



Marketing margin of irrigation technologies in Ghana: An analysis from a supply chain perspective

Technical report

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LIST OF ABBREVIATIONS

ACRONYM	MEANING
AEA	Agricultural Extension Agent
ACDEP	The Association of Church-based Development NGOs
COVID-19	Coronavirus disease
DIKS	Drip irrigation kits and systems
ECOWAS	Economic Community of West African States
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
HTC	Hatoum Trading Company
IWAD	Integrated Water and Agricultural Development Ghana
ILSSI	Innovation Lab for Small Scale Irrigation
MDAs	Ministries, Departments, and Agencies
NGOs	Non-governmental organizations
SPIPs	Solar-powered irrigation pumps
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
VAT	Value Added Tax
WASH	Water, Sanitation, and Hygiene
WLE	Water, Land, and Ecosystems

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SUMMARY

This study investigates the marketing margin along the irrigation supply chain in Ghana. It focuses on the policy and business operating environment, supply chain actors and their interactions, and marketing margins along the supply chain for solar pumps, motorized pumps, and drip irrigation kits and systems. Data from 51 interviews with value chain actors in Greater Accra, Northern, Upper East and Upper West Regions have been utilized for this analysis. These actors include importers, manufacturers, distributors, government agencies, non-governmental organizations (NGOs), and farmers.

The supply chains for irrigation equipment supply are short. Actors in the supply chains play multiple roles as importers/suppliers, wholesalers, and retailers. They offer products and accessories that may be sold to the buyer as a package or as individual components. Marketing margins vary from product to product as well as transaction to transaction. For example, marketing margins range from 10–25%, 8–20%, and 10–20% at the supplier-farmer for solar-powered irrigation pumps (SPIP), motored pumps, and drip irrigation kits and systems (DIKS), respectively.

Actors have tangible and intangible costs and benefits that influence the margins they charge on their products. Marketing margins at each transaction depend on the transaction's volume and value and the existing relationship between the seller and the buyer. Direct sales to end users lead to the highest margins because a retail price is applied. Further, business partnerships and collaborations lead to lower costs for actors within the chain, minimizing the distance actors travel to provide installation, repair, and maintenance services to end users. Foreign exchange fluctuations and government policy on taxes for agricultural products dominate the influence on the margins.

Differences exist across the cost and benefit structure of the marketing margin of three types of irrigation equipment. First, motored pumps sell faster than SPIPs or DIKS due to the relatively low price and several government incentives promoting usage. Profit-making actors can turn around their working capital faster to minimize their costs. Second, actors have different capacities to enjoy tax incentives offered by the government for agriculture due to the difficulty in differentiating imports for agriculture from that of other industries. This increases their costs from payment of import duties and taxes, influencing the prices at all levels of transactions. Third, the level of after-sale interaction between the seller and the buyer differs across supply chains and between transactions. The motored pump supply chain interactions are mainly transactional, with minimal after-sale contact. The interactions in the SPIP supply chain are more dynamic, with the warranty offered on products and regular servicing from the suppliers. The continuous interaction between the buyer and seller for SPIPs may further lead to additional business due to recommendations and upgrades by the farmer.

Irrigation supply chain actors adopt several strategies to sell their products and services and earn marketing margins. Using a project-driven strategy, some actors earn margins by bidding for developmental and commercial projects. Others use a tangible-focused strategy focusing on tangible costs and benefits to decide on marketing margins to charge. A third strategy observed is the blended strategy, combining tangible costs and benefits and intangible costs and benefits. Actors using the blended approach invest in building relationships that may not yield immediate benefits in the short term. Partnerships and interactions within a chain and with other actors outside the chain may help reduce the cost of transactions for actors, leading to lower marketing margins between transactions. Actors may form partnerships for several reasons, including installation, training, and product distribution.

1. INTRODUCTION

Marketing margin indicates the performance of a particular industry and the market structure and efficiency (Tomek and Robinson 1990; Carambas 2005). It is a useful descriptive statistic to show the consumers' expenditure divided among market participants at different levels of the marketing systems (Manan et al. 2013). Although the marketing margin does not provide a measure of farmers' well-being and of companies' performance, decision-makers and stakeholders are interested in the marketing costs and benefits of designing innovative interventions to reduce inefficiencies at the appropriate levels of the distribution chain (Quaye et al. 2009).

Scholars consider marketing margins from two main perspectives. The price perspective measures marketing margin as the difference in the price between the producer and the final consumer and between marketing intermediaries (e.g., Abassian et al. 2011; Mandizvidza 2017; Askan 2019). Marketing margin is therefore calculated as the price difference between the various actors, considering only costs incurred. The chain perspective also looks at factors apart from the incurred costs that may influence the marketing margins (e.g., Quaye et al. 2009; Abankwah et al. 2010; Hussain et al. 2013; Mohammadi et al. 2015). These factors include the value each chain actor adds to the product, collective bargaining power, marketing channels and access to financial and logistic services. Others encompass the relationships between actors and the business operating environment, including government policies, political (in)stability and business culture. Market power concentration is another factor emerging from the market barriers such as license and standard, market infrastructure and information and trading restrictions.

In general, the marketing margin is accompanied by marketing and intermediary costs. The marketing costs appear when commodities move along the chain, whether by producers, intermediaries, cooperatives, marketing boards, wholesalers, retailers, or exporters. The intermediary costs are incurred when intermediaries play roles in various marketing channels, adding to their business costs and profits. These costs vary depending on the nature of the commodity, the amount of processing that the commodity goes through, the distance and the number of intermediaries transporting the commodity, the amount of waste, competition from and the strategies of the intermediaries, and the risk attitude of actors (Abankwah et al. 2010; Abankwah et al. 2013; Hussain et al. 2013; Gachena and Kebebew 2014; Mandizvidza 2017).

Despite the large volume of literature on marketing margins, few studies have looked at agricultural input supply chains, including the irrigation equipment ones (e.g., Abankwah et al. 2013; Agbahey et al. 2015; Sheahan et al. 2016; Gebretsadik 2020). Scholars have studied marketing margins, mainly along food and cash crop supply chains. Food crop supply chain studies focus on vegetables, roots, tubers, and grains. For example, studies into marketing margins have mainly concentrated on agricultural commodity output markets (e.g., Horna et al. 2007; Enete 2009; Robinson and Kolavalli 2010; Mensah-Bonsu et al. 2011; Odongo and Etany 2018). Literature on marketing margins for input supply chains is therefore limited.

Moreover, studies focusing on one actor in the chain (e.g., Mandizvidza 2017) may lead to inadequate information on determining factors of the cost structure and a misleading impression that the marketing channel is inefficient. The cost and benefit structure and the enabling environment in which the supply chain is embedded are key for assessing the efficiency of the marketing margin. Missing these analyses could also lead to designing narrow-focused interventions supporting agricultural development.

According to Ghana's Ministry of Food and Agriculture (MOFA), smallholder farmers account for 70% of the estimated five million farming households (Peprah et al. 2020). On the other hand, irrigated

agriculture still comprises less than 1% of the total agricultural production in Ghana¹. Climatic changes and a growing population make it imperative to intensify irrigation to ensure food security. Farmers' investment in irrigation equipment is challenged by, for example, high initial capital, poor financial services, high energy costs, high labor costs and poor market access. At the supply chain level, availability, accessibility and affordability of irrigation technologies and services are critical for market development. Under-development of the irrigation supply chain leads to poor access to irrigation equipment and services (Minh et al. 2021). Limited knowledge of the economic feasibility along the irrigation supply chains challenges the designing of supporting inclusive and effective businesses and interventions (Balana et al. 2017). Understanding what contributes to the final cost that the farmer pays for irrigation equipment and the marketing margin along the supply chain is, therefore, vital.

To address these gaps, this study investigated the marketing margin along the irrigation supply chain in Ghana. The study specifically asked:

- What is the quantified marketing margin in each irrigation equipment supply chain transaction?
- What are the tangible and intangible costs and benefits that accompany the margin? And
- What are the determinant factors of the cost and benefit structures?

We present a qualitative analysis of marketing margins along Ghana's irrigation equipment supply chain focusing on solar-powered irrigation pumps (SPIPs), motorized pumps, and drip irrigation kits and systems (DIKS). The following sections discuss different perspectives on marketing margin, an analytical framework for the analysis, and the methodological approach used in this study. The result section offers the marketing margin, cost and benefit structure and its determinant factors for the three selected irrigation equipment. The report ends with a discussion and conclusion on the nature of the irrigation supply chain, the challenges of the business environment as well as the policy changes that influence the prices of irrigation equipment in Ghana.

2. ANALYTICAL FRAMEWORK

This study used the supply chain as a conceptual foundation to analyze the cost and benefit structure determining the price and marketing margin (Figure 1). A supply chain is a system of organizations, people, technology, activities, information, and resources involved in moving a product or service from suppliers to customers (Seuring and Müller 2008; Stevens and Johnson 2016). A typical supply chain begins with the ecological, biological, and political regulations of natural resources, followed by the human extraction of raw materials, and includes several production links (e.g., component construction, assembly, and merging), before turning to several layers of storage facilities of ever-decreasing size and increasingly remote geographical locations, and finally reaching the consumer (Shahbaz et al. 2017). Supply chain activities transform natural resources, raw materials, and components into a finished product delivered to the end customer (Singhal et al. 2011).

We define an irrigation supply chain as an assembling of the complex range of activities implemented by various actors to bring a raw material through a chain to the sale of the final irrigation technology (equipment, tools, scheduling/moisture measurement, etc.) and directly related services (e.g., installation, training, maintenance, and repair). These activities can be grouped into four functions—importation, manufacturing, distribution, and utilization (Minh et al. 2020). The chain is governed by rules and regulations, parameters requiring the product, process, and logistic qualification set and have consequences up or down the value chain (Kaplinsky and Morris 2008; Webber and Labaste 2010). The flow of goods, information, and finance through the various stages of the chain are evaluated to detect

¹ www.tradingeconomics.com

problems or identify opportunities to improve the contribution of specific actors and the chain's overall performance (UNIDO 2009).

We define **marketing margin** as the difference between the price actors pay when the commodity moves from one actor to another until it reaches the final user. Measurement of marketing margin encompasses the price and chain perspectives. Specifically, it considers the costs incurred and benefits enjoyed by the chain actors, the chain structure, and the determinant factors in the policy and business environment (Figure 1). We used Mendoza's (1995) formula to quantify the marketing margin for irrigation equipment. Specifically, where a given actor serves as importer, wholesaler, and retailer, the marketing margin of the suppliers (MMssc) is calculated as:

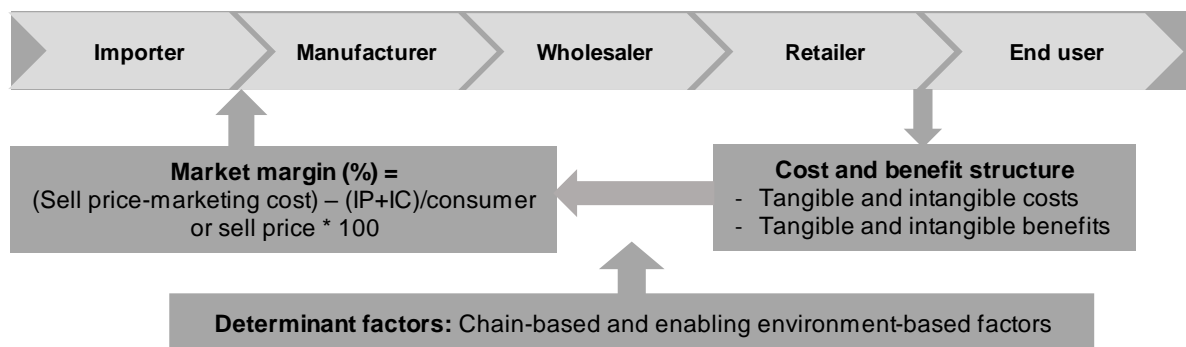
$$MMssc = (sell\ price - marketing\ cost) - (IP + IC) / consumer\ or\ sell\ price * 100 \quad (1)$$

where IP and IC are importer price and import cost, respectively, MC is manufacturing costs, and marketing costs and consumer/sell prices are obtained from the study.

If the equipment is locally manufactured, e.g., drip lines, where a given actor serves as a manufacturer, wholesaler, and retailer, the marketing margin of the supplier of locally manufactured (MMlp):

$$MMlp = (sell\ price - marketing\ cost) - MC / consumer\ or\ sell\ price * 100 \quad (2)$$

FIGURE 1. Analytical framework for marketing margin analysis.



Source: Authors' creation.

If the marketing chain is well developed, the chain actors are importers/wholesalers, assemblers, regional distributors, district distributors, retailers, agents, and farmers. Each actor in every layer incurs costs and benefits, as indicated in Figure 1, from which the marketing margin will be estimated. The quantified marketing margin is accompanied by a **cost and benefit structure** in each chain function. Costs refer to expenses that actors incur during the marketing process. Each marketing actor in a chain incurs costs and reaps the rewards. The rewards are the difference between costs and revenues per unit sold for each supply chain actor. Benefits refer to the advantages actors enjoy in their internal environments during marketing. The costs and benefits may be tangible or intangible. Tangible costs or benefits are the quantifiable costs or benefits. Intangible costs or benefits refer to costs or benefits that cannot be easily quantified; however, they may influence the actors' operations and the end user's final price.

The cost and benefit structure are influenced by various factors in the chain structure and the enabling environment in which the chain is embedded. The determining factors are the advantages and/or disadvantages that affect the cost and benefit structure, influencing the quantified marketing margin. These factors include complex financial regulations and tax regimes, complicated bureaucracies for importing, manufacturing, and distributing equipment, and poor market infrastructure. The performance of a supply chain depends on how well the actors in the chain are organized and coordinated, along with the level of support by the policy and business environment (Mentzer et al. 2008; Anandajayasekeram

and Gebremedhin 2009; Mgale and Yunxian 2020; Gurtu and Johny 2021), usually called enabling environment (Minh et al. 2021). Explaining the characteristics of the supply chain involves considering, for example, chain structure, market competitiveness and market price. The policy environment defines the enabling environment-based influencing factor (e.g., import tax, subsidy policy, extension, and technical support) that may influence the supply chain. This study did not assess the role of extension and technical support. This is because the data gathered did not provide sufficient information to understand the role of extension and technical support.

3. METHODOLOGY

3.1 Research process

We use the commodity sub-system methodology to study the marketing margin by determining marketing channels (Quaye and Kanda 2004; Ekpe 2005). This involves tracing the movement of the commodity from its supply source to the point of final sale by interviewing all the participants in the marketing process. A marketing channel traces agents involved in the marketing process, including their linkages and functions. This is important because linkages between the participants of a marketing system largely affect both the market performance and the pricing characteristics.

First, selecting the type of irrigation equipment based on its current usage and popularity within the study area and its potential market demand was undertaken. As a result, the three types of selected irrigation equipment include 1) solar-powered irrigation pumps (SPIPs), 2) motored pumps, and 3) drip kits and systems (DIKS). At the same time, we selected key actors for each type of equipment, starting from the suppliers in the supply chain and tracing the participants that engaged in each sale transaction. However, tracing the sale transaction was not possible for some types of equipment due to the buyers not being recorded by the suppliers, especially for direct sales to end users. Nonetheless, the local manufacturer of drip systems maintains a database of buyers from which some contacts were provided during the study. The snowball approach was thus used to identify and recruit interviewees for these equipment types starting from either the end-user or the supplier, basis the contacts available and obtained from interviewees and the willingness of actors to provide information.

When farmers were the first to be interviewed, they were asked about the place of purchase of their equipment and the reasons for their preference; further, they offered us contacts where available. While some farmers buy through their extension agents or other farmers traveling to the major towns, others make direct purchases from agro-input shops or directly from the importer in major towns, including Accra, Kumasi, and Tamale. Interviews were then scheduled with agro-input dealers and/or importers to better understand the elements of the given transaction. When the importer was first to be interviewed, information was collected on import prices and procedures, tax regimes, business and policy operating environment and distribution channels to the end user. Where contacts were available, we scheduled interviews with distributors and retailers (mainly agro-input dealers) to discern the other elements of the transaction.

Within each type of irrigation equipment, specific brands were selected. For SPIPs, products from Pumpteck, Hatoum Trading Company (HTC) and Deng were chosen because of the willingness of the actors to participate in interviews to provide sufficient data for the estimation of marketing margins and understanding of the business operating environment. Motorized pumps from HTC were examined, focusing on the Parsun, Honday and PM&T brands. The willingness of HTC—the main importer—to participate in the study allowed us to select these brands. They were also available in agro-input shops willing to participate in the study and are widely used by end users. DIKSs from Reiss & Co., Farm Masters and Interplast was picked for the study. Reiss & Co and Farm Masters were selected by providing sufficient data to estimate marketing margins and understand the business operating environment. At the same

time, Interplast was chosen because it is currently the only local manufacturer of drip irrigation pipes and tapes in Ghana. Although the information from Interplast was insufficient to estimate marketing margins, the business operating environment for manufacturing drip equipment was suitably provided.

3.2. Data collection

Primary data was collected from actors in the marketing chain using qualitative semi-structured interviews. Interviews were conducted face-to-face, via telephone or online tools such as Zoom and Microsoft Teams. Data was collected from 2019 to 2022 in Greater Accra, Northern, Upper East and Upper West Regions. Interviews were conducted in English and the local language, to be transcribed and translated into English for the analysis. Interviewees included farmers, multipurpose importers/distributors, input dealers, borehole drillers/mechanization experts, NGOs, and government actors. In total, 51 interviews were conducted, as presented in Table 1.

Secondary data was collected in instances where sufficient information for estimating the marketing margin of the intermediary was not obtained from primary data. The data collected was mainly the selling price of irrigation equipment from the manufacturer or main exporter, as indicated on their websites. Within the results, secondary data was used in conjunction with primary data to estimate marketing margins for some intermediaries.

TABLE 1. Overview of primary data collected.

Actors	Products and services	Topics discussed
Multipurpose suppliers – 23 interviews		
Dizengoff, Pumptech, Dutch and Co., Hatoum Trading Company, Agroafrica, Agrimat, Reiss & Co., SunIn, Deng, Tech 2 Resources, Northern Solar, Farm Masters	<ul style="list-style-type: none"> - Solar-powered irrigation pumps (Lorentz, Future Pump, Grundfos and others) - Motorized Pumps (PM&T, Honday, Honda, Parsun, and others) - Drip irrigation systems (Metrix Innovation, InGreen) - Drip irrigation kits (Merchantmen of Britain) 	<ul style="list-style-type: none"> - Product: brands sold, import procedure, and import prices - Marketing: sales network, market structure - Irrigation setup based on farmer choice: marketing margin range per project - Business operating and policy environment: declining cost of solar technology, tax exemptions - Marketing cost and margins: cost-benefit structure (tangible and intangible) - Barriers to adoption of solar technology: technical and institutional barriers
Manufacturer of Irrigation Equipment (Drip pipes) – two interviews		
Interplast	<ul style="list-style-type: none"> - InGreen drip pipes 	<ul style="list-style-type: none"> - Product: brands sold, import procedure, and import prices - Marketing: sales network, market structure - Marketing cost and margins: cost-benefit structure (tangible) - Business operating and policy environment: tax exemption challenges
Government agencies and NGOs – seven interviews		
World Vision Ghana, GIZ Green Energy People’s Project, WUZDA Ghana, International Development Enterprises (iDE), Ministry of Food and Agriculture (WIAD), Ghana Standards Authority, and Ghana Irrigation Development	<ul style="list-style-type: none"> - Solar-powered irrigation pumps (Grundfos, Lorentz) - Drip systems 	<ul style="list-style-type: none"> - Challenges with irrigation systems - Barriers to solar technology adoption: technical, bio-physical, cultural, institutional, financial, and market barriers - Government policy towards enforcement of solar technology standards - Government interventions and focus on women's inclusion in solar technology use

Farmers – 15 interviews		
Farmers from Upper East Region (Nyangua, Tekuru Navrongo, Paga, Tono, Saboro), Greater Accra Region (Accra)	<ul style="list-style-type: none"> - Irrigation practices - Solar-powered irrigation pumps (Grundfos, Lorentz, and others) - Motor pump (PM&T, Hoday, Honda, Parsun, and others) - Drip systems 	<ul style="list-style-type: none"> - Challenges with irrigation - Barriers to the adoption of solar technology: technical, bio-physical, cultural, institutional, financial, and market barriers - Drip irrigation and its benefits and challenges
Output market actors – four interviews		
Vegetable retailers and vendors in Paga, Nyangua, and Navrongo market	N/A	<ul style="list-style-type: none"> - Trading of vegetables - Challenges of irrigated agriculture

Source: Authors' creation.

3.3. Data analysis

In analysing marketing margins, it is important to identify elements contributing to the various intermediaries' cost and benefit structure. To achieve the same, each transcript was carefully read several times to identify any elements that may contribute to these costs or benefits in a tangible or intangible way. For each transcript, the following questions were asked: 'what in this transcript provides a tangible or intangible advantage for an actor in the supply chain?' and 'what in this transcript provides a tangible or intangible disadvantage for an actor in the supply chain?' The responses were summarized in a table for better visualization. Each cost or benefit was then discussed in a narrative. Information on the business operating environment was also gathered from the transcripts by asking the following: 'who are the actors in the irrigation supply chain?'; 'what products are sold in the irrigation supply chain?' and 'what in this transcript informs us about how the irrigation supply chain functions?'

4. MARKETING MARGIN OF IRRIGATION EQUIPMENT IN GHANA

4.1 Solar Pumps in Ghana

4.1.1 The solar-powered irrigation pumps supply chain

SPIPs include submersible, surface, and hybrid pumps. Pumps are imported from several countries, including Germany, Netherlands, China, and India. They may be sold as a package to the end user, typically comprising of the SPIP and solar panels, sometimes with accessories for installation or a tool kit for repairs. Pumps, panels, and accessories may be imported and sold to the end user as separate units. Importers often import SPIPs from known and trusted manufacturers such as Lorentz and Grundfos but can import solar panels from cheaper sources, mainly China, to reduce the cost of the whole setup. Such pumps are therefore sold to clients separately from the panels. Clients pay for a suitable number of panels depending on their water needs. In addition, the choice of the panel brand is determined by the user's budget and brand preferences. Importers of SPIPs may import products in anticipation of demand. These include pumps that can serve up to depths of 140m. Other pumps are also imported only for the execution of the projects won during bids. These include irrigation systems for commercial farmers or government projects for community water supply and/or irrigation. This is to avoid locking up working capital since the sale of SPIPs is generally low.

The SPIP supply chain is generally short, as illustrated in Figure 2. Suppliers include a few market actors acting as importers, distributors, and retailers at the same time, including Pumptech, Hatoum Trading Company (HTC), Aggrico, SunIn, and Deng. These are generally multipurpose suppliers. Deng, for instance, sells power products, while HTC sells construction equipment and pumps. Pumptech is also a general

distributor of water-lifting technologies powered by solar, grid, diesel, and petrol. Additionally, these suppliers are not exclusive importers of SPIP brands. They may import other brands apart from their main brands to meet the needs of other market segments, as indicated in the interview:

‘Our main product is German-based. However, we are not fixated on it as while we believe in its competence and quality, there is a market segment for affordability. We are also looking at some Indian and Chinese, even European, brands. We were in China in 2018, striking a deal on some solar pumps just so people have more choices. We import solar panels from Germany, but for the PVs, we open. We take solar panels from elsewhere just to bring the cost down.’

(Source: Interview with Osman Kulendi, Pumptech)

The SPIP supply chain includes both formal and informal agents. Suppliers officially appoint formal agents to sell products and/or carry out installations or repairs on their behalf. An example is Northern Solar which serves as a formal agent for Pumptech in the Upper East Region. Informal agents may be extension agents, input dealers, pump repairers, drillers or mechanization experts who buy products on behalf of the farmer. The nature of their work mandates frequent travel between towns and rural areas. Farmers may contact them to purchase solar equipment and accessories on their behalf from towns such as Tamale, Bawku and Navrongo, where the equipment suppliers have outlets.

Government agencies refer to representatives of ministries, departments, municipal assemblies, and district assemblies which make purchase decisions for the SPIPs. Ministries and departments operate from Accra or regional offices across the regional capitals. Municipal and district assemblies operate at the local government level, implementing government policy. Government agencies may purchase SPIPs for project deployment for farmers and/or farmer groups.

NGOs may be international, regional, based in Ghana, or specific to the study area, focusing on agricultural development. They support smallholders in acquiring or accessing SPIPs through financing schemes involving grants and matching schemes. SPIPs are sometimes for Water, Sanitation and Hygiene (WASH) purposes, with excess water used for irrigation. For instance, pumps provided by World Vision are primarily for WASH purposes. Other NGOs—Catholic Relief Services, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and the Association of Church-based Development NGOs (ACDEP)—tend to provide pumps primarily for irrigation.

End users for the SPIPs are farmers in the Northern, Upper East, Upper West, and Greater Accra Regions engaged in small-scale irrigated agriculture. Pumps may be purchased individually or collectively from equipment suppliers or their agents. Farmers may also benefit from government or NGO interventions promoting solar-based irrigation. Within the study area, there is a high preference for submersible pumps due to the perception of being more secure than surface pumps.

4.1.2. Marketing margin and cost and benefit structure along the SPIP supply chain

Table 2 presents four types of SPIPs for which the marketing margin was quantified. Marketing margin varies from manufacturer to manufacturer and from transaction to transaction. The quantity purchased in one transaction and the relationship between the importer and the agent or distributor may determine the price at which the product is sold. Larger quantities are often sold at lower prices, giving the agent a higher margin range. The nature of the actor’s business also influences prices and the margins charged. Large companies like HTC charge standard Value Added Tax (VAT) rates of 19.25%, while medium-scale companies like Pumptech charge a flat VAT rate of 4% on goods sold.

Further, spending on partnerships and advertising influence the costs incurred and the margins charged. Pumptech, for instance, enjoys free publicity due to its partnership with IWMI—Pumptech products are introduced to farmers during research activities by IWMI. It also has opportunities to increase its visibility

at IWMI webinars and meetings, improving its reach. HTC, on the other hand, bears the costs of advertising products using billboards.

TABLE 2. Marketing margins and cost and benefit structure of selected SPIPs in Ghana.

Parameter	Lorentz PS2 100	Lorentz PS@ 1800	Future Pump SF1	Shakti Pump 5
Marketing margin of the transaction between suppliers and farmers				
Sell price (Cedis)	7,000 (US\$ 583) *	25,000 (US\$ 2081) *	4,095 (US\$ 408) *	22,520 (US\$ 1874) *
Import price (Cedis)	Unknown	Unknown	Unknown	Unknown
Import duty (Cedis)	Not applicable	Not applicable	Not applicable	Not applicable
Marketing costs (Cedis)	Unknown	Unknown	Unknown	Unknown
Gross margin (%)	35%	35%	15–25%	15–25%
Net margin (%)	10–12%	10–12%	Unknown	Unknown
Tangible costs	- Import cost - Storage - Transportation - Warranty - Demurrage - Tax waiver fees	- Import cost - Storage - Transportation - Warranty - Demurrage - Tax waiver fees	- Import cost - Storage - Transportation - Warranty - Demurrage - Business operation costs - Additional fees (Bribes)	- Import cost - Storage - Transportation - Warranty - Demurrage - Business operation cost - Additional fees (Bribes)
Intangible costs	- Bureaucracy - Nonadaptation - Political - Collaboration	- Bureaucracy - Nonadaptation - Political - Collaboration	- Bureaucracy - Nonadaptation - Political - Collaboration	- Bureaucracy - Nonadaptation - Political - Collaboration
Tangible benefits	- Economic profit - Tax waivers	- Economic profit - Tax waivers	- Economic profit	- Economic profit
Intangible benefits	- Partnerships - Visibility - New business opportunities - Reputation - New markets	- Partnerships - Visibility - New business opportunities - Reputation - New markets	- Partnerships	- Partnerships
Marketing margin of the transaction between suppliers and agents or government agencies/NGOs				
Sell price (Cedis)	- Unknown	- Unknown	- Unknown	- Unknown
Marketing costs (Cedis)	- Unknown	- Unknown	- Unknown	- Unknown
Gross margin (%)	- Unknown	- Unknown	- Unknown	- Unknown
Net margin (%)	- Unknown	- Unknown	- Unknown	- Unknown
Tangible costs	- Transportation	- Transportation	- Transportation	- Transportation
Intangible costs	- Unknown	- Unknown	- Unknown	- Unknown
Tangible benefits	- Economic profit - Discounts - Commission - Free deliveries from the supplier	- Economic profit - Discounts - Economic profit - Free deliveries from the supplier	- Economic profit	- Economic profit
Intangible benefits	- Partnerships	- Partnerships	- Partnerships	- Partnerships
Marketing margin of the transaction between agents or government agencies/NGOs and farmers				
Sell price (Cedis)	- Unknown	- Unknown	- Unknown	- Unknown

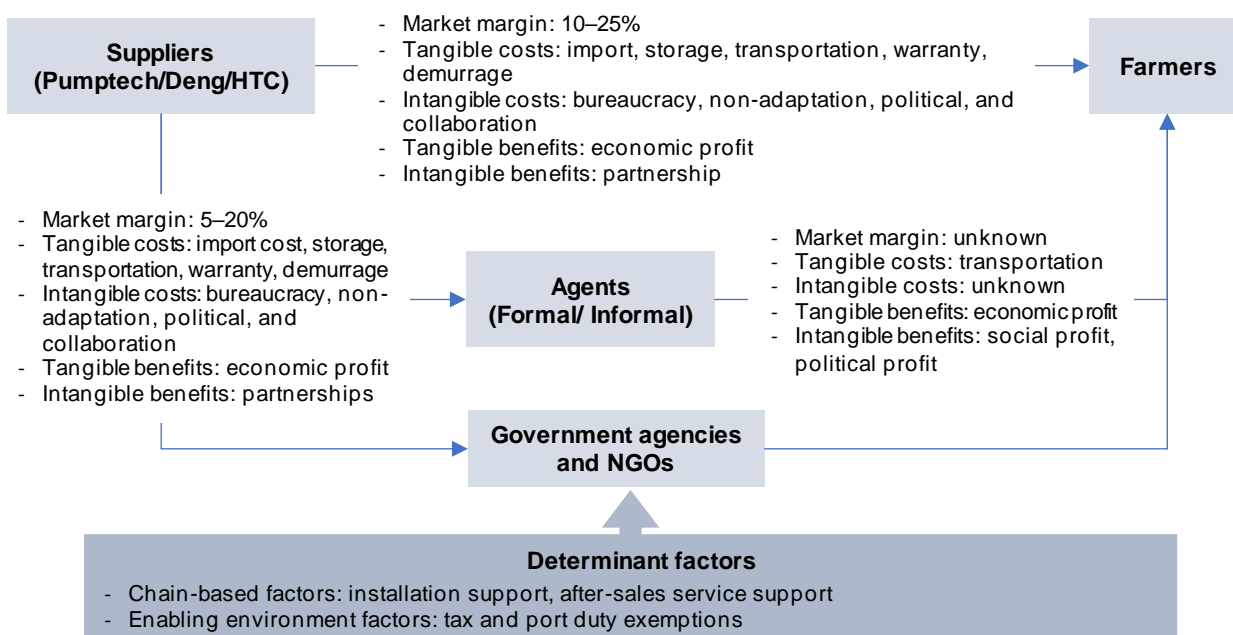
Marketing costs (Cedis)	- Unknown	- Unknown	- Unknown	- Unknown
Gross margin (%)	5–7%	5–7%	Unknown	Unknown
Net margin (%)	- Unknown	- Unknown	- Unknown	- Unknown
Tangible costs	- Transportation	- Transportation	- Transportation	- Transportation
Intangible costs	- Unknown	- Unknown	- Unknown	- Unknown
Tangible benefits	- Economic profit	- Economic profit	- Economic profit	- Economic profit
Intangible benefits	- Partnerships - Social profit	- Partnerships - Social profit	- Unknown - Social profit	- Unknown - Social profit

Source: Authors' creation.

*Exchange rate was based on the rate of 17 January 2023 with one USD = 12 Ghana Cedis

Figure 2 summarizes the marketing margin and cost-benefit structure of three transactions in the SPIP supply chain. This section focuses on two transactions: between suppliers and farmers and between suppliers and formal or informal agents. Discussions on the transaction between suppliers, government agencies, and NGOs have not been undertaken in detail. This is because such transactions could not be fully traced to understand the cost and benefit structure and estimate marketing margins.

FIGURE 2. Marketing margin and the cost-benefit structure along the SPIP supply chain in Ghana.



Source: Authors' creation.

Suppliers- farmers transaction

Data analysis identified a set of **tangible costs** that contribute to the sale price of multipurpose suppliers. The import cost is the sum of the price of the purchased solar equipment, freight charges, and other port charges paid by importers, such as ECOWAS levy and the COVID-19 levy noted by an importer: *'Agricultural materials and goods are zero-rated for import duties. However, when it comes to the port, you cannot just go to take them from the harbor. There are some things that you pay for. Typically, our calculation comes to +/- 8% of cost, insurance, and freight value.'* (Source: Interview with George Brown-Tetteh, Reiss & Co).

The storage cost refers to fees for warehousing irrigation equipment and/or accessories in the warehouse or office location of the importer. The transportation cost is the expense of moving equipment from the port of entry to the warehouse and from the warehouse to the farmer's location. The service cost occurs when the importer/distributor/retailer offers the end user additional benefits such as warranty and maintenance. Warranty may require an actor to repair a defective product, replace, or refund it. Actors such as HTC and Pumpteck offer a warranty on pumps sold: *'It (Shakti SPIP) comes with a 5-year warranty from the manufacturer, but we give the farmer one and half years'* (Source: Interview with Iyad Hatoum, HTC). Demurrage is a fine or charge levied by a courier or freight provider for not taking goods from a port within an indicated time. Importers are often allowed to store goods for several 'free' days, after which such charges are applied.² Importers may incur demurrage costs when they experience difficulties clearing their goods from the port. The delays can sometimes result from the late processing of tax waivers.

Tax waiver fees are paid by importers annually to the Ghana Energy Commission to enable them to access tax waivers on irrigation equipment imported for agricultural purposes. An assessment determines the amount that importers pay by the Energy Commission, Ghana Revenue Authority, and the Ghana Standards Authority. Business operating costs comprise paying salaries, renting facilities, property rates and payment of utilities necessary for maintaining an office. SPIP importers may incur additional costs due to corruption at ministries and government organizations in charge of processing waivers and port duties.

Intangible costs identified for SPIP importer/distributor/retailer include bureaucracy, non-adaptation, political, and poor collaboration costs. Bureaucracy costs are incurred by actors from the multiple government organizations involved in the tax exemption process. Time lost is an intangible cost as described by one actor:

'As I never received the tax exemption letter, customs made us pay fully. So, they say pay now and claim duty later from the Ministry of Finance. To claim your money from the Ministry of Finance, you must go through a big process, starting with the Ministry of Agriculture. Then the Energy Commission, and Ghana Standards Authority as well, to provide the certificates of inspections for products to the Minister of Finance. So, it has been for three years now that we started, and we have not received any of this back.' (Source: Interview with Iyad Hatoum, HTC).

Non-adaptation cost is the lost opportunity by actors to grow the SPIP market in Ghana due to imports that are unsuitable for the financial ability of the target market. Globally, the costs of solar energy technologies have dropped substantially over the last 30 years (Timilsina et al. 2011; Srivastava and Srivastava 2013; Steffen 2020). However, solar technology imported in Ghana is relatively too expensive for the average small-scale farmer. Pay-as-you-go (PAYGO) and pay-as-you-own (PAYOWN) options have not been adequately explored compared to other African countries, especially in East Africa.

Political costs are the loss of business for SPIP importers/distributors/retailers due to political activities. Seasonality in demand for SPIPs has been observed in Ghana, centred around general elections. Politicians invest more in solar irrigation projects close to general elections to canvass electoral votes and slow down on such projects two or three years after winning an election. There are periods of a year or two in the industry where there are several projects, while other years witness no government projects. Some political decisions to site irrigation projects also stem from their interests instead of the potential benefits of the projects to the beneficiaries. As indicated by one SPIP distributor: *'In the year 2021, I expect a dip in sales because it will be after an election. In the first year of any government, nothing happens. They want to do projects closer to elections so people will remember the projects in the communities.'* (Source: Interview with Osman Kulendi, Pumpteck).

² <https://www.tradefinanceglobal.com/freight-forwarding/demurrage/> (Accessed on March 1, 2022)

Poor collaboration costs are other losses in business that actors experience because of a lack of synergy. There is a limited collaboration between government agencies, development partners, private sector entities, research institutions and farmers in driving innovation in the industry to meet the needs of end users. As observed in one interview: *'The donor's needs sometimes overshadow that of the farmers. The farmers' needs might be very fundamental that the donor might not want to sponsor. But that is not in the farmers' interest. For me, in about the 20 years that I've been around, Government has never given one penny for research.'* (Source: Interview with Stephen Asugire, CSIR/WRI).

Tangible benefits identified for SPIP importers/distributors/retailers comprise an economic profit and import tax waivers. Economic profit is the difference between the revenue received from the sale of output, the costs of all inputs used, and any opportunity costs. It is derived by deducting the opportunity and explicit costs from revenues earned. Tax waivers are exemptions from payment of value-added tax and port duties that the Government of Ghana gives to importers who import items for the agriculture sector, including irrigation equipment.

Intangible benefits identified for SPIP actors include partnerships, visibility, new business opportunities, reputation, and new market exploration. Partnerships are mutually beneficial for the actors involved. These may be with product and/or service providers, including pipe manufacturers, borehole drillers, pump repairers, government organizations, NGOs, research institutes, and development partners. For instance, pump distributors like Pumptech partner with pipe manufacturers/distributors, borehole drillers, pump repairers, water application experts, universities, and other service providers to offer full-service packages to their clients. A partnership between Pumptech, the International Water Management Institute (IWMI), the Ministry of Food and Agriculture (MOFA), and the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) has also delivered mutual benefits. MOFA leverages workshop activities to extend training to extension agents on crop water requirements, irrigation practices, and improved irrigation technologies. GIZ and IWMI have benefited from cost-sharing on field expenses for organizing solar pump demonstrations and market linkages workshops. The partnership has also offered IWMI the opportunity to test irrigation scaling models in Ghana's Upper East and Upper West regions; Pumptech has been assisted in identifying key market segments for its products, realizing the extent of the untapped market potential in these regions. This led to Pumptech opening a new office in Bolgatanga, Upper East Region of Ghana, in August 2021. Interviews with Pumptech before the partnership (November 2020) and after a few months of the partnership (January 2021) and in 2022 demonstrate a significant appreciation of the intangible benefit of the partnership, as indicated below:

'We have distribution centres in Upper West, Northern Region, and Accra. We are not in Upper East because we think we are close enough to serve them. We had not explored the market potential of the Upper East, especially in irrigation. Now, we have explored huge market demands since we visited the places. What happens is that commercial businesspeople are sitting and just selling in the markets here and there. But through our partnership with the IWMI, we realized that is not the way to reach farmers. We are able to develop and use a different way, that is, through these segmentations, meetings, and workshops that we are to be engaged in.' (Source: Interviews with Osman Kulendi, Pumptech).

Visibility refers to the benefit obtained by actors because of improved marketing and advertising opportunities. For instance, the joint organization of farmers and farmer groups for workshops has improved the visibility for the GIZ project—Green Peoples' Energy Project—which supports farmers acquiring solar-powered irrigation pumps. More farmers know about the project, and the applications to benefit from the project have improved. Five companies undertake the implementation of the Green Energy People's Project: Deng Limited, Foundries and Agric Machinery Ghana Ltd, Pumptech Limited, Jahan Engineering Services and Agaabi Plumbing Service. Improved enquiries and sales have also aided

Pumptech. Pumptech and Tech 2 Resources have also received improved visibility through a partnership with IWMI. An opportunity has been created for Pumptech to interact with actors such as agricultural extension agents, farmers, farmer groups, the private sector, government organizations and international organizations, including the Food and Agriculture Organization, through workshops, face-to-face meetings, and virtual meetings. Tech 2 Resources has also received more opportunities to demonstrate water application equipment in the northern sector of Ghana. New business opportunity refers to actors' existing and future potential to obtain new business through collaboration with private and public actors. Pumptech, for instance, has obtained new business through collaboration with World Vision and GIZ. Reputation refers to the intangible benefits actors receive because of the beliefs and opinions of clients and potential clients about the organization and its brands. Trust in German technology, for instance, has served as an advantage for Deng and Pumptech. It gives clients added confidence to invest in Lorentz SPIPs.

Suppliers-agents or suppliers-government agencies/NGOs transaction

SPIP importers often sell directly to end users. However, formal or informal agents may be involved in the sale wherever the retail outlets are far from the farmers. Formal agents have an agreement with the supplier to sell products or offer services on their behalf. Informal agents buy SPIPs on behalf of the end users. Informal agents buy products for end users when they travel to towns for other businesses closer to the supplier. The supplier usually offers a discount where agents are involved so that the agent may sell at the same or slightly higher price than the retail price. The importer's margin, therefore, reduces depending on the number of intermediaries in the process. This keeps prices to the farmer similar between transactions, with the difference being the transportation cost to the farmer's location.

Government actors are staff of ministries, departments, and agencies (MDAs) that acquire or help farmers/ farmer groups to acquire SPIPs. Pumps may be provided as a social intervention by a government agency for irrigation or multiple water use, including irrigation. A government agency may also acquire it for farmers on flexible payment terms. NGOs support farmers and farmer groups to acquire SPIPs or to benefit from projects promoting the pumps. The support may be in the form of a subsidy of a SPIP system for a group of farmers or financial assistance such as matching funds for farmers to acquire SPIPs.

Some tangible and intangible costs and benefits were identified for the transaction between the supplier and agent and in the supplier and NGO/Government transactions. **Tangible costs** for agents and government, and NGOs are transportation costs. This is the cost of moving the product from the supplier's outlet to the NGO or Government actor's project site, beneficiaries, or warehouse. The amount charged for the service is contingent upon the distance travelled. Due to the accessibility of data, this study was not able to quantify these costs. NGO and government actors interviewed did not have access to such data or were unwilling to share it due to the sensitive nature of such data. **Intangible costs** are unknown for the transaction between the suppliers and agents or the suppliers and government agencies/NGOs. This is because such costs were not mentioned in any interviews with these actors.

Moreover, these actors are few compared to the other supply chain actors interviewed in this study. **Tangible benefits** identified for this transaction include economic profit, discounts, commissions, and free deliveries. The definition of [economic profit](#) here is similar to the definition in the transaction for SPIP importer/distributor/retailer and the farmer. Discounts refer to the supplier's price reductions to the agent, government, or NGO during purchase. Discounts may be given to actors in the transaction due to bulk purchases or enabling agents to sell at the same or slightly higher price than the supplier. The commission is the percentage of a sale amount or a fixed amount of money given to the agent for linking the supplier to the end-user or for undertaking the service on behalf of the supplier. Formal agents may enjoy the benefit of free deliveries from the main supplier to the agent's location or a nearby location. This occurs when the supplier's staff travels to the agent's location or a nearby location for another project

or service delivery. For such transactions, the **intangible benefit** is partnerships allowing suppliers to minimize their cost of operation by carrying out installation and servicing on behalf of the supplier at locations distant from the supplier's outlet(s). Agents also benefit from the additional income because of installations and servicing offered on behalf of the supplier.

Agents-farmers or Government agencies/NGOs-farmers transaction

Tangible cost for this transaction is the [transportation cost](#). As in the case of the suppliers-agents or suppliers-government agencies/NGOs transaction, the transport cost depends on the distance between the supplier's outlet and the end user. Where extension agents serve as informal agents, the agent may only charge the farmer cost of transportation due to existing relations with farmers. **Intangible costs** for this transaction are unknown since using agents to sell SPIPs is still nascent. Therefore, significant numbers of agents could not be identified to obtain such data.

Tangible benefit of this transaction is [economic profit](#), like the earlier definition of the supplier-farmer transaction. While agents often receive economic profit for this transaction, government agencies and NGOs usually do not engage in this scenario for profit. **Intangible benefits** include social profit, political profit, and supplier advertisement. Social profit is the desired social effect of providing SPIPs to beneficiaries, including women's empowerment and improving food security. NGOs and government agencies may provide SPIPs to end users for social purposes. Political profit is the credit the government receives for improving the lives of beneficiaries by providing them with SPIPs. This may favour the government in winning votes in beneficiary communities during elections. Supplier advertisements refer to communication with potential customers through traditional and social media. This may foster awareness, generating sales for agents.

4.1.3 Determinant factors of SPIPs

There is some level of collaboration among actors in the chain. SPIP distributors collaborate with related sectors for installation and after-sales service. This may reduce installation costs for the farmer because installers are readily available within their vicinity, as a SPIP distributor indicates: *'We have some partnerships like working with Interplast, because they provide specialized equipment. They provide training for our technicians on how to do installations. So, we don't need to send people to those places. These are some of the benefits of synergy. Knowledge sharing and training.'* (Source: Interview with Michael Avle, PEG Ghana).

The Government of Ghana currently offers tax and port duty exemptions for agricultural equipment imports. Importers of SPIPs and accessories qualify for these tax and port duty exemptions if they prove that the imports are for agricultural purposes. This includes exemption from standard Value Added Tax (VAT) of 19.25% and a benchmark subsidy on port charges up to 30%. Our study, however, indicates that some actors struggle with the long and bureaucratic exemption process, perceiving it to be not worth applying for at times. This is due to the multiple organizations that an importer needs to contact for the exemption, depending on the imported product. These include the MOFA, Ministry of Trade, Ghana Standards Authority, Energy Commission and sometimes, the Ministry of Finance, where companies must apply for a refund of exemptions paid to hasten the port clearing process. Corruption within the public institutions granting the exemptions was also mentioned. Notably, however, actors did not want to declare this on record because it may influence their ability to interact with such organizations in future.

4.2 Motorized pumps in Ghana

4.2.1 Motorized pump supply chain

Motorized pumps sold in Ghana are powered by petrol or diesel and are available in several capacities. Low to medium-capacity pumps from 1hp to 7.5hp are common among smallholder farmers and readily

available in trade. Such pumps are sold with either a 2-inch hose or a 3-inch hose. However, higher-capacity pumps often need to be imported on demand. This prevents importers from locking up their business capital due to the relatively low demand for such pumps. Pumps are imported mainly from China, possessing an average life span of two to three years. They require regular servicing, which is carried out by farmers themselves or by local pump technicians. Farmers may abandon pumps due to frequent breakdowns or high fuel consumption as the pump ages. Farmers who own two or more motorized pumps are thus a common sight. Brands imported include Honda, Honday, PM&T, Ducati, Afton, and Parsun.

Due to the low market entry barriers, the motorized pump market (Figure 3) consists of many actors. Motorized pumps are relatively cheap to import, with multipurpose suppliers that can be easily accessed online. Individuals and companies both participate in the market, serving as importers. Some company actors identified include Hatoum Trading Company (HTC), Dizengoff, Farm Masters, and Agrimat. Actors are generally not exclusive importers of brands. Each actor often imports multiple brands depending on the equipment cost and customer preference. They operate mainly from Accra, in regional capitals, and towns with active irrigated agriculture. HTC is a major importer of motorized pumps, sometimes selling through distributors.

Distributors/agents of motorized pumps are organizations and individuals who sell motored pumps to farmers, serving as a link between the farmer and the supplier. These include Pumptech, agro-input dealers, agricultural extension agents, pump repairers or drillers. They may have a retail outlet for irrigation equipment and/or other agricultural inputs and purchase products for farmers on demand. Distributors/agents often operate from major towns, including Accra, Tamale, Navrongo, Wa, Bolgatanga, and Bawku.

Government agencies and NGOs utilize projects to support smallholder farmers in gaining access to motored pumps. Motored pumps may be provided as part of irrigation packages for farmer-based organizations. At other times, farmers may be supported to acquire motored pumps through financing schemes such as matching funds.

Farmers are the beneficiaries of projects as either individuals or as part of farmer groups. They may also invest in motored pumps as individuals or farmer groups. Individuals may buy low to medium-capacity pumps depending on their farm size, while farmer groups buy high-capacity pumps powered by petrol or diesel. Groups may schedule irrigation based on the capacity of the pump(s) purchased, the water needs of the group, and the total number of members. Individual farmers may buy, rent, or borrow motored pumps from other farmers to irrigate their farms.

4.2.2 Marketing margin and cost and benefit structure along the motored pump supply chain

Table 3 quantifies the marketing margin and cost and benefit structure of the three types of motored pumps in three transactions. Figure 3 summarizes the marketing margin and cost-benefit structure of four transactions in the motored pump supply chain. This section focuses on two transactions: the transaction between supplier and farmer and between the suppliers and agents/government agencies/NGOs. This analysis combined the transactions between the suppliers and the agents and the suppliers and the government agencies/NGOs due to the similarities in their costs and benefits structure.

TABLE 3. Marketing margins and cost and benefit structure of three motorized pumps in Ghana.

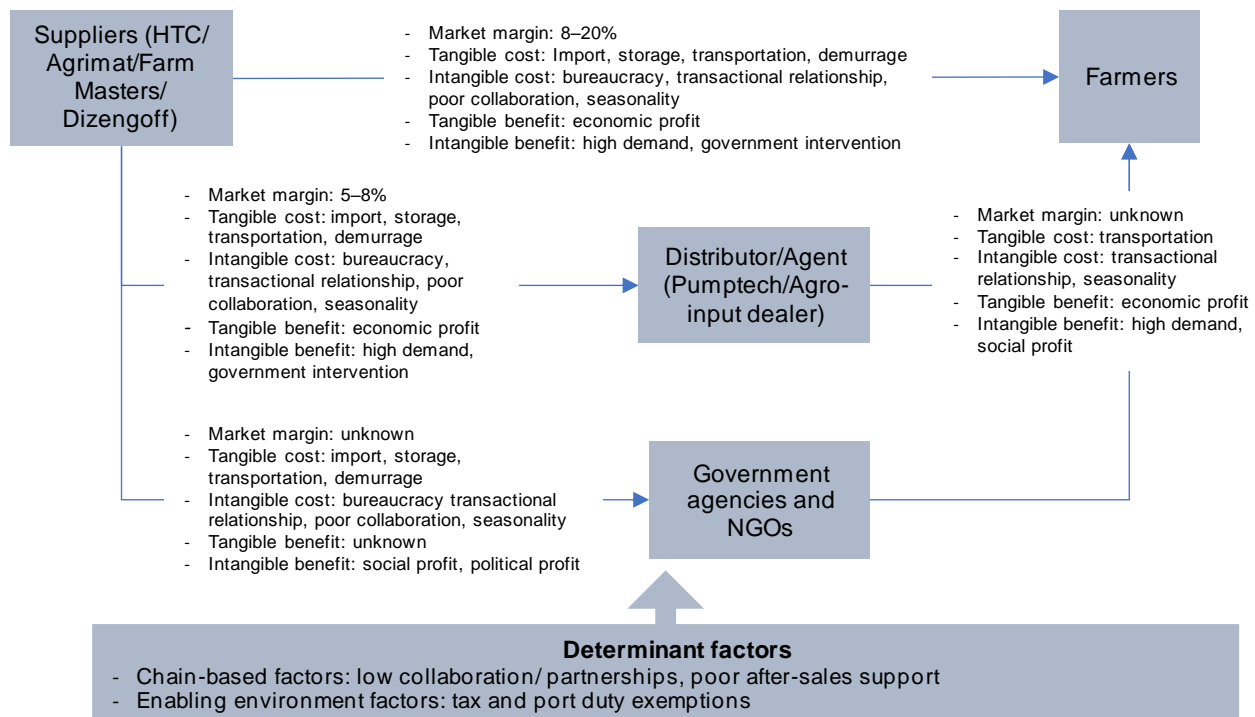
Parameter	Parsun 2-inch pump	Honday 2-inch pump	PM&T 2-inch pump
Marketing margin of the transaction between suppliers and farmers			
Sell price (Cedis)	- Unknown	- Unknown	- Unknown
Import cost (Cedis)	- Unknown	- Unknown	- Unknown
Import duty (Cedis)	- Unknown	- Unknown	- Unknown

Marketing costs	- Unknown	- Unknown	- Unknown
Gross margin (Cedis)	- Unknown	- Unknown	- Unknown
Gross margin (%)	8–20%	8–20%	8–20%
Net margin (Cedis)	- Unknown	- Unknown	- Unknown
Net Margin (%)	- Unknown	- Unknown	- Unknown
Tangible costs	- Import cost - Storage cost - Transportation - Demurrage - Tax waiver fees - Additional fees (bribes)	- Import cost - Storage cost - Transportation - Demurrage - Tax waiver fees - Additional fees (bribes)	- Import cost - Storage cost - Transportation - Demurrage - Tax waiver fees - Additional fees (bribes)
Intangible costs	- Bureaucracy - Transactional relationship - Poor collaboration cost - Seasonality	- Bureaucracy - Transactional relationship - Poor collaboration cost - Seasonality	- Bureaucracy - Transactional relationship - Poor collaboration cost - Seasonality
Tangible benefits	- Economic profit - Tax waivers	- Economic profit - Tax waivers	- Economic profit - Tax waivers
Intangible benefits	- High demand - Government interventions	- High demand - Government interventions	- High demand - Government interventions
Marketing margin of the transaction between suppliers and agents/Government agencies/NGOs			
Sell price (Cedis)	- Unknown	- Unknown	- Unknown
Marketing costs	- Unknown	- Unknown	- Unknown
Gross margin (Cedis)	- Unknown	- Unknown	- Unknown
Gross margin (%)	5–8%	5–8%	5–8%
Net margins (Cedis)	- Unknown	- Unknown	- Unknown
Net margins (%)	- Unknown	- Unknown	- Unknown
Tangible costs	- Transportation	- Transportation	- Transportation
Intangible costs	- Transactional relationship - Seasonality	- Transactional relationship - Seasonality	- Transactional relationship - Seasonality
Tangible benefits	- Economic profit - Tax waivers for imports	- Economic profit - Tax waivers for imports	- Economic profit - Tax waivers for imports
Intangible benefits	- High demand - Government interventions	- High demand - Government interventions	- High demand - Government interventions
Marketing margin of the transaction between agents/Government agencies/NGOs and farmers			
Sell price (Cedis)	650 (US\$ 54) *	620-650 (US\$ 52–54) *	650 (US\$ 54) *
Marketing costs	- Unknown	- Unknown	- Unknown
Gross margin (Cedis)	- Unknown	- Unknown	- Unknown
Gross margin (%)	8–12%	8–12%	8–12%
Net margin (Cedis)	35–40	35–40	35–40
Net margin (%)	5–6%	5–6%	5–6%
Tangible costs	- Transportation	- Transportation	- Transportation
Intangible costs	- Transactional relationship - Seasonality	- Transactional relationship - Seasonality	- Transactional relationship - Seasonality
Tangible benefits	- Economic profit	- Economic profit	- Economic profit
Intangible benefits	- High demand - Government interventions - Social profit - Political profit	- High demand - Social profit - Government interventions - Political profit	- High demand - Social profit - Government interventions - Political profit

Source: Authors' creation.

*Exchange rate was based on the rate of 17 January 2023 with one USD = 12 Ghana Cedis

FIGURE 3. Marketing margin and cost-benefit structure along the motorized pump supply chain in Ghana.



Source: Authors' creation.

Suppliers-agents/Government agencies/NGOs

In this transaction, the **tangible costs** identified include import, storage, transportation, demurrage, tax waiver fees and additional costs (bribes). Import cost is the sum of the price of the motor pump purchased, freight charges and other port charges paid by importers, such as the ECOWAS levy and COVID-19 levy. The storage cost is the fee for warehousing motored pumps in the warehouse or at the office location of the importer. Transportation cost is the expense of moving motored pumps from the port of entry to the warehouse and from the warehouse to the farmer's location. Demurrage is a fine or charge levied by a courier or freight provider for not taking goods from a port within an indicated time. Additional fees refer to bribes that importers sometimes pay to government and port officials to facilitate their tax waivers or expedite their goods' clearance.

Intangible costs identified for motorized pumps include bureaucracy, transactional relationships, poor collaboration, and seasonality. Actors incur bureaucracy costs from the multiple government institutions that importers need to transact with to obtain tax waivers and clear the goods from the ports. Time lost is also an intangible cost for actors. The transactional relationship between importers/distributors/retailers and the end users denies the actors the opportunity to develop the market based on end users' feedback and the end users' participation in product design and re-design. The low collaboration between actors in the supply chain may be described as an intangible cost. Actors in the supply chain currently operate as 'silos', hindering them from exercising group-bargaining power to influence government or institutional policies concerning the market. Motorized pumps are seasonal products with significant demand only in the dry season. Actors, therefore, stand the risk of locking up their business capital in unsold units if they cannot sell stock within the dry season. One actor below expresses this: *'Within this period (the dry season), they will buy, but sometimes you can sit there a whole week, and no one will come and ask about a machine because it is not the season for it. When the season*

is in, they buy, but after that, they pack and go into rain season farming.' (Source: Interview with Augustine Aboyure).

Tangible benefits for motorized pump importers/distributors/retailers include [economic profit](#) and [tax waivers](#) for imports like those discussed in the supplier-farmer transaction for SPIPs. **Intangible benefits** for motored pumps include high demand, government interventions and social profit. High demand serves as an advantage for motorized pump actors. As farmers increase cultivation, manual irrigation tends to become tedious. Therefore, farmers growing vegetables beyond one acre have a high desire to purchase motored pumps to ease the burden of irrigating their crops. Alongside, government interventions have promoted using motorized pumps for irrigation among smallholder farmers in the study area over several years. This has led to wide acceptance among irrigation farmers. Reduction in the marketing effort for encouraging purchase is beneficial for the actors. Government activity in this regard is mentioned by a distributor of motorized pumps as follows:

'Diesel pumps are the cheapest, solar pumps are the most expensive. The gap between the two is the electric pump, but most of their sites are not close to electricity, so they don't have that option. As a result, they find themselves stuck with diesel pumps. The government itself promoted that cheaper pump because of the initial cost. For over 40 years, that is what they have been giving to them as subsidized implements, so they are used to those kinds of pumps.' (Source: Interview with Osman Sahanon Kulendi of Pumptech).

Social profit refers to the goodwill generated among project beneficiaries towards an NGO or government institution. When NGOs or Government projects purchase motored pumps for farmers/farmer groups, it builds positive sentiment towards them, which may be leveraged later to promote other interventions in the beneficiary communities. NGOs and Government actors do not usually seek economic profit to purchase motored pumps for farmers—their focus is more on engendering social profit. Where extension agents serve as informal agents, they may earn an economic profit on a transaction or purchase equipment on behalf of the farmers only for social profit.

Suppliers-farmers transaction

Suppliers of motored pumps often sell directly to farmers, especially when they are close to the farmer's location. Farmers prefer to buy directly from suppliers for a range of reasons. First, the farmer can buy other irrigation accessories directly from the supplier and buy the pump. These include hoses, joints, pipes, emitters, and filters. Doing so saves the farmer the time spent on contacting several suppliers. It also minimizes transportation costs since the farmer can transport several items at a time. Second, farmers can ask for additional information from the supplier regarding the warranty, spare parts availability, and best maintenance practices. The supplier sells at retail price to the farmer. The price and margins charged depend on the number of units purchased, the value of the sale, and the existing relationship between the farmer and the supplier. With the farmer buying one unit at a time, the margins are often high in such transactions, ranging between 8–20%.

4.2.3 Determinant factors

Partnerships and interactions between actors in the motor pump supply chain are low, with actors often operating as 'silos'. Some importers—Dizengoff and Farm Masters—import equipment mainly to meet the demands of projects won. They may sometimes stock up on low-capacity pumps in anticipation of demand. Actors such as Agrimat and HTC stock up on low and medium-capacity pumps regularly but import high-capacity pumps to meet project demands. Agro-input dealers are the main agents for selling motorized pumps, although importers also sell directly to farmers, some times via agents or distributors. Pumptech serves as a distributor for motorized pumps imported by HTC. The discount the agent or distributor receives is based on the number of pumps purchased and the bargaining power of the actor.

In addition, no price caps have been set for selling HTC products, although the company has recommended retail prices: *'Our distributors get between 5% to 12% in discount, depending on the system. They can even sell it higher than us. They are closer to the end user.'* (Source: Interview with Iyad Hatoum, HTC).

Interactions between sellers of motorized pumps and end users are transactional in nature. Post-sale interaction is limited to the occasional purchase of spare parts from sellers. Installation is undertaken by the farmers themselves, often with the help of other farmers. High-capacity pumps, however, are installed by the sellers. Local pump repairers provide operation and maintenance. These are independently run private-owned businesses. Warranty on products sold is almost non-existent, especially for brands imported from China. This is because the manufacturer warranty is often less than one year, and the cost of accessing a warranty is usually expensive, as expressed in an interview:

'We don't offer a warranty on products, but we offer a service warranty. If we install it for you, you get three months warranty on installation. If there are defects, we will replace them for you. We replace small accessories but not the pump itself. When we buy from China, although they give us a warranty, it is more expensive to get the product, so unless you have a major issue, they will usually put it on your next order. We get a warranty for 45 days, but sometimes, we can push for 90 days if a credit facility is involved. so, we can give you a warranty only up to 30 days.' (Source: Interview with Anthony Morrison, Farm Masters).

The Government of Ghana currently offers tax and port duty exemptions for agricultural equipment imports. Importers of motorized pumps and accessories qualify for these tax and port duty exemptions if proof of the imports being for agricultural purposes is furnished. However, some actors in the motorized pump market face challenges accessing these exemptions, similar to findings by other studies (Namara et al. 2019). Motorized pump importers may also apply for the Government of Ghana benchmark value to reduce their port charges by 30–50%. Nevertheless, importers, however, must prove that their pumps are solely for agricultural purposes.

4.3 Drip irrigation kits and systems in Ghana

4.3.1 Drip irrigation kits and systems supply chain

Drip systems and kits (DSKS) sold include the Merchantmen of Britain (MOB) brand imported by Reiss & Co. from India, Mettrix Innovation imported by Farm Masters from China and the locally manufactured brand, InGreen from Interplast. Dizengoff does not focus on a particular brand. The company imports brands depending on the end user's budget and preferences. Several branded and unbranded drip equipment, notably from China, are also available in the market. The Jain brand of drip tapes from China is particularly common.

The sizes of drip systems imported by Dizengoff and Farm Masters are based on the requirements of projects won. Reiss & Co., on the other hand, imports the MOB brand in a package form consisting of drip lines and accessories in three sizes: 30sqm, 150sqm, and 2,000sqm. The DSKS can be self-installed by the farmer as per the instructions in the manual included in the pack. Interplast manufactures 16mm diameter drip pipes available in two variants: a soft drip tape (2,700m) with a life expectancy of 1-2 years and a hard drip pipe (400m) with a life expectancy of 4-5 years. Users buy drip tape or pipes separately from the accessories.

The supply chain for drip systems has been elaborated in Figure 4. Market actors in the supply chain for drip irrigation kits and systems play multiple roles. They may act as manufacturers/importers, distributors, and retailers at the same time. Importers include Dizengoff, Farm Masters, and Reiss & Co. Interplast (under the brand name InGreen), which locally manufactures drip lines. Actors may serve as distributors

for products imported by other actors in the chain. When necessary, purchases may also be made from competitor firms. This may be the case during projects where the end user prefers a product offered by the competitor. Project timelines may also be too short to permit the importation, or the project scale may not make economic sense to import products.

Multipurpose suppliers—Farm Access, Dizengoff, and Reiss & Co.—import agricultural inputs and machinery, including irrigation equipment. They may offer a package including the irrigation setup and provisioning of agro-inputs such as seeds, fertilizers, and greenhouse inputs. The farmer may also buy only irrigation equipment for self-installation or even request installation from the supplier at a fee. Low-capacity drip kits and systems are sometimes stocked by actors such as Farm Access in anticipation of demand. Still, high-capacity ones are usually imported to meet the demands of projects won from countries such as China, Israel, India, South Africa, the USA, and Spain. Importers choose a country based on the price, the end user’s budget, and preferences.

Interplast is a manufacturer-retailer that creates plastic pipe products, including drip pipes and tapes. It designs and installs farm irrigation systems through the irrigation arm of the business. The company offers easy-to-use underground irrigation products, including drip pipes, controllers, valves, accessories, tools, and various sprinkler head options. Interplast imports accessories such as emitters, coupling, elbows, and adaptors mainly from Europe, specifically Spain and Italy.

Agents/contractors include Farm Access, Dizengoff, and others that purchase from multipurpose suppliers to fulfill the demands of projects won through government tenders or private tender processes. Depending on the size of the project, the agent can negotiate discounts with the supplier. Government agencies and NGOs are local and district authorities that decide on irrigation projects. They may support farmers in acquiring drip irrigation equipment by linking them to suppliers; they may also purchase drip equipment to execute a project in their administrative areas for farmers. They assist farmers in acquiring drip equipment, mainly operationalized through projects.

End users are mainly vegetable farmers engaged in dry-season farming. They use drip systems to manage the scarce water available during the 6-7 months of the dry season in the northern sector of Ghana. Farmers grow vegetables for home consumption and the market, with most of the output grown for the market. High-value vegetables such as pepper, onions, and tomatoes are often observed to be grown.

4.3.2 Quantified marketing margin and cost and benefit structure of the drip kits and systems

Table 4 presents three types of DIKS products used to quantify the marketing margin. Margins depend mainly on the volume and value of each purchase and the negotiation skills of the actors in the transaction. Margins tend to be lower for high-volume or value transactions between actors.

TABLE 4. Marketing margins and cost and benefit structure of DIKS in Ghana.

Parameter	MOB Brand (150m)	Metrix Innovation (size on demand)	InGreen Soft tape (2700m)
Marketing margin between importer/manufacturer and farmer			
Sell price (Cedis)	800 (US\$ 67) *	Variable	Unknown
Import price (Cedis)	Unknown	Variable	Unknown
VAT (%)	Not applicable	Not applicable	19.25% of the import price
Import duty (Cedis)	Not applicable	Not applicable	Unknown
Marketing costs (Cedis)	Unknown	Unknown	Unknown
Gross margins (Cedis)	Unknown	Unknown	Unknown
Gross margins (%)	Unknown	Unknown	Unknown
Net margin (Cedis)	Unknown	Unknown	Unknown
Net margin (%)	10%	20–30%	Unknown

Tangible costs	<ul style="list-style-type: none"> - Import cost - Storage - Transportation - Market development - Demurrage - Tax waiver fees - Additional fees (Bribes) 	<ul style="list-style-type: none"> - Import cost - Farm visit cost - Design and installation cost - Storage - Transportation - Installation Warranty - Demurrage - Tax waiver fees - Additional fees (Bribes) 	<ul style="list-style-type: none"> - Import cost (raw materials) - Standard VAT - Conversion cost - Storage - Transportation - Services (Warranty)
Intangible costs	<ul style="list-style-type: none"> - Bureaucracy - Locked business capital 	<ul style="list-style-type: none"> - Bureaucracy 	<ul style="list-style-type: none"> - Bureaucracy - Political costs
Tangible benefits	<ul style="list-style-type: none"> - Economic profit - Tax waivers 	<ul style="list-style-type: none"> - Economic profit - Tax waivers 	<ul style="list-style-type: none"> - Economic profit - Tax waivers - Mother company benefit
Intangible benefit	<ul style="list-style-type: none"> - Partnerships 	<ul style="list-style-type: none"> - Partnerships 	<ul style="list-style-type: none"> - Partnerships - Manufacturing monopoly
Marketing margin between importer/manufacturer and agent/contractor/government agency/NGO			
Sale price	Unknown	Variable	Unknown
Import price (Cedis)	Unknown	Variable	Unknown
VAT (%)	Not applicable	Not applicable	19.25% of the import price
Import duty (Cedis)	Not applicable	Not applicable	Unknown
Marketing costs (Cedis)	Unknown	Unknown	Unknown
Gross margins (Cedis)	Unknown	Unknown	Unknown
Gross margins (%)	Unknown	Unknown	Unknown
Net margin (Cedis)	Unknown	Unknown	Unknown
Net margin (%)	Unknown	Unknown	Unknown
Tangible costs	<ul style="list-style-type: none"> - Import cost - Storage - Transportation - Market development - Demurrage - Tax waiver fees - Additional fees (Bribes) 	<ul style="list-style-type: none"> - Import cost - Storage - Transportation - Services (Warranty) - Demurrage - Tax waiver fees - Additional fees (Bribes) 	<ul style="list-style-type: none"> - Import cost (Raw materials) - Standard VAT - Conversion cost - Storage - Transportation - Services (Warranty) - Demurrage - Additional fees (Bribes)
Intangible costs	<ul style="list-style-type: none"> - Bureaucracy - Locked business capital 	<ul style="list-style-type: none"> - Bureaucracy 	<ul style="list-style-type: none"> - Bureaucracy - Political costs
Tangible benefits	<ul style="list-style-type: none"> - Economic profit - Tax waivers 	<ul style="list-style-type: none"> - Economic profit - Tax waivers 	<ul style="list-style-type: none"> - Economic profit - Tax waivers - Mother company benefit
Intangible benefit	<ul style="list-style-type: none"> - Partnerships 	<ul style="list-style-type: none"> - Partnerships 	<ul style="list-style-type: none"> - Partnerships - Manufacturing monopoly

Source: Authors' creation.

*Exchange rate was based on the rate of 17 January 2023 with one USD = 12 Ghana Cedis

Figure 4 summarizes the marketing margin and cost-benefit structure of different transactions within the DIKS supply chain. This section focuses on the transactions between the importer and the end user and the importer and government agent or NGOs. This is because the sale in the supply chain is often performed directly with the farmers, government agents, or NGOs. When agents or contractors were involved, they could not be traced to identify the margins.

Suppliers-farmers transaction

As indicated in Figure 4, **tangible costs** identified for drip systems range from import costs, storage, transportation, service cost, demurrage, tax waiver fees, market development costs, standard VAT, and conversion costs, to additional fees (bribes). Import costs relate to the importation of drip pipes and accessories. Interplast also imports raw materials for the manufacture of drip pipes and tubes. Storage costs are incurred in storing imports, drip pipes, or tubes manufactured in the company warehouse, premises, or a rented warehouse. Storage cost per unit is usually not included in pricing the drip equipment by importers and local manufacturers.

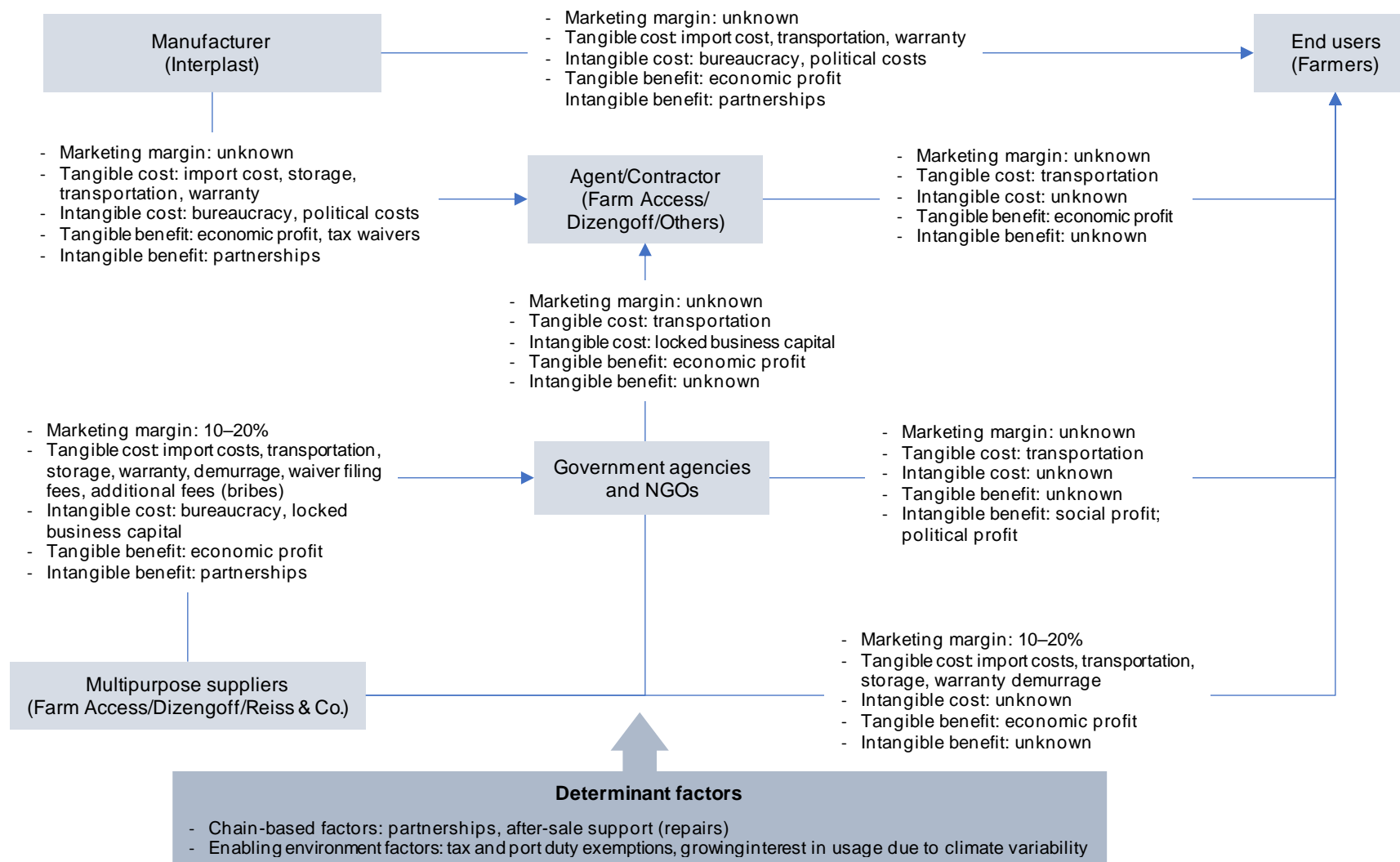
Transportation cost is incurred when moving the irrigation equipment from the port to the storage location and from the storage location to other actors in the chain or the end user. The importer bears the transportation cost from the port to the storage location and may add an estimated amount as part of the drip kits or systems' price. Transportation cost incurred between the storage location and the end user is borne by the end-users, who often arrange their transportation when buying drip systems. Where the end user is some distance away from the supplier, the public bus may be utilized by the supplier to transport the equipment. The transporting cost from the supplier to an agent may be absorbed by the supplier or charged at a subsidized rate: *'Interplast's policy for our agents is that we transport products to them free of charge'* (Source: Interview with Haidar Malhas, Interplast). The staff of importers who operate in other regions may also carry such equipment to agents or the end users at no fee when they happen to be traveling to that location for other projects or installations.

Service costs are expenses incurred for offering a warranty on products or installations. Farm Masters does not offer a warranty on products sourced from China but offers a two-week warranty on installation defects. Any other defects after the warranty period are charged to the end user. The amount charged depends on the cost of the replacement items, the distance travelled to the end user, hotel accommodation, and other expenses incurred by the service staff. On the other hand, Dizengoff and Interplast offer a better warranty on drip systems imported/manufactured and installations. Dizengoff offers a 1-year warranty against defects, and Interplast products may have up to a 5-year warranty. In contrast, installations have a 3-month warranty: *'The materials are warrantied for up to 5 years for manufacturing defects depending on the product. Warranty on installation is for 3 months'* (Source: Interview with Haidar Malhas, Interplast).

Demurrage is a fine or charge levied upon a courier or freight provider for not taking goods from a port within an indicated time. Importers are often allowed to store goods for several 'free' days, after which charges are applied. Demurrage is incurred when companies face delays in clearing goods from the ports. This may be due to challenges in accessing government waivers. Tax waiver fees are incurred by actors when applying for government tax waivers on agricultural imports.

Market development costs are expenses incurred by actors in the promotion of the use of drip technology. Some actors donate drip kits to farmers and institutions for demonstration purposes to encourage usage in the future: *'We give lots of the units out on demo or trial basis because of the people, when you tell them the price, then it scares them off'* (Source: Interview with George Tetteh Brown, Reiss & Co).

FIGURE 4. Marketing margin and the cost and benefit structure along the DIKS supply chain in Ghana.



Source: Authors' illustration.

As indicated by another actor: *'You know, as a factory, we're more interested in manufacturing and selling. The service is there to support the sales of the product, so we don't aim to profit from the services, but rather promote the products we manufacture. I put my business operating costs on the mother companies to promote the technology'* (Source: Interview with Haidar Malhas, Interplast). Others extend credit to creditworthy wholesalers for promoting drip technology: *'We have about 300 to 400 wholesale points in the country with big shops and warehouses. When you start, it's cash down, but when we see that they are okay in paying back, we give them credit with much caution'* (Source: Interview with Samuel Abbey, Dizengoff). Interplast bears other costs that importers in the chain do not bear. The company is charged a Standard Value Added Tax (VAT) of 19.25% on raw material imports. This is because Interplast also manufactures pipes that may be used in other industries apart from agriculture. Interplast also incurs conversion costs for converting raw materials into drip pipes and tapes.

Additional fees refer to bribes that companies sometimes must pay to government and port officials. This is done to facilitate their tax waivers or expedite their goods' clearance. Such fees were mentioned by almost all the actors interviewed in this study.

Intangible costs identified for drip systems include bureaucracy costs, political costs, and locked business capital. Of these, bureaucracy costs are incurred by actors due to the multiple government institutions that importers need to transact with for obtaining tax waivers and clearing goods from the ports. Time lost is another such intangible cost. Political cost refers to the loss of business to drip importers/manufacturers due to political activity. As mentioned by one actor: *'Sometimes a (government) project is announced, but there is no traceability. We submit a document, and suddenly it is either cancelled or put on hold.'* (Source: Interview with Haidar Malhas, Interplast). The lack of a transparent bidding process for government projects becomes an intangible cost for actors in terms of time wasted preparing bid documents and attending bidding events. Locked business capital refers to the inability of actors to use business funds because the funds are locked up in stocks—businesses selling drip equipment, therefore, may not have enough funds to take advantage of new opportunities in the market.

Moreover, the value of the business capital may devalue over time. The low effective demand for drip systems locks up the capital of actors who predict demand and stock up in anticipation of sales. One actor indicates the same: *'For the 2000 sqm, when we give them the price as 3,900 Ghana Cedis, they say it is expensive. None of the people who came for a proforma has come back for a sale. Even the small ones (30sqm and 150sqm), we have stocked them for a long time. That is why we give some out on a trial basis or even at a cost.'* (Source: Interview with George Tetteh Brown of Reiss & Co).

The identified **tangible benefits** for drip systems include economic profit, tax waivers, bulk purchase discounts, and mother company benefits. [Economic profit](#) and tax waivers are similar to earlier definitions applicable in the supplier-farmer transaction in SPIPs. Bulk purchase discounts may be given to government-funded projects or NGOs for buying several units. The percentage of the discounts often depends on the value of the purchase, payment terms, and the negotiation skills of the buyer. Mother company benefits refer to the cost savings of an actor by being part of a larger organization. InGreen, for example, enjoys the additional benefit of being part of a mother company. The mother company, Interplast, absorbs the costs of the irrigation unit, such as storage and utilities *'...because the irrigation business is much smaller than the rest of the factory, management has been boosting and supporting my department by not factoring the storage cost into my product.'* (Source: Interview with Haidar Malhas, Interplast).

Intangible benefits identified for drip systems are partnerships and manufacturing monopolies. Existing partnerships between drip importers and Interplast allow the importers to access supplies to meet tight project schedules quickly. Training programs organized by Interplast also aid in building actors' capacity to expand market activities. Interplast trains technicians for other actors, such as Farm Masters. These

technicians operate from several regions, offering installation and minor repair services. This benefits actors because it minimizes the cost and time of installation and repairs for the end user.

Interplast (*InGreen*) enjoys the additional benefit of having a manufacturing monopoly in the market, with no direct competitor in drip pipes and tape manufacturing. The business, therefore, spends less money on advertising its products online, on the radio, and in print media.

4.3.3 Determinant factors

There is some level of interaction and partnership among drip irrigation actors. Interplast is supporting by offering training on installations and improved technologies to other actors due to the availability of well-trained staff and experience: *'At Interplast, I have five certified plumbers, two landscapers and well-trained designers. I have 20 years of engineering experience from all over the world.'* (Source: Interview with Haidar Malhas, Interplast). As indicated in an interview, value chain actors can thus avail the opportunity to increase their potential: *'There is still a huge potential to reach on the market, so Interplast has agreed to train about 20 irrigation experts for us.'* (Source: Interview with Anthony Morrison, Farm Masters). Interplast also supplies pipes and accessories to other actors when their imports are delayed for urgent projects, as indicated below: *'The reason we had to buy from Interplast was that the process of getting the exemption is too cumbersome and very long. Sometimes, we are at the mercy of local companies that have stock because of the time schedules to complete a project.'* (Source: Interview with Anthony Morrison, Farm Masters). Importers and local manufacturers offer after-sales service to end users at a fee. The service fee is determined by factors including the extent of work to be done, distance to the farm, and the cost of replacement items.

Drip irrigation actors enjoy tax and port exemptions for agricultural imports. Challenges have been indicated, however, in accessing these exemptions, sometimes leading to demurrage: *'In Ghana, they'll tell you duties on agricultural equipment is free. By the time you are done running about for the letter, demurrage has already set in'* (Source: Interview with Kwabena Opagya Amoateng, AgroAfrica).

The interest in drip irrigation is rising in Ghana; increased awareness and climate variability have made farmers conscious about using water more efficiently. As expressed by one farmer: *'Water is not enough in my borehole, so I work with the drip. I know with the drip; I can manage it.'* (Source: Interview with Elijah Bobby Lugiga). The increase in the use of greenhouse technology and the advantage of drip to prevent fungal diseases has also promoted the use of the technology:

'We found that in the greenhouse, you can't do anything but drip. It's the usual way of delivering both water and nutrients in the greenhouse. You don't need human intervention. We use less water, and when we push less water into the atmosphere, our fungal infections are also reduced, so these are some of the reasons why we chose the drip system.' (Source: Interview with Selorm Agbavor).

However, according to some suppliers, the increased interest in drip irrigation has not yet given rise to significant sales. Opinions differ on why sales have not improved substantially. Some actors attribute this to farmers' inability to afford equipment: *'The interest in using drip irrigation is there. But the effective demand is flat. People want it, but to put down the money is the issue.'* (Source: Interview with George Tetteh Brown, Reiss & Co). Other actors see it as unwillingness on the part of the farmers to invest due to a dependency syndrome created by excessive NGO activities: *'Farmers are very wealthy. But due to the support they are getting from NGOs, they mostly pretend they don't have money. They don't want to do the investment themselves. They want to rely on donors.'* (Source: Interview with Samuel Abbey, Dizengoff). Farmers using drip systems in greenhouses and outside greenhouses were interviewed and were observed to express varying opinions. A farmer who grew vegetables in a greenhouse explained why she stopped using drip systems:

'The seeds became a problem, and the water too. When you cannot get the kind of varieties that can survive in the greenhouse, it becomes a problem. You can't use any kind of water, at least the water must be clean. So, when we started, we had to buy water to fill the tank. The market also wouldn't know that it is a special breed, so the market patronage too was a problem' (Source: Interview with Millicent, Saboro, Upper East).

A male farmer who stopped using drip in a greenhouse and started direct planting also explained that the decision was based on the high cost of drip irrigation equipment coupled with poor access to replacement parts. Another farmer also indicated that: *'With the drip, there are intervals, so you have to put the plant where the water is dripping. It is too labor intensive'* (Source: Interview with Lazarus Koyere, Upper East Region). An NGO also mentions the time-intensive nature of setting up and using drip systems: *'For a large-scale land, it needs a lot of care. You need to watch your drip lines to see if emitters are not blocked, amongst others. It needs some ample time. Also, for land preparation, you need to be careful how you do your ploughing to get a good slope and a well-levelled land for your drip lines so water can move through.'* (Source: Interview with Desmond Yesseh, iDE).

However, the local manufacturer Interplast has noted significant sales for drip systems: *'We started sales in 2017 at GHC 200,000 a year. We've exceeded that 1000 times now. It's increasing gradually.'* (Source: Interview with Haidar Malhas, Interplast). Farmers prefer Interplast for several reasons, as mentioned below:

'We chose Interplast because of consistency, quality, and because it's a one-stop-shop with good prices. Interplast has a variety of things we are looking for under one roof at a very competitive price. The other reason why we use Interplast is know-how. The Interplast people we deal with are very knowledgeable, so in dealing with them, we've decided to find out what things we need to use and what things we shouldn't use for each condition.' (Source: Interview with Selorm Agbavor).

'There are two reasons why we chose Interplast. One is we were looking for a supplier that could provide us with pressure-compensated drip lines for greenhouses. We were also keen on ensuring that we have the local capability in the country because also when you have challenges around maintenance, you want the services to be available.' (Interview with Akofa Ata, Ardhi Investment).

5. DISCUSSIONS

5.1 Marketing margins: Similarities and differences

Marketing margins vary from product to product. For **SPIPs**, marketing margins range from 10–25% at the supplier-farmers transaction because farmers pay a retail price. At the supplier-agent transaction, net margins range from 5–20%. Margins at this transaction are lower for three reasons. It is a measure to build and sustain the sales network for SPIPs. When lower margins are charged at this transaction, agents can sell products at the same price as the supplier sells directly to the farmer or slightly higher. This motivates farmers, often price sensitive, to buy products from the agent instead of traveling a long distance to buy from the supplier.

Furthermore, agents may buy multiple units at a time, buying at wholesale prices from the supplier. Finally, agents build business relationships with suppliers due to their frequent interactions. The existing business relationship allows agents to negotiate for products at a lower price and margin. These factors contribute to the lower margins at the supplier-agent transaction despite the cost structure being the same between the two transactions. Market margins for the agent/government agency/NGO-farmers transaction could not be calculated because of insufficient data. However, the cost structure of the agent/government agency/ NGO-farmer transaction differs from the earlier two transactions. Although

the agent may earn economic profit in this transaction, government agencies and NGOs often engage in this transaction for intangible benefits, including political and social profit.

In the **motored pumps**, market margins at the supplier-farmer transaction range from 8–20%. A farmer buys at the retail price, with the relationship between the supplier and farmer being mainly transactional. At the supplier–agent/distributor transaction, margins range from 5–8%, low due to the agents' access to multiple suppliers due to low market entry barriers. Agents, therefore, have several options for receiving stock and can bargain for lower margins from suppliers. Agents/ distributors also benefit from discounts offered due to bulk supplier purchases. Limited information from interviews hindered us from estimating market margins between the supplier and government agency/NGOs and between government agency/NGOs and farmers.

For **DIKS**, suppliers mainly import drip systems to meet project demands. Drip kits may, however, be stocked targeting small and medium-scale farmers. Marketing margins between the supplier–government agency/NGO and the transaction between the supplier-farmer are estimated to be between 10–20%. Government agencies and NGOs nevertheless have an advantage over the farmer. They can negotiate with the supplier for lower margins within the 10–20% range when the project value is high or involves purchasing multiple systems.

There are **similarities** across different products of SPIPs, motored pumps, and DIKS. Forex exchange fluctuations have a major influence on prices within all supply chains, because of the import-dependent nature of the supply chains. Also, marketing margins at each transaction depend on the transaction's volume and value and the existing relationship between the seller and the buyer. The highest margins accompany direct sales to end users because a retail price is applied. Further, business partnerships and collaborations lead to lower costs for actors within the chain. It minimizes the distance actors must travel to provide installation, repair, and maintenance services to end users. Knowledge sharing through training also helps build the actors' capacities within the chains.

Some **differences** were also observed. Motored pumps sell faster than SPIPs or DIKS due to the relatively low price coupled with several government activities promoting their usage. Profit-making actors are, therefore, able to turn around their working capital faster, minimizing their costs due to locked business capital. Actors also have different capacities to enjoy the government's tax incentives for agriculture. Well-established companies like Dizengoff have easier access to government incentives due to reputational advantage and the company's focus on agriculture. However, other companies that offer services to agriculture and other industries—Pumptech, HTC, Farm Access, and Interplast—have difficulty accessing these incentives. This results from the difficulty in differentiating imports for agriculture from that of other industries. Their costs from payment of import duties and taxes are increased, as a result, influencing the prices at all levels of transactions.

The level of after-sale interaction between the seller and the buyer differs across supply chains and between transactions. Interactions in the motor pump supply chain are mainly transactional. Contact after a sale is minimal. On the other hand, SPIP supply chain interactions are more dynamic. The warranty offered on products establishes a relationship that may require further contact after a sale.

Moreover, SPIPs are more complex than motored pumps and DIKS and may require regular servicing from the supplier. Motored pumps and DIKS are often serviced by farmers, minimizing the after-sale interaction. The continuous interaction between the buyer and seller for SPIPs may lead to additional business due to recommendations and upgrades by the farmer.

The marketing margins of the same type of transaction also vary across different supply chains. The margins are often higher when the supplier sells directly to the farmer. This is because the product is offered at a retail price, as the farmer often buys one or two units and does not have an established

business relationship with the supplier. This is in line with the findings on pesticide marketing by Abankwah et al. (2013), where the margin in supplier-farmer transactions was significantly higher than in supplier-wholesaler transactions.

However, a transaction between the supplier and distributor or agent has lower margins for several reasons. First, purchasing higher volumes and establishing business relationships allows distributors or agents to negotiate for lower margins. The supplier also uses this strategy to ensure the sustainability of sale networks. Farmers are price sensitive and may travel to the location of the supplier to buy if the price difference between the supplier and the distributor or agent is significant. Lower margins in sales to distributors or agents help the distributors and agents maintain their selling prices the same as or slightly higher than the supplier. Sustaining demand for products sold by the distributor or agent will help to establish the sales network. This benefits the supplier, bringing products and services closer to the end user.

5.2 Different strategies driving the marketing margin

Different actors adopt different strategies for marketing their equipment, leading to different marketing margins within the chain. These include project-driven, tangible-focused, and blended strategies.

The **project-driven strategy** focuses on earning margins by bidding for developmental and commercial projects. Government bids for agricultural projects may involve the provision of SPIPs, motored pumps, mechanization of groundwater sources using solar, electricity or motored pumps, or multiple agricultural equipment, inputs, and services. Depending on the supplier and their strategies to manage the challenges of supplying equipment and services to government projects, margins may be affected upwards or downwards. Margins may be significantly higher for government-funded projects due to, for example, payment delays, hedging against currency fluctuations, and corruption. Bureaucracies and funding challenges can lead to suppliers often receiving payment for equipment supplied and services rendered for several months or even years on government projects. Some suppliers, therefore, charge higher margins to cater for depreciation in the value of an investment in government bids due to payment delays. Higher margins may also be charged to hedge against currency fluctuations which may affect the supplier's ability to deliver products and services in the long term if currency fluctuations are unfavourable.

Furthermore, paying bribes to government officials to sign contracts and release funds for projects was also indicated to be a common occurrence. The supplier may increase margins to account for the illicit payments demanded by government officials. Government projects may also have lower margins due to bulk purchases. The government is the highest spender in Ghana and often buys products in bulk. Government actors can sometimes negotiate for lower margins from suppliers by giving a contract to suppliers with the lowest bids. Dizengoff and Reiss & Co are examples of companies that use this strategy for projects, including greenhouses, solar pumps, and drip systems.

Projects may also include commercial farmers who chiefly cultivate cereals, fruits, and vegetables for local and/or export markets. Margins charged depend on the size of the project and the payment terms. Large-size projects and projects with short repayment terms tend to attract lower margins. Farm Access and Dutch and Co. are some companies that have offered products and services to commercial farms, including Golden Exotics, Pinora, and Integrated Water and Agricultural Development Ghana (IWAD). Such products include solar pumps, diesel pumps, and drip systems.

The **tangible-focused strategy** emphasizes tangible costs and benefits in deciding on marketing margins to charge. Companies with this strategy do not emphasize partnerships and other relationships that may not yield tangible benefits in short to medium term. For instance, Hatoum Trading Company (HTC) utilizes outdoor marketing through billboards rather than word-of-mouth promotion due to participation in

farmer-related activities with other actors in the value chain. The tangible-focused strategy is the most common strategy in the reviewed literature, for example, Abankwah et al. (2013), Gachena and Kebebew (2014), and Odongo and Etany (2018).

The **blended strategy** focuses on a combination of tangible and intangible costs and benefits. Actors using the blended approach invest in building relationships that may not yield immediate benefits to the actor. This includes collaborations and participation in the value chain-, research-, and marketing-related activities. For example, Pumptech uses this approach to promote the demand-supply matching for the SPIPs it supplies. Relationships built with IWMI and active participation in exhibitions, trade fairs, and Farmers' Day celebrations have promoted Pumptech through word-of-mouth communication and communication materials developed by IWMI. On the other hand, traders may use these partnerships to fix prices of products/ services, as Gebretsadik (2020) reported in the case of sesame marketing in Ethiopia.

5.3 Changes in government policy influencing marketing margins

The Government of Ghana introduced the benchmark value in line with the World Customs Organization's policy of regularly reviewing the valuation database in 2019. The policy aimed to benchmark some products as per the prevailing world prices as a risk measurement tool, to reflect the true market dynamics of the commodities.³ As a result, some commodities, including irrigation equipment, enjoyed up to 50% discount on port charges. In February 2022, the Government of Ghana reviewed the benchmark value, bringing it down from 50% to 30%.⁴ Irrigation equipment importers will pay an additional 20% on port charges which may be passed on to the farmer.

Additionally, the Value Added Tax (VAT) for small to medium-scale enterprises has changed with varying impacts on irrigation equipment suppliers. This is due to the implementation of the Value Added Tax (Amendment) Act, 2021 (Act 1072). Under the Act, any trading company with annual revenue above 500,000 GHC must apply the standard VAT and additional levies totaling 19.25%. Initially, such companies were only required to collect 4% VAT/levies on their products. An increase in the rate may therefore be passed on to the farmer. The standard VAT in 2023 has been further increased by 2.5%. This brought the total VAT rate and additional levies on goods sold to 21%.⁵

Altogether, irrigation equipment importers in the industry may pay up to 37.75% more for imported goods before the changes in the benchmark value and VAT in 2022 and 2023. However, the impact is variable across actors. Interplast, manufacturers of drip pipes will have, however, a lower impact. This is because its pricing component already includes the standard VAT. Prices of small to medium-scale enterprises may, however, increase substantially to reflect the new changes in policy. This upward adjustment in tax and port charges will likely significantly increase the cost of irrigation equipment.

The performance or efficiency of a supply chain results from how well the actors in the chain are organized and how well a range of services supports the chain, also described as 'business development services' (Mgale and Yunxian 2020; Gurtu and Johny 2021). These services include research, input supply, communication, transportation, local administration, market information, and financial services. Market performance could often be improved by improving or gaining access to these services.

³ <https://gra.gov.gh/implementation-of-governments-policy-directive-on-removal-of-reduction-of-values-of-imports-on-selected-items/> (accessed March 1, 2022)

⁴ <https://citinewsroom.com/2022/01/reversal-of-benchmark-value-reduction-to-take-effect-from-january-4/> (accessed February 25, 2022)

⁵ <https://gra.gov.gh/domestic-tax/tax-types/vat-standard> (accessed February 5, 2023)

6. CONCLUSION

Focusing on solar-powered irrigation pumps (SPIPs), motorized pumps, and drip irrigation kits and systems (DIKSs), this study unpacks the supply chain's intangible costs and benefits structure. It examines the business operating environment, partnerships and interactions between actors that influence marketing margins and final price to farmers in Ghana. The results show that varying from product to product and from transaction to transaction, marketing margins range from 10–25%, 8–20%, and 10–20% at the supplier-farmers transaction for SPIPs, motored pumps, and DIKS, respectively. Actors have tangible and intangible costs and benefits impacting the margins they charge on their products. Marketing margins at each transaction depend on the transaction's volume and value and the existing relationship between the seller and the buyer.

The irrigation equipment supply chain is at a niche stage, consisting of a few actors playing multiple roles. Manufacturing costs in the country of import, foreign exchange dynamics, and other contextual and institutional factors in the business environment mainly determine prices. The chain's actors do not have a sizeable influence over equipment prices. Since imports dominate the industry, foreign exchange dynamics have a significant effect.

Taking a step further, this study identified three strategies that supply chain actors pursue to obtain the marketing margin. These are the [project-driven strategy](#), the [tangible focused strategy](#) and the [blended strategy](#). Depending on their business model, actors in the chain may choose the project-driven, tangible focused or blended strategy to obtain market margins. Partnerships and collaborations with other actors, including other suppliers, research institutions and farmers, may offer intangible benefits in future. Others may build lasting relations with their clients by maintaining a client database and following up on their farming progress after purchasing their products.

This study proposes some recommendations. For NGOs and development partners, intervention coordination will benefit farmers more. Collaborations with other actors working towards improving access to irrigation equipment for farmers will minimize duplication of effort and help minimize the tangible and intangible costs incurred by actors. Transportation and storage costs, for instance, may be reduced where interventions are coordinated among government ministries and between government agencies and NGOs. Co-designing and co-planning interventions will allow importers to import irrigation equipment just in time to meet the project timeline, minimizing their transportation and storage costs.

For facilitating the enabling environment, developing a master plan to support equitable irrigation development will curtail haphazard investments based on political or donor interests. Abandoned projects from previous political administrations will also be minimized, reducing the waste of resources. Simplifying the tax exemption process is another critical factor that encourages more irrigation equipment suppliers to apply for it. Providing online application systems or centralized units in regional capitals to serve as one-stop offices for tax exemption applications by government actors may be beneficial. The need to contact multiple government agencies makes the process slow, prone to corruption, and may lead to importers incurring additional costs in the tax exemption process.

Investing in the local manufacturing industry for irrigation equipment is key to significantly reducing equipment costs. It will also reduce the importation of low-quality brands that erode farmers' confidence to invest. The private sector should be encouraged to invest in the local manufacture of irrigation equipment using the Free Zones Scheme currently operated in Ghana. It is designed to promote the processing and manufacturing of goods by establishing Export Processing Zones (EPZs); it encourages the development of commercial and service activities at sea- and air-port areas. The Scheme combines both the enclave and single factory enterprise schemes. Organizations operating under it benefit from tax breaks on imports and exports and are regulated by the Free Zones Act of 1995 and the Free Zones

Authority.⁶ Adopting a similar approach to irrigation technology may encourage manufacturers to set up production or assembly plants in Ghana. This will reduce the cost of irrigation equipment and improve demand.

The limitation of this study stems from data availability, accessibility, and sensitivity. Access to data on farmers as end users is generally low because of poor customer data management and retrieval systems. It is, therefore, impossible to trace to fully understand their tangible costs and benefits in the transactions between, for instance, importer/manufacturer and farmer, and supplier and agent/Government agency/NGO. Certain information was also available but was too sensitive in nature to be shared by some actors. While some actors were unwilling to share such business information, others provided a range to indicate costs and/or margins. Costs such as warranty, demurrage, and tax waiver fees, for instance, could not be adequately estimated due to this limitation.

Additionally, some actors assess costs as a lump sum, making it difficult to estimate the cost per unit. Other actors also do not consider some costs when estimating prices or margins. Storage cost, for instance, is often not considered where actors own warehouses or store goods in their offices.

Finally, the qualitative approach is useful in understanding the cost and benefit structure and the context of the supply chains beyond numerical values. However, it is limited in quantifying the values necessary to estimate marketing values across the supply chains. This study could not obtain a significant portion of the tangible costs and benefits required for measuring marketing margins due to the sensitive nature of the information in conjunction with the qualitative approach adopted. Followingly, the study's findings may be enriched with a quantitative study which undertakes a deep dive into quantifying the costs and benefits of the marketing margin.

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