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Location-specific technology transfer model in an agricultural technology park in Indonesia

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Abstract: Diversity in the characteristics of agricultural locations has the potential to develop. Unfortunately, the weak transfer of technology based on the characteristics of the location indicates that this potential cannot grow properly. This research aims to synthesise a technology transfer model for an agricultural technology park (ATP) by considering site-specific conditions. This cross-case study was conducted at selected ATP locations. Model synthesis uses the system development life cycle stages of initiation, analysis, and design. The resource-based view approach was broken down into several variables during the analysis stage. Three location-specific technology transfer models were successfully developed: a technology transfer model based on highland specificity, a unique technology transfer model for urban farming, and a tourism village-based model**.**

Keywords: analysis; characteristics; design; initiation; resources

Research on technology transfer has been ongoing for several years. This is an important topic to investigate because it is related to increasing quantity and quality and adding value to agricultural products (Putri et al. 2015; Anggraeni et al. 2017). Based on these studies, innovative performance has been achieved in terms of the quantity of developed and launched products and services, the number of applications of current technologies and innovation in production and service processes, and other ways of organising and managing work (Jugend et al. 2018).

Technology transfer in Indonesia is developing with support from several government projects. To create a supportive environment and atmosphere for technology transfer efforts, the Government of Indonesia has built agricultural technology parks (ATPs) in several districts. There are 26 agricultural technology parks distributed across various regions of Indonesia. Nevertheless, there are numerous problems related to technology transfer. The most common problem with technology transfer in Indonesia is the difficulty in obtaining relevant knowledge and technology from R&D institutions and universities because of differences in the characteristics and capacity of local resources (Lakitan 2013; Lian et al. 2021). Additionally, different characteristics and specific site conditions require a technology transfer model that is suitable for these special circumstances. This can be problematic and complicate the technology transfer process. Therefore, intimate knowledge of technology transfer models is es-

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sential to properly understand the relevant models (Brennecke and Rank 2017).

Here, we summarise the relevant literature. Several studies have examined the mechanism of university technology transfer to the industry (Wonglimpiyarat 2016) and the private sector (Lima et al. 2021) including commercial and for-profit sectors. Artyukhov et al. (2021) justified the need to create technology transfer centres at universities as places of concentration of state intellectual potential. They emphasised the regional aspects of the development of technology transfer networks. Kalnins and Jarohnovich (2015) state that institutional, organizational, and individual factors must be considered when trying to understand why technology transfer works or does not work. The results of Diez-Vial and Fernández-Olmos (2017) on the latest trends in science parks and incubators assisted in improving the quality of internal relationships such as true-based cooperation, informal interaction, and entrepreneurial-enabled environments. Bozeman et al. (2015) suggested a transfer technology effectiveness model that considered external factors that affect the effective transfer technology and the characteristics of the transferred object. However, this model must consider the specific characteristics (resources) and uniqueness of the target.

Although several attempts have been made to address this issue, the technology transfer model that can be adapted to specific local resource conditions remains unclear. Although several attempts have been made to address this problem, it remains unclear which technology transfer model can be adapted to the specific conditions of local resources. This research aims to synthesise a technology transfer model for an agricultural technology park (ATP) by considering location-specific conditions.

MATERIAL AND METHODS

Research scope. The Ministry of Agriculture initiated ATPs in collaboration with the district governments. The major activities include crop cultivation, livestock raising, agricultural processing of products, agricultural technology demonstration, product marketing cooperation, tenant building, technology development, training, and technical guidance. The ATP has been under local government management since 2018.

Study site. The first ATP is located in the Cikajang sub-district, Cikajang, Garut Regency, West Java Province, Indonesia. The Garut Regency has a region width of approximately 3 065.19 km^2. Geographically it is located between 6°57'34"–7°44'57" south latitude and 107°24'3"–108°24'34" east longitude. The altitude of Cikajang is 1 278 m, and its distance to the capital regency is 32.7 km (Garut 2021). The major commodities consumed are potatoes, upland vegetables, and lamb. The second ATP is located in Nglanggeran, Patuk sub-district, Gunung Kidul Regency, Special Region of Yogyakarta, Indonesia. The Gunungkidul Regency area is between 7°46'–8°09' south latitude and 110°21'–110°50' east longitude. The distance between the District Capital and Regency Capital in the Gunungkidul Regency is 18.4 km. The Patuk sub-district has an altitude is 236 m and covers a geographical region with steep slopes. The primary commodities of the Nglanggerans ATP are processed chocolate and goat milk. The last ATP is located in Cigombong, Cigombong sub-district, Bogor Regency, West Java Province, Indonesia. The altitude of the Cigombong sub-district is 578 m, and its distance between the District Capital and Regency Capital in Bogor is 34.1 km.

Methodological procedures. This paper presents an observational, descriptive, cross-sectional study assessing the suitability of a site-specific technology transfer model. The research stages based on the system advancement life cycle (SDLC; Wasson 2006) include the initiation, analysis, design, and managerial implications. The system initiation stage aims to identify problems and drawbacks to obtain an overall picture of the system. The system analysis phase describes the specific characteristics of each ATP location based on certain features. System design in the form of conceptual model diagrams makes it easier to comprehend the behaviour of the system according to specific conditions (Figure 1).

The analysis was carried out based on the resource-based view theory. Somsuk et al. (2012) grouped resources into four categories: organizational, human, financial, and technological. In this study, the resource based view (RBV) theory was adopted as a reference for classifying ATPs based on discrepancies in specific characteristics. Grouping ATPs is based on modifying the characteristics of the segmentation of science parks (Ng et al. 2019). We analysed some of the key variables discussed in the literature and added important variables to determine the differences in ATP characteristics based on location-specific conditions (Figure 2).

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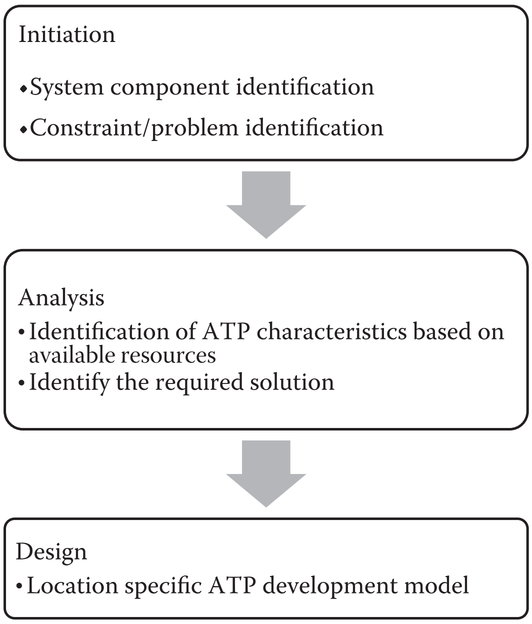

Figure 1. Summary of research steps
ATP – agricultural technology park

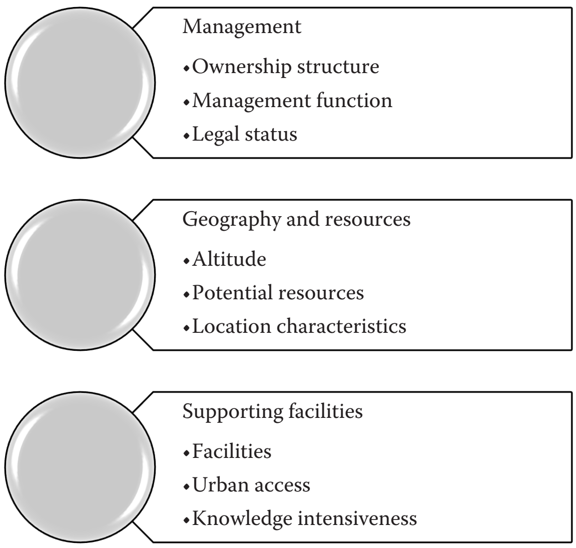

Figure 2. Examples of variables for the analysis

Data collection. Data were collected through focus groups and participatories (focus group discussions) at each investigation location from December 2020 to October 2021. The respondents were representatives from users namely local governments, the Indonesian Agricultural Research and Development Agency (IARDA), managers of ATPs, universities, partner farmer groups, farmer group suppliers of raw materials, start-ups, and visitors. Group discussions were conducted at three different locations with a total of 26 speakers. In-depth interviews with key figures were conducted via telephone and face-to-face interviews. The stages of data collection are listed in Table 1.

RESULTS AND DISCUSSION

Identification of the user needs, constraints, and requirements

A mission's operational need is obtained based on situational assessment. Users need ATPs to gain knowledge and technology and open up business opportunities according to their potential resources, but they do not have the capital to invest in processing equipment, buildings, machinery, or offices to build a sustainable business. Additionally, users cannot improve their businesses because of the lack of extensive marketing networks and substantial business capital. System developers consider the users' needs to be the operational needs of the system. Therefore, they must be used as the basis for following the mission system.

The mission system aims to realise an ATP that can bridge users and producers of knowledge and technology by considering the potential of location-specific resources. According to Wasson (2006), achieving individual and organizational missions requires employing systems, products, and services that leverage human capabilities. The selection

Table 1. Stages of data collection

Stage	Description
Document and literature review	Research articles, reviews, and publications in domestic and international journals about science parks regarding characteristics, location, legal format, transfer mechanism, and activity reports.
Preparatory meeting	We are meeting with representatives of stakeholders to identify problems and carry out variables analysis.
Focus group discussion	Discussion topics relate to the specifications and advantages of each agricultural technology park and the appropriate strategies for technology transfer.
Depth interview	In-depth interviews were conducted with the managers of ATPs and the local government to obtain the history of technology transfer formation, development, and progress at the ATPs.

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or acquisition of these systems begins with an understanding of who, what, when, where, and how the system user(s) plan to accomplish the mission. Figure 3 shows the elements that constitute the ATP technology transfer system (Figure 3).

Several constraints that originate outside the system of interest are referred to as operating environments. The operating environment consists of natural constraints such as weather, temperature, vegetation, and slope and can also be derived from human systems such as rules and habits. However, we encountered several problems. First, the ownership structure of an ATP needs to be clarified as to whether farmer groups or local governments fully manage it. This issue impacts the strategic decisions made by managers. Strategic and long-term decisions require that a firm has clear ownership status. An unclear ownership structure impacts weak management functions and legal status. Corporations have been successfully implemented as one of the most flexible alternatives to legal status and are most commonly used in several European countries (Ruiz et al. 2017). Property management uses business criteria and is responsible for the representatives of the government agencies that maintain the park. In the case of ATPs in Indonesia, development and long-term business plans need to be clearly defined owing to the influence of government policies.

The next constraint is the conflict of interest originating from parties who feel that they have contributed to financing and building an ATP. Conflicts of interest cause the main agenda of technology transfer to differ from what was planned. Another consequence is that the dominant interests influence the direction and strategy of ATP management. The conflicts of interest in Indonesia allow for easily changing policies and planning ATP activities.

Problem-solving requirements are based on needs and constraints originating from natural, human-made, and induced environmental elements. Moreover, it is necessary to describe the initial interaction conditions between the system of interest and the operating environment (Figure 3).

The initial state of the technology transfer system for an ATP was obtained based on Figure 4. The initial situation shows that several obstacles originate from outside the system of interest, including the users' needs for land, resources, and other facilities related to technology transfer. Users hope that ATP can be used for practice and training. Facilities related to technology transfer and support are available, but the conditions are yet to be optimised. Several conditions/requirements of system elements are required to resolve these constraints. A resource-based view approach was suggested to solve this constraint problem.

Resources are the principal capital for achieving business goals. However, under the initial conditions, potential users have limitations in controlling resources. One way to overcome the problem of achieving goals is to use essential resources as functional requirements.

Identification of agricultural technology park characteristics based on available resources

Based on the identification results, several differences in the characteristics of each ATP molecule were observed. Table 2 presents the detailed results.

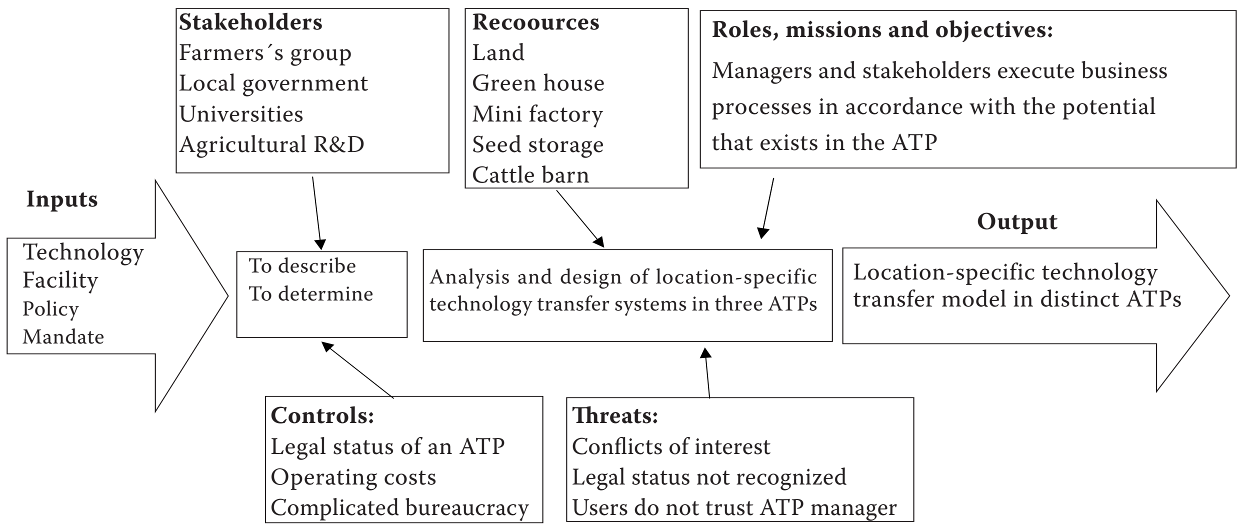

Figure 3 Technology transfer model development system entity in an agricultural technology park (ATP)

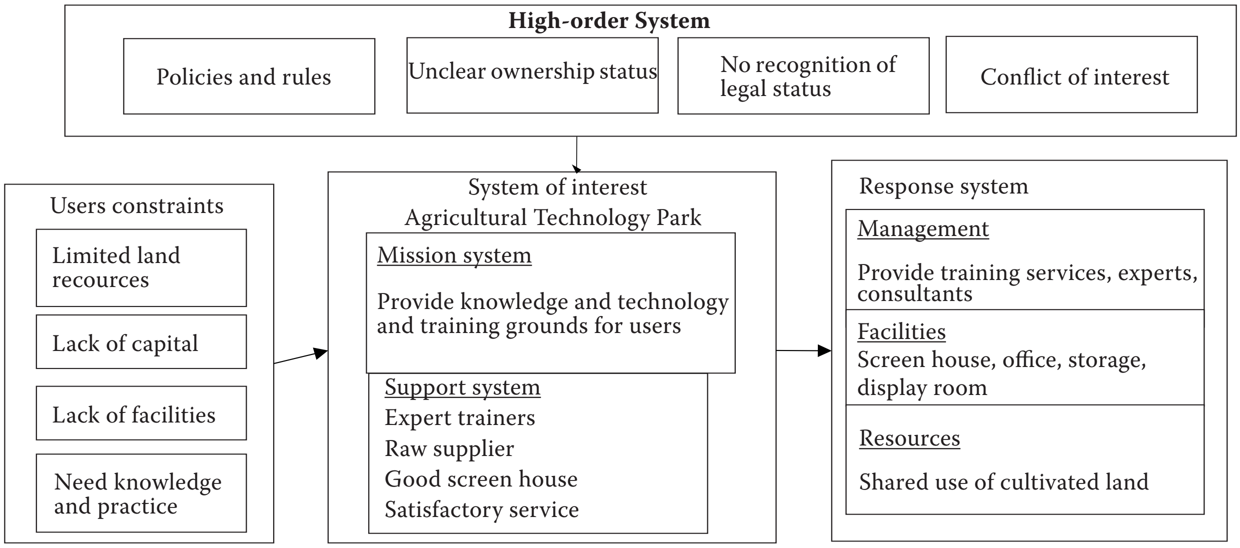

Figure 4 Description of the initial conditions of an agricultural technology park

As shown in Table 2, ATPs exhibit different characteristics. Characteristics that stand out in terms of management, including ATPs Cikajang (CKJ) and Garut Regency, have an informal management function. Informal management is characterised by transparent workflows and responsibilities that are not separated. Leaders and management teams support each other in completing a task or project without being limited by the tasks and functions of the organizational structure. Additionally, managers are representatives of farmer groups with good competence and experience. Therefore, the relationship between male and female farmers is quite good.

ATP CKJ Garut is ideal for growing horticultural crops, such as potatoes, chilies, and broccoli, making it a good location for natural resource potential. This natural resource has great potential because facilities are available to support it. These include places to store the seeds, process resources, and processing rooms. ATP CKJ Garut is recommended as a place to learn, apprentice, and share upland horticultural plant cultivation techniques. By working in conjunction with potato seed breeders and fostering cooperation in the processing of potatoes for snack production, the ATP manager was able to effectively broaden the network to encompass nurseries of industrial-grade quality. Table 3 shows the analysis of knowledge intensity and connectivity for each ATP location.

Based on the results in Table 3, the intensity of knowledge differs in the three locations. ATP Nglanggeran (NLG) has the closest relationship intensity to universities. The proximity of this relationship is evident in the research collaborations on primary ATP commodities. Additionally, a student internship program has been developed to support technology transfer from universities. The internship program provides benefits through new knowledge of ATP management. Apprentices gain entrepreneurial experience and hands-on practice on agricultural lands.

Based on Table 4, ATP NLG, Gunung Kidul, has advantages regarding support facilities and support from the local government. Additionally, the geographical location of the Nglanggeran ATP is advantageous because it is located in a natural tourism area equipped with good road access and other public facilities. Therefore, its existence is well known, and it is often used as a destination for educational visits. Its superior products include snacks made of cocoa and goat milk. Therefore, ATP Nglanggeran can improve its qualifications by taking advantage of its facilities to become a learning centre for the cultivation and processing of cocoa and goat milk, as well as for processing and marketing management.

ATP Cigombong (CGB) has considerable potential for developing urban farming models using leaf and chicken egg commodities. This potential can be developed if the market accommodates harvests from its members and the surrounding community. The ATP plays a role in helping the market and promoting results, as well as buying raw products for processing. This role is crucial because it guarantees business continuity and member motivation.

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Table 2. Specific management and geography resources of the agricultural technology parks (ATPs)

Variable	Cikajang, Garut District, West Java (CKJ)	Nglanggeran, Gunung Kidul District, Special Region of Yogyakarta (NLG)	Cigombong, Bogor District, West Java (CGB)
		Management	
Ownership structure	subordinat of district government	Agriculture and Food Office (local-district government).	Regional secretatiat
Management function	Informal team	Formal	Formal
Legal status	ATP managers are obliged to pay land rent to the sub-district government.	The land, buildings, and ATP facilities are in the territory of the Yogyakarta palace or the Sultan Ground.	The local government owns the land, buildings, and facilities within the ATP environment.
		Geography and resources	
Altitude (m a.s.l.)	1 278 (mid-highland)	236 (lowland)	578 (lowland-medium)
Potential natural resources	Highland horticultural crops	Farmstead crops such as cocoa, cloves, and goats	Lowland veggies using vertical arrangement
Location characteristics	There is extensive agricultural land in the highlands.	Facilities only somewhat surround ATP land for visiting tourists.	ATP land is not too large, only enough for a demonstration of vegetable cultivation.

Identifying the required solution

Several scenarios were prepared based on the results of identifying resources and considering the constraints faced by users. Based on these scenarios, functional and nonfunctional requirements can be formulated to achieve these objectives (Table 5).

Location-specific technology transfer models

A technology transfer model was developed based on user needs by considering potential resources. Additionally, existing obstacles must be considered because they can hinder goal achievement. In general, according to Good et al. (2019), technology transfer in ATPs and interaction with the environment (technology transfer ecosystem) can be classified into three types: introverted, externalised, and allied. In contrast, the model technology transfer of Dias and Porto (2018) is based on patent development and commercialisation with a university-industry collaboration model and spin-off companies. However, in this study, a technology transfer model was designed by considering the components of the needs, constraints, and excellence of users. The steps for creating the conceptual model are illustrated in Figure 4.

Following the stages shown in Figure 5, three technology transfer models were synthesised based on the scenarios in Table 4.

Technology transfer model based on highland-specific conditions. ATP CKJ has advantages in terms of geographical conditions and altitude. It is suitable for the cultivation of vegetables and other horticultural crops. The ATP environment is a community planting area that cultivates horticultural crops. Technology transfer is conducted by holding a planting demonstration using a technology different from that used by local farmers. The ATP manager disseminates information on the technology exhibited on the ATP land through fellow farmer group administrators. This information dissemination effort is effective and runs well if the interpersonal relationships between ATP managers and farmer group administrators are well established (Figure 6).

Figure 6 shows that TTP managers can cooperate with farmers in land use. Farmers who understand the use of new technology are allowed to practice on TTP land using a cooperative scheme. Cooperation is directed toward high-value commodities. Specific technology transfers for commodities with certain geographical conditions can meet the needs of farmers with the same potential backgrounds and problems.

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Table 3. Knowledge intensiveness and connectivity of the agricultural technology parks (ATPs)

Variable	Cikajang	Nglanggeran	Cigombong
Knowledge intensiveness	some universities interact quite closely with the ATP	3–4 universities are collaborating with the ATP in research on the primary commodities in the ATP	Research collaboration with universities is very limited
Urban access/connectivity	located in an agricultural area bordering farmers land	located in an agricultural area bordering tourism objects	located in urban areas around residential areas

Table 4. Presence of facilities

Variable	Cikajang	Nglanggeran	Cigombong
Work-related facilities			
Auditorium and meeting room	available and sufficient	available and sufficient	available and sufficient
Management office	present	present	present
Display room	available indoor and large space adequate for product exhibition	available indoor and satisfy for startup's product exhibition	outdoors are suitable for vertical garden installation exhibitions
Shared usage of R&D facilities space			
Screen house	large capacity; used for the production of potato seeds.	Small capacity; used for cut flower production.	Medium capacity; used for vertical crop systems.
Warehouse	Available, good condition	Unavailable warehouse product	There is a storage shed, but it is not in good condition.
Leisure facilities			
Homestay	located within ATP region	located outside ATP complex but around the tourist village	homestays are located in community settlements outside the ATP area.
Parking lot	medium	Large and outdoor theatres for performances or technical guidance.	medium

R&D – research and development

Mechanism 1 regulates the cooperation between users and ATP in land use, production support facilities and equipment, product marketing, research, and internships. Only prioritised users who received training and technical guidance were allowed to collaborate. The use of support facilities is encouraged to reduce equipment investment costs. For instance, farmer groups trained as seed breeders can use land, whereas snack-food-processing groups and upland vegetable producer groups can use processing equipment.

The second mechanism regulates how ATP manages the income generated from the shared use of supporting facilities. Users pay rental fees by allocating a portion of their income to product sales. To ensure continued mutually beneficial cooperation, ATP provides storage and sorting facilities to maintain high product value and extend shelf life. As part of their work procedures, internships or research students may create online profiles, brochures, or websites to promote the activities, products, and services of the ATP. This mechanism can be formalised as a Public Service Agency following Indonesian Ministry of Home Affairs Regulation No. 78 of 2018 for Regional Public Service Agencies (Minister of Home Affairs Indonesia Regulations 2018).

Tourism village-based technology transfer model. The TTP NLG technology transfer model was designed based on a tourism village. One way to transfer technology is to implement tourist-village policies by the local government. Facility support

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Table 5. Identification of scenario and requirements

Scenario	Functional Requirement	Nonfunctional requirement
Users need knowledge and technology from ATPs but they do not receive what is needed	**Knowledge and technology:** Several methods of transfering knowledge and technology; face-to-face, practice and consulting	**Oganizational requirements** Management, leadership, legal status, simple bureaucracy
Users receive technical guidance and training on the new technology but need more resources to implement the technology.	**Resources** Permitting the use of the producing support equipment of the ATP	**Environment requirement** Products, processes, and services are not causes of environmental damage, sources of pollution, or land degradation
Users have succeeded in producing technology-based products but have been unable to reach a broader market	**Venture capital**: Providing venture capital for prospective new technology-based entrepreneurs with a mutually beneficial and no-interest scheme **Buyback mechanism:** Buyback products from farmers who are fostered by several mechanisms	**External requirements** Regulatory, cultural, and ethical requirements

ATPs – agricultural technology parks

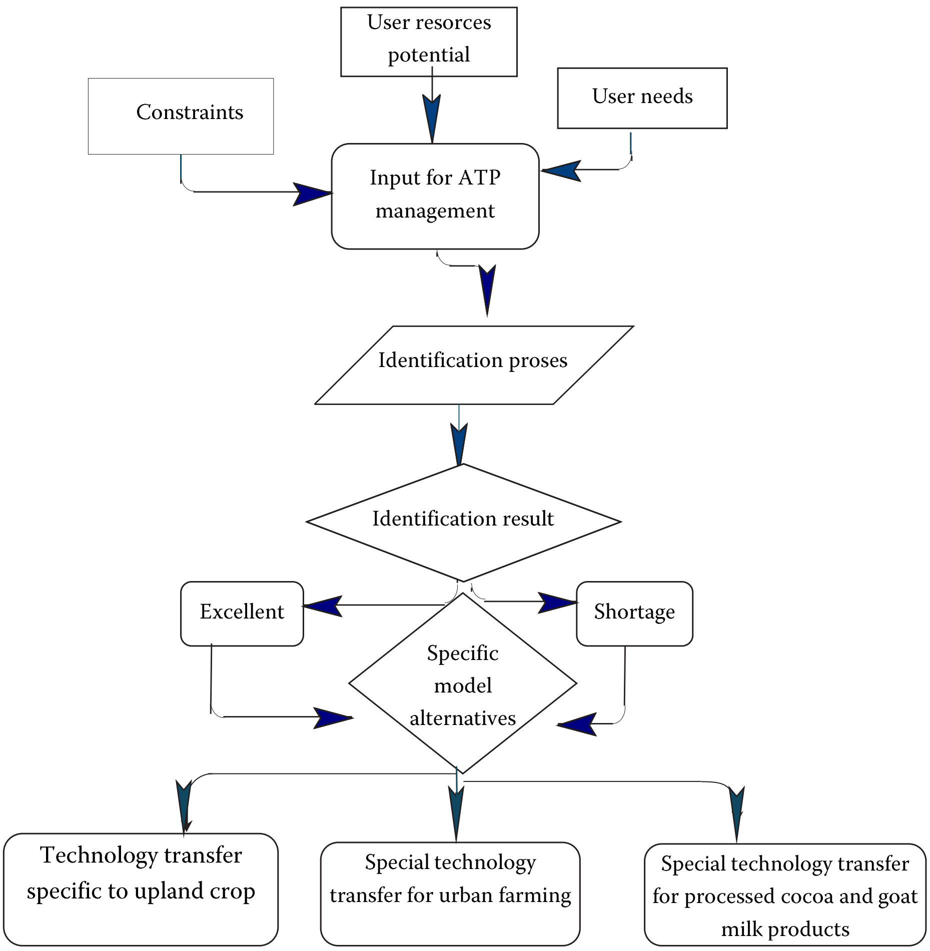

Figure 5. Preparation stages of the conceptual model of technology transfer

ATP – agricultural technology park

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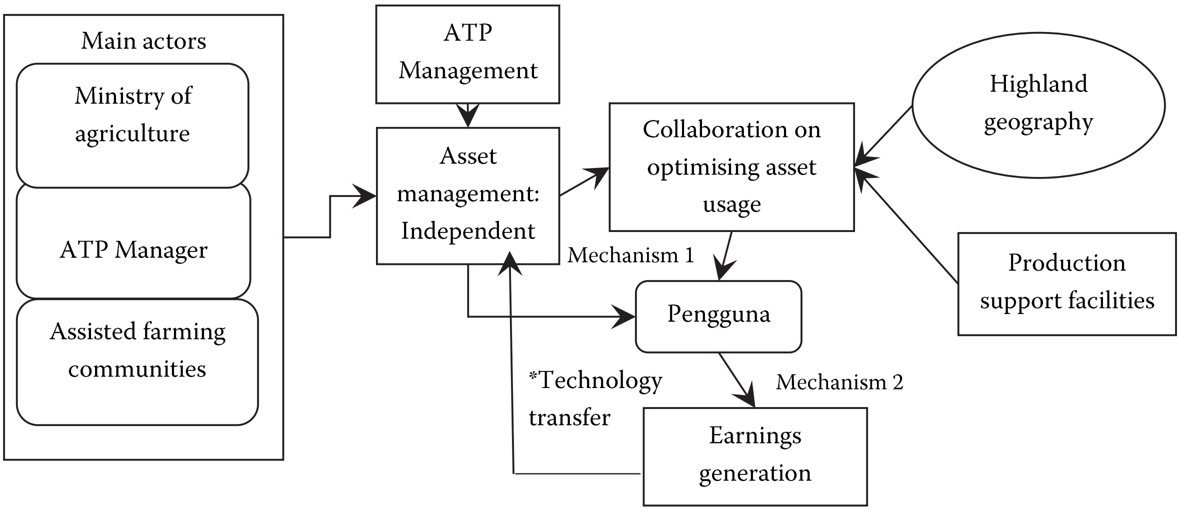

Figure 6. Model for transferring technology specific to a particular plateau region

* Innovation display and practical experience mechanism; 1 – enhanced availability of land, production facilities, and processing facilities; mechanism 2 – rental of facilities, tools, and profit percentage, ATP — agricultural technology park

related to visitor needs can complement the existing production-related facilities at ATPs. The resources owned by farmers include productive-age cocoa plantations and goat farms. Farmers have limitations in increasing the added value of these commodities. ATP serves as a learning and practice centre for the production and processing techniques related to these commodities. Figure 7 illustrates the technology transfer model for a tourism village.

As shown in Figure 7, the ATP manager can develop a cooperative model using processing facilities with users. The intended users assisted cocoa farmers, cocoa-producing farmers, start-ups, students, and visitors. The use of facilities is prioritised for groups that already understand the use of new technology. In addition to production facilities, supporting facilities, such as meeting rooms, gallery spaces, outdoor theatres, and ample parking, can be used. Policy support is required for the real-world implementation of this model. The local government has prepared for road access, adequate public facilities, and budgetary assistance. Infrastructure support from the government as a technology transfer strategy in Thailand was also disclosed by Wonglimpiyarat (2016).

To strengthen capital, we offer interest-free lending programs for various equipment, process rooms, and quality control laboratories over specific periods. One way to raise capital is to expand business by collaborating with multiple producers and creating a joint venture with a proportional profit-sharing agreement.

Urban agriculture-based transfer technology model. The ATP CGB uses a technology transfer model that focuses on urban agricultural technology. Urban agriculture typically occurs in areas with limited space, such as narrow residential plots. There are limitations to cultivation, which must be eco-friendly, soothing, and artistically satisfying. Furthermore, commodities are expected to have short lifespans and economic values. Technology transfer was designed specifically for urban areas with vertical vegetable cultivation systems combined with poultry and fish (Figure 8).

The urban-agriculture-based technology transfer model involves resource persons, technology, supporting facilities, marketing institutions, and product transportation subsystems. The ATP team is responsible for ensuring that users clearly understand the technology and its appropriate applications. Resource personnel can explain and guide users on vertical vegetable cultivation. Our users consist of the local community, product recipients, and traders. The technology transfer model, specifically in the context of urban agriculture, can be applied to other regions that share similar characteristics with the study area, such as utilising chicken breeding coops, sorting rooms, grading, and packaging to earn income. They can also cooperate by sharing the profits from product marketing.

Urban-peri-urban agriculture has been proven to provide many benefits, such as adequate production and nutrition, increased food and environmental security, and a better life (FAO, Rikolto, RUAF joint 2022).

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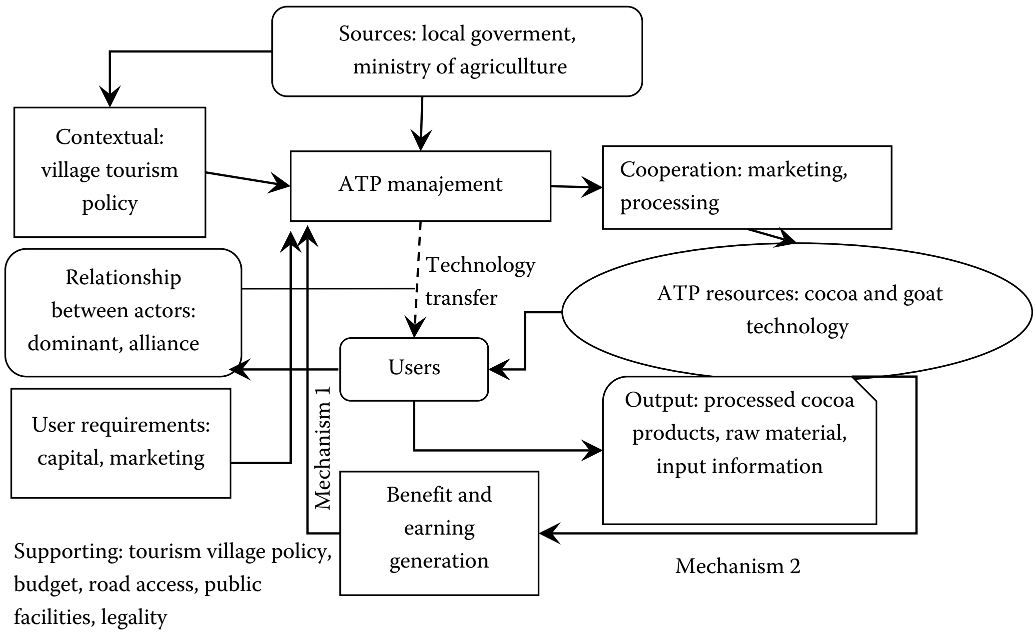

Figure 7 Model of technology transfer based on a tourism village

ATP — agricultural technology park

Urban agriculture is a system that allows the transfer of agricultural technology. This study proves that urban agriculture can be recommended as a technology transfer model for agriculture-based urban communities.

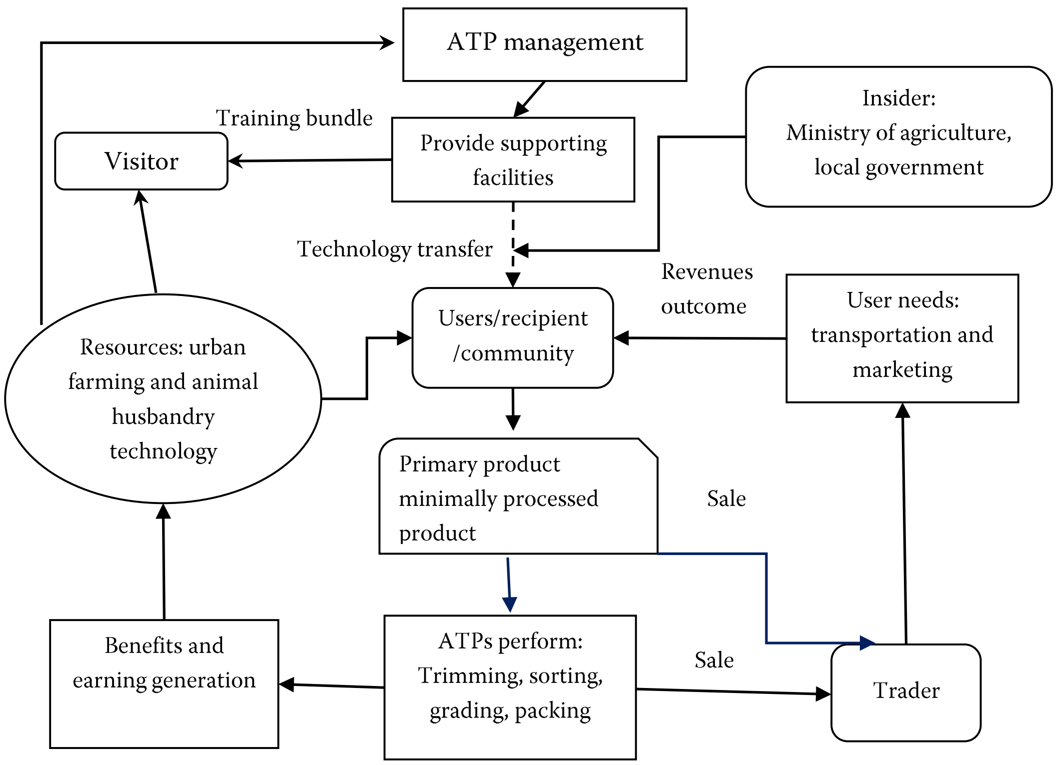

Figure 8 Technology transfer model focused on urban agriculture

ATP — agricultural technology park

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CONCLUSION

Following these objectives, this study formulates a location-specific technology transfer model based on a resource approach. Based on this analysis, the following conclusions were drawn. First, the potential regional advantages and uniqueness of each location are added values that must be considered when designing the model. Second, the technology transfer model must be adapted to user needs so that the designed model matches real-world conditions. The model designer only needs to improve the flow/procedure and the flow of communication to ensure that the designed model is adequate. Third, a technology transfer model based on specific locations can be developed for locations with similar conditions. The application of a location-specific technology transfer model results in several changes. These changes are related to strategy, structure, processes, or resources that may affect TTP performance, employee welfare, or relations with external parties (e.g., suppliers, customers, or the government). This technology transfer model could be broadly developed in Indonesia. The results of the analysis indicate that the development of the model must consider: (*i*) the availability of resources and environmental potential; (*ii*) the capacities of the actors involved in technology transfer; (*iii*) the mechanism for earning income; and (*iv*) the government policies that are in line with the model development plan.

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