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The Contribution of Information, Communication, and Technology (ICT) in Supply Chain Performance at Kebun Bangelan

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Abstract: Indonesia is the fourth largest coffee producer after Brazil, Vietnam, and Colombia, with an average coffee production value in Indonesia in 2022 reaching around 789.97 thousand tons per year. In 2014-2023, the largest type of coffee production was robusta coffee at 72.71% or 517.41 thousand tons. Kebun Bangelan, which produces coffee beans. This study aims to analyze the ICT, quality information sharing, supply chain collaboration, and supply chain performance. A mixed-methods approach was used in this research to determine the ICT by distributing questionnaires and depth-interviews with Kebun Bangelan employees. The coffee bean supply chain begins with planting raw materials, and production using machine technology. ICT used by Kebun Bangelan includes the computers and supply chain data processing through applications, namely System Application and Product in Data Processing (SAP) and spreadsheet. ICT shows a strong correlation with information sharing quality, a good correlation with supply chain collaboration, and a good correlation with supply chain performance.

Keywords: Information and Communication Technology, Quality of Information Sharing, Supply Chain Collaboration, Supply Chain Performance.

INTRODUCTION

Information and communication technology encompasses various tools and technologies that have become an important part of life in the digital landscape (Setiawan *et al.* 2023). This technology consists of hardware and software that facilitate the smooth running of the digital world (Al Aidhi *et al.* 2023). Hardware includes computers that facilitate the processing of relevant data and quality information according to user preferences. The existence of information and communication technology helps companies monitor events in the supply chain. ICT is based on information sharing that provides various information to improve inventory in each supply chain and share information among partners in the supply chain (Tannady *et al.* 2020). Sharing quality information can reduce the risk of demand uncertainty

for the supply chain. If the information presented is unclear between workers or from a technology, it will cause problems in the supply chain relationship.

According to Kain and Verma (2018), supply chain management is a system within a company that consists of people performing activities to transform products. There are supply chain activities that transform raw materials and resources from unfinished components into finished materials until they are delivered to consumers. Companies integrating supply chains must work together to share information, production planning, technology use, shipping, and distribution activities (Warella *et al.* 2021). Overall, the supply chain pays attention to every process and stage from raw materials to finished goods and considers other important aspects such as production technology, information technology, labor, shipping, storage warehouses, information, and teamwork. The supply chain cannot stand alone and definitely requires cooperation between partners. Supply chain collaboration enables companies to respond strategically by making good decisions on market opportunities, easily introducing new products, and solving problems (Kumar & Modgil, 2020). There is also a decision-making process involved because there are partners that are interdependent, involving togetherness and mutual responsibility. Supply chain collaboration (SCC) refers to collaborative activities undertaken by companies to enhance the overall competitiveness of the supply chain and achieve shared goals. This boosts collaborative advantage and significantly impacts company performance (Chen, 2023) and competitive business environment, the companies must understand the benefits of information technology in supply chain collaboration, as several communication challenges faced across various supply chains can be overcome by using technology (Baah, 2021)

Indonesia is the fourth largest coffee producer after Brazil, Vietnam, and Colombia, with an average coffee production value in Indonesia in 2022 reaching around 789.97 thousand tons per year. In 2014-2023, the largest type of coffee production was robusta coffee at 72.71% or 517.41 thousand tons. The main producers of robusta coffee in Indonesia are South Sumatra, Lampung, Bengkulu, East Java, and Central Java (Kementrian Pertanian 2023). Coffee is one of the products of plantations that plays an important role in Indonesia's economic activities, and the largest coffee production in 2022 was in Malang Regency, East Java Province (BPS 2022). The Kebun Bangelan is part of PTPN 1 Regional 5, which is under the umbrella of the State-Owned Enterprise (BUMN). The product of the Kebun Bangelan is robusta coffee beans. These products will be sold locally and internationally. With so many shipping destinations, accurate, and precise information is needed to prevent problems between partners.

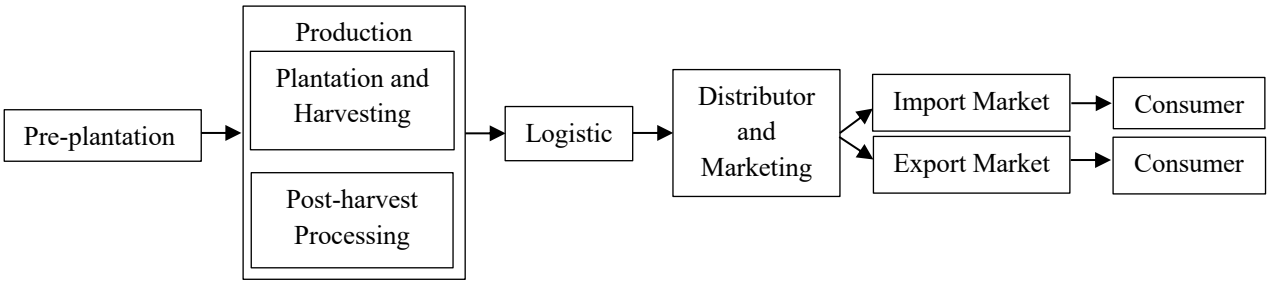
The Kebun Bangelan utilizes Information and Communication Technology (ICT), particularly Internet-based System Application Products in Data Processing (SAP) and spreadsheets to compile coffee bean productivity reports, process data, and present information to support decision-making in improving robusta coffee productivity. For the competition, companies must build stronger, more strategic, and more proactive partnerships. However, some employees still face constraints or are still in the process of learning to master information and communication technology for data processing because ICT skills development training has not been or has never been held, and inadequate internet networks hinder the submission of daily activity reports. Companies need to ensure they have adequate working facilities and employes capable of operating the technology (Hijrasil, 2023). The purpose of this research is to identify the characteristics of Kebun Bangelan employes and analyze ICT to supply chain performance, including quality information sharing and supply chain collaboration. Quantitative and qualitative analysis will also describe the use of ICT in Kebun Bangelan, such as computers, internet-based applications, and internet networks in the administration of coffee bean production activity reports.

Literature Review

Supply Chain Management

Supply chain management describes the coordination of all supply chain activities, starting with raw materials and ending with customers. According to Martono (2020), supply chain management was originally the science of logistics management, which has an integrated system that coordinates all processes within an organization/company that prepares and delivers all products/finished goods to consumers/customers. Supply chain management includes information flow, information technology, processing technology/machinery, and resources that will be related to business competitiveness (Tan *et al.* 1998 and Saberi *et al.* 2019). In agribusiness, supply chain management also fully responsibility for products by meeting partner/consumer demands, including price, quality, and quantity (Gazi, 2020).

Figure 1. Kebun Bangelan Supply Chain Flow



Source: Adapted by Kamilaris (2019)

a. Pre-plantation/supplier

At the supplier stage, there are providers of information about plants, planting, preparation before planting, the use of chemical pesticides, fertilizers to fertilize coffee plants, and so on. The Kebun Bangelan is a provider of unfinished materials or raw materials. Before starting planting, the Kebun Bangelan submits a funding proposal to the PTPN I Regional 5 Surabaya Office to provide the raw materials to be planted.

b. Production: Plantation and Harvesting & Post-harvest Processing

Production involves seedling, cultivation, plant maintenance, and harvesting. After harvesting, the plants are processed into finished products using processing machines.

c. Logistic

After the coffee beans have been successfully processed, this stage includes product packaging, product delivery, product storage before shipment, and delivery to the PTPN 1 Regional 5 Surabaya using truck transportation.

d. Distributors and Marketing

After the goods have arrived at the PTPN 1 Regional 5 Surabaya, they are separated into goods for export and goods for local distribution. Marketing, ordering, and other activities are carried out at the Surabaya Head Office through the website PTPN 1 Regional 5 Surabaya.

e. Export Market and Local Market

Coffee beans processed at the Kebun Bangelan will be exported and distributed locally by PTPN I Regional 5 Surabaya. Coffee beans are exported to countries such as Japan, China, and Korea. Meanwhile, local distribution is limited to cities within Indonesia.

f. Customers/Industry

After export and local shipments have been made, the beans arrive at an industry and are processed into coffee powder. This study focuses on the production and logistics carried out at the Kebun Bangelan.

Information and Communication Technology (ICT)

Information and communication technology (ICT) is developing rapidly and rapidly throughout the world. The main aspects of ICT are hardware such as computers and software such as internet-based applications, for the example application of System Application and Product in Data Processing (Rukamana *et al*. 2023). The research by Quadras *et al.* (2023), with the development of technology information, new technologies have emerged that integrate the internet with computer tools that provide a variety of real-time business information to improve agricultural performance. Information and communication technology is also an inseparable condition that contains a broad understanding of all activities related to the processing, management, and transfer of information between media. Computers have become a necessity for companies in managing and monitoring every task by turning processed data into reports. Computers themselves have an internet network to access and disseminate information. Information and communication technology in supply chain management have made it important to make decisions that achieve competitiveness, service levels, low inventory management, and reduced supply chain costs (Yuliana, 2021).

Information Sharing & Information Quality

According to the latest theory on supply chain management, the supply chain requires good information between parties in the supply chain. When information flows from employees, vendors, suppliers, and effective information sharing does not occur, everything will fail (Zhao, 2025). Information sharing quality means distributing information that is useful for systems, workers, or organizational units. Information sharing involves using information and communication technology to improve relationships between supply chain partners, buyers, and the others can reduce transaction costs (Baily *et al.* 2022). Every business strategy involves partners in investment quality information sharing and also participating in activities that create joint coordination with the aim of improving the performance of the agricultural supply chain. In developing a strategic vision among suppliers and partner relationships, quality information and information and communication technology are needed to improve the quality of information by providing a consolidated view of data from multiple sources used in the supply chain ecosystem (Lee, 2021).

Chopra and Meindl in Pujawan and Mahendrawathi (2010), good and quality information has several characteristics that make it useful in supply chain decision-making:

a. Accurate: Information must describe the actual conditions and be reliable.
b. Timely: Consider what information is appropriate and needed by the company, and it must be delivered in a timely manner.
c. Up-to-date: Informing colleagues of the latest information.

The quality of information data is not only important for suppliers but also crucial in enhancing the effectiveness and efficiency of supply chain performance. High-quality information facilitates better work performance and improves supply chain performance within the company (Chesangalur-Smith, 2023).

Supply Chain Collaboration and Supply Chain Performance

Supply chains are complex, meaning that collaboration within the supply chain will be effective if achieved through good, high-quality, timely, and accurate information. Supply chain collaboration enables companies to respond strategically by making good decisions on market opportunities, easily introducing new products, and solving problems (Kumar and Modgil, 2020). There is also a decision-making process involved because there are partners that are interdependent, involving togetherness and mutual responsibility (Susanto & Othman, 2021). Mofokeng (2019) examined there are several benefits of supply chain collaboration, including applying important dimensions to collaborative relationships, such as sharing information, plantation resources, synchronizing decisions, and communication with partners. Supply chain performance is an important driving force for all companies, providing many benefits and unlimited advantages.

All supply chain will provide good products with high quality, timely delivery, and produces the right amount of goods according to demand to improve supply chain performance (Asnordin *et al.* 2021). Okore (2019) state that good supply chain performance is usually seen in terms of logistics, collaboration with suppliers, and increasing product output, because supply chain performance will be successful if it works in a balanced/synchronized manner. Pham and Doan (2020), an inadequate or unfavorable environment, such as competitors, weather, and relationships within the supply chain, will cause the business supply chain to become slow and ineffective. The objective of supply chain management is to organize the supply chain to maximize competitive advantage and benefits for end consumers (Heizer *et al.* 2020). Supply chain performance must also be evaluated between organizations in a feasible manner (Sundram *et al.* 2020).

METHOD

The research was conducted at PTPN I Regional 5 Kebun Bangelan, Malang Regency, East Java. The research method used a mixed-methods through quantitative and qualitative analysis. Data collection used primary data in the form of observations, questionnaires, and interviews, as well as secondary data in the form of literature, journals, and books. The questionnaire was distributed to 25 employees consisting of nine employees from the main office, nine employees from the plantation office, and seven employees from the factory office with 57 items of questionnaire and 1-5 scale: 1 = strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree. In-depth interviews were conducted with four employees, namely the manager, an employee from the factory office department, an employee from the plantation office department, and the foreman. The sample was taken based on employees who used ICT to process coffee productivity reports. The data collection results were processed using SPSS version 26 through validity tests, reliability tests, descriptive analysis tests of respondent and variable characteristics, and correlation tests (Spearman's rank) using percentage values to determine the category level of the ICT variable, quality information sharing, supply chain collaboration, and supply chain performance.

RESULTS AND DISCUSSION

Process Flow and Overview of Coffee Bean Processing

Cultivation

The stages of coffee bean cultivation at the Kebun Bangelan begin with land preparation, followed by seedling propagation using the grafting method with tree planting, weed control and removal, and the planting of protective plants. Next is plant maintenance until the final stage of plant care. Productivity is achieved through pruning, watering, soil management, and regular fertilization until harvest.

Processing

The processing stage after harvesting involves weighing the coffee beans in stages to be transferred to the factory for further processing through weighing, separation, washing, drying, hulling, sifting, sorting, mixing, and packaging. Coffee beans are classified into grade 1, grade 4, and local grade. This determines which coffee beans will be exported and which will be distributed locally between cities. Coffee bean processing includes weighing, separation, peeling the fruit and skin, soaking in water, drying, washing to remove mucilage from the coffee fruit, sorting the coffee fruit based on quality/defects, and putting the coffee beans into sacks.

Respondent Characteristics

Table 1. Characteristics Respondent

Variables	Average Total Score	Total	Percentage
Gender	Man	25	100%
	Woman	0	0
Age	21 – 30 years old	0	0
	31 – 40 years old	12	48%
	41 – 50 years old	10	40%
	51 – 60 years old	3	12%
Education	Diploma	21	84%
	Graduate	4	16%
Length of service	6 – 10 years	4	8%
	11 – 15 years	8	32%
	16 – 20 years	9	24%
	>20 years	4	8%

Based on the Table 1, the employees of Kebun Bangelan who are working by the computer who use computers to create daily reports are male, and there are no female employees. The average age of Kebun Bangelan employees is 31-40 years. The highest level of education among Kebun Bangelan employees is held by 21 employees with high school diplomas, and the longest-serving employees has been with the company for 16-20 years. Based on depth interview, the employees of Kebun Bangelan employees have a high school senior education because they are recruited from Bangelan village where education is lacking.

Respondent usage ICT

Table 2. Respondent Usage ICT

Variables	Average Total Score	Percentage	Description
Application/software	Systems, Applications, and Products in Data Processing (SAP)	9	36%
	Spreadsheet	16	64%
Duration of computer usage	6 hours	5	20%
	7 hours	8	32%
	8 hours	9	36%
	As needed	3	12%

Based on the Table 2, the Kebun Bangelan have three offices: the main office, the estate office, and the factory office. The SAP application is only used by employees at the main office, spreadsheet is used by employees at the garden office and factory office, and spreadsheets are used by all employees at Kebun Bangelan. The difference in duration when using ICT depends on how much or how little work load is assigned to each employee. Working on a computer for about 6 to 8 hours out of an 8-hour workday.

Table 3. Application of ICT in the Supply Chain at Kebun Bangelan

	Cultivation	**Processing**	**Logistics**
Activity	Planting planning, coffee bean cultivation, and calculation of coffee beans to be processed.	Processing and handling coffee beans after harvest according to the stages.	Coffee bean storage, delivery and inspection of coffee bean sacks in accordance with applicable SOP.
ICT Used	a) Spreadsheet b) SAP Application c) NADINE application (Electronic Official Document)	a) Spreadsheet b) SAP application c) Sensory robot for sorting d) NADINE application (Electronic Official Document)	a) Spreadsheet b) SAP Application c) Global Positioning System (GPS) d) NADINE application (Electronic Official Document)

Based on the Table 3, the result by observation and depth interview, Kebun Bangelan activities range from cultivation and processing to logistics. Cultivation begins with planning, such as selecting raw materials, caring for the soil and plants, planting coffee trees, and harvesting. Followed by processing the coffee cherries through several stages to produce coffee beans. During the sorting stage, Kebun Bangelan has adopted sensory robots to simplify the sorting process, as sorting is the most time-consuming stage. Previously, the sorting process was carried out manually by human. After going through the processing stages, Kebun Bangelan has logistic to ship the coffee beans using vehicles equipped with GPS technology . A daily report will be made for each process carried out to determine the progress of cultivation, processing, and logistics.

Based on the Table 2. Respondent Usage ICT, a comparison between departments at Kebun Bangelan shows that there are differences in the using ICT with differences in the data reporting applications used. This research is in line with Syafitri *et al.* (2025), in their research which found a gap in the level of information technology utilization based on departments.

Validity and Reliability Results

The validity test results on the research instruments show that the rvalue>rtable (0.396) indicates that all variables, items on the ICT variables, quality information sharing, supply chain collaboration, and supply chain performance are valid and can be used as data collection tools in this study. The reliability test showed 0.847 that Cronbach's alpha value was > 0.60, meaning that the variable items in this study were reliable to continue the questionnaires.

Variable Descriptive Analysis

Table 4. Variable Descriptive Analysis

Variables	Average Total Score	Percentage	Description
Information and Communication Technology (ICT)	3.70	74%	Good
Quality Information Sharing	4.31	86.2%	Very Good
Supply Chain Collaboration	3.86	76.7%	Good
Supply Chain Performance	3.73	74.6%	Good
Total Score Average	**3.70**	**77.8%**	**Good**

Based on the Table 4, descriptive analysis techniques using percentage criteria according to Arikunto (2010), it is known that the total average score of 77.8% is in the good category. The use of information technology in information exchange at the Kebun Bangelan is highly dependent on ICT, such as computers, SAP applications and spreadsheets to make the productivity coffee bean data every day. These makes it easier for employees to access and share coffee productivity data (Rukmana, 2024). Information is disseminated at the Kebun Bangelan both directly and indirectly through technology. Unfortunately, according to the findings of the interviews, the unequal distribution of the network in Kebun Bangelan, particularly in the factory office, and the distance between the three Kebun Bangelan offices continue to cause frequent disruptions to the internet network. Employees who are expected to produce daily activity reports will find it more difficult to do their jobs as a result. Internet network disruptions still occur frequently, resulting in many reports of decreased coffee productivity due to the geographical location being far from urban infrastructure. Problems related to the uneven quality of internet services, especially in rural and remote areas that still face challenges in obtaining adequate internet access and this limitation slows down the everyday activity of writing reports for Kebun Bangelan (Anugrah *et al*. 2025)

Good and quality information can be seen from three aspects, namely that the information is accurate, timely, and regularly updated. The company provides accurate and relevant information to employees and partners so that work runs according to the direction of the business process by their ICT. From the data productivity, they making easier to solve the problems and making decision. This is in line with Baba (2021), who states that sharing good information has a significant impact on the business world, such as in the supply chain, which refers to the exchange of information through technology, production, and information that enables an understanding of the process from upstream to downstream, which ultimately improves company performance.

In supply chain collaboration, Kebun Bangelan conducts joint product demand planning involving employees and suppliers. Raw material planning and control are key factors in coffee bean production and reduce the risk of production results not meeting the desired quality standards (Soleh, 2024). Meanwhile, evaluations at each stage of final production are not yet/rarely carried out routinely. Through evaluation, continuous process analysis will be carried out, and companies can identify stages in specific areas where errors occur and implement improvements (Sirine, 2024). So far, the collaboration carried out by the Kebun Bangelan is considered very good because it always involves the opinions of employees and suppliers.

Based on the observation and depth interview, each processed coffee plantation requires the supervisor's signature on the delivery order before shipment. If there is excess production, a request is submitted to the PTPN 1 Regional 5 Surabaya for resale or storage in a warehouse for future sale. Goods are shipped with records stored using the SAP application, GPS

technology on delivery trucks, and supervised by vendors and accompanying employees in accordance with SOP rules to prevent fraud in shipping. Kebun Bangelan has not been able to respond quickly to changes in demand due to several factors such as weather, plants condition, and production processes, which require replanning and further coordination through the information technology used. Poor internet connectivity sometimes hinders Kebun Bangelan ability to respond. Firmansyah (2022) emphasizes the importance of responding quickly to demand in order to improve the performance and competitiveness of the supply chain.

Variable Correlation Test

Table 5. Descriptive Analysis of Variable Correlation Test

Variables	Significancy	Pearson Correlation
ICT & Information Sharing Quality	0.000	0.682
ICT & Supply Chain Performance	0.000	0.750
ICT & Supply Chain Collaboration	0.000	0.653

Based on the Table 5, the results of the analysis between ICT variable and the quality of information sharing, according to Sugiyono (2019), show a strong correlation, with a correlation coefficient of 0.000 < 0.005 and a Pearson correlation > r-table, namely 0.682 > 0. 336 This statement is reinforced by the results of questionnaires, observations, and interviews conducted on the quality of information sharing at Kebun Bangelan, which show that employees have a positive perception of ICT in promoting the quality of information sharing. Kebun Bangelan provides relevant and accurate up-to-date information to employees, and the company is able to exchange information because there is information that must be disseminated to prevent misunderstandings in receiving information. This study is in line with Yuliana (2021), who states that information technology provides access to information from organizations or other people by expanding, multiplying, and updating the information, thereby improving the quality of information. The Pearson correlation value < r-table, namely 0.750 < 0.336, which according to Sugiyono (2019) indicates a strong correlation between variables. The use of ICT in supply chain performance shows that employees have a positive perception (agree) of ICT use in driving supply chain performance. This study is in line with research by Yuliana (2021) and Sundram (2020), which states that the existence of information and communication technology (ICT) in business processes results in the rapid dissemination of information, which ultimately improves supply chain performance. Using internet technology changes the way companies operate, allowing them to find and determine everything they need. Supported by interview results, the use of ICT such as SAP, WhatsApp, and spreadsheet are internet-based applications makes it easier for employees to create daily activity reports during the coffee bean processing process. The correlation is 0.000 < 0.005 and the Pearson correlation is > r-table, namely 0.653 > 0.336. This statement is reinforced by the results of questionnaires, observations, and interviews with employees who have a positive perception that the company collaborates in product demand and long-term planning, uses existing technology, and determines raw material supplies, thereby building good and long-term supply chain collaboration with partners and the Kebun Bangelan work environment. This study is in line with Yuliana (2021), the existence of information and communication technology is capable of providing various information and communication collaboratively between internal and external partners in the supply chain, which ultimately develops closer relationships through real-time information exchange.

CONCLUSION

The conclusion of this study is to discuss the use of information and communication technology in supply chain performance, including quality information sharing and supply chain collaboration. The characteristics of the respondents in this study were all male employees who worked using computers. The age of Kebun Bangelan employees was predominantly around 41-50 years old. The average education level of Kebun Bangelan employees is high school/vocational school. Using information and communication technology at work involves using computers to process daily coffee bean productivity reports using the System Application Products in Data Processing (SAP) application and spreadsheet which operates for 6–8 hours per 8-hour day, approximately 6 days per week.

The results of the SPSS version 26 analysis show that information communication, supply chain collaboration, and supply chain performance are good. The sharing of quality information at Kebun Bangelan has been running well, as can be seen from the accurate, timely, and up-to-date information.

However, Kebun Bangelan is still constrained by inadequate internet connectivity because it is located in a village far from urban infrastructure. This sometimes makes it difficult for employees to send daily reports or access other work. By producing coffee beans, Kebun Bangelan is able to meet market demand for local and export markets. This will encourage Kebun Bangelan supply chain to improve by utilizing existing technological facilities. This study examines the impact of information technology on supply chain performance, including quality information sharing and supply chain collaboration. Information and communication technology correlates with supply chain performance at a rate of 0.750. This impact depends on companies managing the use of information and communication technology in supply chain performance. The results of the study show that some employees still have difficulty using computers to process data smoothly because the data is in numerical form. Since the transition from manual to digital recording, there has been no training program in the use of ICT, so most employees have developed their skills through self-study and by asking their colleagues. In processing coffee beans using old machines, the internet connection is inadequate and it is difficult to predict weather changes. This will hinder the delivery of data/reports to the Surabaya Head Office. As some employees still have difficulty operating computers, it is advisable for the company to organize an ICT training program so that all employees have equal skills. If this situation persists, it will have an impact on the company. ICT training is needed to improve employees knowledge, practice, and work skills to meet company standards (Affandi, 2021). It is necessary to adopt other technologies modern such as IoT or drones to make it easier for plantation workers to see the condition of the plantation, such as plants, soil, weather, soil moisture, and air temperature. The use of IoT can help provide information on soil and plant conditions and the behavior of pests that will attack (Ahmed, 2018).

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