

Digital Inclusion for Resilient Post-COVID-19 Supply Chains: Smallholder Farmer Perspectives

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Abstract—The coronavirus (COVID-19) pandemic has and continues to have far-reaching global economic and environmental implications. In developing economies and regions, the pandemic's disruption of the agriculture commodity supply chain has made it difficult for smallholder farmers to exist. Smallholder farmer's traditional struggles have worsened. However, technology may provide promise of improving conditions for vulnerable farmers even in a period of crises such as the COVID-19 period. In this article, we draw on lessons learned in developed and developing countries to propose critical digital transformation for building a resilient and sustainable post-COVID-19 supply chains for developing countries, especially for smallholder farmers operating in global value chains. We discuss how digital technologies and specifically digital inclusion of smallholder farmers can prevent major disruptions from damaging the livelihoods of society's most vulnerable. We discuss feasibility and provide some caveats for a post-COVID-19 digital inclusion in developing countries.

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I. INTRODUCTION

MANY farmers and agricultural workers in the *Global South* are feeling the economic effects of coronavirus (Covid-19) pandemic forces. The health impacts are yet uncertain and are unlikely to be negligible. COVID-19 has disrupted the global supply chain—of which the agriculture supply chain, a focus of this article, is especially disrupted.

The COVID-19 pandemic sustainability implications will likely result in pervasive societal changes after the crisis subsides [1]. Sustainability implications of COVID-19 have begun to manifest. Even before the crisis, almost a billion people worldwide experience chronic hunger and whose access to food has become even more limited due to disruptions in the agriculture supply chain [2].

Border closures, production shutdown, and restricted exports have contributed to inflationary prices impacting the world's poorest and most vulnerable populations [3]. In the cocoa sector, lockdowns have disrupted the global supply chain. Several countries that import cocoa from Ghana, a major cocoa exporter, are under lockdown, forcing the closure of many cocoa processing plants.

Although inflationary pressures do exist, some areas are facing depletion of income due to unbalanced demands. The Ghana Cocoa Board lamented a fall in cocoa prices, causing difficulty in paying smallholder farmers who depend on the cocoa income for livelihood. The smallholder farmer becomes even more vulnerable due to cocoa price decline, lack of access to markets and essential services, and harvest difficulties due to illness [4].

Although the conditions of developing countries smallholder farmers such as those in Ghana have worsened; some farmers in developed countries prosper during the pandemic by adopting online ordering and home delivery through digital transformation [5]. Digital innovation can be the fine line between prospering and faltering during lockdowns and other commerce barriers.

Can this situation allow us to rethink—as an example of commodity market supply chains—the flawed global cocoa supply chain? Can this be a learning event to invest in long-term, resilient, and sustainable digital transformations to benefit the world’s vulnerable smallholder farmers in developing countries?

We draw on lessons learned in developed and developing countries to propose critical digital transformation for building a resilient and sustainable post-COVID-19 supply chains for developing countries. How digital technologies and specifically digital inclusion of smallholder farmers can prevent major disruptions from damaging the livelihoods of society’s most vulnerable are discussed. However, we also reason why the road may not be as easy, yet the transition needs to be seriously considered and hopefully commence.

II. PLIGHT OF SMALLHOLDER FARMERS DURING THE COVID- 19 PANDEMIC

The most vulnerable groups affected by agriculture supply chain disruptions are smallholder farmers, pastoralists, and fishermen [6]. These smallholder farmers are the foundation of the cocoa supply chain in developing countries. They are separated from end markets through long and complex supply chains [7]. During the COVID-19 crisis,

smallholders face challenges in market access to sell their produce.

Lockdowns have disrupted traditional market interactions between buyers and sellers in cocoa and other supply chains. This situation compels smallholders in agriculture supply chains to accept prices well below traditional market periods. Even in regular time periods, they receive a very small fraction of the ultimate value of the commodity product [8].

Fortunate smallholder farmers who do find buyers are concerned about receiving the cash for the fear of COVID-19 transmission. Although, the World Health Organization (WHO) has not issued any warning or statement on COVID-19 transmission through physical money, many are taking precautionary measures. As a precaution, WHO has supported the use of contactless payments; in some cases, banks disinfect cash with ultraviolet or heat treatments to prevent contagion [9]. There are many contagion conduits for face-to-face transactions.

Smallholder farmers face upstreams supply chain challenges. Their access to essential agricultural supplies, including fertilizer, seed, and insecticide, is severely limited. Border closures in response to the pandemic have exacerbated the situation. Sellers have resorted to price gouging smallholders. Smallholders are feeling cost and price pressures on both sides of their supply chain.

Smallholders find it more difficult to get information and services from agriculture experts during the crisis. For example, smallholder farmers would gain knowledge and expertise from government Agriculture Extension Officers on fertilizer application, disease control, and sustainable farming methods to increase the farm yield. This training has slowed. Smallholder livelihood

and sustainability of the cocoa supply chain is at risk.

To reduce the COVID-19 impact, organizations have resorted to digital technology. Cargill, Hersheys, and Farmerline have developed digital solutions to assist smallholders. It is likely that a COVID-19 remnant is that it will ignite discussion on adopting digital transformation to the global cocoa supply chain, and other commodity supply chains. But, appropriate digital innovations for smallholders in developing countries need to be determined. Also, lessons can be learned for developing countries from developed country digital inclusion of smallholder farmers. These issues are now discussed.

III. DIGITAL TECHNOLOGIES FOR SMALLHOLDER FARMERS IN THE COCOA AND AGRICULTURAL SUPPLY CHAIN

Digital technologies such as sensors, drones, satellites, climate-smart agriculture, and blockchain are promising developments for global cocoa and commodity supply chains. These new technologies have led to a fourth agricultural revolution or *Agriculture 4.0* [10].

Even with the hype, digital technologies adoption in the cocoa supply chain has been slow [11]. Adoption challenges include the implementation cost, low awareness of benefits, mistrust, and technical difficulties. Institutional actions can minimize the challenges, reduce adoption constraints, and improve sustainability and ultimately support digitalization technologies.

Digitization for smallholders has improved access to services and enhanced smallholder market inclusion [12]. Inclusiveness typically refers to the integration of

smallholders into markets, where activities benefit the business community while enabling poverty alleviation [13]. Examples of digital solutions for smallholders are *MPESA* in Kenya and Cargill's *FarmForce*. Despite smallholder digitization benefits, full potential has yet to be achieved. Smallholder farmers remain tied to traditional farming methods, cash transactions, and manual product sales to buyers, especially in developing countries.

Digital innovations are showing some promise for farmers in selected rural areas. The Chinese government is working with private companies, including Alibaba, to digitize farming. From web portals to mobile Internet-based services, rural farmers benefit from advice and capital on expanding access. These web-supported portals increase productivity and earnings. If policymakers and managers adopt these transformations in developing countries, it will make the cocoa and other agricultural commodity supply chains more resilient and alleviate suffering for developing country smallholders. Case examples from the cocoa commodity supply chain—especially in Ghana—are provided in the following section.

IV. DIGITAL INCLUSION FOR POST-COVID-19 COCOA SUPPLY CHAIN RESILIENCE AND SUSTAINABILITY

We, therefore, propose the need for the following transformations in the post-COVID-19 cocoa supply chain.

A. Digital Payments to Secure Financial Inclusion for Smallholder Cocoa Farmers

Ghana can adopt the universal use of electronic money in the cocoa transaction. In developing countries like Ghana, transactions in the cocoa sector are purely by physical cash. This traditional way of

cocoa transactions subjects buying companies and smallholders to robbery attacks, fraud, and thefts. Digital payment services enable cocoa buyers to access digital records of payments made to farmers. This service helps to map the flow of cocoa sales from the individual farmer to the cocoa buyer to the exporter. Also, it enables cocoa farmers' access to financing mechanisms, which increases productivity.

Furthermore, the digital payment can be used to purchase inputs, reduce the time spent in traveling to make payments, better control their finance. For instance, in the early 1980s, Ghana COCOBOD introduced the *Akuafu Cheque System* to eliminate the physical handling of cash throughout the cocoa supply chain. Unfortunately, this initiative failed because of the unsuitable enabling environment at that time [14]. Recently, Cargill has reactivated the need for digitization through the introduction of digital payment to farmers and other players in the cocoa supply chain. Cargill's initiative met many challenges such as low rural Internet penetration, illiteracy, high cost of data, and little use of smart devices.

Notwithstanding these setbacks, the company has been successful in ensuring trust and transparency with their farmers and other actors in the supply chain. Also, The World Cocoa Foundation (WCF) partnered with the Better Than Cash Alliance to assist cocoa companies in transforming from physical handling of cash to digital payments [14]. The mobile Network Operators provided an enabling environment for this initiative. This innovation is also yielding some positive results. As a result, Ghana Cocoa Board has embraced this initiative implementing it with the Licensed Cocoa Buyers Association of Ghana (LICOBAG).

Consequently, many Licensed Buying Companies (LBC) have established digital payment solutions within their business operations. In other African countries with massive exposure to digital innovation, mobile phones have dramatically enhanced financial transactions such as *MPESA* in Kenya and *Agrikore* in Nigeria. Therefore, we recommend using digital payments in the entire cocoa supply chain after the COVID-19 to eliminate all problems associated with physical transactions, especially in this pandemic period, where handling of cash poses a threat to the human life. It will also eradicate all acts of corruption and theft, thereby establishing a high sense of confidence and accountability in cocoa operations.

B. Blockchain Technology to Connect Buyers Directly to Smallholders

Smallholder cocoa farmers encounter many intermediaries before cocoa beans are processed locally or exported. LBCs are represented by agents called purchasing clerks (PCs). These PCs work on commission and deal directly with farmers. PCs may also have local buying assistants—sub-PCs—who buy directly from smallholder farmers. LBCs entrust money into the hands of middlemen to purchase cocoa. Corrupt PCs and sub-PCs sometimes do not pay smallholder farmers after they have taken the farm produce. Blockchain technology can play a significant role in reducing middlemen, disintermediations and may allow smallholder farmers to directly connect with buyers and end-users, reducing the possibility of corruption [13].

Application programming interfaces (APIs) can aide matching cocoa sellers and buyers. APIs can immutably link sustainability and fair labor attributes to cocoa products, helping to prevent unscrupulous actors from exploiting smallholders during a crisis like the COVID-19 pandemic. Blockchains can facilitate

“smart contracts” to automatically execute cocoa contract deliverables and payments.

These blockchain features can reduce the duration and severity of difficulties facing smallholder farmers in the global cocoa supply chain. Given the profound and devastating effects of this pandemic on smallholders, it may be time for revolutionary changes in the cocoa supply chain that will allow actors, especially smallholders, to emerge stronger and more resilient.

Blockchain example cases exist in this environment. Cellulant Agrikore blockchain solution uses blockchain technology to connect smallholder farmers directly to commodity buyers, and agriculture inputs suppliers, financial institutions, insurance companies, and other development partners in a trusted ecosystem in Nigeria and other regions in Africa. In Ghana, AgroCenta provides an online platform that connects smallholder farmers in the staple food value chain—maize, rice, millet, and soybeans—to a broader online market. It also provides access to delivery services and real-time market information, delivered on mobile phones via SMS and voice services. As of November 2019, AgroCenta has registered 46 100 smallholder farmers on the AgroTrade platform across four regions and 512 communities [15].

These technologies enable smallholder farmers to access direct markets and financial services to allow buyers to access pandemic situations.

C. Adopting Digital Training Systems for Cocoa Experts and Smallholders

The right information at the right time is critical for crop protection. For years, the Ghana Cocoa Board offered technical support and training to farmers through the cocoa health and

extension division (CHED). The CHED officers are community-based agents who assist local farmers with better farming practices. They train farmers in pruning, pest and disease control, cocoa pollination, and fertilization. They may also train lead farmers who, in turn, train their fellow farmers.

The COVID-19 crisis exposed traditional farmer training services vulnerability. Farmers cannot be trained because trainers cannot render traditional face-to-face assistance. Online training may overcome this specific barrier; the use of instructional videos may also reach farmers. Farmers can use a mobile app to provide technical services.

Trainers can draw on the experiences of plantwise-digital devices that facilitate the work of plant doctors by sharing disease data between smallholders and experts. The use will prevent farmers' inability to access essential services even after COVID-19. Cocolink, MergeData, Esoko, and Farmerline are examples of online training and information sharing. The value of these tools and methods becomes more obvious in emergency periods, and provides a feasibility test for post-COVID-19 training.

D. Introduce Online Sales Portals for License Buying Companies

The cocoa supply chain has many activities and actors. A smallholder farmer encounters many intermediaries as cocoa beans are processed locally or exported. Ghana's cocoa supply chain has four main levels: the farmer level, society level, district level, and the takeover point or ports [14]. A specific standard operating procedure to guarantee food safety and traceability exist at each level.

These operating standards may involve specific batch identification,

time and location data, and systems requirements. LBCs purchase cocoa from farmers at a district level. PCs work on commission and operate within societies while dealing directly with farmers. PCs buy, prepare, and deliver cocoa to the district officer at the district depots. District officers prepare cocoa for grading, sealing, and delivery to the port for takeover.

Payment exchanges and activities can be moved onto an online marketplace where sales advertisements will be rendered to the final destination. This does not remove the human interface entirely; however, it makes big data accessible for decision making. All transactions are recorded electronically, and thus, data are accessible at the right time. The UTZ Good Inside Portal—a voluntary cocoa certification scheme—is an example of an online cocoa trading platform for private enterprises. Large-scale adoption in Ghana's cocoa supply chain will be beneficial to the farmers and the entire actors in the chain; something that can be further evaluated in COVID-19 and post-COVID-19 management of the cocoa supply chain.

E. Embarking on Smart Village Projects

Energy is the foundation of digital technology. There is a need to provide reliable, cheap, and sustainable power for any technological innovation adoption by smallholders primarily living in underdeveloped rural areas with limited electricity access.

IEEE Smart Villages is an exemplary program that seeks to provide sustainable renewable energy services to rural communities. This initiative enables digital connectivity for new information and communication technologies [16]. The smallholder farmer can more effectively use mobile phones and other electronic gadgets in times of restrictions on human contacts such as the COVID-19 period.

Secure and reliable energy is derived from the smart village project's renewable dimensions, which can help farmers establish microenterprises and diversify their incomes away from the volatile agriculture commodities trade.

F. Encourage Local Processing Companies

Like most developing countries, Ghana exports about 80% of its annual production of cocoa and locally processes only about 20%. The international trade environment has been slowed due to COVID-19 as borders are closed. This global supply chain relationship makes it difficult for smallholder farmers who may not be able to sell their harvests.

To boost cocoa purchases when exports are interrupted, there needs to be more local processing capabilities. Supporting smallholder farmer cooperatives to acquire basic technology to process cocoa beans into wine, animal feed, and chocolates are necessary. Apart from smallholder cooperatives, there need to be enabling digital infrastructure for local processing. It is essential to promote the consumption of local cocoa products made in developing nations locally and internationally; social media and digitization of information can greatly benefit localization capacity. As digitalization increases, this post-COVID-19 environment becomes more realistic.

G. Adopting Precision

Agriculture There is a need to modify smallholder farmer production systems through the use of farm technology that can include drones, farm market apps, and satellite monitoring of crop performance. These activities can be linked to Big Data Analytics and the Internet of Things (IoT) to help transform traditional agriculture into modern ones; and can be completed at a relatively economically reasonable cost. An example is a project called

“Transforming Africa’s agriculture: eyes in the sky, smart techs on the ground,”¹ which supports the use of drones for farming. These technologies will reduce human interface and ensure an uninterrupted smallholder farmer supply chain in times of restricted movement. Despite its implications on human labor, we believe it is a safer approach to build a resilient and sustainable post-COVID-19 cocoa supply chain; even during the pandemic—or other crises—these technological tools can be important for supply chain partners and can keep the smallholder farmer operational.

V. FEASIBILITY OF POST-COVID-19 DIGITAL INCLUSION

Several digital technological recommendations have been made to help smallholder farmers business continuity, especially in developing nations. The feasibility of these activities may be called into question and rightfully so. There needs to be operational and economic feasibility. The technologies exist, so technological feasibility is not a major issue.

Operational feasibility means that smallholder farmers must be able to operate these technologies. There are infrastructural requirements, and awareness-raising, training, trust, and reliability concerns. The concerns here can be mitigated through help from the governmental action and investment. And in countries such as Ghana and Nigeria, these efforts are occurring. But, operational feasibility can also be managed by nongovernmental organizations, such as IEEE Smart Village or for-profit corporate partners.

The for-profit partnerships may require some investments in training,

¹See: https://cgspace.cgiar.org/bitstream/handle/10568/101306/2080_PDF.pdf

yet the benefits of such training can be more reliable and inexpensive sourcing of material such as cocoa. The benefits can also be social and environmental from better operations. The reputation and image of these larger organizations can improve if the smallholder farmer’s situation improves. This investment can improve competitiveness for some basic commodity channels.

Relatedly, economic feasibility must also occur. In many cases, farmers may have access to some mobile phones and rudimentary computing capabilities. The additional costs may be the development of applications. Still service providers may be able to subsidize applications and even technologies by helping with various sustainability efforts and improving smallholder fair trade situations.

Thus, feasibility exists. In these uncertain times, it may be the best time to try these various digitization activities. Distancing, isolation, and health concerns can overcome technology adoption barriers, especially if the alternative is losing your business. These are not easy activities, and substantial coordination and effort are required. Not all of it has to be face-to-face, and this is one dimension where acceptance of virtual communication may provide benefits to smallholder farmers to pursue digitalization.

VI. CONCLUSION

In this article, we shed light on digital transformations necessary to build a resilient post-COVID-19 smallholder (cocoa and other agricultural commodities) supply chain to improve the livelihood of vulnerable smallholders and the entire supply chain. We provided some examples of success stories and potential success stories. We believe that Ghana and other developing countries may have laid the foundation. It may be the best time to

adopt these technologies to benefit the bottom of the pyramid and the smallholder agricultural supply chains. However, we believe some pertinent issues need to be considered to make these transformations successful.

The first concern is how to utilize existing platform technologies and merge with emergent technologies for digital inclusion. For example, Farmerline and AgroCenta with emergent artificial intelligence, blockchain, global positioning, 5G, and cyberphysical systems.

Also, there is a concern about the roles and effectiveness of various stakeholders and institutions in the digital transformation. For example, LBCs, private multinational firms,

NGOs, governments, and local communities have roles in introducing or managing the technological innovations in the cocoa supply chain for sustainable development.

A. Caveats Digital inclusion can increase productivity and resilience while reducing the vulnerability of hundreds of millions of smallholder farmers. However, we observe that digital technologies and approaches alone will not increase the post-COVID-19 commodity supply chain resilience or improve the livelihoods of smallholder farmers who participate in complex systems.

Previous investments in research, development, and some technology transfers have not transformed smallholders' livelihood in developing

countries. Evidence suggests that top-down command and control systems for technology diffusion do not generate sustainable change [17].

The challenges related to digital inclusion faced by smallholder farmers in developing countries are complex. They involve new and specific types of collaborations and opportunities to bring together industry players with diverse viewpoints, positions, and responsibilities. Instead, these actors need to participate, represent their interests, and negotiate for mutually beneficial results. Digital inclusion is a feasible path forward for smallholder farmers, but without substantial investment in the enabling environment like participation and collaborations, it will not achieve its potential.

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