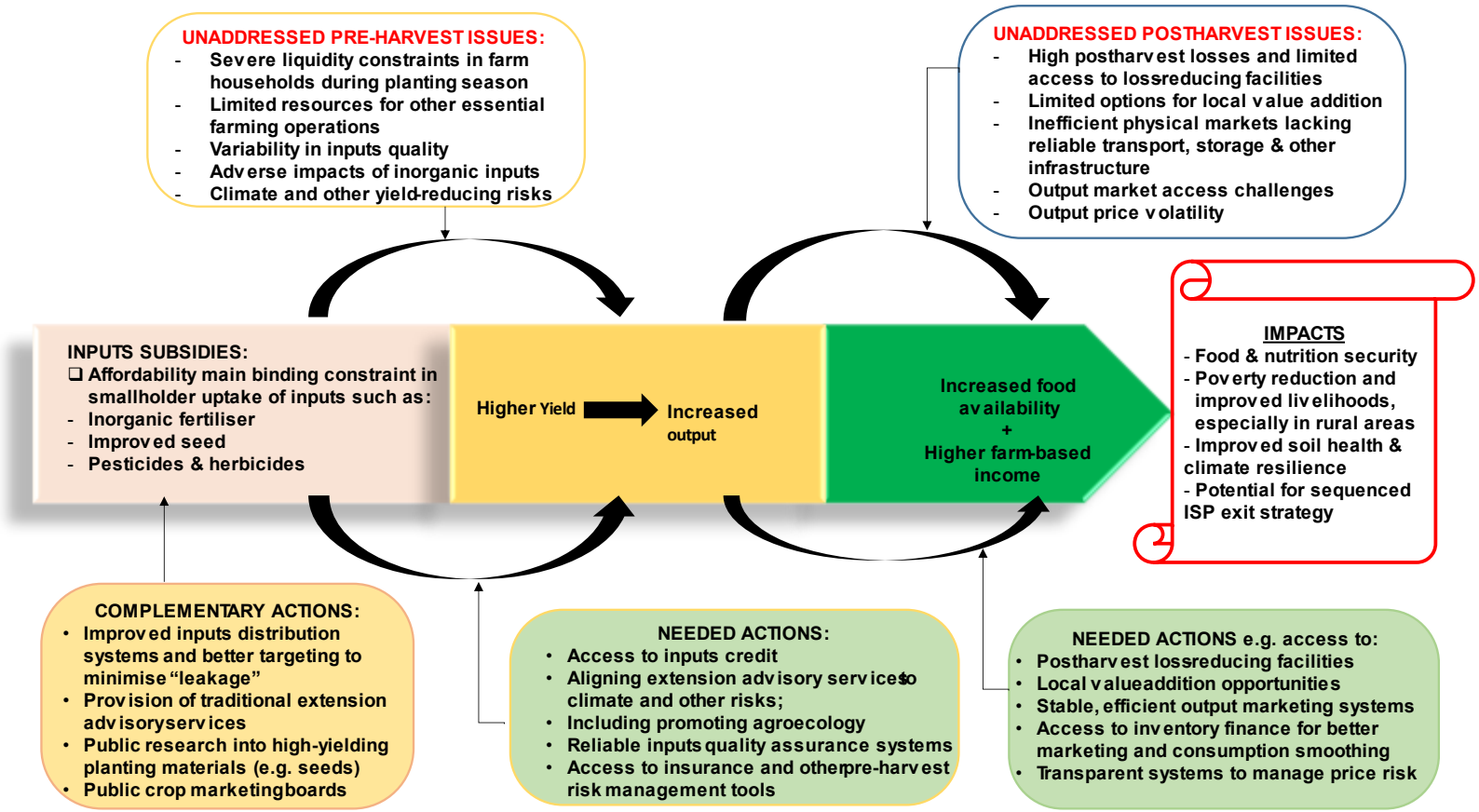
Source: PARM (2016)

Despite the above, the policy focus in bridging the yield gaps has been on promoting uptake of yield-enhancing technologies, including in particular increasing the intensity of fertiliser application, especially in Africa's staple crops subsectors. For example, in 2006 African Union member states adopted the "**Abuja Declaration on Fertilizer for the African Green Revolution**" pledging to increase average fertilizer use in Africa from 8 kg per hectare (about one- tenth of the global average) to 50 kg per hectare by 2015[2]. Increased uptake of inorganic fertiliser was seen as critical in achieving a *Green Revolution* in in Africa. ISPs represented one of the key policy levers used to drive uptake of fertiliser and other inputs, especially by smallholder farmers. The main elements of the ISPs and associated conceptual justifications are summarised in Figure 2 below.

[1] The financial benefit of fertiliser use is often computed as a Value (of incremental output) to Cost (of the input) Ratio or VCR. If the VCR is above 1 (or conventionally 2 and above), then it is profitable for farmers to apply fertiliser. Hence, where distribution costs increase the cost of fertiliser and/or output market inefficiencies result in lower producer prices, the VCR may end up lower than 1, indicating that use of the input is not profitable.

[2] The Abuja Declaration on Fertilizer for African Green Revolution is a resolution declared at the Africa Fertilizer Summit in Abuja, Nigeria, June 9-13, 2006.

Figure 2: Underpinning framework for ISPs and other interventions to boost smallholders' productivity in Africa



Source: Authors

As indicated in Figure 2, ISPs usually prioritised distribution of inorganic fertiliser, higher-yielding planting materials (e.g. grain seeds) and agro-chemicals (e.g. pesticides and herbicides). Not much government effort went into improving access to organic fertiliser and/or promoting the adoption of farming practices (e.g. regenerative agriculture) that optimise output but also minimise emissions and enhance biodiversity. Until recently, only major staple food crops (e.g. maize) were targeted but the basket of supported subsectors has been expanded in many countries including Zambia (as discussed below).

It was generally presumed, in the design and implementation of ISPs, that affordability is the main obstacle limiting uptake of target inputs by smallholder farmers. Hence, lowering inputs prices through subsidies was expected to catalyse more intensive utilisation by smallholders and boosting yield and output. This in turn results in increase in the supply of staple foods and also impacts positively on farm household incomes and wellbeing as depicted in Figure 2. The main complimentary actions which have been implemented by governments include the following:

- Public-funded research into higher-yielding crop varieties, with the potential for the best-performing varieties being distributed through the ISPs.
- Provision of extension advisory services which focus mainly on technical guidance on application of the distributed inputs. The advice provided tends to be standardised, for instance, fertiliser application is usually based on blanket recommendations across the country or entire regions, without due consideration of differences in soil types and other agroclimatic conditions which have impact on fertiliser response rates (and therefore profitability).
- Development of inputs distribution systems which ease access by the target farmers, especially where smallholders are the main target beneficiaries. The two ISP case studies in this paper (Nigeria and Zambia) show that governments invest considerable time and resources into improving inputs distribution systems, especially to address the challenge of inputs "leaking" to non-target farmers.

Until the 1990s, most ISPs were complemented by government-funded credit schemes, often at heavily subsidised interest rates. In addition, parastatal marketing boards assured output market access with guaranteed prices, usually set pan-territorially and pan-seasonally (meaning that the same price levels applied across the whole country and throughout the season). These programmes were either abolished or substantially scaled down in the 1990s as part of Structural Adjustment Programmes (SAPs).

Expectations versus marginalisation of multiple hindering factors

Policymakers' high expectations about the outcome of ISPs appear to be supported by arguments from some researchers. For instance, Gautam (2015) argues that by breaking the vicious cycle of low-inputs, low-productivity and poverty, ISPs can unleash potentially strong dynamic general equilibrium impacts including boosting productivity and rural incomes whilst contributing to broader economic growth and rising real wages as a result of lower food prices. This expectation is illustrated in Figure 2. Furthermore, Carter et al. (2014) add that ISPs can trigger learning effects among farmers with little experience of using fertiliser and other inputs. The valuable knowledge gained by such farmers is expected to make them better placed to continue to purchase commercially-supplied fertiliser when the subsidy regime ends. This effect is expected to be particularly pronounced in areas where fertiliser use is uncommon but likely to be profitable at commercial market prices.

Despite these rather high expectations, evidence from past and recent reviews converge on the conclusion that the ISPs recorded limited success. This includes recent cross-country studies by Jayne et al. (2018) and Ntinyari et al. (2022). De Weerdt and Duchoslav (2022)

come to similar conclusions after reviewing the ISP in Malawi. They note in particular that many so-called “unproductive” smallholder farmers tend to sell the subsidised inputs they obtain to “more productive farmers” through a parallel market. Their recommendation is therefore for policymakers to take cognisance of this and prioritise distribution of subsidised inputs to the “more productive” farmers. What this recommendation does not clearly bring out are the underlying factors triggering the emergence of the parallel market as well as the social implications of excluding a large population of “unproductive” farmers from farming in an economy with very few productive options to absorb that. Based on their findings, Ntinyari et al. (2022) also recommend that policy attention need to shift from more intensive use of inorganic fertiliser to biological nitrogen fixation and organic manure in order to achieve reach yield and output optimization targets.

2.3 Why the suboptimal ISP outcomes in Africa?

The evidence discussed in Section 2.2 clearly indicate that the outcome of ISPs in Africa has generally suboptimal. Viewed within the context of the framework outlined in Figure 2, this outcome is not surprising as discussions in this section show that it is the result of the combined effects of ineffective/inadequate complementary/supporting actions as well as unaddressed pre-harvest and postharvest issues.

2.3.1 Ineffective/inadequate complementary/supporting actions

These actions include: improving inputs distribution systems; provision of extension advisory services (EAS); sustaining research capacity to develop and release improved planting materials, usually higher-yielding crop varieties. These are briefly discussed below.

Improving inputs distribution systems undermined by poor rural infrastructure

As discussions below on the two ISP case studies show, governments invest considerable effort into designing and re-designing inputs distribution systems, usually with the aim of ensuring that target farmers benefit and “leakage is reduced. However, the state of rural road and transport infrastructure remains poor, mainly because of public sector under investment. The result is high transport costs, which impede the development of efficient and competitive rural inputs distribution networks, making physical access to inputs difficult. This was noted by Binswanger & Rosenzweig (1986) more than three decades ago but still remains as a valid challenge.

Inadequacies in agricultural extension advisory services (EAS)

Provision of extension advice is to enable, especially, SHFs to properly apply inputs in order to maximise yields and output. The first challenge is limited access to EAS by most SHFs. This is due mainly to very low extension agents for farmers ratios across Africa (PARM 2018). Second, is the advisory message which is provided. In most cases the advice offered to farmers is based on blanket technical recommendation which do not take account of differences in agroclimatic conditions. For instance, fertiliser application is not based on field tests to assess soil health and specific micronutrient deficiencies on particular farms but on standardised application rates, some of which have not changed for decades. This is despite empirical findings stressing the need for recommendations on fertilizer application rates to reflect soil type and soil health (Ichami et al. 2019). These factors appear to be marginalised in the design of ISPs in many African countries, contributing to the low average fertiliser response rates and profitability. Amede and Dialo (2022) confirm this based on field evidence which shows that the absence of soil testing and crop response-based recommendations on application rates contributes in a major way to the low agronomic and economic returns SHFs achieve in applying fertiliser in Africa.

Weather conditions also impact on fertiliser response rates. For instance, incidence of dry conditions can depress yields when fertiliser has been applied whilst humid conditions increase the risk of leaching of soil nutrients. It is, therefore, no surprise that, as observed by Nsabimana (2022), farmers purposively reduce investment in yield-enhancing inputs such as fertiliser when there is high risk of drought or dry spell. However, EAS messaging in most African countries does not take account of such farm risks (PARM 2018).

Promoting uptake of high-yielding crop varieties

Research institutions dedicated to developing and releasing higher-yielding crop varieties are common in Africa and their role is seen as complementary to actions to promote use of yield-enhancing inputs, especially by SHFs. Evidence from Hurleya et al. (2018) appear to justify investments in such organisations as they argue that encouraging the use of both fertiliser and improved seed varieties is important in catalysing productivity gains across much of Africa. They argue further that the sequence to follow should be introduction of farmers to improved seed varieties before encouraging the use of fertilizer because "*farmers are more likely to see larger improvements faster and with less additional effort*". It has to be stressed, however, that releasing high-yielding varieties is not enough to drive sustained productivity growth, especially where issues such as storability of the varieties and market absorption are marginalised. Furthermore, it has been noted that lax regulatory regimes which allow for counterfeit seed to be marketed tends to discourage uptake by farmers. This occurred in various crop value chains in Uganda (PARM 2015) and in the maize value chain in Nigeria (Onumah et al. 2021).

2.3.2 Unaddressed pre-harvest issues

Weather risks and impacts of intensifying use of chemical inputs marginalised

The impact of weather risks on, for example, fertiliser response rates as well as variability of inputs quality on uptake by farmers have been mentioned in the preceding subsection. It is also worth noting that when these climate-related risks combine with inefficiencies in output markets and policy risks, the heightened uncertainty created tends to induce increased risk aversion among producers, especially SHFs. The consequence is to discourage farmers from taking up inputs from the commercial markets (van Asseldonk 2022).

Another marginalised issue is the adverse impact of intensifying the use of chemical inputs such as inorganic fertiliser. The manufacturing process can result in emission of air pollutants whilst inappropriate management of industrial waste increases the risk of contaminating water bodies. Intensification of inorganic fertilizer is also reported to harden soil and reduce soil fertility (Pahalvi et al. 2021). They add that it can alter soil pH, thereby decreasing organic matter load in soils and stunting plant growth. Similar concerns have been expressed about the negative environmental and human health impacts of the use pesticides, though it is acknowledged as an under-researched area (Fuhrimann et al. 2021).

Liquidity constraints appear more binding than affordability

There is evidence showing that uptake of farm inputs by SHFs is price sensitive, more so than for large-scale farmers, who are better-resourced and can benefit from bulk procurement of inputs. Due to the dominance of smallholders in staple grains production, the national level impact of high inputs prices on output can be quite significant. For instance, WFP (2022) in a recent study in East Africa found that, holding other factors constant, an average fertiliser price increase by 10% reduces offtake of fertiliser and causes a drop in national maize output by about 38% as yields decline. This is one of the main arguments in support of ISPs but anecdotal evidence reported in VCA4D studies (maize in Nigeria and sorghum in Ghana) shows that for many SHFs, liquidity constraints may be a more binding constraint in terms of accessing subsidised inputs. Holden and Lunduka (2014) attribute this situation to the fact that

most SHFs sell the bulk of their produce during the harvest season when output prices are often low so that by the planting season they usually do not have cash to pay for inputs. They also cannot secure credit from formal financial intermediaries (FFIs) to buy the inputs. It is apparent that factor is a major driver in "encouraging" SHFs to either sell the subsidised inputs they obtain (or their right to acquire those inputs) to better endowed farmers, creating a parallel (unofficial) inputs market. It is very doubtful that the reason why that market has emerged in so many countries, including Malawi, is because "unproductive" farmers decide to sell their allocation to the "more productive" ones as argued by De Weerdt and Duchoslav (2022).

The same resource and liquidity constraints make it difficult for SHFs to finance use of farm mechanisation services as well as non-family labour for planting and other farm maintenance activities such as weed. It is apparent that under-investment by SHFs in these essential on-farm activities directly contribute the below par yields they obtain even if they are able to access subsidised inputs.

2.3.3 Unaddressed postharvest issues

One of the main unaddressed issues in the design and implementation of ISPs is marketing of the output obtained by farmers. This is crucial because adoption of high-yielding varieties, fertiliser and other inputs is not simply about increased yield but the profitability of such an investment by a producer. The financial benefit of fertiliser use is often computed as a ratio of the Value of incremental output to the Cost of the input used, i.e. Value/Cost Ratio (or VCR). In theory, if the VCR is above 1 (or conventionally 2 and above), then it is profitable for farmers to apply fertiliser. Hence, rising fertiliser costs will dampen demand unless compensated for by increased crop output prices.

However, rural output markets for most staple crops in Africa are under-developed and often characterised by multiple handling of commodities by a number of under-capitalised traders. The consequence is that producer margins get squeezed significantly, driving down the VCR and weakening farmers' financial incentives for taking up fertiliser and other such as inputs. This theoretical expectation is borne out by empirical evidence from studies, including by Sheahan et al. (2013). Output market prices also tend to be volatile and SHFs have little or no access to tools for managing price risks. The result is heightened uncertainty about farm-based income that further discourages rational smallholders from investing in uptake of costly inputs. Furthermore, in most of the underdeveloped staples markets, the burden of storage is borne by SHFs who lack efficient storage facilities, the result being high levels of postharvest losses which decreases farm income and therefore the VCR.

3. Case studies in ISP and B2F in Africa

The evidence discussed in the preceding section shows that ISPs have generally produced suboptimal outcomes. Even where yield-boosting expectations was achieved, as exemplified in the quote below citing the case of Malawi, the impacts have not been sustainable.

> *"Within (a) haystack of gloom shines the needle of Malawi, where a government-led fertilizer subsidies program has produced two bountiful maize harvests, filling stomachs and cupboards across this formerly destitute sliver of southern Africa. … The success of Malawi's subsidy program has overturned conventional donor wisdom and may have set an example for other African nations to follow"[3].*

[3] Source: Report by David Lepeska dated 15th May,2008: https://www.devex.com/news/the-promising-case-of-malawi-and-the-future-of-farm-output-in-africa-29331

In this section, we review two ISP cases from Nigeria and Zambia to see if the outcomes are consistent with this rather optimistic expectation or the more pessimistic view which emerged in the discussions in Section 2.

3.1 Nigeria's ISP: programme modifications but limited smallholder impact

3.1.1 Evolution of ISPs in Nigeria

Implementation of ISPs in Nigeria dates back to the 1970-80s, when fertiliser was the main subsidized input. Centralised procurement was undertaken by the Fertilizer Procurement Distribution Division (FPDD) with state governments procuring and distributing it through sales agents. Smallholders were the main target beneficiaries and they were supported with training by public extension services personnel. The subsidy varied between 25%-50% and 75%-85%, depending on additional transport and distribution costs.

A review of the earlier programme by Eboh et al. (2006), showed that the programme was impeded by a number of factors including: supply chain logistics challenges, especially at the ports; lack of control over fertilizer quality; high storage and transit losses; non-delivery of fertilizer due to transportation problems; and poor subsidy administration and management, including evidence of over-invoicing by some fertilizer importers. Banful et al. (2010) add that significant leakage of subsidized fertiliser to non-targeted farmers occurred.

The Fertiliser Voucher Programme in Nigeria

In an attempt to address, in particular, the leakage problem, the Fertiliser Voucher Programme (FVP) was launched in 2009. It started in Kano State and involved collaboration between Federal and State Governments, private suppliers/dealers and the IFDC. The key difference between the FVP and earlier ISPs was that participating farmers, who were required to be members of farmer groups, received vouchers representing a 50% discount on the market price of the fertiliser provided: two bags of nitrogen phosphorous potassium (NPK 15:15:15) and one bag of Urea (46% nitrogen).

Participating farmers had to make upfront payment of their contribution of 50% of the cost of fertiliser allocated to them. Every member had to pay up before a single voucher is issued for each group. As a result those who pay up promptly often had their funds tied up as they wait for others to pay. They also faced the risk of non-delivery of their allocation of fertilizer, partly because of non-payment by some members. The FVP was considered more transparent and cost-effective than the earlier subsidised fertiliser distribution programmes in Nigeria, as noted by (Liverpool-Tasie et al. 2010). However, in addition to the above-stated challenges faced by participating farmers, there were other problems which led to its replacement by another ISP three years later, in 2012. For instance, payments to participating fertiliser distributers were often delayed. A programme to incentivise local extension agents to support farmers by providing required extension advice could not be implemented due to funding problems. As a result, the more competent extension personnel reportedly disengaged from the FVP and found better-paid jobs such as working for NGOs.

The Growth Enhancement Support Scheme

The Growth Enhancement Support Scheme (GESS), also known as the e-Wallet Scheme, was launched in May 2012. The key design innovation involved a shift from paper vouchers to electronic vouchers posted directly to the mobile phones of participating farmers in order to purchase agricultural inputs (Fadairo *et al.* 2015). The range of inputs covered by government subsidy was also expanded beyond fertiliser to include improved seeds, insecticides and

herbicides and the volume provided per farmers was equivalent to the generic requirements recommended for one (1) hectare (Nwaobiala and Ubor, 2016). The participating farmers are selected through the local offices of the Federal Ministry of Agriculture and Rural Development (FMARD). There is verification of farmers to avoid multiple registration by beneficiaries. This is done using a database hosted by the National Identity Management Commission. The scheme involves a 50% subsidy, which is co-funded equally by the Federal and State Governments (each contributing 25%).

3.1.2 Complementary actions in support of Nigeria's ISPs

Sourcing of fertiliser and improved seed

To reduce reliance on imports for the ISPs run in the 198090s, the Federal Government, in 1988, established the National Fertilizer Company of Nigeria (NAFCON) to blend fertiliser locally. However, the government at the same time reduced import tariffs from 10% to 5%, making imports more competitive. Other policy actions impacted on the viability of NAFCON. These include policy reversals such as discontinuation of the fertiliser subsidy in August 2000 and its reintroduction in 2002, when fertilizer import tariff was also abolished. In 2006, the Federal Government opened up the domestic fertiliser market to attract private manufacturers and blenders. A private sector-based fertiliser distribution network was expected to develop but this was partly hampered by the parallel to public distribution of subsidized fertiliser, which made it difficult for private traders to compete (Banful and Olayide, 2010).

Nigeria has an elaborate seed system. The Ibadan-headquartered International Institute of Tropical Agriculture (IITA) leads in research and development of improved planting materials, including being the lead breeder seed producers in the country. The public Institute of Agriculture (IAR) at Zaria is the institution which is mandated to produce foundation seed, though some major private seed companies such as Premier Seed also engage in primary research to produce foundation seed. A large number of private companies produce and distribute certified seed producers, including through small-scale retail outlets which sell to smallholders. The National Agricultural Seed Council (NASC) regulates the release and distribution of certified seed. As reported by Onumah et al. (2021), this system has enabled Nigeria to reach over 90% uptake of improved seed in the maize subsector, with landraces accounting for less than 10% of the maize seed planted nationwide. They note, however, that assuring the quality and performance of marketed maize seed has become a challenge which is driving down demand by farmers. The NASC is, therefore, exploring options to tighten regulatory controls in the seed market.

Extension delivery system

The National Agricultural Extension and Research Liaison Services (NAERLS) is the lead public institution responsible for the delivery of farm extension advisory services. The services are delivered through a network of field agents posted at state levels and in local government areas (LGAs). Most farmers surveyed during the recent maize value chain study reported that they little or no access to extension services. This is confirmed in official reports (NAERLS 2020), which attribute the situation to funding and logistics challenges. Is also the problem of multiplicity of actors providing extension. The NAERLS annual reports also provide details on the incidence and impact of various agricultural risks, including weather and other natural risks such as outbreak of crop pests and diseases. However, extension messaging appears to focus mainly on technical guidelines on inputs application rates and generic agronomic practices. Usually, the guidance provided does not reflect area-specific differences in agro-climatic conditions. Furthermore, not much attention is paid to management of the reported risks.

Financing inputs distribution and uptake

As stated above, the inputs subsidies are directly funded from federal and state budgets under the GESS. Table 2 shows the allocation of federal budget resources to agriculture. Average federal budget allocation to agriculture from 2001 to 2021 is about 2.9% of the total budget, significantly below the target of 10% set by the African Union[4]. The average share of public expenditure allocated to agriculture between 2011 and 2021 was even lower, about 1.5%. The share of the agricultural sector budget spent in support of ISPs dropped even more steeply, from about 4.3% between 2001 and 2009 to about 0.64% in 2011-2018. There was a recovery in 2018, when the share of the sector budget utilized for ISPs rose to 2.65%. It has to be noted that lack of data on aggregate state-level contributions to subsidies on agricultural inputs makes it difficult to properly estimate total public spending on the country's ISPs.

Under the GESS, there was a shift from direct federal government procurement of inputs to the transfer of subsidies to selected inputs dealers. The selected private companies became responsible for procuring and distributing inputs to target beneficiaries. To ease financing constraints the suppliers face in procuring or manufacturing inputs, the Federal Ministry of Finance runs a credit guarantee scheme, which covers up to 70% of advances provided by participating local financial institutions. The guarantee scheme does not extend to participating farmers.

As is the case with ISPs, a number of credit schemes have been promoted by the Federal Government of Nigeria to improve access to finance by farmers. Umeh (2019) lists some of these schemes, including: the Agricultural Credit Guarantee Scheme Fund established in 1978; the Supervised Agricultural Credit Scheme established in 1979; the Special Emergency Agricultural Loans Scheme in 1984; the Agricultural Credit Support Scheme in 2006; the Commercial Agricultural Credit Scheme in 2009; Small and Medium Scale Enterprise Credit Guarantee Scheme in 2010; the Nigerian Incentive based Risk Sharing system for Agricultural Lending (NIRSAL) in 2010; and the Anchor Borrowers' Programme in 2015. Despite these schemes, it is quite evident that most smallholders lack access to finance, a critical factor which severely limits their ability to take up available subsidized inputs, as noted in the report by Onumah et al. (2021).

[4] Source: AU's Malabo Declaration 2014.

Table 2: Allocation of resources in support of ISP in Nigeria in USD (2001-2021)

Year	Budgetary Allocation to Agriculture (USD)	Share (%) of national budget	Inputs subsidy cost (USD)	Share (%) of agriculture budget allocated to ISP
2001	147,599,772.73	7.26	3,825,000.00	2.59
2002	101,826,818.18	4.23	3,375,000.00	3.31
2003	36,466,363.64	1.11	2,700,000.00	7.40
2004	113,469,090.91	4.19	5,589,000.00	4.93
2005	174,174,318.18	4.79	3,978,255.03	2.28
2006	244,236,136.36	5.72	7,970,909.09	3.26
2007	287,727,272.73	5.50	11,035,434.08	3.84
2008	389,545,454.55	5.41	32,417,899.98	8.32
2009	419,318,181.82	5.38	25,000,000.00	2.59
2010	64,136,363.64	0.61	50,744,318.18	79.12
2011	203,400,000.00	1.80	NA	NA
2012	177,454,545.45	1.60	36,173.80	0.02
2013	192,679,545.45	1.70	161,474.40	0.08
2014	157,881,818.18	1.40	416,210.30	0.26
2015	90,000,000.00	0.90	584,656.00	0.65
2016	172,272,727.27	1.25	774,674.25	0.45
2017	287,454,545.45	1.70	964,692.50	0.34
2018	414,545,454.55	2.00	10,979,464.31	2.65
2019	31,6254,545.45	1.56	NA	NA
2020	188,636,363.64	1.34	NA	NA
2021	637,045,454.55	1.37	NA	NA

Source: Computations based on Federal Ministry of Finance, Budget & National Planning data (2022)

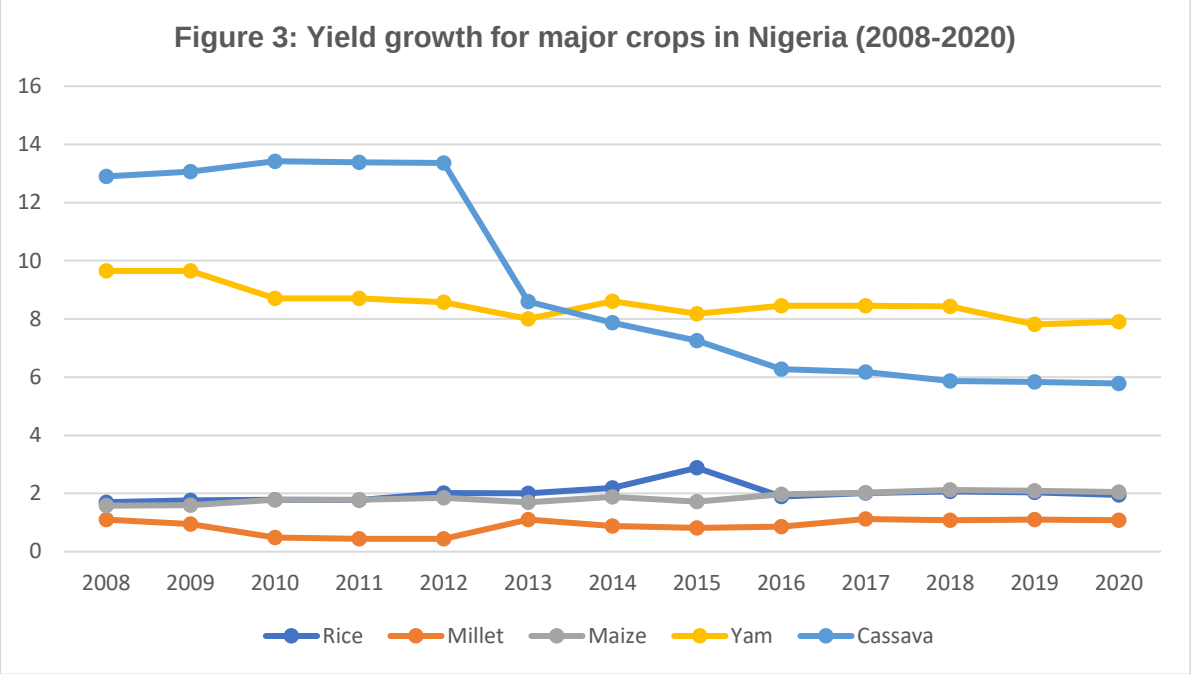
3.1.3 Overall impact of Nigeria's ISPs

Lack of data makes it difficult to report on the number of smallholders who actually benefited from the ISPs. However, anecdotal evidence from the recent VCA4D study on the maize VC in Nigeria indicates that very few of the smallholders consulted are able to take up the subsidized inputs[5]. It is evident though, as depicted in Figure 3 below, that farm yields have in general either stagnated or declined in most of the major crops value chains in Nigeria. The maize subsector recorded positive yield growth over the 12-year period from 2008 to 2022, but that increase appears rather marginal.

One of the factors cited for the lower-than-expected impact of the ISPs on agricultural yields is the fact that private sector participation in the schemes has been rather variable. This is attributed, among others, to repeated changes in the ISPs as shown in the discussions in Section 3.1.1. Delayed payments by state and federal governments also compound liquidity problems which they face, especially where SMEs involved in rural inputs distribution systems have limited access to finance, unlike the large-scale inputs suppliers and manufacturers. The consequent low-density of agro-dealers in the rural areas makes journeys to redeem inputs vouchers costly for many smallholders.

Most smallholders consulted during the Nigeria maize VC study mentioned liquidity constraints in farm households as a major binding constrain in uptake of subsidised inputs. This same challenge also makes it difficult to carry out other farming operations which does not rely on family labour, including mechanised land preparation and planting, weed control during the gestation of the crop and even harvesting. The consequence is that, even when they are able to acquire and apply inputs, the yields they obtain are suboptimal.

[5] Refers to Onumah et al. (2021).



Source: Based on data from Nigeria's National Bureau of Statistics (2021).

3.2 Zambia's ISP: multiple actions, unsustainable outcomes

Zambia's ISP is among one of the most researched and cited as is the case of neighbouring Malawi. The main programme is the Farmer Input Support Programme (FISP) but that runs along another programme which targets very poor rural households, the Food Security Pack (FSP). In addition, the Government of the Republic of Zambia (GRZ) supports output market prices through grain procurement and marketing by the parastatal Food Reserve Agency (FRA). These interventions are reviewed in this subsection.

3.2.1 Evolution of ISPs in Zambia

The country's FISP was formerly known as the Fertilizer Support Programme and was launched in 2002 as a temporary measure to cushion smallholder farmers against the impact of severe drought which occurred in 2000/2001. According to the World Bank (2010) the programme involved provision of hybrid maize seed and fertilizer with a subsidy representing 50% of the cost for the first two consecutive seasons. During the third year the subsidy was to be scaled down to 25% and the eligible farmers fully weaned off the support programme after that, the expectation being that incremental income accumulated over that period will enable them to acquire market-supplied inputs.

Rather than being phased out as originally planned, government in 2009 restructured the fertiliser support programme and relaunched it as FISP. The package of inputs remained improved seed and fertilizer, mainly targeting maize producers. However, the package was limited the requirements for one hectare and target number of beneficiaries increased from about 210,000 to 500,000 smallholders. During the 2015/16 season FISP was reformed, and an E-voucher system (E-FISP) piloted in 13 districts and targeting 241,000 smallholder farmers. This was part of efforts to address the problem of leakage of inputs to non-targeted farmers. It was scaled up in 2016/17 to reach 39 districts and over 600,000 target beneficiaries. Nationwide roll out targeting over 1,000,000 farmers was carried out in 2017/18 (MoA, 2016) but with a variation: a hybrid system with some farmers receiving inputs under E-FISP whilst others were supplied through a Direct Input Supply (DIS) programme.

Under the hybrid system, farmers participating in the e-Voucher scheme have a choice of inputs to acquire but those under DIS receive a standard pack consisting of inputs for maize and legumes such as soya. Unlike DIS beneficiaries who are supplied by government agents, those under E-FISP can redeem the vouchers from a wide range of inputs dealers, especially those with rural distribution networks.

The Food Security Pack (FSP) has been running concurrently with the main ISP since the 2000s. It was designed as a social safety net programme targeting the poor and vulnerable but viable farming households and run by the Ministry of Community Development and Social Services (MCDSS) rather than the Ministry of Agriculture (MOA) which is responsible for the ISPs. The pack consists of fertiliser and seed requirements for 0.5 to 0.75 hectares per farmer. Beneficiaries are required to "repay" in the form of farm output representing 10% of the inputs provided. This is either kept at community level or sold with proceeds being invested in ventures which are expected to benefit the poor. The investments include acquisition of hammer mills, maize shellers, chickens and small ruminant animals (e.g. sheep and goats) for distribution to the needy in the communities. The FSP originally targeted approximately 35,000 households per year.

3.2.2 Complementary actions in support for Zambia's ISPs

Zambia, as is the case in most African countries, has an elaborate public sector-based system for developing and releasing improved crop varieties to farmers. The country also has one of the most developed and competitive private seed and fertiliser distribution industries on the continent. The private sector, therefore, leads in the supply seed, fertiliser and other farm inputs. During the early stages of the ISPs (i.e. around 2001), the private suppliers were contracted by GRZ to import or manufacture on its behalf. They were also paid deliver the fertiliser to farmers in the rural areas. Following the reforms under FISP, the private sector competes to supply to farmers and receive full payment (subsidy plus farmers' contributions) through designated banks.

Supporting extension services

The public sector predominates the extension delivery landscape in the country. As is typical across Africa, extension messaging focuses on disseminating blanket technical advice on inputs application and basic agronomic practices. Very little attention is paid to environmental challenges facing farmers. However, for over two decades a non-government initiative has been promoting sustainable cropping systems through conservation agriculture in the country. It is implemented under the Conservation Agriculture Scaling-Up (CASU) project. Fusillier et al. (2021) note from recent evaluations that the rate of adoption of the practices promoted has been low but is likely to pick up as the incidence of drought is increasing in the country.

Financing uptake of inputs by smallholders

During the early 2000s, smallholders targeted under Zambia's ISP were supplied inputs on credit (representing the 50% cost which was not subsidised). Suppliers were expected to recover this credit on behalf of GRZ and were paid a commission for that. This scheme ensured that farm households were not constrained from acquiring inputs due to lack of cash to cover their 50% contribution for the inputs. It was largely abandoned under FISP due to extremely low loan recovery rates. Hence, under FISP, farmers can only take up subsidised inputs after they have fully paid their contribution. Anecdotal evidence suggests that due to liquidity constraints, most smallholders are unable to pay up their contribution and end up trading their rights to purchase the inputs (via the vouchers) to better-endowed producers, including public servants resident in the rural communities. This is factor underlies the emergence of the parallel rural inputs market, similar to what was observed by De Weerdt and Duchoslav (2022) in the case of Malawi.

In the absence of a government-backed financing scheme for smallholder farmers, the Zambia National Farmers Union (ZNFU) initiated the Lima Credit Scheme which made it possible for

smallholders to obtain inputs finance from commercial sources. It involved bundling insurance with inputs credit and interlocking that with firm forward output marketing arrangements. The scheme, which is briefly described in Box 2, proved to commercially sustainable as it offered a win-win option for farmers, financiers, insurance companies, and grain buyers. The biggest challenge which impacted negatively on its sustainability was severe countrywide drought which private insurance could not sustain and definitely worth further attention (van Asseldnonk et al. 2022).

Box 2: Financing inputs uptake by smallholders in Zambia: the "Lima Credit Scheme"

Led by the Zambia National Farmers Union (ZNFU) and supported under the EU-funded Farm Risk Management for Africa (FARMAF) Project, the Lima Credit Scheme was initiated in 2008 targeting smallholder farmers. The scheme involved provision of crop insurance by the Zambia State Insurance Corporation (ZSIC) and later in 2013/14 by Mayfair Insurance Company. Credit was provided by Zambia National Commercial Bank (ZANACO), which made direct payments to suppliers for inputs delivered to participating farmers. ZNFU negotiated forward sales contracts with large-scale processors and grain aggregators, who paid for grains delivered through ZANACO, enabling the bank to recover loans granted before crediting the accounts of the farmers with the balance. The scheme ensured that farmers obtained inputs on a timely basis and were not constrained by household liquidity problems. They also had certainty about the marketing of their output. Premiums for the insurance was funded as part of the inputs credit, and in theory ensured repayment in the event of weather risks such as drought or flooding. Farmers, therefore, didn't have to sell off their assets (e.g. livestock) to repay loans when these risks occurred, resulting in loss of their crops.

It allowed participating smallholders to be less reliant on subsidised inputs and participation increased more than 8-fold between 2011 and 2015 (from 2,220 to 18,690 smallholders). The scheme enabled participating farmers to expand area cultivated by over 30% and the average yields they obtained for maize rising by about 75% (from 2 to 3.5 tonnes per hectare). Consequently, the scheme which was not subsidised in any way resulted in gross farm income obtained by the participating farmers almost doubling over 2011 to 2015. Its sustainability was severely tested when in 2015, Zambia experienced El Nino-related drought on a catastrophic scale, making it difficult for the insurance companies to settle claims promptly. It was therefore scaled down substantially. However, it proved that bundling insurance with credit and also interlocked with secure output marketing arrangements ease smallholders' access to finance and enable them to become more productive. Appropriate insurance products are key in this context.

Source: Van Asseldonk et al. (2022).

Output market support for smallholders

Heavy government involvement in grain (mainly maize) output marketing is the other key half of the two-pronged GRZ support for smallholder farmers, which Fusillier et al. (2021) refer to as a "double subsidy" scheme. Under this scheme, smallholders who benefit from the ISPs can sell their output through the Food Reserve Agency (FRA) at administratively-set producer prices which are often not well-aligned to the open market. This is expected to cushion farmers against price shocks but many have raised doubts about the benefits and sustainability of this intervention. For instance, Chapoto (2019) criticises the pricing model used by FRA, arguing that quite often both the producer and consumer prices are de-linked from the supply situation in the domestic market. He adds that most smallholders are unable to access the FRA market, backing this with evidence showing that during the 2017/18 season only 2.8% of the "better-off" farmers accounted for about 50% of maize sales to the FRA. He also notes that FRA interventions in rural grain markets tend to drive up rural grain prices to the detriment of grain-deficit households, especially during the lean seasons. Smallholder households which sell to FRA also experience acute liquidity constraints because, though the Agency may offer above-market prices, their payments are often delayed, sometimes for months.

Fusillier et al. (2021) conclude that though FRA was established to stabilise the domestic grain market, combining its involvement in the market with ad hoc restrictions on regional grain exports has only accentuated the volatility to which traders and producers are exposed. Furthermore, the private grain traders often get crowded out of the market, especially during the harvest season, a situation which has undermined long-term development of the trade.

3.2.3 Impact of Zambia's ISPs

Table 3 provides brief details of Zambia's ISP, showing that contrary to the original plans that it will be a temporary intervention with a clear exit strategy, it has remained and actually grown in scale. The number of target beneficiaries has ballooned from 120,000 in 2002/03 to over 1,000,000 by the 2021/22 season. The average share of the budget of the MOA allocated to FISP has also remained around the average of about 31%. In the 2021/22 season, when FISP spending represented a relatively low 10.6% of the agriculture sector budget, the amount spent was about €400 million. It has to be noted also that the additional annual expenditure on the FSP accounts for about 18% of the total budget of the MCDSS.

Table 3: Agriculture budget/FISP allocations and other details (2003-2022)

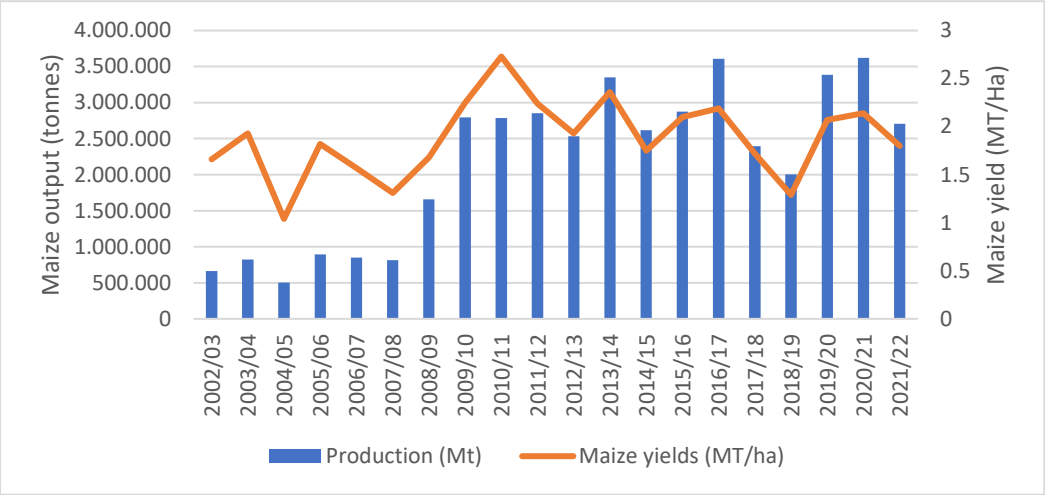
Season	FISP Budget/ share of MoA Budget (%)	Targeted Beneficiaries	Subsidy Level (%)	Fertiliser distributed (tonne)
2002/2003	34.4	120,000	50	48,000
2003/2004	31.4	150,000	50	60,000
2004/2005	21.7	115,000	50	46,000
2005/2006	27.6	125,000	50	50,000
2006/2007	18.9	210,000	60	84,000
2007/2008	15.9	125,000	60	50,000
2008/2009	34.6	200,000	75% fertilizer; 50% White Maize seed	80,000
2009/2010	31.7	500,000	75% fertilizer, 50% White Maize seed	100,000
2010/2011	35.3	891,500	76% fertilizer, 50% White Maize seed	178,000
2011/2012	27.9	914,670	79% fertilizer, 53% for seed	182,454
2012/2013	22.8	877,000	79% for fertilizer, 53% for seed	183,634
2013/2014	14.4	900,000	50% for fertilizer, free seed (i.e. 100%)	188,312
2014/2015	30.7	1,000,000	NA	208,236
2015/2016	29.3	1,162,572	70% for fertilizer, 84% for maize seed	276,519
2016/2017	52.5	1,602,521	70% for fertilizer, 84% for maize seed	343,298
2017/2018	35.4	1,024,434	100% e-voucher; farmer contribution ZMK 400 (approx. 20% of cost)	256,109
2018/019	34.3	1,022,434	75% e-voucher + 25% DIS & farmers' contribution ZMK 400 (less than 20%)	257,718
2019/2020	33.1	1,024,434	48% e-voucher + 52% DIS, farmers ZMK 400 (less than 20%)	265,000
2020/2021	10.6	1,000,000	16.6% e voucher (166,761 farmers) + 83.4% on DIS; farmers ZMK 400	Data not available
2021/2022	77.7	1,024,434	100% DIS, farmer contribution ZMK 400 (less than 20% of cost of inputs)	328,265

Source: MoFNP (Budget allocation) and MoA FISP Implementation Manual

Despite this high level of public spending on ISPs, it is apparent that its impact on overall yield growth has been rather marginal. This is illustrated in the case of the maize subsector in

Zambia in Figure 4 below. After dramatic growth between 2003/04 and 2009/10, growth in both yields and total maize output has slowed significantly, leaving the country still vulnerable to food insecurity especially when the rainfed smallholder production is hit by drought. This is not surprising partly because uptake of subsidised inputs by the low-input/low-yield smallholders, remains very low (Chapoto & Subukanya, 2019). It is also evident from profitability estimates presented by Fusillier et al. (2021) that smallholders have no financial incentives to invest in non-subsidised yield-enhancing inputs. Their estimates indicate that profits per hectare obtained by smallholders who do, actually decline by a steep 41%. This is partly because adopting such inputs also imply increased farm maintenance and harvesting costs, which the resource-constrained farmers are unable to fund. Where they cannot, for example, ensure effective weed control due resource limitations, they cannot obtain expected yields resulting in significant decline in farm income which affects profitability of their operations.

Figure 4: Maize production and maize yields in Zambia (2002–2021)



Source: Crop Forecast Surveys, Ministry of Agriculture

There is also scant evidence suggesting that the ISP in Zambia has had any significant poverty-reducing impacts, due partly the low uptake by targeted smallholders. A recent Rural Agricultural Survey Results (2019), cited by Fusillier et al. (2021), show that, at the national level, about 49% of FISP beneficiaries are better-off farmers cultivating over 5 hectares, whilst the relatively poor smallholders cultivating about 0.5 and 1.0 hectares account for only 27% of the subsidised inputs distributed. They also cite evidence attributed to Makungu (2017) which shows that the FSP, is reaching only 0.6% of rural people living in extreme poverty.

3.3 Case studies of Business-to-farmers (B2F) model:

3.3.1 Definition and generic description of B2F model:

The Business-to-farmers' (B2F) model, which we discuss in this sub-section, has shown promise in boosting yields obtained by smallholders and increasing their farm-based income on a sustainable basis through enhancing access to yield-enhancing inputs. Two main examples identified in VCA4D studies are analysed in this paper. These are from the sorghum VC in Ghana and maize VC in Nigeria.

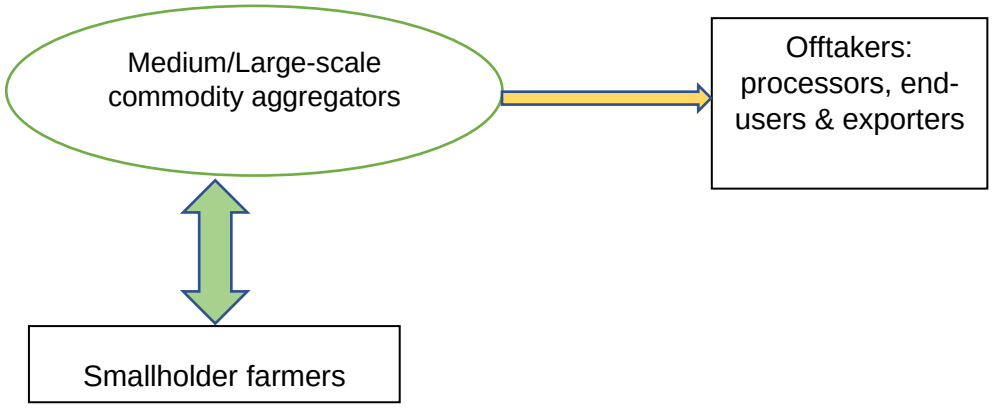
The B2F model involves formal or informal ties between agribusinesses and smallholders. Though some agribusinesses pursue such initiatives for corporate social responsibility reasons, the main focus of our analysis is on the transactional nature of the relationship, which are built on expectations of reciprocal benefits to the parties involved. There are three key parties involved in the linkage, these being: smallholder farmers, commodity aggregators and

large-scale offtakers of agricultural raw materials (e.g. processors such as grain millers, exporters and end-users like large-scale poultry farmers that formulate their feed on-farm.

As shown in Figure 5, commodity aggregators are at the centre of the B2F linkages. The main economic incentive for engaging in this is to secure access to sufficient volumes of agricultural commodities in order to meet obligations under supply contracts with the offtakers. They also need to ensure that the quality of commodities delivered to them either meet standards specified by the offtakers or can be re-conditioned (i.e. further dried, cleaned and/or sorted) at very low cost.

Similarly, offtakers need assurance of regular, year-round supply of raw materials. This is important because of the seasonality of production of commodities such as grains which are predominantly produced under rainfed conditions in most African countries. Supply uncertainty can disrupt their processing and marketing activities. It also important for them to manage sourcing of raw materials in order to avoid compromising the quality of their products. This is not only for purposes of assuring safety of products for consumers but also to avoid potentially costly sanctions by the standards authorities.

Figure 5: Business to farmers' (B2F) linkages in agricultural value chains



Source: Authors

Smallholders participating in these linkages receive a package of support which includes funding to procure inputs, including what is provided under government-run ISPs. They receive better access to farm extension partly because field agents of agribusinesses who provide this service, simultaneously monitor their farming operations. They are required to sell sufficient volumes of their output to enable the agribusinesses to recover inputs finance provided. They also can, and usually do, sell any extra marketable volumes to the agribusinesses because the farmgate prices offered are often higher than what is offered in the rural markets.

In the subsections below we review the two cases of B2F from Ghana and Nigeria. We also triangulate the emerging evidence with a case from the soyabean value chain in Zambia, in part, to demonstrate that the B2F model can also work in non-staple crops value chains.

3.3.2 B2F model in sorghum value chain in Ghana

Figure 5 depicts the B2F linkage between smallholder sorghum producers in Northern Ghana and agribusinesses, comprising commodity aggregators and a brewery. Their roles and key functions within the B2F are discussed below.

Industrial brewery

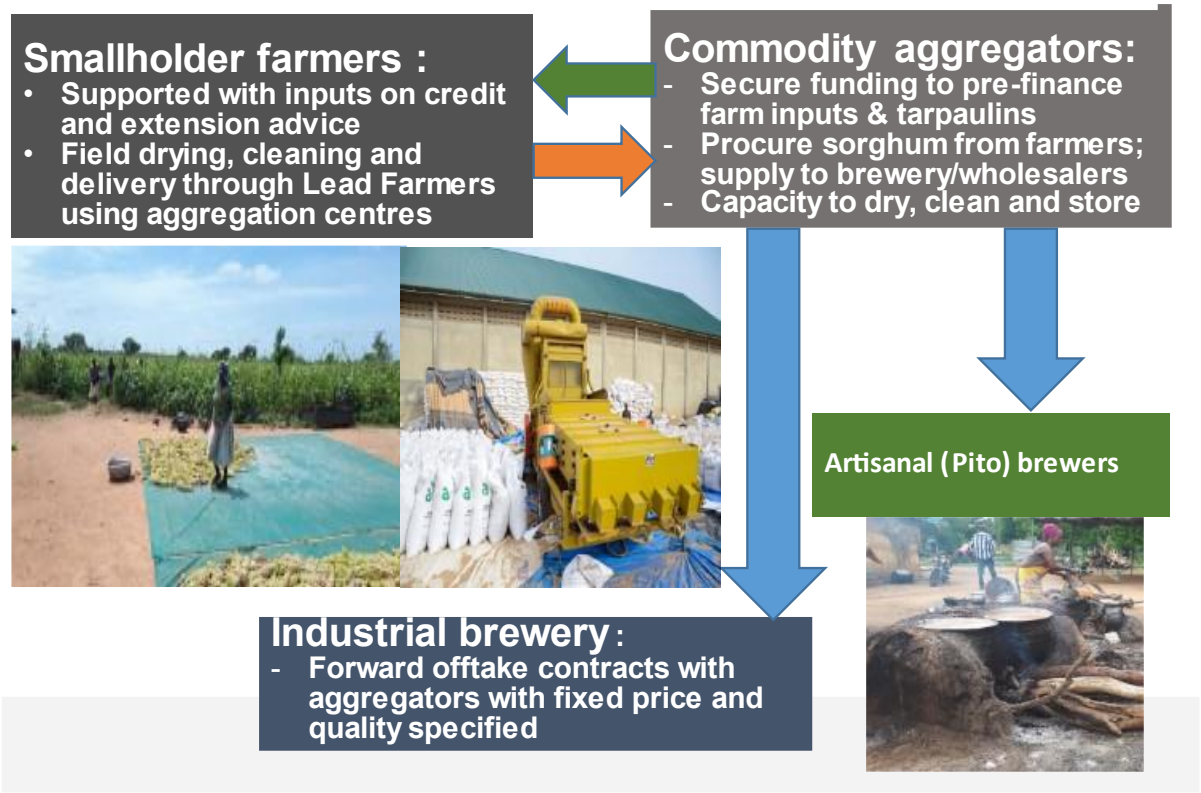
This term is used with reference to the leading brewery in the country, which is involved in the B2F, and is used in order to distinguish it from artisanal brewers who use sorghum grain to

produce a traditional low-alcohol beer called *pito*. It opted to switch from using imported barley to locally-produced sorghum grain to brew beer and other non-alcoholic beverages. This occurred after research supported by a donor and local research institutions (see Box 3). To assure consistent supply of quality sorghum grain, the brewery signs annual contracts with aggregators, specifying the following:

- Volume of sorghum grain to be supplied by an aggregator;
- Quality standards to be complied with;
- Fixed offtake price for aggregators, based on which producer prices are also fixed; and
- Designated bank through which payment is made to individual aggregators.

The offtake price incorporates a formula which makes it possible to set farmgate prices which are competitive relative to prices in the informal market. Representatives of smallholders are, however, not involved in negotiation of farmgate prices. They are, essentially, price-takers but prices in the informal market act as a benchmark. The brewery does not provide any credit lines to aggregators but, as discussed below, their contracts and payments system tend to be leveraged in securing finance from commercial sources.

Figure 5: Business-to-farmer (B2F) linkage in Sorghum Value Chain in Ghana



Source: Onumah (2021).

Commodity aggregators

The core business of commodity aggregators is to procure and sell sorghum grains to the industrial brewery and other small-scale offtakers, including grain wholesalers and, sometimes, the artisanal *pito* brewers. Their supplies to the industry brewery are under *formal contracts*, as mentioned above. Beyond procurement, their aggregation functions include drying and cleaning grains to ensure that what they supply meets quality standards set by the brewery. Some of them also provide grain warehousing services which make just-in-time

delivery the brewery possible. This is despite the fact that the brewery has leased and runs grain storage facilities close to the factory.

The aggregators, who are in competition with each other and with large-scale sorghum grain producers, provide the following services to smallholders in order to enable them to supply the sorghum grain they require:

- Credit to cover 50% payment fertiliser, improved seed and pesticides procured under Ghana Government's Planting for Food and Jobs (PFJ), its "flagship" ISP. The funding provided is for inputs needed for cultivating one hectare of land.
- Assure access to extension advisory services through their own field staff as well as by facilitating access to extension agents from the public sector and a GIZ-funded project operating in Northern Ghana – the Market Oriented Agriculture Project (MOAP).
- Support mobilisation farmers into groups to facilitate access to services and resources.
- Provision of tarpaulins to facilitate field drying of the grains in order to minimise postharvest losses (PHL) and improve grain quality. The cost of the inputs of the tarpaulin is amortised over three years and recovery is through sorghum grain sales.
- Use of small village stores (capacity of about 20 tonnes of grain) as aggregation centres, thereby shifting storage from homes and further contributing to reducing PHL.
- Providing an assured market and at a fixed price.

Funding for the inputs supply as well as working capital for their operations is usually obtained from local banks, leveraging the formal contracts with the brewery as a form of security. Some of the aggregators are also able to funding from MOAP to on-lend to participating farmers. The brewery does not directly finance the operations of the aggregators or, through them, provide inputs credit to participating farmers.

Participating smallholder farmers:

Smallholder producers have average land holdings of about 5 hectares but dedicate only 1-2 hectares to sorghum cultivation. The other crops they grow are millet, maize, rice and groundnuts. One of the aggregators, who was consulted during the VCA4D study, was working with about 2,000 smallholders. They are mobilised into groups by Lead farmers (LFs), who facilitate linkage with aggregators, distribution of inputs and access to extension. They also monitor on-farm activities by members, coordinate bulking of harvest for delivery to aggregators, and act as the first line of quality assurance, ensuring delivery of quality grains.

Box 3: Enabling role of government and donors in B2F in sorghum VC:

The Government of Ghana (GOG), through its Planting for Food and Jobs (PFJ), makes inputs available to all categories of farmers at 50% of its cost. However, for participating smallholders, the inputs finance provided by aggregators has proved pivotal in enabling take up the subsidised inputs. Tax incentives offered by GOG encouraged the brewery to explore substituting imported barley with locally-produced sorghum in brewing beer and other non-alcoholic beverages. The substitution process was facilitated through research by the public-owned Food Research Institute (FRI), which identified the sorghum varieties suitable for the brewery. The Savanna Agricultural Research Institute (SARI) then carried out breeding, multiplication and release of the selected varieties to farmers.

The Common Fund for Commodities (CFC), which is an intergovernmental organisation, funded the research into the use of sorghum in Ghana under a project which run from 2006 to 2011. The GIZ-funded Market Oriented Agriculture Programme (MOAP) supported provision of extension services and inputs credit under its "Outgrower and Value Chain Fund".

Source: Based on Onumah et al. (2020).

3.3.3 Impact of B2F model in sorghum value chain in Ghana

Evidence reported by Onumah et al. (2020) shows that SHFs participating in the B2F in the sorghum VC obtain average crop yields which are about 25% higher than those obtained by their counterparts who are unable to access inputs. They are able to take up and apply inputs distributed under the PFJ because of credit provided by aggregators. It was observed that the participating smallholders also increased area planted with sorghum by about 20%. Their participation in the B2F also contributed to reduction in PHL, on the average, by about 35%. This is attributable to improved grain drying using tarpaulins supplied by the aggregators and also the fact that the producer prices offered tends to be pan-seasonal, implying that farmers have no incentive to delay sale and hold stocks at home in inefficient facilities. The combined effects of the yield increase, expansion in area cultivated and lower PHL is a rise in total volume of sorghum grain marketed by about 30%. Furthermore, the volume of sorghum grain available for household consumption also increased by about 40%, implying improvement in household food security, at least in terms of food availability.

Despite the increase in volume of sorghum grain marketed and the higher producer prices they received, the participating farmers were only marginally more profitable than non-participants, posting a return on turnover (ROT) of about 24.2% compared to the respective rate of about 22.0%. This is largely because the low-input, low-cost mainstream smallholder farmers avoided not just the cost of inputs but also the labour and other costs associated with on-farm application.

The income effects of participating in the scheme was far more significant. The estimated annual income earned from sorghum production by participating smallholders was about $322 or €287, which is above the national poverty line estimated at $274 or €245 per annum. In contrast, non-participating smallholders, who dedicate their entire landholding to sorghum production obtain estimated annual income of about $149 or €132, which is 45% below the national poverty line[6]. The implication of this is that there is potential to lift them out of poverty and improve their social well being on a sustainable basis if they are integrated into systems such as the B2F which secures their access to yield-enhancing inputs and other services as well as to remunerative and stable formal markets.

Other gains from the development of the B2F, which has emerged as a result of the use sorghum grain by an industrial brewery in Ghana include the following:

a. Entry by the brewery, aggregators and service providers (e.g. transporters) is having a significant impact on contribution to public finances in the sorghum VC. In 2018 the sorghum VC in Ghana contributed about €29 million to public finances in the form of taxes and local council levies. The bulk of this came from the (about 65%) and 30% from suppliers of goods and services, including aggregators. It is anticipated that as the B2F improves supply of quality grains, investment by formal sorghum processors will increase, resulting in further growth in the VC's contribution to public finances.
b. In terms of employment generation through the B2F is mainly growing at the level of grain aggregation and also through attracting younger farmers into sorghum grain production because it is perceived as quite remunerative.
c. The B2F linkage is also impacting on Ghana's balance of trade. About €36 million is spent per year on imported intermediate goods and services used in the VC. However, it does not generate much foreign exchange because only trace volumes of sorghum grain are exported into sub-regional markets. However, substitution of imported barley

[6] Source: Ghana Statistical Services (2018) "Ghana Living Standards Survey Round 7: GLSS7 – 2005-2017).

with sorghum grain in the brewery industry is saving foreign exchange estimated at about €6.6 million per annum.

Despite these benefits from the B2F linkage in the sorghum VC, there are some challenges and unmitigated risks which need to be addressed, including the following:

i) As mentioned above, producer prices are set based on prices negotiated between the brewery and aggregators. The participating smallholders are not represented in the bargaining process. This exclusion can undermine long-term trust between farmers and other actors and, in turn, weaken the linkage.
ii) Vulnerability of sorghum grain producers to natural risks including natural risks such as erratic rainfall and crop pests appear to be rising as a result of climate change. In particular, incidence of late rains is reported to be causing crop losses and quality deterioration during the harvest season. Currently, there is no formal insurance cover against such risks, a situation which negatively affects the risk profile of producers as far as financial intermediaries are concerned and therefore limits access to finance.
iii) As far as the B2F model is concerned, the biggest risk appears to be dependence on one giant offtaker (the brewery). A dip in its economic fortunes as occurred during the COVID-19 pandemic when demand for its products dried up, results in lower uptake of sorghum grains. The main cushion for producers during COVID-19 was offtake by the artisanal *pito* brewers.
iv) However, artisanal brewing is associated with adverse environmental impacts from the high level of utilisation of firewood and associated health hazards for the predominantly women brewers.

3.3.4 B2F model in the maize value chain in Nigeria

The structure of the B2F model in Nigeria's maize value chain is very similar to what exists in the sorghum value chain above, though there also some clear differences. The ***commodity aggregators*** in the Nigeria maize VC are much larger-scale private enterprises than the aggregators in Ghana's sorghum VC. For instance, the case studied in Nigeria had a reported outreach of about 100,000 smallholder farmers compared to 2,000 in the sorghum case. Usually, they do not trade on the basis of firm forward contracts but rather market to a number of major millers and feedstock producers (***the offtakers)***. Hence, what they leverage in accessing credit lines to fund inputs supply and other services is their long-standing track record of transacting with formal maize processing companies. They have, however, been able to secure grant funding as well as commercial finance from local and offshore financial institutions. Their core business is grain trading but they add complementary support services to farmers which are very much the same as those provided under the B2F model in Ghana (described above).

The participating smallholders are similar to those in the sorghum B2F in terms of size of land holding as well as the resource constraints they face. Most of the participating smallholders cultivate between 2-5 hectares, with average area under maize cultivation being 3.5 hectares. The aggregators usually acquire and supply a package of inputs on credit, with repayment in the form of grain output delivered by the farmers. The inputs package usually consists of improved seed, fertiliser, pesticides and herbicides. The field agents of aggregators provide extension advisory services, which is also a means to monitor the operations of participating farmers. At postharvest, farmers are provided with suitable packaging materials. They market their output directly to the aggregators not long after harvest, reducing the length of storage at the farm household level. Consequently, the average postharvest losses for the participating smallholders is significantly lower than for non-participating smallholders, estimated respectively at about 13.5% and 18.5%.

Selling to aggregators also shortens the marketing chain and makes it possible for them to obtain premium prices, including for delivering quality grains. However, setting of prices and other terms is often by the aggregators. This creates mistrust, especially regarding terms for repaying inputs credit. It tends to be on “barter-type” terms – bags of maize grain for specified volume of inputs received.

The main role of the Federal Government is in the distribution of subsidised fertiliser. It has also established a financing window – the Nigeria Incentive-based Risk Sharing Agricultural Lending (NIRSAL) – which is open to the aggregators, even if not directly to most smallholder farmers. Some state governments, including the Kaduna State Government, are also investing in aggregation and storage facilities which can benefit farmers and traders.

3.3.5 Impact of B2F model in Nigeria maize value chain:

In the recent maize VCA4D study in Nigeria, Onumah et al. (2021) estimate the average yield obtained by smallholders participating in the B2F at about 2.1 tonnes per hectare, which is close to 20% higher than what is recorded by non-participating smallholders. This it is still below levels obtained by medium-scale farmers in Nigeria, which is estimated at about 3.5 tonnes per hectare. This is mainly because they tend to spread, especially, the fertiliser they receive over a wider area than is recommended.

Analysis of their operations shows that they are slightly less profitable than non-participating smallholders, posting a ROT of 31.5% compared to 34.2% for the latter. This is because uptake of inputs usually results in increased use of non-family labour and other resources. Obtaining higher yields whilst PHL is reduced results in significant increase in the volume of maize grain which is available for sale as well as for household consumption. They also receive comparatively higher producer prices, close to 25% higher than the farmgate prices usually offered to non-participating smallholders selling into mainstream informal markets. This is partly because they market quality grains and also the premium from selling in bulk.

The ability to sell more grain and at higher producer prices has resulted in a substantial rise in maize-based household earnings for smallholders participating in the B2F in Nigeria’s maize VC. On the average the maize-based household income they obtain is about $700 (or €625) per annum, which is far above the national poverty line estimated at $380 (€340) per annum). In contrast the non-participating smallholders earn average annual maize-based income of about $190 (i.e. €170), which is well below the poverty line and has to be supplemented with income from other crops. Furthermore, rising yields per hectare has positive environmental impacts. Despite these gains, the B2F linkage in the maize VC in Nigeria faces challenges and risks that require attention. Key among these is the very weak bargaining position of the smallholders, who tend to be poorly represented in negotiating terms and conditions under which many B2F schemes in the maize VC operate. It is apparent that though participating smallholders have better access to extension services than non-participants, the messaging needs to be improved to take account of factors such as flood or run-off/erosion control, soil health issues, pest and disease management and weed control. Quite clearly maize farmers are vulnerable to these risks and require knowledge on how best to manage them.

In contrast with the situation in the sorghum VC in Ghana, aggregators in Nigeria’s maize VC can sell to multiple large-scale processors and exporters. This minimises the risk of depending on one big offtaker. However, it exposes the aggregators and the farmers linked to them to price volatility in a financial market which lacks effective instruments for hedging. However, artisanal brewing is associated with adverse environmental impacts from the high level of utilisation of firewood and associated health hazards for the predominantly women brewers.

3.3.6 B2F model in the soyabean value chain in Zambia

The case of smallholder soyabean in Zambia provides a contrast to the two other B2F cases. Unlike sorghum in Ghana and Maize in Nigeria, soyabean is not a traditional smallholder crop. Its production in Zambia began as a commercial farmer's crop grown in rotation with irrigated wheat. However, from small beginnings in the late 1980s, smallholder share of national output has now risen to nearly 50%. Through the National Soyabean Research and Development programme a variety was suitable for smallholders was released. It was described as a "promiscuous" variety because it yielded without the addition of inoculum. Government subsidised seed production, distributing and extension advice to smallholders during the 1990s but for 15 years uptake by smallholders was low because of output marketing problems. From around 2010, market demand for soyabeans grew due to increasing demand for stockfeed and cooking oil, triggering significant upscaling of private industrial processing capacity. Small-scale private grain traders got into the soya grain trade and smallholder production picked up.

Large-scale private commodity trading companies took advantage of this business opportunity. One such company offered smallholder soyabean growers a credit package consisting of higher yielding varieties with inoculum and fertilizer and bought their output. A competitor, which was a major cotton company, also started to sell improved soyabean seed and inoculum to its cotton outgrowers at subsidised prices. Both companies provided extension advice to the smallholder producers and promoted production of the crop as a crop rotation option which can reduce the cost of fertilisation when cultivating cotton. One such case in Box 4 was reviewed in the Zambia Eggs VCA4D study (Onumah et al.2018).

Box 4: "Piggy-backing" smallholder soyabean production onto cotton outgrower schemes

The case involved a commodity trading company, NWK Agri-Services Ltd. (NWK), whose core business is cotton marketing. As part of their strategy to enable smallholders diversify, they promoted soyabean production by farmers participating in their cotton outgrower scheme. This was done under the Smallholder Soya Outgrower Scheme piloted in Mpongwe District in Zambia, which was developed with support under the EU Technical Assistance Facility (TAF). The support was intended to enable NWK supply quality soyabean to a leading egg producer in Zambia, which was also being assisted to scale egg production in the country. Assured of a market, NWK supplied improved soya seed, inoculum, herbicide and fertiliser on credit to the participating farmers. Extension advice was also provided by its field staff and the company bought the soya using its rural seed cotton procurement network on a sort of barter basis (volume of soya delivered by the farmers in repayment for inputs credit provided by NWK). Anecdotal evidence indicates that participating farmers obtained comparatively higher yields because of access to high quality improved seed and inoculum. Their household incomes also rose due to the increased volume of output and the competitive prices paid by NWK. However, volatility of soya prices in the Zambian market posed a risk smallholders. Upscaling of production by the leading egg producer also contributed to lowering egg prices and improved access by relatively poor urban households.

Onumah et al. (2018).

This case illustrates the potential benefits to smallholders who access yield-boosting inputs with credit under the soyabean packages, especially when combined with extension advice and access to markets. Public investment in research and development can provide options which reduce risks for smallholders. This is key for reducing their vulnerability external factors outside of their control, including climate risks and market volatility. When prices of inputs and producer prices are "fair", a win-win outcome is possible for both smallholders and the trading company providing inputs on credit. For instance, in this case, soyabean provided not only an extra source of income for the participating farmers, but also an option for improving soil fertility

and reducing fertilizer costs. It is also apparent that governments can learn from TAF about the utility of investing public funds as “seed investment” in initiatives of this nature which foster long-term inputs and marketing support package for smallholders, including where “new” crops are promoted using systems developed for established value chains.

4. Conclusions and where to with ISPs in Africa

4.1 Frustration with underperformance of ISPs:

Many African countries have a long history of implementing ISPs with the aim of increasing productivity in the low-input low-yield agricultural system which is dominated by resource-constrained smallholder farmers (SHFs). In this paper we have reviewed generic from across the continent and also focused on cases from Nigeria and Zambia. The evidence shows that governments and policymakers in many African countries are justified in being frustrated by the outcomes of the substantial investments made in implementing ISPs. The subsidy levels tend to be quite high, ranging in some cases from between 50% to over 80% and taking up substantial public resources. For instance in Zambia, annual public spending on ISP is about €400 million, and consistently accounts for over 30% of public expenditure on agriculture. Despite this, there is scant evidence that access to yield-enhancing inputs by smallholders has improved in a significant way in many countries. ISPs have generally not triggered significant growth in average yields for many of the major crops in Africa, especially the staple grains which are usually targeted under such programmes.

In Nigeria, evidence in Figure 3, shows that farm yields have either stagnated or declined for most crops since the early 2000s. In the maize subsector yield growth over that period was positive but rather marginal. In Zambia yields, especially for maize, grew between 2003/04 and 2009/10, but has subsequently slowed, leaving the country vulnerable to food insecurity. Uptake of subsidised inputs by smallholders remains low in both countries and there has also been no evidence of a poverty reduction impact, as noted by Chapoto and Subukanya (2019). These results are consistent with findings from major empirical studies including Jayne et al. (2018) and Hemming et al. (2018) and explain why most African countries are not on track to meet farm productivity targets set under the Malabo Declaration of 2014, as reported in a review by the AUDA-NEPAD (2022).

Many countries have responded to the sub-optimal outcomes of ISPs by focusing on reforming design of the programmes and inputs delivery systems. For instance, many have tried to switch paper to electronic voucher systems and created space for private sector involvement in inputs delivery rather making that an exclusive public sector activity. However, these changes have had little or no impact on changing outcomes form ISPs. The framework we have used in analysing these programmes, which is summarised in Figure 2, shows that attention should rather be focused on some fundamental bottlenecks such as limitations in the complementary support actions by governments and unaddressed pre and postharvest problems which affect the outcomes of ISPs.

Governments usually support ISPs with a traditional extension advisory system with the aim of ensuring that farmers apply inputs based on technical guidance which optimise yields. However, outreach remains low, constrained by limited resources in the public extension delivery system. Furthermore, extension messaging stress blanket recommendations which do not take account of area-specific differences in agro-climatic conditions. Quite often, the messaging does not reflect changing climate and how farmers should respond to them. The evidence though indicates as noted by Thomas (2020), that uptake of fertilizer, improved seeds and pesticides is insufficient to drive increase in crop yields in Eastern Africa (specifically Rwanda, Ethiopia and Uganda) unless accompanied by adoption of practices

which are effective in mitigating the adverse impacts of climate-related risks. Winnie et al. (2022) also point out that only slight improvements in maize yield is attainable unless decline in soil fertility is reversed through effective agronomic and soil health management practices. They came to this conclusion after a multi-country assessment of fertiliser uptake in Africa following AU's special Fertiliser Summit in Abuja in 2006.

ISPs basically focus on the problem of affordability through subsidising inputs prices. Most of these programmes do not address the challenge of acute liquidity constraints in smallholder households during the planting season and how it limits their capacity to take up available inputs. This emerged when smallholders were consulted during the VCA4D studies in Nigeria and Ghana, which have been discussed in this paper. It is also consistent with previous findings by Duflo et al. (2011) about why Kenyan farmers underinvest in fertilizer even when it is profitable do so. It is also apparent that profitability and not just affordability is critical in driving sustained uptake of inputs, including by smallholders. However, profitability estimates presented by Fusillier et al. (2021) that smallholders have no financial incentives to continue to invest in yield-enhancing inputs, especially when very high subsidies are withdrawn. The implication is that, whilst driving yield growth, equal attention needs to be paid to postharvest handling challenges which affect the volume of output that can be sold and/or consumed by the farm household. Output market inefficiencies also need to be addressed if uptake of inputs is to be profitable.

4.2 Do the B2F models offer a way forward?

Frustration with the outcome of ISPs has led to debates about policy focus on smallholders, including suggestions that governments should shift attention to medium and large-scale farmers if productivity and output growth is to be achieved in Africa's agriculture. The business-to-farmers (B2F) linkages reviewed in this paper shows that it is possible to pursue a more sustainable approach to increased productivity and output growth which is also inclusive of smallholder farmers in Africa. The B2F linkages, briefly described in Section 3.3, are transactional ties which are developed between agribusiness and smallholder farmers. The primary intent is mutual economic benefits rather than any espoused corporate social responsibilities. Two cases are focused on in Ghana's sorghum VC and the maize VC in Nigeria are analysed based on specific VCA4D reports. In both cases the smallholders participating in the B2F initiatives are very similar to those targeted under public-funded ISPs in terms of landholdings, area under cultivation and the resource constraints faced by the farmers. It is also evident that i the scale of support provided is equivalent to what is available under the public ISPs, mainly limited inputs required to cultivate one hectare of land. However, the outcomes appear to be different as discussed above and summarised below.

The participating farmers targeted in the B2F models were able to access inputs with little or no evidence of leakage. However, it has to be noted that, the scale of these programmes is relatively small, the largest being the B2F in the maize value chain in Nigeria which is reported to be reaching about 100,000 smallholder farmers. One of the main reasons for the limited outreach is the fact the private aggregators running these schemes have to fund the supply of inputs on credit. The inputs they facilitate access to is often sourced from national ISPs, implying that their role is actually helping to improve outreach under those programmes.

It is evident that participating smallholders obtained higher yields than their counterparts who are unable to access available inputs, even under ISPs. The level of yield growth is, however, lower than is achievable and this is largely because the resource-constrained farmers tend to spread the inputs across other crops in their diversified portfolio, possibly as part of their household risk management strategy. The participating farmers also recorded lower postharvest losses due partly to marketing arrangements which reduced the need for

household storage, which tends to be rather inefficient. In the case of the sorghum value chain, the participants also received support in the form of basic drying technology which contributed to the reduction in postharvest losses. As a result of these effects, the participating smallholder households benefited from increase in the volume of food crops available for household consumption and for sale.

Increase in food availability contributed to improvement in household food security, but the evidence on this is rather anecdotal and will need to be validated empirically. There were evident positive income effects due to increase in the volume of the marketable crop and access to comparatively higher producer prices reflecting the fact that the smallholders are selling into a formal market which offers premiums for quality and grain aggregation. Evidence from the sorghum and maize VCs show that the rise in farm income for the participating smallholders is very likely to lift them out of poverty, as the average incomes earned are above national poverty lines. There is also evidence that their participation in these schemes has positive impacts on value chain growth, especially as it leads to growth at the level of transformers in the VCs through improving access to raw materials. This impacts positively on contribution to public finances and generation of rural employment. The B2Fs also help to enhance social sustainability of the value chains. In terms of the environment, there is a positive impact from increased yields and lower postharvest losses, but it is also anticipated that better extension advisory support, which is facilitated through the B2F structures can equip farmers to manage emerging climate change related risks more effectively, thereby enhancing environmental sustainability of the value chains.

Among the main drawbacks is the apparent asymmetric power of the aggregators at the centre of these schemes. It sometimes raises concerns about fairness of the terms of participation, especially in relation to inputs credit repayment and the determination of producer prices. Though access to extension advisory services by smallholders improves under the B2Fs, the messaging often does not reflect risks which are being accentuated by climate change. There is also the need to enhance farmers capacity to reduce postharvest losses. Farmers access to finance for inputs and other farming operations is currently limited to what the aggregators can secure from commercial and donor sources. Alternative de-risked financing mechanisms need to be explored in order to scale up participation by smallholders. Remunerative and stable output markets are critical if these private sector-driven initiatives are to be sustained. Hence, policy interventions which destabilise output markets need to be avoided.

To conclude, the B2F models have demonstrated the potential of a more sustainable and inclusive to boost farm productivity, especially for smallholders who also benefit from increase in household income whilst food availability at the household level also rises. This has been achieved by enabling smallholders take up available inputs through access to credit. The field officers interact more closely with the farmers, thereby improving access to extension advice and the incentive for this includes strengthening monitoring the operations of the farmers in order to minimise non-performance risk. Furthermore, the marketing systems which they provide reduce household-level stockpiling and associated high postharvest losses, whilst also being more remunerative in comparison with alternative informal rural agricultural markets. Some issues which need addressing include weak bargaining power of smallholders, limitations in extension messaging and limited supply of finance. Further research is therefore needed to enhance the utility of the B2F models to smallholders, agribusinesses and policymakers.

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