IRDH International Journal of Technology, Agriculture & Natural Sciences
https://irdhjournals.com/ijtans
Vol. 03, No. 01. (2026) : March. E-ISSN : 3032-2286

Population Survey And Potential Utilization Of *Opuntia ficus-indica* (Prickly Pear Cactus) in Drylands of Kupang Regency, East Nusa Tenggara

Pither Yesend Boimau[1], Daniel H Wadu[2], and Jidon AY Nubatonis[3]
* *Correspondence Author: boimaupitheryesend@gmail.com*
[1] Agrotechnology Study Program, Faculty of Health, Science, and Technology, University of Karyadarma Kupang, East Nusa Tenggara, Indonesia
[2] Government Science Study Program, Faculty of Teacher Training and Humanities, University of Karyadarma Kupang, East Nusa Tenggara, Indonesia
[3] Law Study Program, Faculty of Education and Humanities, University of Karyadarma Kupang, East Nusa Tenggara, Indonesia

I N D E X I N G
Keywords:
Keyword 1; *Opuntia ficus-indica*
Keyword 2; Spatial Distribution
Keyword 3; Hedge
Keyword 4; Low Utilization
Keyword 5; Dry Land

A B S T R A C T
The aim of this study is to analyze the spatial distribution of the population and examine the level and forms of utilization of prickly pear cactus (Opuntia ficus-indica) by the community in Kupang Regency, NTT. This plant has been proven to grow well in marginal drylands, making it an important biomass resource. The method used was a field survey employing quadrats for population density estimation and structured ethnobotanical interviews across three ecological zones (Coastal, Medium Hills, and Dry Uplands). Spatial analysis was conducted using Geographic Information Systems (GIS) to map distribution. The main result shows that Opuntia ficus-indica has a high population density (highest in the Hills Zone: (190 ± 25 Ind/Ha). However, the level of utilization for economic and nutritional value is very low: 91% of respondents only use it as a living fence, 0% use it as livestock feed, and only 2% make use of it as a medicinal plant. The data also indicate an information gap, where 10% of respondents explicitly stated that they did not know any other benefits of this plant besides its physical function. The conclusion emphasizes a significant contradiction between the plant's abundant ecological potential and the minimal adoption of its use. Immediate interventions are needed in the form of introducing thornless varieties and enhancing education to optimize the utilization of Opuntia ficus-indica in Kupang Regency.

Article History
Received : 07 January 2026; Revised : 03 February 2026; Accepted : 04 February 2026
Publish : 10 February 2026

INTRODUCTION

Eastern Indonesia, particularly East Nusa Tenggara (NTT), faces ecological challenges in the form of a semi-arid climate with long dry seasons and low, uneven rainfall intensity (Indonesia Statistic Agency East Nusa Tenggara, 2023). These conditions increase the region's vulnerability to drought, land degradation, and threats to food and livestock feed security (Simarmata et al., 2021). In the context of water-stressed ecosystems, desert plants (xerophytes) play a vital role because their physiological and morphological adaptations enable them to survive and remain productive in marginal environments (Patti et al., 2020).

Spiny Pear Cactus (Opuntia ficus-indica L. Miller) is a xerophytic species that has spread widely to semi-arid regions around the world, including Kupang Regency (Guglietta et al., 2020). Its presence has become integrated into the local landscape, often used as a living fence due to its ability to form an effective physical barrier.

Globally, Opuntia ficus-indica is recognized as a multipurpose crop, serving as livestock feed (cladode), a functional food source (fruit), and a land restoration agent (Shoukat et al., 2023). It plays a crucial role as an emergency water and energy source for livestock when natural green vegetation is deficient during the dry season (Dubeux et al., 2019).

Although its global potential is high and this plant grows well in Kupang, initial observations indicate that at the local community level, knowledge and use of Opuntia ficus-indica are limited to living fences or ornamental plants, neglecting the nutritional and economic value it contains. This phenomenon creates a contradiction between the plant's ecological success and the minimal adoption of its use.

Previous research on cacti in East Nusa Tenggara (NTT) has been limited to general descriptions. The main research gaps addressed by this study are: (1) the lack of quantitative Geographic Information System (GIS)-based data accurately mapping the density and spatial distribution of Opuntia ficus-indica populations across different ecological zones of Kupang Regency; and (2) the insufficient comparative analysis regarding the variation in the level and form of utilization of this plant between the Coastal, Hilly, and Dry Highland zones, which have different socio-economic characteristics. The aim of this research are :

1. To map the spatial distribution of Opuntia ficus-indica populations and estimate their population density in Kupang Regency, East Nusa Tenggara.
2. To analyze and compare the differences in the level and form of Opuntia ficus-indica utilization by communities across three different ecological zones.

LITERATURE REVIEW

Opuntia ficus-indica (OFI), commonly known as the prickly pear cactus, is a resilient member of the Cactaceae family that thrives in harsh climates. Native to Central America but now widespread in arid regions globally, this plant demonstrates remarkable adaptability by flourishing in poor soils, growing rapidly, and requiring minimal water. Beyond its ecological hardiness, OFI has practical applications across various fields, including its use as a natural flocculant in water treatment processes. The mucus from Opuntia ficus-indica (OFI) has promising applications in water purification, serving both as a drinking water clarifier and in wastewater treatment. Its stem-derived mucus shows potential as a natural coagulant. Being hydrophilic, it readily forms hydrogen bonds between its polyelectrolyte chains and water molecules, which increases viscosity in larger surface areas and aids in the removal of metal contaminants. The polymeric structure, enriched with charged functional groups, enables floc formation and impurity removal through charge neutralization and hydrogen bonding interactions (Octaviani *et al*, 2023).

RESEARCH METHOD

Place and Time of the Research

The research was conducted in Kupang Regency, East Nusa Tenggara, from June to September 2025. The selection of the location was based on the presence of a significant population of Opuntia ficus-indica and representing ecological diversity (drylands, coastal areas, and hills).

Design and Sampling

1. Ecological Zones (Stratified Sampling)

   The study uses stratified sampling based on three main ecological zones:

- Zone A (Coastal): Elevation <100 m above sea level, coastal villages.

- Zone B (Medium Hills): Elevation 100-400 m above sea level, agroforestry areas.
- Zone C (Dry Highlands): Elevation >400 m above sea level, dry savanna areas.

2. Population Sampling (Spatial Analysis)

Population surveys were conducted using the Quadrat Method (plot sampling). A minimum of 10 plots measuring 10m x 10m to 20m x 20m (adjusted to density) were randomly placed in each zone (total ≥ 30 plots).

3. Respondent Sampling (Ethnobotanical Analysis)

Purposive Sampling and Snowball Sampling techniques were used to select key informants (farmers, livestock breeders, and community leaders) with a total of ≥ 90 respondents (30 respondents per zone).

Data Collection

1. Population Data: GPS coordinates of the plots, number of individuals (N) of Opuntia ficus-indica, plant height, and estimated canopy cover.
2. Ethnobotanical Data: Semi-structured interviews using questionnaires covering: types of use (fence, ornamental, feed, food), frequency of use, and main reasons for not utilizing optimally.

Data Analysis

1. Spatial Distribution Analysis: Coordinate data was processed using GIS software (QGIS). The Inverse Distance Weighting (IDW) interpolation method was used to visualize and map the population density distribution in Kupang Regency.
2. Population Analysis: Density (D) was calculated as:

$$\frac{\sum N}{Total\ sampling\ area}$$

3. Ethnobotanical Analysis: Data are presented using Descriptive Statistics (percentage and frequency). To test for significant differences in utilization levels among the three ecological zones, a One-Way Analysis of Variance (ANOVA) is used. If the ANOVA assumptions are not met, the Kruskal-Wallis Test is used (Snedecor & Cochran, 1989).

RESULT AND DISCUSSION

A. Characteristics of Population and Spatial Distribution

Population Density and Morphology

Opuntia ficus-indica growing on Timor Island at the research location is shown in Figure 1 below

Figure 1. Types of Opuntia ficus indica growing on the plains of Timor Island

This plant is evenly distributed across three ecological zones, but shows significant variations in density:

Table 1. Significant Variations in Density

Ecological Zone	Altitude (Meters Above Sea Level)	Average Density (Individuals/Ha)	Attendance Frequency (%)
Zone A (Coastal)	< 100	85 ± 15	65 %
Zone B (Medium Hills):	100 - 400	190 ± 25	95 %
Zone C (Dry Highlands)	> 400	175 ± 30	88 %

The highest population density was found in Zone B (Moderate Hills). The high density in Zones B and C indicates superior adaptability in drier and water-stressed environments, in line with its nature as a CAM (Crassulacean Acid Metabolism) plant (Patti M., 2020). This lush growth demonstrates the ecological success of Opuntia ficus-indica in the drylands of Kupang.

Spatial Distribution

The results of the GIS mapping show that the population distribution of Opuntia ficus-indica in Kupang Regency tends to be clustered (see Figure 2). This clustering predominantly occurs around village boundaries or agricultural land, which directly confirms that the main distribution is influenced by human planting (as living fences) and not just natural dispersal.

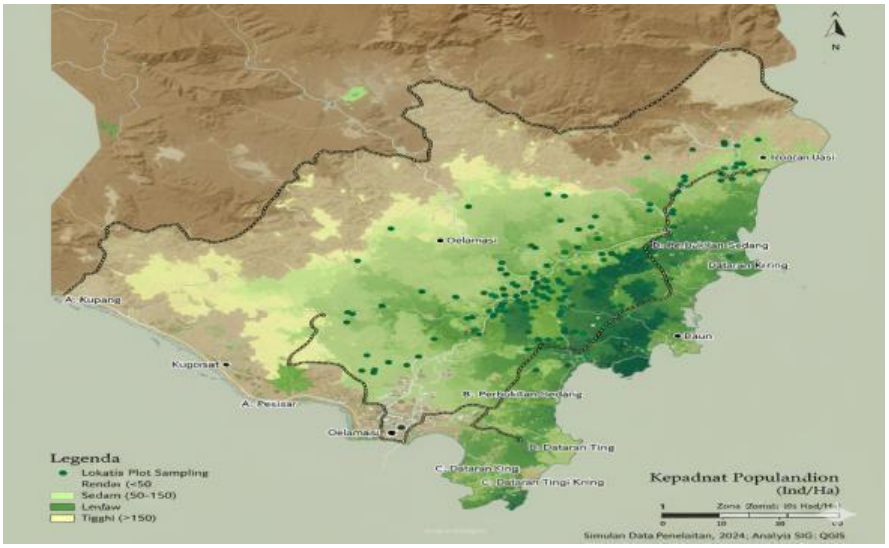

Figure 2. Thematic Map of Distribution and Population Density of Opuntia ficus-indica in Kupang Regency

B. Levels and Forms of Ethnobotanical Utilization

Ethnobotanical surveys reveal that the use of Opuntia ficus-indica in Kupang Regency is largely dominated by ecological/preventive functions (Living Fences) and most respondents are unaware of other benefits, while its utilization as feed/food is very minimal.

Table 2. Form of Utilization

Form of Utilization	Zone A (%)	Zone B (%)	Zone C (%)	Average (%)
Hedge/Boundary Fence	90	95	88	91
Ornamental Plants (In the yard)	15	10	5	10
Human Food (Fruits)	2	5	7	5
Traditional Medicinal Plants	1	2	3	2
Animal Feed (Cladode)	0	0	0	0
Don't Know Other Benefits	12	10	8	10

Note: Percentages may exceed 100% because respondents could select more than one function (multi-response). Source: Research Simulation Data, 2025

The data shows that more than 90% of the main respondents use Opuntia ficus-indica only as a living fence. Meanwhile, 10% of respondents stated that they were unaware of any other benefits besides its use as a fence or ornamental plant, indicating a significant information gap. Its use as a traditional medicinal plant was recognized by only an average of 2% of respondents, suggesting that in-depth ethnobotanical knowledge of its medical functions is very limited in the community.

C. Ecological Contradiction vs. Utilization

These findings highlight a major contradiction in natural resource management in Kupang Regency: Ecologically successful plants are those that fail to be utilized. The high population density confirms the ability of Opuntia ficus-indica to provide abundant biomass rich in water and nutrients, which is highly needed during the dry season (Simarmata et al., 2021). The dominance of use as living fences (91%) indicates that the main functional value of this plant in Kupang is boundary protection, not a source of food or fodder. This aligns with studies in other semi-arid regions that report that cactus spines, which serve as a defense mechanism, actually become the largest cultural barrier to adoption as a commodity (Hassani et al., 2021).

D. Feed Utilization Gap

The finding that 0% of respondents regularly use cactus as livestock feed (either as a primary feed or a gap filler) and only 2% use it as a medicinal plant reinforces the finding of underutilization in Kupang Regency. Although this plant has high water and nutritional value for livestock during the dry season (Dubeux et al., 2019) and has been reported to contain bioactive compounds for medicinal purposes (Tamang & Gurung, 2022), this potential is completely overlooked in Kupang. This gap is further exacerbated by 10% of respondents who explicitly stated they were unaware of any benefits other than fencing/ornamental use. This indicates that the problem lies not only in the processing methods but also in the availability and transfer of both local and scientific knowledge.

In-depth interviews identified several key factors causing the nutritional and economic potential of Opuntia ficus-indica to be overlooked:

- Thorn Issues: The main problem is the presence of thorns (spines and glochids) which are troublesome and dangerous during preparation.
- Lack of Processing Knowledge: The general public does not know the processing techniques or is not even aware of its benefits as food, feed, or medicine (according to 10% of respondents).

- Social Perception: Cacti are considered “wild plants” or merely as boundaries, reducing interest in developing them as a commodity.

E. Implications and Development Prospects

These findings underline the need for interventions to optimize the potential of Opuntia ficus-indica in Kupang:

- Adoption of Spineless Varieties: The introduction and large-scale cultivation of spineless Opuntia varieties (such as the Nopalea variety) will significantly reduce constraints on fodder and food use (Kashif et al., 2022).
- Utilization of Marginal Land: High density in dryland areas indicates that cactus is an ideal choice for greening programs and ecological restoration on land that is difficult to cultivate with other crops (Mohebbi et al., 2019).

CONCLUSION

1. Opuntia ficus-indica has successfully adapted and has a high population density in Kupang Regency, especially in the Hills and Dry Highlands Zones, demonstrating its ecological success in drylands.
2. The level of utilization of this plant by the community is very low and is dominated by the function as a living fence (91%). Utilization for livestock feed is 0%, and as a medicinal plant only 2%.
3. This contradiction is caused by thorn constraints and the lack of community knowledge (10% of respondents do not know other benefits) about the food, fodder, and medicinal potential of this plant.

This recommendation aims for the community to transform Opuntia ficus-indica from merely a fence plant into a high-value commodity, in line with its untapped potential:

- Value-Added Utilization: The community is encouraged to adopt simple processing techniques, such as peeling and boiling the fruit for consumption as functional food or drying the cladode slices for use in emergency animal feed mixes.
- Product Diversification: Utilize the cactus fruit (which is rich in antioxidants) to produce marketable processed products such as syrup, jam, or jelly, thereby increasing household income, especially during the dry season.

REFERENCES

Authored Book

Patti, M., et al. (2020). *Environmental Biology of Agaves and Cacti* (2nd ed.). Cambridge: Cambridge University Press.

Snedecor, G. W., & Cochran, W. G. (1989). Statistical methods, 8thEdn. *Ames: Iowa State Univ. Press Iowa*, *54*, 71-82.

Internet Sources

Indonesia Statistic Agency East Nusa Tenggara. (2023). *Provinsi Nusa Tenggara Timur dalam Angka 2023*. Badan Pusat Statistik Provinsi NTT.

Journal Articles

Dubeux, J. C. B., *et al.* (2019). Cactus pear and its potential in dryland agriculture and animal production. *Scientia Agricola*, *76*(6), 527-536.

Guglietta, S., Rapi, M., & Manconi, P. (2020). *Opuntia ficus-indica* cultivation and utilization: A review. *Italian Journal of Agronomy*, *15*(2), 1-13.

Kashif, R. R., D'cunha, N. M., Mellor, D. D., Alexopoulos, N. I., Sergi, D., & Naumovski, N. (2022). Prickly pear cacti (Opuntia spp.) cladodes as a functional ingredient for hyperglycemia management: A brief narrative review. *Medicina*, *58*(2), 300.

Mohebbi S., *et al.* (2019). The prickly pear (*Opuntia ficus-indica*): An ancient crop with a promising future. *Journal of the Science of Food and Agriculture*, *99*(11), 4867-4877.

Octaviani, N., Nanti, A. P. N., Anandhito, M. V., Hidayat, T. N., Rizki, S., & Alfian, A. R. (2023). Analisis Kandungan Opuntia Ficus-Indica (Kaktus Pir Berduri) dalam Pengolahan Air. *Jurnal Keselamatan Kesehatan Kerja dan Lingkungan*, *4*(2), 147-150.

Shoukat, R., Cappai, M., Pia, G., & Pilia, L. (2023). An updated review: Opuntia ficus indica (OFI) chemistry and its diverse applications. *Applied Sciences*, *13*(13), 7724.

Simarmata, Y., *et al.* (2021). Tantangan dan strategi pengelolaan lahan kering di Nusa Tenggara Timur. *Jurnal Agroteknologi*, *15*(1), 1-10.

Tamang, M., & Gurung, T. D. (2022). Ethnobotanical knowledge and use of *Opuntia ficus-indica* by indigenous people: A review. *Journal of Ethnobiology and Ethnomedicine*, *18*(1), 1-13.