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Strengthening the Value Chain Resilience of Indonesian Agricultural Fintech in the Aftermath of the Covid-19 Pandemic

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ABSTRACT

Following the COVID-19 pandemic, the default rate for Indonesian agricultural fintech remained elevated at seven percent. Agricultural fintech companies and their farmers must develop a strategy for the agricultural fintech value chain resilience. This descriptive study aims to develop risk mitigation and recovery strategies for agricultural fintech in Indonesia. It uses a survey to gather data from fintech value chain actors, which is then analysed using the House of Risk model. The priorities are cash flow management, the minimum payment amount and leeway, the harvest price contract, the procurement of seed and fertilizer agro-inputs, and the harvest supply contract.

Keywords*: Fintech value chain; house of risk; mitigation; recovery; value chain risk.*

1 Introduction

The financial technology industry in Indonesia has grown significantly in recent years, from 24 companies in 2016 to 352 in 2021. These companies offer a range of products including digital payments, crowdfunding and innovative financial planning solutions. However, the industry was affected by the COVID-19 pandemic, with most fintech companies experiencing a decline in sales due to reduced numbers of users in several business areas, including agriculture. In addition, the pandemic resulted in lower productivity and efficiency, difficulties in fundraising, and increased market and operational risks, all of which stalled business expansion efforts.

Fintech companies have been slow to adjust their business models and formulate future targets, and some have implemented policies to strengthen cash management, terminate employment, enforce unpaid leave and cut salaries. While these policies have positively impacted the fintech companies' internal conditions, they have also negatively impacted actors along the value chain, including employees, investors and borrowers, and increased the potential for bad loans.

One example is the peer-to-peer lending industry, where the level of non-performing loans increased during the pandemic, resulting in debt repayment defaults and a rise in default rates. This also affected the rate of return, which fell to 92.01%. Fintech companies have generally focused on short-term strategies, such as credit restructuring or assistance with the credit insurance claim process. However, comprehensive and integrated long-term mitigation strategies that address upstream and downstream situations have not yet been observed.

Preventing bad loans requires addressing production and marketing risks in the agricultural sector, particularly during the pre-planting, planting and maintenance, harvesting, and post-harvesting stages, as well as in the marketing of crops at the farmer level. Atta and Micheels (2020) highlight that production and marketing risks, such as variations in output prices, variability of rainfall and changes in input prices, pose significant threats to the agricultural sector.

In the aftermath of the COVID-19 pandemic, the default rate of Indonesian agricultural fintech remained high at seven percent. Each actor in the fintech value chain in the agricultural sector must develop a value chain resilience strategy. Linkov et al. (2020) and the Asian-Japan Center (AJC) (2020) propose that such strategies be called value chain resilience. According to Tieman (2017), a value chain resilience strategy can take the form of mitigation and risk recovery that is integrated and collaborative. Consequently, risk mitigation and recovery strategies involving actors along the value chain must be designed to prevent the adverse effects of the COVID-19 pandemic from exacerbating the situation for fintech industry players in the agricultural sector.

This study aims to identify the risks and their agents, measure the level of risk, and develop risk mitigation and recovery strategies for agricultural fintech. These strategies will serve as an action framework for agricultural fintech actors in the post-pandemic era. This study also provides solutions to problems faced by the agricultural fintech value chain.

The literature review in the next chapter serves as the foundation for this study. In the third chapter, we explain the research design and data analysis methods. The results of this study are presented in chapter four, the Results and Discussion chapter. In the fifth and final chapter, we provide conclusions and recommendations based on our findings.

2 Literature Review

2.1 Agricultural fintech value chains

Mapanje et al. (2023) posit that the advent of agricultural fintech has transformed the value chain system. Agricultural fintech has digitalised the value chain (Küçükçolak et al., 2022), and it has been demonstrated that the fintech value chain approach can address various challenges in the agricultural sector, including financing (Maryam and Ahamad, 2021).

Agyekumhene et al. (2018) and Ansari et al. (2019) conducted studies on digital technology in agricultural financing. Agyekumhene et al. (2018) found that digital platforms have the potential to create new forms of networking and financial cooperation among actors in Ghana's maize value chain. However, the success of leveraging digital platforms does not solely depend on digital access and inclusion for farmers but also on effective intermediaries and network governance in agricultural ecosystems. Ansari et al. (2019) developed a platform that integrates agricultural business processes across various actors, using smartphones as multipurpose devices to facilitate all agricultural business transactions, including personal services, market price transparency and digital payments. These two studies describe the role of digital platforms in financing agricultural businesses, and provide solutions based on technical processes.

Sadia et al. (2018) evaluated fintech supply chains based on Agri-Blockchain (Agri-BC), making the processes more transparent and eliminating traditional supply chain intermediaries. Ningrat and Nurzaman (2019) examined the

development of an Islamic agricultural fintech value chain system that integrates all agribusiness actors from different market segments, including landowners, suppliers, farmers, brokers, retailers and investors, into a platform based on the Sharia system or Islamic values. Khan et al. (2021) described an Islamic agricultural fintech business model that uses *waqf* (a kind of inalienable charitable endowment). This fintech value chain system develops under normal circumstances.

The fintech industry, including fintech in agriculture, faces significant challenges owing to the COVID-19 pandemic. These challenges include the accelerated digitalisation of financial services, a slowdown in economic activity, the declining performance of debtors such as farmers and MSMEs, and various risks (Tripalupi and Anggahegari, 2020). It is imperative that companies, including fintech firms, and particularly those operating in the agricultural sector, develop value chain resilience to mitigate these risks and adapt to changing market conditions.

2.2 Value chain resilience

Resilience assessments can reveal the benefits of inefficiencies such as unused capacity, which may be critical during periods of disruption. Thus, resilience analysis can protect and encourage the creation and delivery of broader system values, even in the face of loss. Methodologically, assessing a system's value chain resilience requires demarcating the boundaries of that which falls under its functionality and anticipating its ability to adapt by learning from past experiences (Linkov and Trump, 2019). Anchor agencies play a significant role in the resilience of food value chain systems (Cunningham et al. 2023).

Agricultural value chain resilience has received limited attention in recent studies. Wenban-Smith et al. (2016) studied value chain resilience in developing countries, with particular regard to food resilience. Ali et al. (2022) found that food value chains are more resilient when they collaborate with domestic and global partners rather than with international partners alone. Vroegindewey and Hodbod (2018) used the concept of socio-ecological resilience to conceptualise food value chain resilience. Olafsdottir et al. (2018) developed a VALUMICS project for modelling value chains resilience in food systems. Doherty et al. (2019) emphasised the complex resilience of value chains and argued for a comprehensive research agenda for food system resilience.

Aboah et al. (2019) identified resilience elements relevant to tropical agriculture value chains. McIntyre et al. (2019) demonstrated that resilience and adaptability are key attributes for creating agribusiness value. Canevari-Luzardo (2019) examined the relationship between the network structure of value systems and the ability of agribusinesses to adapt to climate change, highlighting the benefits of resilient systems for enhancing the adaptive capacity of actors. Ludi et al. (2019) concluded that a value chain resilience system could support climate-resilient economic development. Linkov et al. (2020) developed value chain resilience in the agricultural sector during the Covid-19 pandemic. They suggested a quantitative method and incorporated the element of disruption in evaluating the resilience of the value chain. Manyise and Dentoni (2021) emphasised the importance of balancing economic, social, and environmental aspects in food value chain resilience. Brassesco et al. (2022) explored the significance of an integrated agri-food value chain resilience.

2.3 Mitigation and Recovery of Value Chain Risks

The COVID-19 pandemic has had a profound impact on societies and economies, and has tested the resilience of value chains. Hosseini et al. (2019) noted that the industry has established resilience mechanisms, such as risk mitigation inventories, subcontracting capacity, backup supply and transportation infrastructure, omnichannel distribution systems, flexible production technologies, and data-driven real-time monitoring and visibility systems, that enable companies to weather the pandemic.

Risk assessment is of paramount importance for identifying potential hazards within a system. However, an accurate risk assessment cannot be conducted if a hazard cannot be predicted (Park et al., 2013). The lack of reliable statistical data, such as information on possible hazards and their consequences, further hinders risk management practices, including enterprise risk and business continuity management. Tieman (2017) suggested building value chain resilience through the implementation of mitigation and recovery strategies. Ewertowski (2022) presented a mitigation strategy to reduce risk in the aftermath of the Covid-19 pandemic. Paul et al. (2023) proposed a recovery strategy that considers dynamic and uncertain situations. Specifically, for the fintech industry, Pham et al. (2022) proposed a spreading approach to recover fintech organisations following the Covid-19 outbreak by diversifying products and consumers, with a focus on legal risk and resource management.

Finally, it is essential to enhance the resilience of fintech in the agricultural value chain during the ongoing Covid-19 pandemic. The agricultural fintech value chain can be maintained by reducing risks during normal situation; however, it is necessary to recovery the value chain's risks during this pandemic. Rouhanizadeh et al. (2022) have emphasized that mitigation and recovery are closely related to post-disaster situations. Mitigation involves minimising the damaging effects of a disaster, whereas recovery involves restoring normalcy after being affected by a disaster.

3 Methods

3.1 Research design and instrument

This study uses a descriptive survey approach, encompassing three agricultural fintech Peer-to-Peer (P2P) platforms, 30 lenders, and 90 borrowers. This study also adopts the value chain risk concept, as advanced by Calatayud and Katterer (2016), comprising the following dimensions: market risk, including market uncertainty and changes in market rules; operational risk, comprising supply, production and administrative uncertainties; credit risk, including collateral uncertainty and agricultural segment uncertainty; and liquidity risk, including payment cycle uncertainty and the financial health of farmers or companies.

3.2 Data Collection

We conducted structured interviews and distributed questionnaires to gather quantitative data from agricultural fintech P2P lending companies and farmers acting as borrowers, utilizing all the questions in Appendix 1. We also interviewed lenders to gather their advice using the third question in Part 1 of Appendix 1. As part of our document analysis, we collected relevant information from the research site.

3.3 Data Analysis

The data analysis adopted the House of Risk (HOR) technique from Pujawan and Geraldin (2009). The steps are as follows:

- Identifying risk events and their risk agents in the fintech value chain.
- Assessing the impact or severity of a risk event (if it occurs). This assessment uses a 1-10 scale on which 'one' indicates not severe and 'ten' indicates very severe.
- Assessing the occurrence likelihood of a risk event. This assessment uses a 1-10 scale on which 'one' shows that something does not occur and 'ten' shows that it occurs very often.
- Assessing the relationship between each risk event and each risk agent illustrated in a relationship matrix. Rij (relationship) {0, 1, 3, 9} with a value of 0 indicates no correlation, while 1, 3, and 9 indicate low, moderate, and high correlation.
- Calculating the aggregate risk potential of agent j (ARPj) using the following formula:

$$ARP_j = O_j \sum S_i R_{ij} \quad (1)$$

Where: ARPj: Aggregate Risk Potential of Agents j
Oj: Value of occurrence
Si: Value of severity
Rij: Value of relationship

- Ranking risk agents based on potential aggregate risk from the highest to the lowest value.
- Selecting a high-priority ranking for a number of risk agents using Pareto analysis of ARPj to be mitigated or recovered.
- Identifying relevant strategies to prevent risk agents. Several strategies can overcome one risk agent, and one strategy can overcome several risks with one or two positive signs.
- Determining the relationship between each strategy and each risk agent, Ejk. The value 0 means that there is no relationship, 1 is a low relationship, 3 is a medium relationship, and 9 is a high relationship between action (k) and agent (j). This relationship (Ejk) shows the level of effectiveness of action k in reducing the occurrence of risk agent j
- Calculating the total effectiveness (TEk) of each action using the following formula:

$$TEk = \sum ARP_j . E_{jk} \quad \nabla k \quad (2)$$

Where : $\sum$ARPj: Sum of aggregate Risk Potential of Agents j
E_{jk}: Value of each risk agent
∇k: Value of action k

- Assessing the level of difficulty in carrying out each mitigation or recovery action (Dk) using a Likert scale, other descriptive scales and/or other sources needed during the mitigation or recovery actions.

- Calculating the ratio of the Total Effectiveness (TEk) to difficulty level (Difficulty Dk) using the following formula:

$$ETD_k = TE_k/D_k \quad (3)$$

Where : ETD_k: the Ratio of Total Effectiveness
TE: Value of total effectiveness
D_k: Value of difficulty level

- Determining the priority rank of each action (Rk); the first rank indicates the action with the highest ETDk.
- Finding several risk-mitigation or recovery measures that are related to each other: two plus signs (++) for a strong relationship and one plus sign (+) for a positive relationship (correlation matrix).

4 Results and Discussions

Agricultural fintech must pay attention to the details found throughout agricultural fintech activities, from farmers to investors. Each stage is inseparable from the risks that can result in high failure rates. Therefore, at each stage of the agricultural fintech business, it is necessary to identify the points that can cause losses by analysing the possible problems in each activity carried out at each stage.

4.1 Risk Event and Risk Agent of Agricultural Fintech

According to Arkanuddin et al. (2021), fintech peer-to-peer lending involves three fundamental risks: operations, liquidity and credit. According to Calatayud and Katterer (2016), value chain risk includes four risks: market, operational, liquidity and credit. This study adopted these concepts to explore the risk events and agents (Table 1).

Table 1.
Types, events, agents, mitigation, and recovery of the agricultural fintech value chain.

Type	Risk Event	Risk Agent	Mitigation & Recovery
Market Risk	E1. Market changes	A1. Availability of substitute products	M1. Increase the value-added of the product
		A2. Quality Standards priority for hygiene	M2. Product hygiene priority
		A3. Consumer behaviour changes from offline to online	M3. Online Marketing
	E2. Market uncertainty	A4. The input prices (seeds and fertilisers) increased	M4. Contract prices for seeds and fertilisers
Operational Risk	E3. Supply uncertainty	A5. Stagnant yield(quantity and price)	M5.Contract for harvest supply
		A6. Availability of seeds and fertilisers	M6. Contract for supply of seeds and fertiliser
		A7. Delays in delivery	M7. Strict scheduling
	E4. Production uncertainty	A8. Diseases and pests	M8. Assistance for diseases and pest management
		A9.Climate, precipitation, weather, and temperature extremes,	M9. Utilisation of weather information
			M10. Insurance
	E5. Administrative uncertainty	A10. Profits drop	M11. Contracts for harvest price
		A11. Delays or failures in administrative procedures	M12. Orderly bookkeeping
Liquidity Risk	E6. Financial health levels of farmers or companies.	A12. Poor cash flow	M13. Cash Flow Management
Credit Risk	E7. Payment uncertainty	A13. Bad credit	M14 leeway and minimum payment

4.1.1 Market Risk

Market risk results from unstable commodity prices, either as resources (agro-input) or harvest (agro-output). Market risk is a type of risk that often occurs in the agricultural sector. Agribusiness market risks have increased significantly

since the onset of the pandemic (Gu and Wang, 2020). Komarek et al. (2020) reported that market risk is the most frequently studied agricultural risk. Agricultural fintech's market risk events include market changes and uncertainty.

During the COVID-19 pandemic, market changes were triggered by the availability of substitute products, changes in preferences for hygiene priority, and changes in consumer behaviour from offline to online shopping. Mandal et al. (2021) reported that 90% of households purchased food on the basis of availability in the market. Consumers purchase the product they want, but when the product is not available, they switch to other products that are. They also switch when substitute products that are more hygienic become available. Finger et al. (2021) reported that food hygiene is a priority for consumers. Kumar et al. (2020) reported that digital platforms directly connected farmers and markets during the Covid-19 outbreak. Market changes challenge agricultural fintech and its partners to produce agricultural products that have strong differentiation, hygiene and availability in the online market.

Furthermore, market uncertainty is caused by fluctuating input prices (seeds and fertilisers), which tend to increase. Kumar and Sing (2022) and Kumar et al. (2021) stated that market uncertainty is related to agro-input availability. The Covid-19 pandemic has made it increasingly difficult to predict the market (Sharma et al. 2020). The effects of the pandemic are still evident: although the acute phase of the Covid-19 pandemic has passed, agro-input prices have not decreased and are likely to increase. For example, in Maluku, Indonesia, the cost per hectare of pesticides for rice cultivation was IDR 2.4 million (US$ 158) before the pandemic and IDR 3 million (US$ 197) during and after the pandemic.

4.1.2 Operational Risk

Operational risk in agricultural fintech arises from internal issues and is often caused by mismanagement, from planning to control. The degree of operational risk significantly affects investors' investment decisions (Li and Wang, 2019). Operational risks include supply, production and administrative uncertainties.

Supply uncertainty may result from a supply-demand mismatch (Ali and Govindan, 2023). The COVID-19 pandemic has created uncertainty regarding food supply and demand (Mitchell et al., 2020; Chen et al., 2020). Supply uncertainty may also arise from the scarcity of fertilisers and seeds, delays in delivery, and harvests stagnant in terms of quantity, quality and price. Agricultural fintech should be equipped to manage uncertainty in the supply of agro-input and agro-output, as the flow of goods between regions has become relatively smooth after the pandemic.

Production uncertainty may stem from disease and pest attacks, weather, extreme temperatures, and erratic rainfall owing to global warming (Sharma et al., 2020). Agricultural fintech can anticipate production uncertainty better than traditional agriculture because farmers have good knowledge of and experience in dealing with pest and disease attacks. However, they still struggle to address the effects of climatic anomalies and longer-term climate change.

Administrative uncertainty, such as declining profits, delays or failure in managerial procedures, can also contribute to operational risk (Sharma et al., 2020), as can poor management (including administration). Another latent problem in agriculture is that farmers are often reluctant to record their transactions and activities. Maintaining records is beneficial for farmers when applying for financing (Messmer et al. 2021). Therefore, it is crucial to encourage farmers to maintain the appropriate bookkeeping practices.

4.1.3 Liquidity Risk

Liquidity relates to a company's ability to fulfil its financial obligations. Liquidity is positively correlated with the financial performance of farmers and agricultural companies (Vukovic et al. 2022). Liquidity has a significant effect on company and farmer profitability. According to Zulkipli et al. (2019), liquidity can describe the profitability level of both companies and farmers.

Liquidity risk indicates the financial health of farmers or companies triggered by poor cash flows. Liquidity risk is closely related to capital management policies (Qian & Olsen, 2021). Nathan et al. (2022) reported that the COVID-19 pandemic negatively impacted financial health, especially business actors' cash flow. Earnings are reduced and savings are eroded. Agricultural fintech needs to manage liquidity risk to reduce the negative effect of covid-19 on the company (Udalova et al., 2019).

Agricultural fintech companies must manage their liquidity risks, including those of their partner farmers. Partner farmers are at the forefront of the agricultural fintech value chain. If liquidity risk fails to be mitigated or restored, it will have an impact on the debt repayment ratio. The domino effect is that fintech companies will have financial problems that could cause them to collapse.

4.1.4 Credit Risk

Liquidity, or the financial health of farmers and companies, is an important factor for credit payments. Farmers responsible for large farms may seek credit because of their optimism regarding payments, despite decreasing profits

from agricultural businesses. However, farmers of smallholdings face difficulties in obtaining bank credit, hence the role of fintech companies in funding their farming businesses.

Credit risk is a critical aspect of ensuring the stability of financial institutions worldwide (Jafroudi and Pourali, 2021). Traditional risks, including liquidity and credit risks, are classified accordingly in each fintech business model (Bartlett et al. 2022). Uncertainty in payments resulting from bad loans is a concern in the fintech industry.

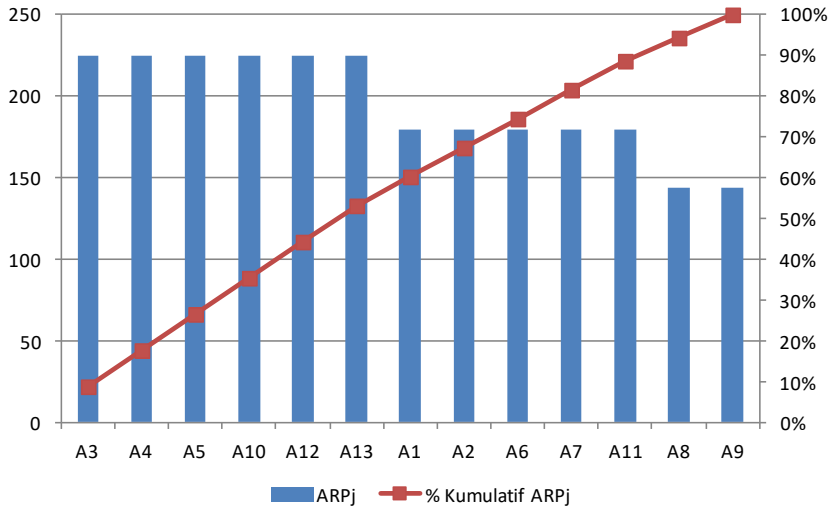

Figure 1. Aggregate Risk Potential (ARP)

Pi et al. (2022) emphasise the need for more attention to be paid to credit risk in the fintech industry. One weakness of agricultural fintech in Indonesia is that it does not provide comprehensive support to farmers in their farming businesses. Credit payments may be adversely affected when a crop fails or the harvest is suboptimal. Agricultural fintech companies can offer assistance to their partners in mitigating the risk of bad credit.

In our study, the four types of risk consisted of seven events with 13 risk agents. Based on ARPj or Aggregate Risk Potential (Figure 1), there are 10 risk agents that dominate agricultural fintech and are priorities of risk management strategies. They are: changing consumer behaviour from offline to online (A3), increasing input prices for both seeds and fertilisers (A4), stagnant crop yields in both quantity and price (A5), declining profits (A10), poor cash flow (A12), bad debts (A13), the availability of substitute products (A1), prioritised quality standards for hygiene (A2), the availability of seeds and fertilisers (A6), and delays in delivery (A7).

4.2 Risk Mitigation and Recovery Priorities

The Covid-19 pandemic has adversely affected the operations, markets, liquidity and credit of agricultural fintech value chain actors (Table 1). To ensure recovery, it is crucial to address several key risk factors (Table 1) through strategic action. Strategy prioritisation refers to the ranking indicated in the house of risk (Figure 1).

4.2.1 Recovery Strategies

Following the COVID-19 pandemic, the implementation of recovery strategies for various stakeholders in the agricultural value chain is of utmost importance. McEntire (2021) emphasised the significance of recovering from disasters and this study proposes five priority areas for recovery, as shown in Figure 2: cash flow management, establishment of leeway and minimum payment amounts, execution of harvest price contracts, execution of harvest supply contracts by quantity, and procurement of seed and fertilizer agro-inputs at negotiated prices. We will examine each in turn.

Cash flow management is a critical aspect of financial administration that tracks the inflow and outflow of cash in every business organisation, including those in the agricultural fintech industry. The three key elements of cash flow management are receivables, payables and available business capital. It is essential to maintain a balance between these elements. Furthermore, the cash flow challenges faced by farmers in the agricultural industry are commonly attributed to the nature of their businesses, which typically involves earning revenue only during the harvest season. To alleviate this issue, fintech companies should offer flexible payment schedules that do not disrupt farmers' cash flows. Ningrat and Nurzaman (2019) suggest that offering lax payment terms can be beneficial to farmers' cash flow management.

Farmers also need leeway on the minimum payment amount. In contrast, agricultural fintech companies require regular payments for operational and financial health. Fintech may gain stability if supported by non-commercial associations or groups, as suggested by Khan et al. (2021), who recommend a model of Islamic agricultural fintech using waqf funds. In this model, fintech companies obtain funds from waqf institutions to meet farmers' needs, such as for seeds and fertilisers, with a profit-sharing scheme at harvest. Waqf is a charity fund for Muslim societies (Khalil et al. 2020).

Agent \ Mitigation and Recovery		Increase the value-added of the product	Product hygiene priority	Online Marketing	Contract prices for seeds and fertilisers	Contracts for harvest supply	Contract for supply of seeds and fertiliser	Strict scheduling	Contracts for harvest price	Cash Flow Management	Leeway and minimum payment	ARPj
		M1	M2	M3	M4	M5	M6	M7	M11	M13	M14	
A3	Consumer behaviour changes from offline to online			9								225
A4	The agro-input prices (seeds and fertilizers) increased				9		1			9		225
A5	Stagnant yield(quantity and price)					9			9	9		225
A10	Profit down								9			225
A12	Poor cash flow									9	9	225
A13	Bad credit										9	225
A1	Availability of substitute products	9										180
A2	Quality Standards priority for hygiene	1	9			3						180
A6	Availability of seeds and				3		9	3				180
A7	Delays in delivery							9				180
Total Effectiveness of action (TEk)		1,800	1,620	2,025	2,565	2,565	1,845	2,160	4,050	6,075	4,050	
Difficulty level of action		4	2	2	1	1	1	1	1	1	1	
Effectiveness to difficulty ratio		450	810	1,013	2,565	2,565	1,845	2,160	4,050	6,075	4,050	
Priority Rank		8	7	6	3	3	5	4	2	1	2	

Figure 2. House of Risk (HOR)

Contracts for harvest prices ensure price certainty at harvest time for farmers. This process is known as hedging or *salam* (in the Islamic economy). According to Hudaifah et al. (2019), this contract would benefit farmers because they can obtain the best price and subsequently manage their cash flow and improve their financial health. Smallholding farmers generally tend to obtain low prices during the harvest season (Cardell and Michelson, 2023), so their position is more precarious and thus more susceptible to improvement through this scheme.

Furthermore, agricultural fintech companies are responsible for ensuring the sale of their farmers' products, regardless of quantity. Such companies provide a viable alternative for their farmers' partners in the event that the harvest quantity falls short of the agreed upon amount. Ichsan et al. (2021) noted that palm oil farmers in Indonesia could not sell their product to partner companies because the harvest quantity was below the contract amount.

Agricultural fintech companies should also facilitate agro-input contracts for their partner farmers. A guaranteed supply of seeds, fertilisers, and pest and disease control materials will allow farmers to recover quickly from the effects of the Covid-19 outbreak. Pratiwi et al. (2023) suggested that agri-fintech helps farmers to cooperate with agro-input companies to obtain agricultural materials and tools.

4.2.2 Mitigation Strategy

It is necessary to mitigate risks or take all preventive actions before a disaster occurs. McEntire (2021) also promoted mitigation for vulnerability reduction. This study recommends two mitigation priorities: strict scheduling and agro-input supply contracts.

The parties in the agricultural fintech value chain can adopt a strict schedule related to the duration of the contract between farmers and fintech companies, disbursement of financing, realisation of planting, supervision, and assistance in the field. If the contract schedule is appropriate but the time of realisation is not, it will delay the subsequent stages, such as distribution and marketing. In addition, Bizikova et al. (2020) stated that marketing and sales assistance for farmers has a significant impact on farmers' household improvement.

Farmers require seed and fertiliser supply contracts to ensure the availability of required agro-input during their crop application schedule. Fintech companies must help to procure agro-input agreements to ensure fair prices and quality products. According to Isah et al. (2023), agricultural productivity is low if the supply of agro-inputs is hampered.

Several risk mitigation and recovery efforts are related. Price contracts for seed and fertiliser agricultural inputs have a strong relationship with other contracts, such as harvest contracts. This shows that agricultural fintech creates contracts with farmers for the procurement of agricultural inputs and the marketing of harvests. These contracts provide certainty regarding production, operations and markets.

5 Conclusions and Implications

The impact of the Covid-19 pandemic on the agricultural fintech value chain has been significant, affecting such aspects as markets, operations, liquidity and credit. The pandemic has given rise to ten risk agents, with the majority being primary sources of risk and therefore requiring immediate attention. These agents include changes in consumer behaviour from offline to online (A3); increases in input prices for seeds and fertilisers (A4); stagnation of crop yields in terms of both quantity and price (A5); decreased profits (A10); poor cash flow (A12); bad credit (A13); the availability of substitute products (A1); priority quality standards for cleanliness (A2); the availability of seeds and fertilisers (A6); and delivery delays (A7).

Based on these priority risk agents, there are five (sequential) recovery priorities: cash flow management (M13), leeway and minimum payment amounts (M14), contracts for harvest price (M11), contract pricesfor seeds and fertilisers (M4), and contracts for harvest supply (M5). Two mitigation priorities are essential: strict scheduling (M7) and seed and fertiliser supply contracts (M6).

Agricultural fintech companies and farmers must critically evaluate their current business models and consider undertaking redesign measures to effectively navigate the risk management and recovery processes. Agricultural fintech companies must prioritise assisting partner farmers in obtaining agricultural input and harvest contracts. To achieve this, agricultural fintech companies could provide field officers in each region, with assistance from their farming partners.

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