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## Improving the supply chain of motor pumps to accelerate mechanized small-scale private irrigation in Zambia

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During the past decade, smallholder groundwater irrigation with motor pumps has increased considerably in Zambia. This study analyzes an important but hitherto ignored factor for adoption: the supply chain of imported motor pumps. The main obstacles for farmers are identified as: the highly centralized supply chain and financing facilities in urban hubs; lack of information about prices, which vary significantly for the same make and model of pump; lack of information and training on proper use and maintenance; and lack of financing facilities. The Zambia National Farmers Union seems best placed to remove these obstacles.

**Keywords:** smallholders; groundwater; mechanization; pumps; trade; import; financing facilities; Zambia

### Introduction

#### *Rationale*

Zambia has a substantial yet untapped potential for individual small-scale groundwater irrigation. Out of Zambia's 6 million ha under cultivation, only 200,000 ha (3%) is currently irrigated. At least half of this area (100,000 ha), which consists largely of lowlands with shallow groundwater tables, is estimated to be irrigated informally by individual smallholders for winter vegetables (GoZ, 2010). Most of this area (75,000 ha) is irrigated with buckets. On an estimated 10,000 ha, smallholders use river diversions (in particular in the northern, high-rainfall area of Zambia) or treadle pumps (in various other areas). Remarkably, an estimated 15,000 ha are irrigated with motor pumps, which represents an increase from virtually nil only 10 years ago (Colenbrander, Kabwe, & Van Koppen, 2011). Profit margins for smallholders using portable pumps are considerably higher than for smallholders using any other technology (Colenbrander et al., 2011). Moreover, the prices of the pumps have declined. Up to the end of the 1990s, only the more expensive pumps were available, which were only used by a few, better-off farmers. Since then, the retail prices of especially the Chinese pumps of 3–5 horsepower (hp) have come down to USD200 for the cheapest pump. This is about the same as the current retail price for treadle pumps in Zambia.

The potential for further adoption of motor pumps is immense. Zambia has an estimated 400,000–600,000 ha of land for further irrigation development (GoZ, 2010). Bucket

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irrigators may well step up from buckets to motor pumps. Indeed, a growth path similar to that of South Asia since the 1980s may be possible (Mukherji et al., 2009). There, large community and government-managed schemes are giving way to mechanized groundwater irrigation by individual smallholders (Shah, 2009). In India, more than 60% of the nation's irrigation now comes from atomistic motorized-pump irrigation, despite ongoing investments in government irrigation schemes.

Expansion of individual motor-pump irrigation would fully fit the policies of the government of Zambia. The Zambia Irrigation Policy and Strategy (GoZ, 2004) states as general objective for smallholders: "to empower smallholders to develop and use irrigation and other water management technologies so as to alleviate poverty and achieve food security". Its specific policy objectives are "to rehabilitate and upgrade public sector irrigation schemes, to initiate new public sector, farmer managed, irrigation schemes, to increase the productivity of rainwater through water harvesting and to promote sustainable dambo (lowlands, wetlands) utilization". The government has taken fiscal measures to support technology adoption in large- and small-scale farming. Furthermore, ongoing and planned investment in small-scale irrigation programs amounts to USD842 million over a period of about 10 years. However, out of this, only USD16 million (2%) is to be spent on traditional and low-cost technologies of individual smallholders (GoZ, 2010). Although policies are supportive, private smallholder irrigation has received limited attention as yet.

Past policy research on private smallholder irrigation has rightfully focused on the demand side and the marketing of irrigated produce (Hichaambwa, 2010). Produce markets are the "pull" factor for smallholder irrigation. Spontaneous smallholder irrigation is most frequent around the capital Lusaka and other urbanizing hubs, where national and international markets are flourishing. Yet, the "push" factors of improved supply of produce are also important. However, research and policies to support the supply of produce tend to focus on agronomic practices, in particular cultivation practices, fertilizers, choice of seed, water conservation and gravity or manual irrigation. Generally, limited research has been done on individual small-scale irrigation adoption patterns. For the supply chain of motor pumps in particular, the authors are unaware of any earlier research. Yet, a better understanding of the factors in the supply chain that contributed to this rapid increase, but also the obstacles that farmers still face, could further unlock the potential to mechanize smallholder groundwater irrigation. This study aims to fill this gap.

### ***Research question and method***

The research questions addressed are:

- What is the nature of the supply chain of portable motor pumps in Zambia, in terms of factors that enable adoption and obstacles that farmers face?
- How can farmer organizations, government, donors and NGOs address those obstacles to accelerate pump adoption by smallholders?

These questions were explored qualitatively and quantitatively through literature review and in-depth interviews with key actors in the supply chain. These included about two dozen small-scale irrigation farmers, as well as staff of the Zambia National Farmers Union, which has associations for smallholders in all districts of the country. In Lusaka and elsewhere, 21 retail shops were visited. Interviews were held with the Customs Department of the Zambia Revenue Authority (ZRA) under the Ministry of Finance and National Planning and with a customs clearing agent. Interviews were also held with the Ministry of

Agriculture and Cooperatives, which is responsible for formulation and implementation of irrigation policy. NGOs and micro-finance institutions (MFIs) that provide loans for agricultural equipment to smallholders, and one MFI membership organization, were visited as well. The study took place between November 2010 and November 2011 and covered the 2010–2011 rainy season and the 2011 dry season.

**Conceptualization and research sub-questions**

In order to define the research sub-questions, we conceptualized the supply chain as consisting of the entire network of interdependent actors that deliver products and services to the same customer, in this case the *Zambian smallholder farmer*. Adapted from the report by Research Into Use (RIU, 2007), Figure 1 shows how an agricultural input supply chain is an integral part of the agricultural production value chain.

A fully developed value chain and supply chain entail not only the flow of goods and services but also the flow of information about various aspects of the chain, such as importation procedures, prices, quality and customer preferences. The flows are bi-directional, upstream and downstream along the chain.

Focusing on the supply chain of one type of input, namely portable motor pumps for irrigation, Figure 2 details the manufacturers, importers, wholesalers, retailers (including after-sales services) and buyers (the farmers) of the motor pumps, and their transactions. The research sub-questions address each of these items.

The following section discusses the respective findings on: manufacturers and types of motor pumps; import, wholesale, retail and after-sales services; fiscal measures that are meant to improve this flow; retail prices; and financing facilities that enable the flow of payments. The last section discusses conclusions and provides recommendations.

**Findings on the motor-pump supply chain in Zambia**

**Manufacturers and types of motor pumps**

As the national electricity grid in Zambia only reaches 4% of the rural population (as opposed to 47% in cities and towns), this study focuses on pumps powered by petrol and diesel engines. Fuel stations are found in most districts in Zambia.

All motor pumps used in Zambia are imported. Most common are the Chinese makes King Max, Eagle, Asia, RATO, Kipor, Jiangdong, Changfa and NTC. Fewer pumps are

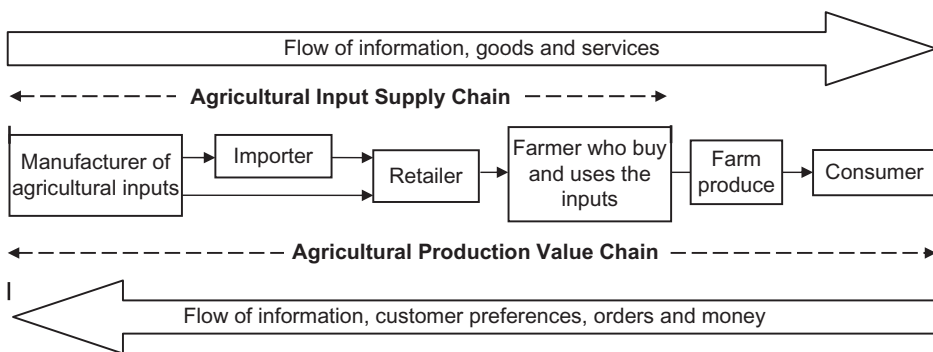


Figure 1. The input supply chain embedded in the production value chain (adapted from RIU (2007)).

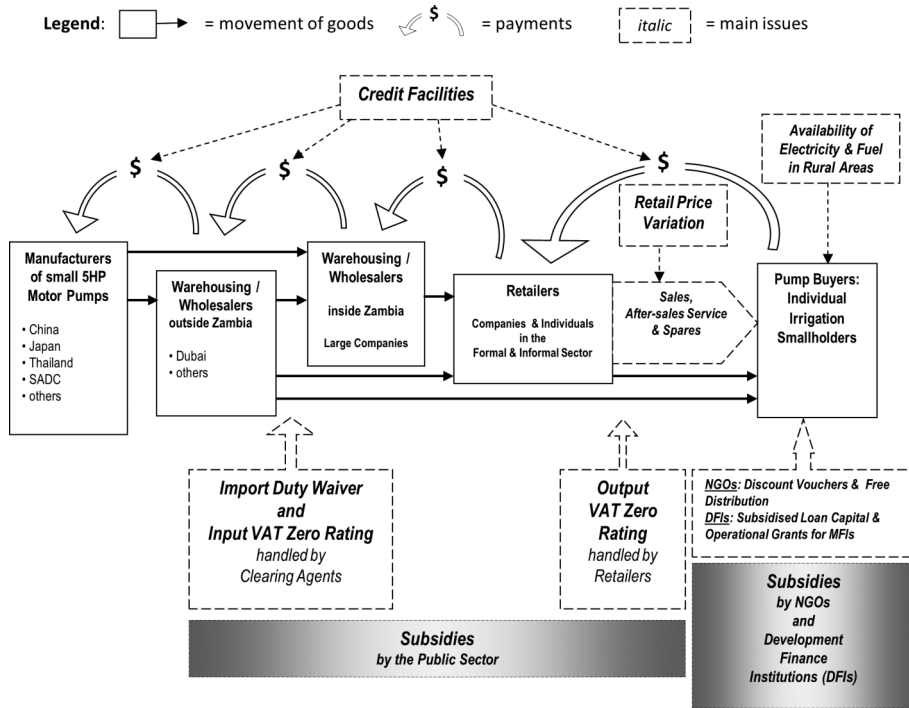


Figure 2. Motor-pump supply chain actors and issues in Zambia.

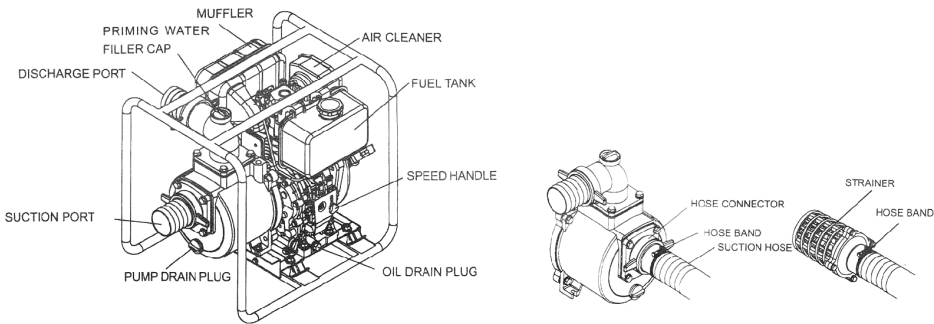


Figure 3. A typical portable motor pump.

imported from Thailand; these are mainly Thai Honda, which are made under license from Honda Japan. Japanese makes are Honda, Koshin and Dayliff. The most common models found in this study are 2-to-3-inch petrol pumps (3 to 5 hp, 30–60 cubic meters per hour), followed by 2-to-4-inch diesel pumps (3.5–9 hp, 20–60 m<sup>3</sup>/h). All portable pumps have a suction limit of 8 m. See Figure 3 for a typical portable motor pump.

**Import, wholesale, retail and after-sales services**

The study identified four groups of actors in the supply-chain, each with specific import, wholesale and retail, and after-sales services arrangements. The first group consists of

large importers: those specialized in agricultural and irrigation equipment (of which five were visited); and general retail stores that also sell pumps (of which eight were visited). These bigger companies do sell spares and provide after-sales services in all their shops, but some after-sales services are only provided in their Lusaka headquarters. The bigger stores usually sell a large range of pumps, either retail or wholesale.

The second group consists of smaller importing companies who usually import cheaper Chinese pumps for retail only (of which six were visited). Most of them do not sell spares or provide any after-sales services.

The third group consists of companies that specialize in providing irrigation services to farmers (of which two were visited). They either import themselves or buy locally. They always provide spares and after-sales services to their clients.

The fourth group consists of individuals in the informal sector who import pumps on order from individuals or companies. In this case there is no spare-part provision or after-sales service.

An important obstacle in the supply chain, echoed in the main complaint of smallholder farmers interviewed about the motor-pump supply chain, was the centralization of the companies in the urban centres along Zambia's "line of rail". Farmers complained that there were no nearby, reliable retail shops for pumps and spares, and no repair facilities. The cost of travelling to those urban retail outlets can easily constitute one-third of the price of the pump. For example, motorized-pump irrigators in Livingstone, in the south-west corner of Zambia, said that they buy their motor pumps from individual traders who bring them from shops in South Africa, while others buy pumps from companies in Lusaka, 500 km away. These complaints reflect a demand for pumps in rural areas, which apparently still fails to reach sufficient critical mass to incite formal retailers to open up new sales points there. Purchases over long distances, and informal individual traders and irrigation service providers, currently fill the gap to some extent. The centralized nature of the supply chain also means that farmers in remote rural areas are poorly informed about the range of available pump makes and models and, as elaborated below, their prices.

In order to address the limited availability of spare parts and after-sales services, some retailers mentioned that they are prepared to train mechanics, from areas where there is a market for their pumps, in the maintenance and repair of pumps. These trained mechanics could also order spares from the retailers. A last obstacle observed during the farmer interviews is that farmers lack information and skills on how to handle their pumps properly. For example, some fail to use proper foot-valves, so that the pump sucks water mixed with soil, which causes pump seals to quickly wear out. This indicates that the supply chain is also underdeveloped in terms of after-sales services, information and training.

### *Fiscal measures*

Retail prices can be influenced by governments through fiscal measures. Zambia introduced two fiscal measures with the aim (among others) of increasing the supply of farm equipment to smallholders: an import duty waiver on irrigation equipment and on pumps for agriculture and horticulture (SI No. 13 of 2003); and zero rating of value-added tax (VAT) on the importation of farm equipment, inclusive of pump sets (SI No. 3 of 2009).

Import duty on irrigation equipment would normally be 15%, but since SI No. 13 of 2003, there has been a suspension of duty on irrigation equipment and on pumps for agricultural and horticultural purposes. Duty-free importation of pumps became possible since SI No. 13 of 2003 became effective, but only when an "additional procedure code" (APC 416) could be applied. This was a highly complicated procedure, outside the reach of

small farmers. It differentiated between specialized providers of agricultural and irrigation equipment and services, who could bring in pumps duty free, and general retail stores that bring in pumps for general purposes and thus had to pay duty. For small individual importers of pumps who operate in the informal sector, there was no formally registered information on the way they import.

Interviews with nine companies that were importing their own pumps revealed that actors in the supply chain were not always aware of duty and VAT regulations. Categorization of imported items appeared highly complex. ZRA staff confirmed that there is often misunderstanding between the ZRA and importers on classification of goods and that it is advisable to seek regular advice on classification, especially prior to importation. However, since the Customs and Excise Amendment Act of 2011 became effective on 28 December 2011, all portable motor pumps can be imported duty free under Customs Code 8413.19.90.

The second fiscal measure, issued in February 2009 (SI No. 3 of 2009), was the VAT zero rating for importing small-scale agricultural equipment and spares, including portable pumps. The ZRA said that the VAT zero rating will “ensure that unregistered farmers who cannot claim input VAT on such equipment do not incur any VAT. The measure will also reduce input costs and enable farmers to expand production and make farming a viable sector.”

The VAT in Zambia is currently 16% and is normally collected at each stage of the supply chain where value is added to goods or services. A business incurs input VAT when purchasing goods or services and charges output VAT when supplying goods or services. At the end of each tax period, the VAT due is arrived at by deducting the total input tax from the total output tax. Any company with an annual turnover of more than USD40,000 is VAT registered, but pumps they import are VAT zero rated. (Such a company pays 35% company tax, as opposed to smaller companies which pay only 3% turnover tax.) VAT zero rating for importing pumps means that the end-buyers (farmers) cannot be charged VAT.

Both fiscal measures are likely to further develop the supply chain. Future research should assess the strategies adopted by importers, wholesalers, retailers and farmers in further detail. They could reduce the price, open up branches in more remote areas, or both.

### ***Retail prices***

Prices strongly influence farmers' adoption rates. A comparison was made of the retail prices of different sizes of pumps, as measured by the diameter of the outlet of the pump. The findings are based on a total of 41 different pump makes and models. The analysis highlighted important differences in prices by type of fuel (diesel or petrol), by country of origin and, last but not least, by retailer. Overall, pump prices ranged from the cheapest 2-inch petrol pumps (USD200) to the more expensive 4-inch diesel pumps (USD1000).

Figure 4 shows the comparison between minimum and maximum retail prices of pumps fuelled by petrol or diesel for the same pump diameter. The figure shows that price differences between same-size petrol pumps are much larger than between same-size diesel pumps. Diesel pumps are always more expensive than petrol pumps of the same size, because the diesel engines that drive the pump are more expensive to manufacture. (The pumps that are connected to a diesel or a petrol engine are of the same type and price range.)

The make of the pump also influences the retail price. As shown in Table 1, Thai Honda petrol pumps are 16–39% more expensive than the Chinese makes of pumps. Petrol pumps

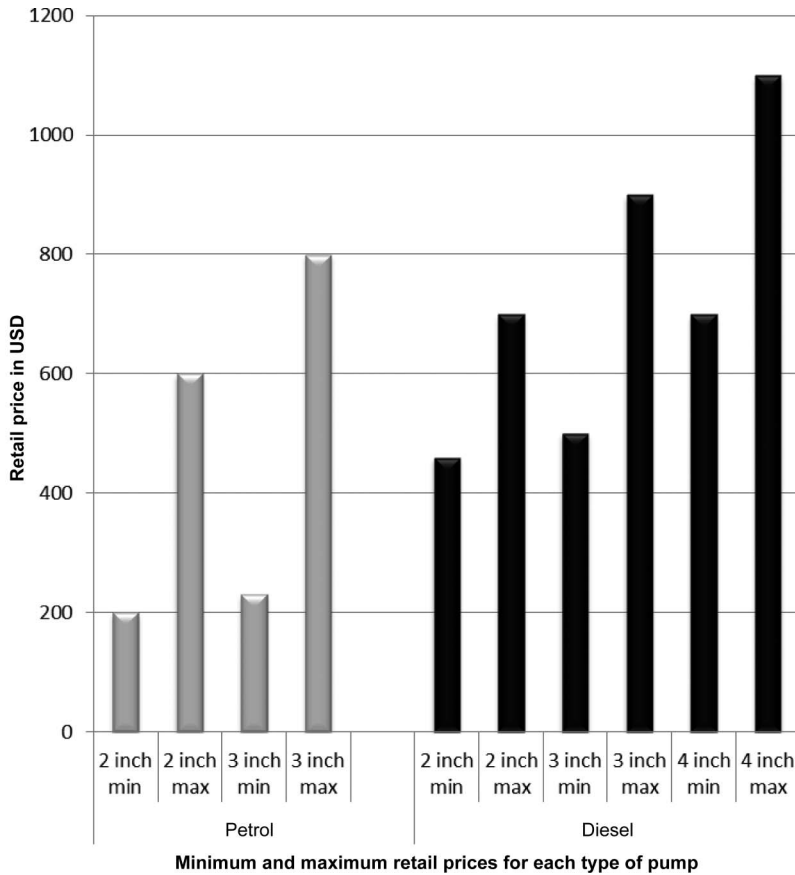


Figure 4. Retail prices by type and size of pump.

of Japanese makes are up to 160% more expensive than the petrol pumps of Chinese makes. Diesel pumps of Japanese makes are 55% more expensive than diesel pumps of Chinese makes. The price difference between Japanese and Chinese makes is much smaller for diesel pumps than for petrol pumps. The cheapest petrol pumps, usually made in China, are of rather poor quality and good parts supply is usually lacking. However, they can still

Table 1. Average retail prices by type and make of pump (n/d: no data available).

Pump country of origin	Average retail price (USD)		
	China	Thailand	Japan
Pump type			
2" petrol	245	285 (16%)*	600 (145%)*
3" petrol	270	375 (39%)*	700 (159%)*
2" diesel	570	n/d	n/d
3" diesel	580	n/d	900 (55%)*
4" diesel	800	n/d	n/d

\*Retail price premium compared to Chinese pumps.



last for a year or two. There is still demand for these Chinese pump makes, especially from farmers who are changing over for the first time from the bucket or the treadle pump. The expensive pumps are bought by the more experienced farmers who are replacing their cheap start-up pumps.

A third price analysis compared prices of the same models and makes of pumps but from different price retail outlets (see Figure 5). There were remarkable differences in retail price for exactly the same make and model of pumps between the different retail outlets. The differences within the capital, Lusaka, were between up-market large agricultural retail shops and the smaller downtown shops in the same markets where smallholders are selling their crops. Pumps were priced lower in the large shops, which also have good after-sales service and spare-part provision. Some of the bigger shops are even giving warranties

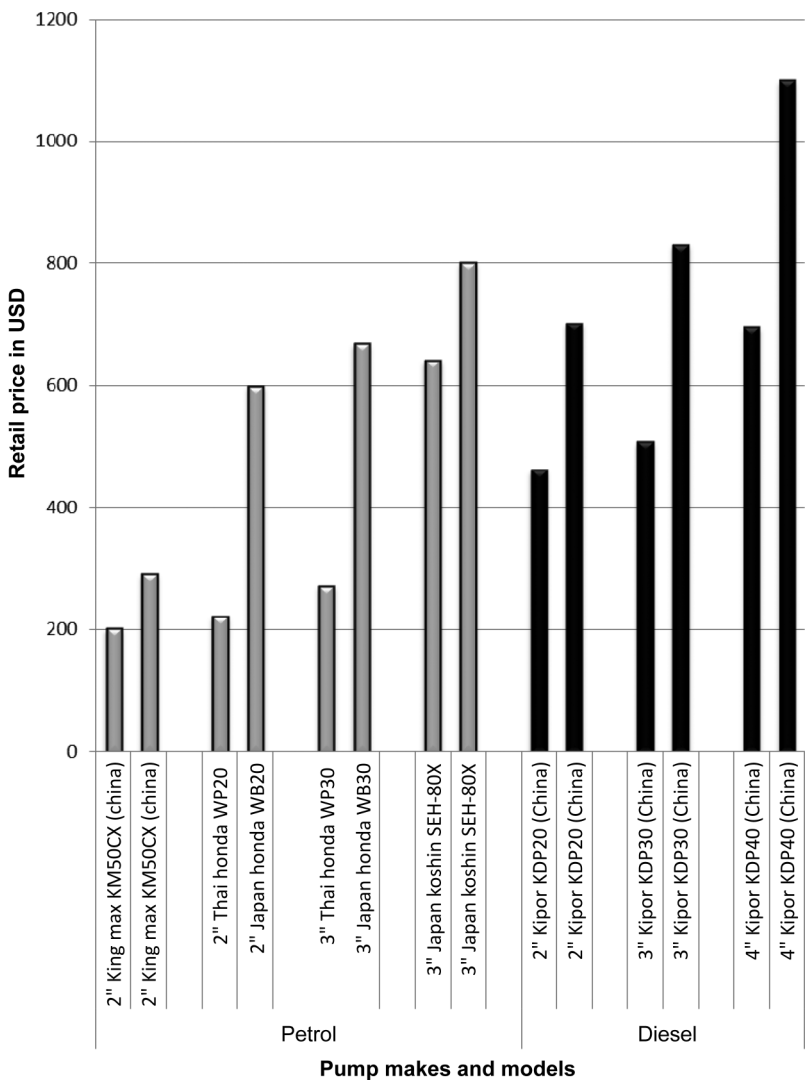


Figure 5. Retail price variation between suppliers of the same pump makes and models.

on portable motor pumps, usually for a period of six months. This points at the diverse marketing strategies of the different retailers. Reasons for this have still to be identified, but one reason could be the economies of scale. The large shops import large quantities at once, just before the irrigation season starts. They are also much more aware of the formal procedure for importing duty free.

### ***Financing facilities: loans and subsidies***

Various ways were identified in which NGOs and MFIs currently enable smallholders to purchase pumps, and how facilities can be improved in the future. Only a few MFIs were found to deal specifically with loans to farmers, and only one of them, the Christian Enterprise Trust of Zambia (CETZAM), specializes in loans for irrigation equipment. The few MFIs in rural areas providing credit facilities to smallholders give loans to smallholders who would not qualify for loans from commercial banks because of lack of collateral. This is claimed to justify much higher interest rates than those of commercial banks. Usually the loans are small and for a few months only. When MFIs give loans for pumps, it is at an interest rate of about 4% to 5% per month. They generally recover the loan within six months (three months grace period, three months repayment). Their interest rates are 30–50% per annum. Some of the MFIs buy the pumps on behalf of their client farmers, while others let the farmer buy the pump of their choice within the agreed credit ceiling. Farmers tend to prefer the latter arrangement. The interviewed MFIs were not well informed about where to buy the best pump at the best price.

Discount vouchers support smallholders and the pump supply chain more directly. In Zambia, they have been provided for the promotion of treadle pumps, but not yet for motor pumps. However, a similar system could be possible for motor pumps. For the treadle pumps, a subsidy of 40% of the value of the irrigation equipment is provided by the Mennonite Economic Development Association in the form of a discount voucher whereby the farmer pays the remaining 60%, which means that the farmer buys the equipment at a discount of 40%. The supplier redeems the voucher value from the issuer and so receives the normal retail price for the equipment. Hence, there is no market distortion. The supplier as well as the farmer benefit from this kind of subsidy as it creates a higher demand for the equipment.

Lastly, pumps can be given for free. Such free distribution occurred, for example, in the intensively irrigated areas in the Katuba area, 20 km north of Lusaka. An NGO distributed 30 portable motor pumps free of charge to female, mixed and male groups of smallholders to promote the use of pumps in a particular area. The project's targeting of women's and mixed groups did ensure that more female-headed households got access to the motor pumps than would have if they had had to acquire them privately (Colenbrander et al., 2011). Distribution for free can be justified to promote innovation, create a critical mass, and target specific groups, such as female-headed households. At longer-term or wider scales, free distribution distorts markets.

### **Discussion and recommendations**

Returning to the research question – “What is the nature of the supply chain of portable motor pumps in Zambia, in terms of factors that enable adoption and obstacles that farmers still face?” – the foregoing findings show that the supply chain is still underdeveloped. In no link in the chain is the flow of information, goods or services optimal. This is not surprising given that the supply chain only started developing a decade ago. The supply chain needs

to be further developed, and obstacles need to be overcome, so that any smallholder in Zambia who wants to obtain a motorized pump is also able to do that and to use the pump sustainably. This would accelerate the expansion of irrigation in Zambia.

The pump supply chain is primarily underdeveloped in the sense that the provision of goods and services is centralized in Lusaka and few other urban centres, while many smallholders live far from those centres. This applies to retail outlets, to the after-sale services provided by retail outlets, and to the provision of credit facilities. This centralized nature of the supply chain negatively affects smallholders' access to goods and services.

The supply chain is also underdeveloped in that information is concentrated among a few. This is the most striking with regard to pump prices: they vary widely, yet even NGOs and MFIs are unaware of the variations, let alone farmers. The large import and retail companies, and of course the ZRA and the customs clearing agents, are well informed about procedures for duty waiver and VAT zero rating. However, even during this study, it appeared difficult to obtain that information. The smaller retail outlets and the MFIs who deal with agricultural loans are not (or only partly) informed about duty waiver and VAT zero rating.

Smallholder farmers are the least informed. They are in an isolated position in the supply chain: not well informed, and not in a position to influence processes in the chain. They lack information on available pump makes, retail prices and price differences between retail outlets, and the availability of spares and after-sales services. They lack information and training on the proper use and preventive maintenance of the pumps.

So, what is the answer to the second question, "How can farmer organizations, government, donors and NGOs address those obstacles to accelerate pump adoption by smallholders?" It is not feasible for retailers to decentralize and set up outlets in rural areas as long as the effective demand for pumps is limited. Neither is it feasible for MFIs to set up branches in rural areas if their potential client base is small or perceived to be high-risk. The government and NGOs can play supportive roles, but also lack sufficient basis in rural areas to reach all potentially interested smallholders.

This conundrum cannot be solved by isolated individual farmers, but organized farmers could be highly effective. The Zambia National Farmers Union (ZNFU), especially, is well decentralized through its district associations and could unlock each component of the pump supply chain. The ZNFU already submits annual proposals to the Ministry of Finance in which they indicate which issues should be addressed in Zambia's annual budget for the benefit of the farming community. They make proposals for which farming inputs should be free of import duty, to stimulate a particular farming sector. They could also negotiate with a supplier to bring in pumps at a negotiated price favourable for the supplier as well as the farmer (or farmers' associations that have the capacity could import pumps themselves). Further, they could make information available in their magazine, *The Zambian Farmer*, on the range of portable pumps that are available for irrigation in Zambia, their specifications, the sources of supply and the retail prices with the different retailers. They could negotiate the supply of pump spares, so that individual farmers do not have to travel long distances to buy parts. They could explore the observed willingness of retailers to train local mechanics in the maintenance and repair of supplied pumps. Farmers' associations could also approach MFIs and provide them with information useful for the MFIs' market research. This could all be done through advertisements in the printed media and through radio and TV, beside publications in the ZNFU magazine. In that way, smallholders will become the pulling force behind the accelerated mechanization of private irrigation in Zambia.

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