Ex-Situ conservation strategy with apsilviculture systems based on *Trigona incisa*

**Budiaman**, **Yusran**, **Samuel Arung Paembonan**, **Iswara Gautama** and **Hertasning Yatim**

1 Lecturer of Forestry Faculty of Hasanuddin University, Makassar
2 Lecturer of Agriculture Faculty of Luwuk Tompotika University

Email: lintassapi@yahoo.com

**Abstract.** Luwu Utara District has the potential of natural resources and other supporting potentials in the development of the local bees *Trigona incisa*, but until now has not been inventoried accurately so there is no data base to formulate its development strategy in order to optimize the potential use. This study aims to determine Formulating an ex-situ conservation strategy for local beekeeping in North Luwu Regency. The potential development of local bees cultivation *Trigona incisa* in North Luwu. The research method used is direct observation, secondary data review, semi-structured interviews, ven diagrams, braistorming and discussion with target groups. The data collected consist of primary data and secondary data. The socioeconomic data obtained, analyzed descriptively, the role data between sectors were analyzed by Ven Diagram, policy data were analyzed with Content Analysis, while the local cultivation development strategy was analyzed by SWOT Analysis. The results showed that: North Luwu Regency had considerable potential in supporting the development of *Trigona incisa* local bees culture, among others: government policy, socio-cultural breeders, biophysical conditions and basic skills/knowledge of mastering several apiary technologies.

The formulation of local bees cultivation development strategy in North Luwu Regency covers short and long term strategy. Short-term strategies include: Strengthening potential data base, network and information of farmers community through counseling/training. While long-term strategy include: Improvement of community empowerment of farmers through counseling/training (cultivation, harvest management, processing and marketing), creation of queen bee breeding center, and training of queen making and pest and disease control techniques.

1. **Introduction**

In the development of Forestry in North Luwu Regency, the forest and its surroundings are developed to produce forest benefits for the community and utilize the land around the forest with various forestry businesses, so that forest sustainability is more secure. One of these types of business is the development of local beekeeping.

The new paradigm of forest management since the reformation era in 1998 has changed from an economic orientation to a balance orientation between economic and ecological benefits that places communities as part of the forest ecosystem. Utilization of natural resources as the main points of people's prosperity is carried out in a planned, rational, optimal and responsible manner in accordance with the carrying capacity of potential facilities by prioritizing the prosperity of the people and paying attention to the preservation of environmental functions and balance for
sustainable development.

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Beekeeping activities in Indonesia have been carried out by the community traditionally for a long time, namely hunting wild bees and keeping local bees in gelodok. The government realizes that beekeeping activities are very beneficial, both directly and indirectly, among others, increasing the provision of employment, increasing community income, improving community nutrition, increasing fruit production as a result of pollination, as well as maintaining environmental damage and reducing the rate of forest damage due to encroachment forest [1]. However, in this case, it is still limited to hunting wild Apis dorsata and local beekeeping Apis cerana, while the development of superior bee Trigona incisa has only been developed in a limited way on Java Island, while South Sulawesi has a fairly supportive development potential [2].

North Luwu Regency is one of the regencies in South Sulawesi Province which is quite large, and most of its land is covered by vegetation with a high diversity. This indicates that North Luwu Regency has a high diversity of flower species which are a source of food for honey bees. Furthermore, honey bees play a role in converting the abundant flowers into materials for trade, raw materials for the pharmaceutical, cosmetic, textile and export industries [3].

Based on the description above, it is necessary to formulate an ex-situ conservation strategy for local beekeeping including Trigona incisa in North Luwu Regency. and inventory/identification of potentials that can support the development of local honey bees in North Luwu Regency, so that an accurate picture of the current support potential can be obtained that can be used as a benchmark for developing local honey bee cultivation strategies by optimizing

2. Materials and methods

2.1. Tools and materials

2.1.1. Social, cultural and economic data
a. Material: Interview guide
b. Tools: calculator, markers and cartoons to make ven diagrams, scales, local bee colony

2.1.2. Biophysical data
a. Material: Secondary data

2.2. Method of sampling (sampling)
The sampling method (sampling) based on data from the aspects of data collected, namely:

2.2.2. Socio-cultural aspect
a. Inventory of supporting policies and feed inventory.
b. Sampling is done purposively with the institution or agency being the sample unit.
c. Supportive socio-cultural
Sampling is carried out by "Systematic sampling", in this case there are 2 ways [4], namely:
1. North Luwu Regency is systematically divided into three major sections based on the similarity in development trends, namely South, Central, and West, then purposively selects sub-districts and villages as the sample units in each of these areas (furthermore, all the farmers are used as
2. Systematically, North Luwu Regency is divided into several sub-districts with each sub-district being a sample unit. (Furthermore, it was purposively determined that 5 people knew about beekeeping in each sub-district/village).

2.2.3. Economic aspect
   a. Potential marketing and distribution channels
      Sampling is done purposively in this case marketing places, institutions or related agencies are the sample units.
   b. Financial analysis
      It was carried out purposively at the test case locations (Rongkong, Seko and Radda).

2.2.4. Bio-physical aspect
Sampling was done by “first dividing the area”, namely North Luwu Regency was divided into 3 major parts based on the similarity of flowering tendencies. Furthermore, purposively select areas that begin to develop local bees in each of these parts, namely: the southern region, the middle region, and the western region.

2.3. Data types and sources
The types of data collected consist of primary data and secondary data which include:

2.3.1. Social – cultural aspect
   a. Policies that support the development of local honey bees.
   b. Institutional
   c. Behavior and response as well as community culture.

2.3.2. Economic aspects
   a. Marketing potential
   b. Marketing distribution channel

2.3.3. Bio-physical aspects
   a. Land potential
   b. Feed potential
      • Value potential
      • Type
      • Feed calendar
   c. Bee technology
   d. Internal factors of local beekeeping.
      • The ability to breed (queen egg laying capacity)
      • Age of imago (productive age of the queen)
   e. External factors of local bee cultivation
      • Climate (temperature, humidity, precipitation and wind)
      • Food sources (nectar and pollen) and feed calendar
      • Biological factors (competitors, pests and diseases)
      • Use of pesticides

Further sources of data sources include:
1. Relevant agencies/institutions (Ministry of Forestry and Plantations, Agriculture, Department of Forestry and Land Conservation, Plantations, Bappeda Level I & II, Ministry of Trade and Industry).
2. Study results and supporting literature.
3. Local government
4. Society
5. Live observation
6. Internet

2.4. Data collection and analysis techniques

2.4.1. Socio-cultural and economic data
a. Secondary data review (secondary data review)
b. Semi structured interview (semi structured interview)
c. Direct observation (direct observation)
d. Discussion with the target group (focus group discussion)
e. Brainstorming
f. Role data between sectors analyzed by ven diagram
g. Policy data analyzed with content analysis

2.4.2. Bio-physical data
a. Secondary data review (secondary data review)
b. Direct observation (direct observation)
   - Data on internal and external factors collected will be analyzed with data tabulation and descriptive.
   - Socio-cultural, economic and biophysical data collected will then be entered into a SWOT worksheet (Table 1) where:
      a. Strengths (S) = strength of internal factors
      b. Weaknesses (W) = weakness of internal factors
      c. Opportunities (O) = opportunities from external factors
      d. Threats (T) = threat from external factors
Furthermore, the data will be analyzed using a SWOT analysis matrix (Table 1) to create an ex-situ conservation strategy.

Table 1. SWOT Analysis matrix

| IFAS (Internal Faktor Analysis Strategy) | STRENGTHS (S) | WEAKNESSES (W) |
|----------------------------------------|---------------|----------------|
|                                        | Internal strength | Internal weakness |
|                                        | 1.              | 1.              |
|                                        | 2.              | 2.              |
|                                        | 3.              | 3.              |
|                                        | 4.              | 4.              |
|                                        | 5.              | 5.              |

| EFAS (Internal Faktor Analysis Strategy) | STRATEGY (SO) | STRATEGY (WO) |
|----------------------------------------|---------------|---------------|
| External opportunities                 | Creating strategies that use strength by taking advantage of opportunities | Creating strategies that minimize weaknesses to take advantage of Opportunities |
|                                        |               |               |
|                                        |               |               |
|                                        |               |               |
|                                        |               |               |
|                                        |               |               |

| OPPORTUNITIES (O) | STRATEGY (SO) | STRATEGY (WO) |
|-------------------|---------------|---------------|
| 1.                |               |               |
| 2.                |               |               |
| 3.                |               |               |
| 4.                |               |               |
| 5.                |               |               |

| TREATHS (T) | STRATEGY (ST) | STRATEGY (WT) |
|-------------|---------------|---------------|
| External threats | Creating strategies that use strength to overcome threats | Creating strategies that minimize weaknesses and avoid threats |
| 1.          |               |               |
| 2.          |               |               |
| 3.          |               |               |
| 4.          |               |               |
| 5.          |               |               |
Based on this analysis, 4 (four) strategies will be created, namely SO, WO, ST and WT strategies. These four strategies were created by paying attention to the point of contact of the elements from one factor to another [5].

3. Results and discussion

3.1. Development potential

3.1.1. Potential of local bee development policy. Based on the results of the Secondary Data Review and Content Analysis analysis, it is known that: there are government policies (authority holders) that can support the development of local bees in North Luwu Regency such as 9 policies that support the Ministry/Agency/Agency that supports local honey bee development programs. These include the fields of: general, production, marketing, capital, science and technology and institutions, all of which are interrelated in supporting and supporting the synergy of local bee development [6].

3.1.2. Social, economic and cultural potential of local beekeepers

3.1.2.1. Socio-cultural society of breeders. Based on the results of semi-structured interviews and discussions with target groups, local beekeeping communities in Sinjai Regency have a high (serious) response in the business of cultivating local bees because they think that the development prospects are great. Therefore, if local bees are developed in the form of government or private programs or other institutions [7], the community will accept them well and try to cultivate them. This is due to the community's assumption that it will become a new source of employment and a new source of income in the countryside, forests and surrounding forests [8].

The habit of forest bee hunter communities that have potential value is illegal hunting in the wilderness which is carried out with three systems, namely the Damu Tambung, Damu Titian and Damu Sorong systems. Hunting is carried out individually and in groups (3-7 people) consisting of family members, neighbors or professional friends, but the most common are family members. In bee hunting there is a clear division of tasks, namely climbers and smoke makers, bearers and sorters of products, while marketing is carried out together [9]. The results of the hunt are 2, namely the product can be directly divided equally or the money from the sale. Meanwhile, the ownership system is based on an unwritten agreement, namely the first to find or mark an individual password that has been agreed upon. Hunting teams from outside the village/community area can be carried out as long as there is no marking, because the ownership of the hunting territorial area/authority rights does not generally exist in North Luwu Regency.

3.1.2.2. Institutional potential. Based on the semi-structured interview method, discussion with target groups, secondary data review and diagrams, it was found that the socio-cultural institutions that play a role in the development of local bees in North Luwu Regency are as follows:

- Farmers
- Non-governmental organization
- LKMD
- Religious groups / mosque administrators
- Youth Association Group
- Bee Hunter Group
- Village Unit Cooperative (VUC)

This institution plays a role in organizing the adoption of beekeeping technology and is a means to discuss the problems faced. Also plays a role in bridging the interests/programs of the government, NGOs, and the farming community [10].
3.1.2.3. **Marketing potential.** Based on the Secondary Data Review, Semi-Structured Interview, and Internet methods, the marketing potential of local honey bee products is obtained, while the marketing potential based on export destination countries shows that there are six types of industries that are potential markets for local honey bee products. This shows that post-harvest from honey bee cultivation will later be absorbed by the industry in Sulawesi, Java, Sumatra, Kalimantan and developed countries such as the United States, Japan, Germany, England, France and some Arab countries, especially Saudi Arabia [11].

3.1.3. **Potential external factors**

3.1.3.1. **Climate**

a. **Temperature.**

The average temperature in Sinjai Regency and South Sulawesi generally ranges from 15°C - 35°C with an average of 26.4°C. This is very feasible for local bee development in North Luwu Regency, because it is still in the optimal range for local honey bee development, namely 14°C - 38°C. This type of bee thrives in temperature range of 15°C - 37°C [12].

b. **Humidity**

The average humidity in North Luwu Regency and in South Sulawesi generally ranges from 58-91% with an average of 76%. This moisture data strongly supports the development of local bees. In this case, local bees can live well at a relative humidity of 60-95% [13].

c. **Rainfall**

Rainfall in North Luwu Regency and South Sulawesi generally ranges from 0-1,234 mm/year with an average of 68mm/year and the number of rainy days ranges from 2-30 with an average of 18 DH. Rainfall that is too high only occurs 3-4 months a year, so on average it still supports the development of local beekeeping in North Luwu Regency and South Sulawesi in general [3].

d. **Wind**

Wind speed data shows that wind speed in North Luwu Regency and South Sulawesi generally ranges from 0.6 to 10 km/hour with an average of 3.27 km/hour. Under these conditions, local bees are feasible to develop, except in coastal areas and mountain peaks where the wind speed is very high, (greater than 6 km/hour). The ideal wind speed in the cultivated area is 0-5 km/hour. [14].

3.1.3.2. **Feed plants.** Data on nectar and pollen sources as well as the feed calendar show that North Luwu Regency, South Sulawesi is generally very rich in food sources, both nectar and pollen sources, as well as feed, both nectar and pollen sources, and the flowering schedule of forage plants varies based on the location and type of plant [15].

3.1.4. **Biological factor.** Biological factors that affect the development of local bees are pests, diseases and other competitors. The Appendix shows that there are 12 types of pests and 2 types of ectoparasites, no disease and 2 types of other competitors. In these conditions, local bees can still be developed as long as the control factor is carried out intensively, but it is still a threat that needs to be watched out for. Biological factors that are serious disturbances are mites *Tropilaelas clareae* and *Varroa destructor* [16].

3.1.4.1. **Pesticide use.** Examples of pesticide use and the time of application in North Luwu district show that the timing of pesticide use varies at various stages of development of alebe feed plants. However, what does not support the development of local bees is their use in the flowering phase. In this phase the use of pesticides needs to be avoided [14].

3.1.4.2. **Potential mastery of apiari technology.** The types of beekeeping technology that are known and unknown to local beekeepers in North Luwu Regency indicate that on average the types of
technology that have been known by local beekeepers in North Luwu Regency are 14 types and are more or less balanced with those they don't know yet. they need to master further [17].

3.2. Results of identification of ex-situ conservation SWOT elements

3.2.1. Identify the Elements of SWOT. Based on the results of the study, the results of the inventory and identification of the elements of SWOT (Strengths, Weaknesses, Opportunities, Threats) of local bee development strategies in North Luwu Regency [18] are as follows:

• Strengths
  1. Socio-cultural aspects
     a. Supportive beekeeper community culture
     b. Community response to maintain is quite high
     c. Habit of consuming bee products
  2. Institutional aspect
     a. The existence of bee hunter groups, farmer groups, and Village Unit Cooperative (VUC)
  3. Technical aspect
     a. The land potential for development is very wide
     b. The potential for bee feed (nectar and pollen) is very abundant
     c. Types of forage crops and flowering schedules vary, so trees last all season
     d. The basis for mastering apiary technology already exists
• Weaknesses
  1. Socio-cultural aspects
     a. The productive age of the queen is still low
     b. Breeders have not produced their own queen
     c. Breeders have not mastered the techniques of controlling pests and bee diseases
  2. Institutional aspect
     a. The empowerment of socio-cultural institutions has not been optimal
• Opportunities
  1. Socio-cultural aspects
     Government policies, both central and regional
  2. Institutional aspect
     There are sectors that play a role and are interrelated (government, community and private)
  3. Economic aspect
     a. The prospect of marketing honey bee products is quite high
     b. Broad market segment
     c. Financial feasibility analysis is very feasible for cultivation investment
     d. The potential value of feed is very abundant and until now most of it is still wasted
  4. Economic aspect
     a. The types of feed are very varied
     b. Does not take up large areas
     c. Agricultural, forestry and plantation crops require intensive pollination assistance
• Threats
  1. Technical aspect
     a. The dependence of the queen bee from outside like Java
     b. Tropilaelaps clareae and Varroa destructor attack
     c. The use of pesticides in the flowering phase of forage plants

3.2.2. SWOT analysis results. The results of the SWOT analysis of the development of local beekeeping in North Luwu Regency can be seen in the SWOT Analysis Matrix. In the matrix, it appears that at the point of tangency, the elements of Strength and Opportunities there are 2 sets of strategies, the elements of Strength and Threats have 3 sets of strategies and on the elements of
Weaknesses and Threats there are a series of strategies. The point of contact is an effort to maximize strengths, opportunities and simultaneously minimize weaknesses and threats, so that the development of local bees can ideally be achieved in order to utilize the potential of nectar and pollen resources [19].

3.2. Ex-situ conservation development strategy
After the SWOT elements of the local bee development strategy in North Luwu Regency were analyzed in the SWOT matrix, the development strategy was formulated as follows:

a. SO (Strengths-Opportunities) strategy
1. Strengthening the potential data base, network and information, data collection on land potential, types of feed and flowering schedule is carried out regularly, then well organized. Meanwhile, the existing marketing network is maintained and looking for new networks. Furthermore, it is hoped that data information on policies and infrastructure can be obtained easily from related agencies and the farmers themselves and continuous monitoring of the latest information data.
2. Improving farmer community empowerment through counseling/training. The counseling/training carried out is based on the needs of the community (colony cultivation and management, harvesting, processing and marketing), so that the community can be more stimulated and empowered in the context of investment, so that many agricultural, forestry and plantation crops are pollinated.

b. ST (Strength-Threats) strategy
1. Establishment of a queen bee breeding center in South Sulawesi, so that South Sulawesi beekeepers no longer depend on the island of Java, so that the risk of delays and unqualified queens can be overcome. And on the other hand, breeders already have the basics of beekeeping technology.
2. Improving the skills of human resources in beekeeping technology. Basic knowledge of existing apiary technology continues to be improved, especially bee pest and disease control techniques, so that the threat of bee pests and diseases can be overcome.
3. Increase cooperation between farmer groups, farmer groups, and related agencies. With good cooperation and coordination, farmers can easily take advantage of agricultural, plantation and agricultural crops and farmers no longer use pesticides during flowering [3].

c. WO (Weaknesses-Opportunities) strategy
1. Optimizing the use of land rich in nectar and pollen to maintain the productivity of queens and migratory if necessary. Local bees are grazed on land rich in nectar and pollen and when the plants stop flowering, the bees are transferred to other plants that are in bloom so that the queen’s productivity is maintained.
2. Improve coordination with socio-cultural institutions, financial institutions and related agencies [8]. With good coordination, it is hoped that a good cultural investment climate will grow, so that the potential of existing trees can be optimized for use and supported by government policy instruments.
3. Periodically creating and evaluating calendar. Tree calendars need to be made and evaluated regularly to support queen productivity so that bee migration is right at the time of flowering.

d. WT (Weaknesses-Threats) strategy
1. Training on queen making, increasing the age of queen productivity and pest and disease control techniques. To anticipate the decline in queen productivity, the explosion of potential pests and
diseases and the use of pesticides at the time of flowering, it is necessary to carry out training efforts so that farmers have the skills to anticipate these problems. Meanwhile, periodic and continuous monitoring is carried out to determine anticipatory steps if unfavorable symptoms begin to occur [20].

The preparation of the various strategies mentioned above, needs to involve the government, the community and the private sector. The involvement of these three parties has an equally important relationship for the successful implementation of the strategy, but the beekeeping community is the focus of development (Community-Based Development). This relationship can be seen in Figure 1 [21]:

Figure 1. The reciprocal relationship between the community, government and private sector in local bee development in North Luwu Regency

The strategy described above is the first step to achieve the ideal local bee development in North Luwu Regency. However, in its implementation it cannot be carried out simultaneously, but a priority scale of various programs is made as shown in Figure 1 [20]. The series of strategies stated above is the first step to achieve ex-situ conservation conditions in the context of developing an ideal local bee in North Luwu Regency [21]. The scheme for achieving the ideal development conditions can be seen in Figure 2 below [22].
Figure 2. Schematic of ideal local bee development conditions in North Luwu Regency

Strategy

Short-term and long-term strategy operations

Short-term Indicators

Farmer community independent

Long-term Indicators

1. The number of people who cultivate local bees is already large
   a. Stable colony cultivation and management
   b. Harvesting and processing techniques are standard
   c. Marketing has been smooth and stable
2. The breeding center already exists and is able to supply the queen’s needs South Sulawesi
3. Comprehensive and integrated mastery of apiary technology
4. Vegetated and cultivated land has been filled by local bees

1. Availability of complete and accurate potential databases, networks and information
2. Established cooperation and coordination between farmer groups, farmer groups and related agencies.
3. Established cooperation and coordination between socio-cultural institutions, financial institutions, and related agencies
4. Breeders regularly make feed calendars and evaluate them from year to year
5. Counseling and monitoring run regularly
   a. Unproductive queen bees are replaced regularly
   b. Controlled pests and diseases
   c. The use of pesticides in the development phase is no longer available
4. Conclusions and suggestions

4.1. Conclusion

- North Luwu Regency has considerable potential in supporting the development of local beekeeping, including: government policies, social culture of the breeder community, biophysical conditions and basic skills/basic knowledge of mastering several beekeeping technologies.
- The formulation of a strategy for developing local beekeeping in North Luwu Regency includes short-term and long-term strategies. Short-term strategies include:
  - Strengthening potential database, network and information of farmer community through extension/training.
  - Increased cooperation, between farmer groups, farmer groups and related agencies.
  - Optimizing land use.
  - Improved coordination with Socio-Cultural Institutions, Financial Institutions, and related agencies.
  - Making and evaluating feed calendars on a regular basis. While the long-term strategies include:
  - Improved community empowerment of farmers through counseling/training (Cultivation, Harvest Management, Processing, and Marketing).
  - Making a queen bee breeding center.
  - Training on queen making and pest and disease control techniques.

4.2. Suggestion

Based on the results of the study obtained, it is recommended and recommended to be followed up, so that:

- The government, the private sector and the people of North Luwu Regency are aware of the importance of this untapped and unsold regional potential value (potential of local honey bees), especially in welcoming autonomy and the need to immediately realize the operation of the short-term and long-term development strategy in North Luwu Regency.
- The financial institution pays attention to the funding of the beekeeping business in North Luwu Regency in the context of increasing income and employment in rural areas, as well as improving nutrition and health of rural communities.

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