

Ethnobotany of local banana (*Musa* spp.) variety *Loka Pere* in West Sulawesi, Indonesia

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Manuscript received: 20 October 2023. Revision accepted: 15 December 2023.

Abstract. Fettig JS, Prayogo C, Sirappa MP, Sukiman, Burhanuddin, Sultan, Kurniawan S. 2023. Ethnobotany of the local banana (*Musa* spp.) variety *Loka Pere* in West Sulawesi, Indonesia. *Biodiversitas* 24: 6472-6483. Compared to modern crop varieties, many farmers' varieties are nutrient dense, stress tolerant, disease resistant and suited to local conditions. It is thought that increased utilization of farmers' varieties in agrifood systems can improve rural livelihoods. One underutilized farmers' variety is *Loka Pere*, a local banana (*Musa* spp.) in Majene District, West Sulawesi. The purpose of this research was to study ethnobotany of *Loka Pere* to develop its knowledge base regarding cultural importance, management and local perception of its potential, spatial dynamics and production constraints. Ethnobotany data was collected in the villages Adolang, Adolang Dhua, and Betteng through participatory observation, open-ended conversations, semi-structured interviews, and surveys. Descriptive, qualitative data was recorded alongside total use value and relative frequency of citation for its characteristic traits, ideal growth conditions, and limitations to production. Surveys included ranking and scaled perception questions. *Loka Pere* is an endemic farmers' variety originating from the study area and may be locally adapted. It has a strong link to the local community's identity - often called *Manurung Adolang*, or the "icon of Adolang" - and is the preferred banana of locals. It has unique phenotypic characteristics and uses, including use as a traditional fertility medicine. After approaching disappearance, local conservation projects and growing desire to utilize the resource led to its reintroduction to production systems. Respondents agreed they would benefit from its increased utilization, including development of processed products. Farmers described ideal conditions and processes for *Loka Pere* cultivation. It is often grown intercropped or in agroforestry systems. Limitations to production include wild boar, climate, and value chain. *Loka Pere* appears to be a farmers' variety with high potential for regional development. Strengthening traditional knowledge related to its cultivation and use can aid in its reintegration into agrifood systems.

Keywords: Agrobiodiversity, ethnobotany, farmers' varieties, *Loka Pere*, *Musa* spp.

Abbreviations: CV: Cultivar, HOH: Heads of Household, NU: Neglected and Underutilized, RFC: Relative Frequency of Citation, spp. or sp.: Species, UV: Total Use Value

INTRODUCTION

Traditional farmers historically utilized and preserved intraspecific mixtures of locally adapted crop varieties to protect harvest security and agroecosystem resilience (Clawson 1985; Reiss and Drinkwater 2018; Pingali 2019). Despite the fact that global agriculture has been moving towards increasing homogeneity (FAO 2019; Khoury et al. 2022) there are areas where agricultural diversity is preserved. Modern crops and technologies generated from the Green Revolution have been most easily adopted by those near population centers who could afford the input-intensive methods required, or on lands suitable to monocultures (Massawe et al. 2015; Khoury et al. 2022). Farmers in other areas continue to steward traditional crops and varieties in environmental niches for their agronomic characteristics, ecological function, culinary use, or cultural

value (FAO 2019; Pingali 2019). Such crops and crop varieties are called neglected and underutilized (NU) plants, landraces, or farmers' varieties, and they represent a reservoir for diversification of today's agrifood systems (Massawe et al. 2015; FAO 2019; Mustafa et al. 2019). In the face of further biodiversity loss, conserving crop diversity is an important sustainability strategy (Massawe et al. 2015; Pingali 2019).

Bananas and plantains (*Musa* spp.) are incredibly diverse fruit crops with over 1200 cultivars and landraces worldwide (Van den houwe et al. 2020). Bananas from the AAA 'Cavendish' subgroup dominate export markets, but this only accounts for about 15% of total global *Musa* spp. production (CABI 2010). Traditional farmers continue to preserve varieties of *Musa* spp. for social, nutritional, agronomic and cultural reasons (Edmeades et al. 2007; Kilwinger et al. 2019). One such farmers' variety is *Musa x paradisiaca* Linn.

cv ‘*Loka Pere*’, or *Loka Pere* (Figure 1), in Pamboang Sub-district, Majene District, West Sulawesi, Indonesia. It has a strong link to the local community’s identity - often called *Manurung Adolang*, or the “icon of Adolang” - and is the preferred banana of locals.

Loka is the Mandar word for *Musa* spp. This banana has long been a traditional food source for the Mandar people of the Pamboang Sub-district, but in 2016 it was described as a neglected variety under threat of extinction (BPTP 2016). Conservation of socioeconomically important crop wild relatives and landraces is of first priority in Indonesia, including *Musa* spp. (Rahman et al. 2019). Conservation of these resources is important to prevent crop genetic erosion and to maintain the benefits of crop diversity.

Loka Pere possesses a variety of reported beneficial characteristics, including a unique sweet flavor, a long period of ripeness and easy storability, adaptability to dry soil, easy propagation and resistance to diseases (Nurhafsa et al. 2022). When compared to modern hybrid varieties, many NU farmers’ varieties are nutrient dense, require fewer agricultural inputs, are stress tolerant and disease resistant, have higher yield stability and are suited to local agroecological and socioeconomic conditions (Ficiciyan et al. 2018; Padulosi et al. 2018; Li et al. 2020). The conservation, reincorporation and increased utilization of NU crops into agrifood systems may help to reduce malnutrition, improve food security and food sovereignty, increase climate and market resilience, and alleviate poverty (Massawe et al. 2015; Padulosi et al. 2018; Mustafa et al. 2019; Li et al. 2020; Khoury et al. 2022). *Loka Pere* is thought to have potential towards these ends (BPTP 2016).

One major challenge to achieving meaningful reintegration of NU crops in agrifood systems is limited knowledge systems (Padulosi et al. 2018; Mustafa et al. 2019; Borelli et al. 2020), including a relative lack of information about cultural dynamics, local adaptation, agronomic characteristics and management practices. Much of this information is contained within traditional knowledge systems, but these are often informalized and can deteriorate as farmers’ varieties become marginalized (Khoury et al. 2022; Mutaqin et al. 2023). In turn, the degradation of local knowledge can result in loss of biological diversity (Swiderska et al. 2011). Strengthening traditional knowledge systems is critical in order to achieve sustainable conservation and utilization of farmers’ varieties (Kagawa-Viviani et al. 2018; Borelli et al. 2020).

Ethnobotany methods have proven effective in investigating traditional knowledge systems, having been used to identify *Musa* spp. cultivar diversity, distributions, propagation methods, preference criteria, production constraints and various cultural dynamics (Edmeades et al. 2007; Chabi et al. 2018; Kilwinger et al. 2019). The purpose of this research was to study the ethnobotany of *Loka Pere* in Majene District, West Sulawesi, Indonesia. In particular, we sought to identify *Loka Pere*’s cultural importance, local perception of the crop’s potential, perception of its historical spatial dynamics and perceptions of production constraints, as well as describe local management of the resource.

Strengthening the knowledge base of *Loka Pere* in these ways can support efforts to conserve and further utilize the variety for improved livelihood in the area (FAO 2019).

MATERIALS AND METHODS

Study area and timeline

The study was conducted within the Pamboang Sub-district of Majene District, West Sulawesi, located at the geographical position of 2° 40' 25.55" S, 118° 54' 25.75" E (Figure 2). Three villages - Adolang, Adolang Dhua, and Betteng Villages - were purposively selected for the study with the assistance of local partners based on reported historical presence of *Loka Pere* cultivation. Adolang and Adolang Dhua make up the current range of *Loka Pere* cultivation. Betteng is a part of the historic *Loka Pere* range where some plants are found on marginal lands. The study villages are non-coastal, hilly landscapes consisting primarily of secondary forest and agricultural land. The climate is relatively dry, with the wettest months occurring in December-January and the driest month in August. Average temperatures range from 27.4 to 28.5°C (Nurhafsa et al. 2022). The local ethnic identity is Mandar Asli and the languages spoken are *Mandar* and *Bahasa Indonesia*. Research was conducted from June 2021 to February 2023.



Figure 1. A. A terraced *Loka Pere* production plot in Adolang village, B. A harvested *Loka Pere* bunch and C. A bunch of *Musa* AAA ‘Dwarf Cavendish’ for reference (USDA-TARS 1990)

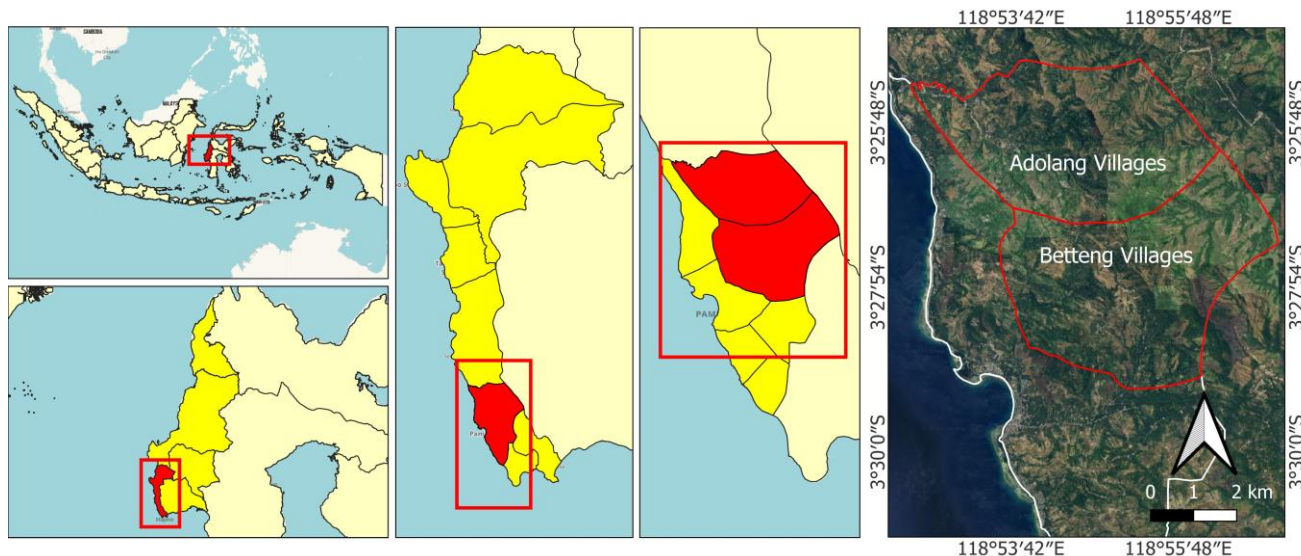


Figure 2. Map showing the three villages selected for the study in Pamboang Sub-district, Majene District, West Sulawesi, Indonesia

Procedures

Biocultural approaches, participatory research and prior informed consent

Research that actively involves the local community in design and execution, embraces different forms of knowledge, and supports local decision making can lead to more robust data production and therefore achieve higher impact on local resource management (People's Knowledge Editorial Collective 2016). To facilitate this, the present work followed a biocultural approaches to conservation framework, within which activities carried out with the goals of sustaining both biophysical and sociocultural components of complex social-ecological systems (Gavin et al. 2015). Out of respect for the ownership of the local people over their traditional knowledge systems and local biological resources, all research activities were determined with input from local leaders and conditional upon authorization from the local community. After the scope, objectives, and design were clarified with the assistance of local partners, the research team obtained free and prior informed consent from the local communities.

Social and ethnobotany methods

Researchers engaged in participatory observation of activities such as *Loka Pere* propagation, cultivation, harvesting and cooking, and cultural events. Informal, open-ended conversations were carried out for insight into the local culture and values, the local people's history, local agrifood systems, challenges local people are facing, and various perspectives on *Loka Pere*.

Building upon the information gathered in these steps, in-depth, semi-structured group interviews were conducted. Guiding questions focused on the history of the plant, *Loka Pere*'s unique characteristics, its cultural value, the types of environments where *Loka Pere* grows best, local cultivation practices, local monitoring systems, local soil management, local perceptions of constraints, and marketing. Farmers

familiar with *Loka Pere* from each village were selected via purposive sampling by the village leaders and invited to participate. As many as 15 respondents were interviewed from Adolang, 12 from Adolang Dhua and 13 from Betteng, resulting in a total of 40 respondents which represent 5% of all Heads of Household (HOH) in the study area. Local partners determined that mostly male participants be interviewed. Demographic information of respondents is recorded in Table 1. Interviews lasted 30-60 minutes each. The interviews were carried out in *Bahasa Indonesia*, and village leaders helped translate to *Mandar* when needed. Key terms in the local language were recorded and are used in the results and discussion below. Observational and interview data were recorded primarily as descriptive, qualitative data. Additionally, total Use Value (UV) reported for the plant was recorded. Relative Frequency of Citation (RFC) was counted for characteristic traits of *Loka Pere*, ideal growth conditions of *Loka Pere*, and for limitations to its production.

After group interviews, systematic surveys were designed in collaboration with local leaders and groups of local partners were invited to respond. Respondents were selected via purposive sampling by the village leaders and asked to participate. As many as 16 respondents participated from Adolang, 12 from Adolang Dhua and six from Betteng, resulting in a total of 36 respondents representing 4.5% of all HOH in the study area. Demographic information of respondents is recorded in Table 1. The surveys had respondents indicate to what degree they agreed or disagreed with a series of statements regarding *Loka Pere* (Table 9). A response of 1 indicated strong disagreement, 2 indicated disagreement, 3 indicated a neutral position, 4 indicated agreement, and 5 indicated strong agreement (Nichols 1991). Median and mode responses were determined for each statement, along with the percentage of respondents in each category.

Table 1. Characteristics of survey respondents

Characteristic	Group	Open interviews		Structured surveys	
		No. of informants	Percentage (%)	No. of informants	Percentage (%)
Age group	Young (18-36)	5	12.5	7	19.4
	Middle-aged (37-55)	28	70.0	22	61.1
	Elderly (>56)	7	17.5	7	19.4
Sex	Male	38	95.0	36	100
	Female	2	5.0	0	0.0
Occupation	Farmer	35	87.5	33	91.7
	Government	3	7.5	3	8.3
	Housewife	2	5.0	0	0
Education	No schooling	0	0.0	0	0.0
	Primary	9	22.5	10	27.8
	Secondary	27	67.5	20	55.6
	University	4	1.0	6	16.6

Table 2. Local *loka* (bananas) utilized in preference rankings

Local name	Common name
<i>Loka Pere</i>	<i>Loka Pere</i>
<i>Loka Manurung</i>	<i>Pisang Kepok</i>
<i>Loka Barangan</i>	<i>Pisang Hantu</i>
<i>Loka Tambilao</i>	<i>Pisang Ambon</i>
<i>Loka Loka</i>	Unknown
<i>Loka Balambang</i>	<i>Pisang Raja</i>
<i>Loka Tanduk</i>	<i>Pisang Tanduk</i>
<i>Loka Kappal</i>	<i>Pisang Pendek</i>
<i>Loka Walowo</i>	Unknown
<i>Loka Sellessorang</i>	<i>Pisang Seribu</i>

Respondents were also asked to rank *Loka Pere* against nine other local bananas (Table 2) in categories of preference for consumption, cultural value, and economic value. Ties were allowed. Median and mode rankings were determined, and individual rankings were summed to create a “score” which was then converted to a discreet rank to indicate the varieties’ relative value. Lastly, respondents ranked the most frequently referenced conditions for *Loka Pere* growth and limitations to *Loka Pere* productivity from most to least important. Again, ties were allowed. Median and mode rankings were determined, and the same scoring process was followed with the final rank indicating relative importance.

RESULTS AND DISCUSSION

Origin, distribution, history and conservation of *Loka Pere*

The historic range of *Loka Pere* consists of four non-coastal villages in the Pamboang Sub-district - the three in the study area and neighbouring Banua Adolang - collectively referred to as *Adolang Lama*. It is widely accepted that *Loka Pere* originated in *Adolang Lama*, and was not brought from anywhere else. A few *panguma* (farmers) recalled asking their grandfathers where *Loka Pere* came from, and they were told that *Loka Pere* had always been in *Adolang Lama*. It is thought to have emerged in the region

as *rahmat Allah* (grace from God), and has since been propagated and utilized by the local communities.

Somaclonal variation is particularly important in a vegetatively propagated crop like *Musa* spp., and before modern tissue culture and genetic modification technologies was virtually the only way new banana and plantain varieties were generated (De Langhe et al. 2015; Martin et al. 2020). When this occurs under the care of traditional farmers, they may continue to propagate somatic variants based on preferential traits. Kitavi et al. (2016) found that 90 East African Highland banana varieties all arose from somaclonal variation after a single hybridization event. It is possible that *Loka Pere* emerged as a somaclonal variant of different variety cultivated in the region and has been managed by the local community ever since. Genomic analysis could help provide a better understanding of *Loka Pere*’s identity and history.

As people from *Adolang Lama* have migrated to other areas throughout Sulawesi, it has been a common practice for them to bring a *pamulang Loka Pere* (plantlet) and plant it near their new homes. Through this practice, it has been planted in a variety of places, such as nearby coastal villages, Majene City, Makassar (South Sulawesi), and Karossa (7-8 hours north of *Adolang Lama*). However, the unanimous testimony is that *Loka Pere* frequently experiences fruiting failure outside of its region of origin, and any fruit that is produced is small and lacking the characteristic *Loka Pere* taste. This coincides with previous testimonial reports suggesting that *Loka Pere* does not as grow well outside of its area of origin (BPTP 2016; Nurhafsah et al. 2022). During plant domestication processes, crops can experience adaptation to local environments (Kantar et al. 2017; Cortinovis et al. 2020). Since farmers’ varieties are a result of selection over multiple generations by local communities, they often have experienced such adaptation to local ecological conditions (Hufford et al. 2019; Lagneau et al. 2021).

In prior generations, *Loka Pere* was frequently brought as a food source by *posasig* (seamen) on fishing or trading expeditions. It was chosen for these voyages because of its extended period of freshness and due to the belief that it increases stamina and vitality. This indicates an important past relationship between coastal villages and *Adolang Lama*, where *panguma* in *Adolang Lama* would provide

Loka Pere in trade for fish or other goods. Today, no citizens living in the study area work as *posasig*, but they still purchase fish from the coast as an important source of protein.

Agricultural diversity in the study area has undergone shifts in recent generations. Modern cultivars for a number of crops have been introduced and *nasi* (rice) has supplanted *ubi kayu* (cassava) as the staple carbohydrate. While it used to be planted broadly in Adolang Lama, over time *Loka Pere* has been planted less frequently and attention has been given to other varieties perceived to have more value in cash economies and less impacted by *hama bowe* (wild boar pest) issues, such as *Loka Barangan* (*Musa* AAB ‘Barangan’) or *Loka Manurung* (*Musa* ABB sub. Pisang Awak cv. ‘Pisang Kepok’). By 2016 the variety had nearly disappeared, with only a few hundred plants remaining. At that time that the *Kepala Desa* (village leader) of Adolang instituted a conservation program where every household was asked to plant at least one *Loka Pere* tree on the land around their house. Most households followed through on this request and maintain a tree somewhere near their home. Planting of traditional plants in homegardens can be effective in conserving local biodiversity, providing for self-consumption, and generating occasional income (Shao et al. 2021). To further support its conservation, *Loka Pere* was registered with the Centre for Plant Variety Protection, the West Sulawesi Institute for Implementation of Agricultural Instrument Standards and the Ministry of Law and Human Rights.

Along with this, a handful of *panguma* began giving more attention to small-scale cultivation of *Loka Pere*. The spirit of this conservation effort spilled over into Adolang Dhua, and there are now a few thousand trees cultivated in home gardens and in plots surrounding Adolang and Adolang Dhua. Betteng no longer cultivates *Loka Pere*, and instead focus on other food crops and a local pineapple variety called *Nenas Belada*. Nurhafsah et al. (2022) report a population of roughly 2,900 *Loka Pere* plants and three hectares of land currently designated to its cultivation.

Survey respondents across all three villages strongly agreed that conservation of *Loka Pere* is important and that local communities would benefit from increased production (Table 3).

Currently, only a few *panguma* cultivate *Loka Pere* on a meaningful scale. In some instances, *panguma* will ignore *Loka Pere* plots after planting, only to return when harvest time approaches to collect whatever fruit is available. When asked why they do this, they said they shift their focus to other crops that are actively productive and have more economic potential, such as *ubi kayu*, *cabe* (chili peppers), *jagung* (corn) or *bawang merah* (shallot). One *panguma* said, “If they knew *Loka Pere* would be profitable, then they definitely would care for these plots again.” Respondents generally disagreed that planting *Loka Pere* has high risk of financial loss (Table 3), but it clearly is not perceived to have the economic potential of other resources.

Cultural importance of *Loka Pere*

Everyone in these villages is familiar with *Loka Pere* - it has become a symbol of the local community’s identity and is surrounded by a sense of regional pride. According to the local communities, the defining characteristic of *Loka Pere* is “*Loka Pere manurung Adolang*”, or that it is the “icon” of Adolang Lama. Local partners also told of a *Mandar* song about the Majene region that references *Loka Pere* as one of the traditional local crops. To symbolize this iconic status, a statue of *Loka Pere* has been erected at the entrance to Adolang village (Figure 3A). It is not uncommon for groups of people to identify with a particular local resource. For example, the Kanak people in New Caledonia are also known to associate traditional *Musa* spp. varieties with group identity (Kagy and Carreel 2004). This link to identity may be one reason why *Loka Pere* has persisted for so long despite the pressures it faces (Velásquez-Milla et al. 2011; Galvis-Tarazona et al. 2022).

Table 3. Scaled perception statements and responses by community members

Question	Median)	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Conservation of <i>Loka Pere</i> is important	5	0%	0%	0%	32%	68%
<i>Loka Pere</i> is an important source of food and nutrition in this region	5	0%	0%	18%	21%	61%
The market price of <i>Loka Pere</i> is an important issue	4	0%	0%	9%	65%	26%
Planting many <i>Loka Pere</i> trees represents risk of financial loss	2	47%	47%	3%	0%	3%
I would like <i>Loka Pere</i> production to be further developed	5	0%	0%	0%	9%	91%
The people of this village will benefit if <i>Loka Pere</i> production is increased	5	0%	0%	0%	41%	59%
If <i>Loka Pere</i> is further developed, it would be best if it remained in Adolang	4	0%	9%	21%	35%	35%
If <i>Loka Pere</i> is further developed, it can develop in other areas as well	4	0%	35%	6%	56%	3%
I would like to see the market price of fresh <i>Loka Pere</i> improved	5	0%	0%	0%	12%	88%
I would like the processing of <i>Loka Pere</i> to be developed locally	4	0%	0%	0%	65%	35%
I would like to see collaborations with outside companies to utilize <i>Loka Pere</i>	5	3%	0%	3%	38%	56%
<i>Loka Pere</i> that fruits during rainy season is best tasting	4	0%	9%	18%	24%	49%

*Note: 1: Strongly disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly agree

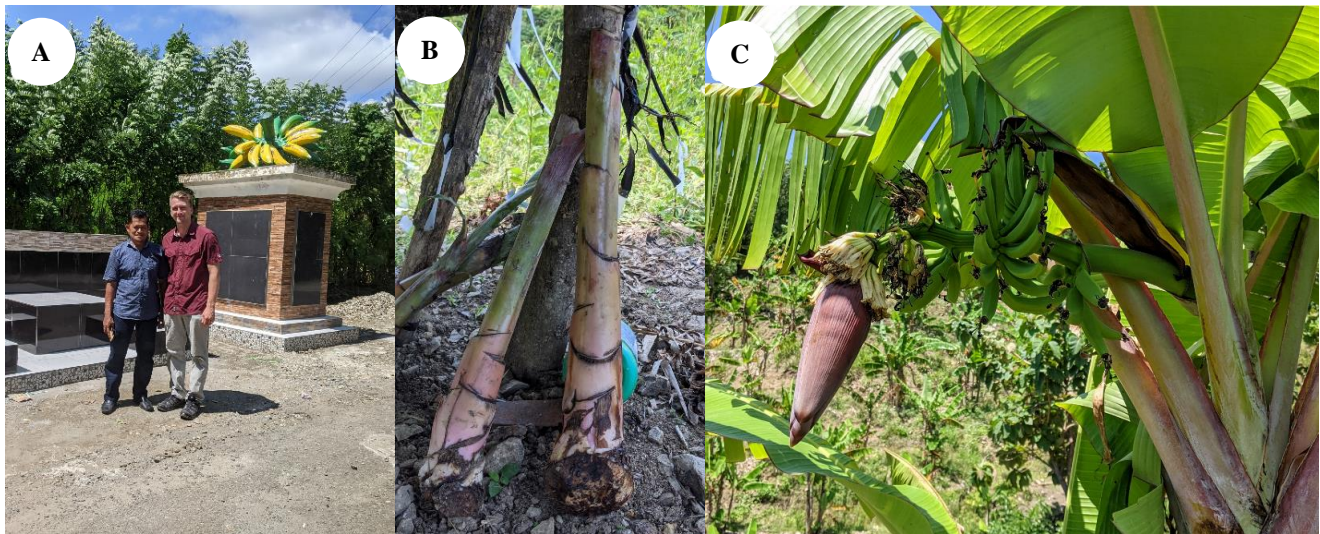


Figure 3. A. A statue of *Loka Pere* at the entrance to Adolang Village, B. *Loka Pere* suckers trimmed and left to sit before replanting and C. The erect stalk of *Loka Pere* with young fruit

Along with this strong connection to identity, *Loka Pere* showed evidence of additional cultural value. Although it only ranked 5th (E) in the survey regarding cultural value, it had a median ranking of 2 and the mode ranking was 1 (Table 4). Other *loka* varieties such as *Loka Barangan* and *Loka Manurung* ranked higher because local partners reported that they take a more central role in numerous *acara adat* (traditional/cultural events). Cultural and ethnobotanical studies among Mandar people have reported the use of specific *loka* varieties in *acara adat* such as marriage traditions, birth celebrations and *assalamakang* (blessings/thanksgivings) (Nurdin et al. 2019). There is one *acara adat* where *Loka Pere* has a specific utilization, *Maulid Nabi Muhammad* celebrations. During this holiday *sapping* (bunches) of *Loka Pere* are gifted to visitors.

Characteristic traits of *Loka Pere* and their relationship to people's preference

The cited *ciri khas* (characteristic traits) of *Loka Pere* can be seen in Table 5. The name of the variety comes from two words in the Mandar language - *pere*, meaning bent, and *loka*, meaning banana/plantain. *Loka Pere* gets this name due to the slight curve in the fruit that can bend in multiple directions on a single *sapping* (Figure 1B). The fruits have a pointed tip and the peel is often *cobok-cobok mallotong* (spotted black). This spotting is less intense if the plant gets frequent *tappa nyaindo allo* (direct sunlight). Depending on who you ask, the spots may or may not be desirable. Some think it affects the appearance negatively and reduces consumer appeal, while others think it is a distinguishing characteristic and thus helps marketing. The spots on the skin do not effect the fruit quality.

Loka Pere is also believed to be disease resistant. Multiple common *Musa* spp. diseases are widespread in the region and affect other varieties such as *Loka Manurung* (Pisang Kepok) and *Loka Balambang* (Pisang Raja), but *panguma* maintain that *Loka Pere* is not affected.

Along with having a distinctive *mammis* (sweet) and aromatic taste, the fruit is valued for its high nutritional value and has *massai nyialai* (a long shelf life). In the structured survey, respondents ranked *Loka Pere* as the preferred *loka* for personal consumption (A). In Betteng it ranked slightly lower, at 4th (E) (Table 4). Taste, smell, energy density/nutrition, and medicinal uses are known to be factors that influence preference for *Musa* spp. varieties (Chabi et al. 2018; Madalla et al. 2023). This also may help explain why the variety has persisted in the region (Velásquez-Milla et al. 2011; Chabi et al. 2018; Galvis-Tarazona et al. 2022). This raises the question, however, of why the variety fell to such critically low levels in recent years. Previous reports have suggested its decline was due to a lack of perceived economic value compared with other varieties or other crops (BPTP 2016), which coincides with the perception of locals in this study. Jones et al. (2011) found that traditional staple foods of the Samoan islands, such as *fa'i* (*Musa* spp. AB Colla), have been displaced in the market by imported staple foods due to economics and convenience as opposed to shifting preferences. This may be the case for *Loka Pere*, since preference for traditional foods continues to be strong among Mandar people, including among youth (Kasmiati et al. 2022). Other factors shown to impact smallholder farmers cultivar selection for *Musa* spp. include high productivity and large bunches, short growth cycles, disease resistance, plant stature, drought tolerance, alternative uses, and cultural factors (Chabi et al. 2018; Madalla et al. 2023).

Ethnobotanical knowledge of *Loka Pere* uses

Loka Pere had a UV of nine (Table 6). *Daunna loka* (banana leaves) of *Loka Pere* are not utilized due to lack of strength. The *puso loka* (male banana flower) is edible but is not consumed in the study area since other varieties are preferred for this use, in particular *Pisang Manurung* (Pisang Kepok). The *pappia* (sap) and *ponna* (stalk) are not used for any purposes.

Table 4. Preference rankings of *Loka* varieties in the study area

<i>Loka</i> variety	Personal consumption				Cultural value				Economic value			
	Median	Mode	Score	Rank	Median	Mode	Score	Rank	Median	Mode	Score	Rank
Manurung	1	1	56	B	1	1	61	B	1	1	57	B
Tambilao	1	1	90	D	1	1	72	C	4	1	108	E
Pere	1	1	46	A	2	1	128	E	1	1	89	C
Barangan	1	1	71	C	1	1	45	A	1	1	54	A
Seribu	8	9	264	J	8	9	244	I	8	9	271	I
Balambang	3	1	114	F	3	1	105	D	3	1	96	D
Tanduk	6	6	196	G	7	7	212	G	6	6	173	G
Loka	1	1	108	E	5	1	139	F	6	6	154	F
Walowo	8	8 & 10	260	I	7	7	233	H	8	8	246	H
Pendek	7	7 & 8	245	H	9	10	280	J	8	8	281	J

Note: ¹Score is the sum of all individual rankings, approximating an absolute ranking, ²Rank is an alphabetical character assigned to each variety indicating rank order

Table 5. *Loka Pere* characteristic traits

Trait	RFC
Over-ripe fruit becomes firm again when boiled	16
Unique sweet and aromatic taste	16
Functions as a medicine for reproductive health	12
Long shelf-life	9
Leaves tear easily and do not remain whole	8
Slightly bent fruit	7
Highly nutritious	5
Stalk doesn't turn downward	5
Disease resistant	4
Tip of fruit is pointed	3
Peel gets black spots	3
Produces lots of suckers	3
Relatively tall plant	2

Table 6. Cited *Loka Pere* uses (UV = 9)

Use	Description
1	Fruit eaten fresh
2	Fruit eaten fried
3	Fruit eaten boiled
4	Fruit given as gift or souvenir
5	Fruit sold at the market
6	Fruit used as a traditional fertility medicine
7	Fruit processed into flour
8	Fruit processed into <i>keripik</i> (chips)
9	Fruit processed into <i>selai</i> (spread)

Loka Pere is still considered an important local food source in Adolang and Adolang Dhua, where 100% of survey respondents indicated that they either agreed or strongly agreed with this statement (Table 3). When fried it is often served with *golla* (palm sugar). When *ngirakang* (boiled), whole overripe fruit in the peel are placed into a pot of boiling water until the cook judges them as sufficiently done. Boiling overripe fruit transforms the *loka* such that they are *mattdor* (firm again) and pleasant in texture. One *panguma* shared, "Once, in Makassar, I don't know whose family brought *Loka Pere* there, but *Loka Pere* was brought in a cardboard box, the box was left closed for a while, and after opening it and seeing that the peels were all black and the fruit soft this person threw them away, because they didn't know about *Loka Pere*."

Then, the person who gave the *Loka Pere* to them saw this, grabbed the *loka* out of the trash, boiled them, and they were delicious! The person who threw the *loka* away was in amazement, because other *loka* are not like this."

Loka Pere is also frequently given as *oleh-oleh* (souvenir), either brought to family, given to visitors passing through the region, or given to *pejabat* (government officials) as an honorary gift. It is said that every time a *pejabat* visits *Adolang Lama*, they request *Loka Pere*. Researchers observed that when an extension officer from the provincial government visited a farmer group meeting, fried *Loka Pere* was served and three *sasseh* (hands) of fruit were gifted to him to bring home.

Local communities view *Loka Pere* as a highly nutritious fruit. Nutritional analysis of *Loka Pere* has revealed high content of fiber, complex carbohydrates, vitamins and minerals (Nurhafsah et al. 2022). It is used as traditional *pauli* (medicine) for fertility, in particular as *loka ngirang* (boiled banana). It is said to improve male stamina and can cure both male and female infertility. The characteristic erect pseudostem (Figure 3C) and ability of the overripe fruit to become firm after boiling provide visual indicators of this potency. One story was told about a visitor from Kalimantan whose wife was unable to conceive. He was given *Loka Pere* as *oleh-oleh*, and shortly after returning home sent word to back to Adolang that he and his wife were expecting their first child. They attributed the pregnancy to *pauli Loka Pere*. Several other studies report the use of *Musa* spp. as traditional medicine related to fertility, pregnancy, childbirth, and postpartum (Fathurrahman et al. 2016; Kilwinger et al. 2019). A wide variety of medicinal benefits have been reported elsewhere for *Musa* spp., including improved cardiovascular health and reduced risk of hypertension or stroke, weight reduction and diabetes management, improved kidney function, regulation of bone health, digestive regulation, reduced cancer risk, maintained muscular function, mental alertness and improved mood (Ranjha et al. 2022).

Loka Pere fruit can be processed into additional products, but there is no historical tradition for this. Today, only small scale *pengolahan* (processing) of the fruit exists, creating *kripik* (chips), *tepung* (flour), or candies. *Pengolahan* is limited by lack of incentives, lack of training, and technical limitations. Community members

are interested in continuing to innovate and create other added value products from *Loka Pere* (Table 3). This interest is strongest in Adolang Dhua, where women have formed a small co-op for *pengolahan*. While men are generally responsible for farming, women in the study area are responsible for *pengolahan* of natural resources - including *Loka Pere* - and the creation of added value products.

Ethnoecological knowledge of *Loka Pere* cultivation and management

The cited ideal conditions for *Loka Pere* cultivation can be found in Table 7. All of these conditions were considered important, with a mode ranking for each of 1. Local partners outlined cultivation practices of *Loka Pere* from propagation to harvest. When removing *tunas* (suckers) for propagation, those selected should be healthy looking and uniform. The *pokoh loka* (corm) of the plant is exposed and then a chisel-like knife is used to extract a portion of the *pokoh loka* attached to a *tunas*. The *pamulang* (plantlet) is then removed by hand. Once *pamulang* are removed, all but the youngest few *daunna loka* cut off and the *pamulang* is left in the shade, propped upright, for about three days to dry before replanting (Figure 3B). This is called *pamulang nyialai tallungallo*, and is a practice that local *panguma* do for all types of *loka* and for *ubi kayu* as well. *Pamulang* are *mattudza* (planted) about 30 cm deep. All soil in the area is considered *marumbo* (fertile) for *Loka Pere*.

Panguma consider it best to *mattudza pamulang Loka Pere* (plant *Loka Pere* plantlets) a few months into *wattu timur* (dry season) so that fruit emerges and matures during *wattu urang* (rainy season). They feel this leads to optimized yield and slightly better flavor (Table 3). Plants were spaced about 3-9 m apart, with 5 m generally considered ideal. *Loka Pere* grows best in *litak gembur* (loose soil) on slopes that get *tappa nyaindo allo* in the morning, have significant diurnal temperature swings, and *litak marae* (moderate soil water availability). *Litak* around the base of the plant is weeded to be free of any other plants, called *mappa cini roepong*. For maximum productivity *pupuk tai' weke* (goat manure) should be added. *Panguma* practice *mappa cini daunna* - or the complete removal of dry leaves - and *tunas* are ideally limited to two or three. Excess *tunas* can be removed for replanting. Mulch - from weeding - is sometimes added to the base of the tree on the uphill side.

Panguma classified all soil in their region as fertile, with variations in what types of plants would grow well in any particular area. Soils were differentiated by depth, texture, stoniness, color, and vegetation. Soils are generally shallow and stony. Nurhafsah et al. (2022) report that soils in the area vary widely in terms of chemical properties, and that the most common soil type in Adolang Lama is Kambisols.

Loka Pere is often intercropped in mixed cropping or agroforestry systems. They are found on sloping land, terraced plots, or flat land, and at both high elevations (370 m) and low near the river *Lembang Dolang* (24 m). Crops observed alongside *Loka Pere* included *ubi kayu* (cassava), *jagung* (maize), *lamtoro* (river tamarind), *kelapa* (coconut), *pohon aren* (sugar palm), chili pepper, red onion, *kunyit*

(turmeric), and other herbs. *Weke* (goat) husbandry is also very common in the area, and *weke* are often kept in or near fields. After two to three successive generations, *pokoh loka* are uprooted and plants are replaced (called *pamulang mippa lenggu*) to maintain productivity.

Panguma know it's time to harvest because the fruit thickens and the skin brightens. The best way to know when to harvest is through experience. It is unclear what impact these traditional cultivation practices have on *Loka Pere* quality. In some cases, traditional farming methods have been shown to lead to increase in quality and flavor of traditional crops (Nakamura et al. 2022).

Respondents reported that their knowledge of *Loka Pere* came from their parents or grandparents, handed down within families. This is a common method of traditional knowledge transmission for farmers' varieties (Galvis-Tarazona et al. 2022). Occelli et al. (2021) discuss the importance of household learning in developing good soil management practice, observing that farmers engaged in home learning are more likely to be good soil managers.

Perceptions on challenges facing *Loka Pere* production and marketing

Limitations to *Loka Pere* cultivation are recorded in Table 8. These can be divided into categories of *hama* (pest limitations), *cuaca* (environmental limitations), and value chain limitations. This is in line with the report of Jalaluddin and Othman (2022) who report that smallholder banana farmers in Malaysia face challenges such as high cost of cultivation, uncertain yield, sale price risks, flood, susceptibility to pests, wild animal attacks, soil fertility limitations, drought stress, labor limitations, and limited access to capital. (Chabi et al. 2018) also reported that drought, strong winds, excess water and land limitations limited banana and plantain production.

The most significant limitation is *hama bowe* (wild boar), which will uproot *Loka Pere* plants to eat the *pokoh loka* and *ponna*. Wild boars are generalists that eat mostly plant material, and are a common agricultural pest wherever they are found. A large portion of their diet in both native and introduced ranges comes from agricultural products (Ballari and Barrios-García 2014). *Panguma* attest that the *bowe* show a preference to *Loka Pere* above other *loka* varieties or other crops. One *panguma* shared a story about establishing a *Loka Pere* cultivation plot only to return the following morning and find all the plants uprooted and the *pokoh loka* eaten.

Various attempts have been made to control the *hama bowe*. Men in Adolang and Adolang Dhua gather together on Sundays for *bowe* hunting. Nearly every household keeps a hunting dog for this purpose. Spears and machetes are the primary tools used for the *bowe* hunt, and it is considered a dangerous activity. Some have noted that participation in this endeavor is not optimal. Communal wild boar hunting is common in other areas of Indonesia as a traditional activity for managing the *hama*, and can develop into a recreational activity to relieve stress and fill free time (Kurniawan and Komaini 2020).

Table 7. Local ethnoecological knowledge of *Loka Pere*'s ideal growth conditions and their relative importance

Growth condition	RFC	Ranking results			
		Median	Mode	Score ¹	Rank ²
Not too much water	9	5	1	175	J
Fertilized with manure	9	1	1	89	C
Successive generations relocated	8	1	1	88	B
Loose soil	7	1	1	142	F
Control number of suckers	6	3	1	150	G
Plantlets saved three days before planting	5	1	1	109	E
Grass around base removed	5	1	1	82	A
Direct sunlight in the morning	4	1	1	103	D
Dry leaves removed	4	5	1	164	I
Diurnal temperature swings	3	6	1	178	K
Do not plant too close together	3	1	1	153	H

Note: ¹Score is the sum of all individual rankings, approximating an absolute ranking, ²Rank is an alphabetical character assigned to each condition indicating perceived relative importance

Table 8. Local knowledge of *Loka Pere* production constraints and their relative importance

Limitation	RFC	Ranking results			
		Median	Mode	Score ¹	Rank ²
Wild boar pest	26	1	1	44	A
Marketing	12	3	1	123	D
Processing	11	4	4	157	H
Market price	11	4	1	129	E
Long drought	6	2	1	91	B
Sunlight	5	5	1	139	F
Changing climate	3	5	1	146	G
Strong winds	2	2	1	111	C

Note: ¹Score is the sum of all individual rankings, approximating an absolute ranking, ²Rank is an alphabetical character assigned to each constraint indicating perceived relative importance

Wood fences have been tried as a control method, but *bowe* can burrow underneath them. Electric fences have also been implemented, but with infrastructure issues, heavy rains, high costs and impact on other animals - such as dogs, cats, cattle and *weke* - it is not considered a desirable solution. Some leaders feel the *bowe* issue would be less pressing if there was significantly more *Loka Pere* cultivation, but others are not willing to risk planting more until a clear plan for *hama* control is in place.

Vasudeva Rao et al. (2015) report other potential *bowe* control methods include spreading of human hair clippings around the crops, installation of colored sarees around crops, hanging kerosene-soaked fabric, surrounding crops with coconut ropes soaked in sulfur, making living fences of thorny plants and scaring wild boars with sound. These methods ranged in effectiveness from 25-80%. Sarwar (2019) recommends hunting as a complement to an intensive trapping program, since trapping can be less labor intensive. New methods of wild boar management are being developed.

Cuaca factors also have a significant impact on *Loka Pere*. Due to *litak dangkal* (shallow soil solum) in the area, *makerring anging* (strong winds) can knock down the crops. *Panas attu timur* (extended, hot dry season) also lead to fruiting failure. *Panguma* note *urang* (rainfall) patterns have become less consistent and harder to predict over the last 10-15 years. Farmers' perception of changing

climate has been reported elsewhere as a limitation to NU crops production, and their perception seems to have real grounding (Arotoma-Rojas et al. 2022; Atube et al. 2022). Karieny et al. (2020) report that smallholder banana farmers prefer irrigation and shifting of planting windows as climate adaptation strategies.

Value chain limitations include lack of *pemasaran* (marketing), unstable *alli pasar* (market prices), supply/demand issues, and post-harvest processing. *Panguma* have observed that *Loka Pere* does not demand as high a price at the *pasar* (market) compared to other varieties such as *Loka Manurung* or *Loka Balambang*. 65% of survey respondents agreed that the market price of *Loka Pere* was an important issue, and 88 percent strongly agreed that they would like to see the market price improve (Table 3). To overcome these limitations, the *Kepala Desa* in the study area would like to receive support from institutions such as the regional agricultural office.

In order to promote increased utilization of NU crops, value chain development must coincide with knowledge base improvement (FAO 2019; Li et al. 2020; Anggraeni et al. 2023). This includes availability of planting material, development of post-harvest and processing technology, marketing, investment and consumer education. This can be supported through internalization of funding into the value chain, creation of new legal frameworks, and financial support (Weituschat et al. 2023). In addition,

collective market participation is one way to work towards addressing smallholder farmers' limited access to markets and gives better negotiation power, lower transaction costs, and increased revenue (Orejudo et al. 2022).

Remaining *Loka Pere* after home consumption and *oleh-oleh* uses is brought to the *pasar* (market). *Panguma* say it is difficult to estimate what portion of *Loka Pere* is allocated to each of these uses due to high seasonal variability. The closest *pasar* is in the village Serindu, about 20 minutes from Adolang Dhua and 30 minutes from Adolang. *Loka Pere* is sold by the *sasseh* or by the *sapping*, and *panguma* or family members bring the fruit directly to the *pasar* themselves. Even with value chain limitations, *panguma* rate *Loka Pere* as having economic potential. In the survey it was ranked 3rd (C) in terms of economic value, with a median and mode response of 1 (Table 4). Its importance in household consumption and its potential as an added value product may positively influence perception of its economic value. There is strong desire for both production and *pemasaran* to be increased, and for the utilization of *Loka Pere* to be developed through multiple channels (Table 3). Respondents were open to this development happening outside of the *Adolang Lama* region as well, although its lack of productivity in other areas remains a barrier.

In conclusion, the purpose of this research was to investigate the ethnobotany of *Loka Pere*, including its cultural importance, historical spatial dynamics, local perception of the crop's potential, management and production constraints. *Loka Pere* is a culturally valuable local icon that is strongly linked to the local community's group identity, and is local people's preferred banana variety for personal consumption. Local communities steward important knowledge related to its history, uses, characteristic traits, and management. It is an endemic *Musa* spp. variety that originated in the *Adolang Lama* region, possibly through somaclonal variation. It may be adapted to local agroecological conditions, and its cultivation has not been established outside of its region of origin. It has unique phenotypic characteristics and uses, including use as a traditional fertility medicine. Boiling overripe, softened fruit makes them firm and pleasant in texture. Plants are often grown intercropped or in agroforestry systems. Management of surrounding vegetation and the relocation of successive generations were rated as the most important factors for its cultivation. Limitations to production include wild boar, climate, and value chain factors. After nearly disappearing, locally initiated conservation projects and a growing desire to utilize the resource led to its reintroduction to production systems. *Loka Pere* is still a valuable local food source and is considered to have some economic potential. Respondents agree they would benefit from its increased utilization, including the further development of processed products. Collaboration with a variety of stakeholders is welcome in pursuit of this development.

Further research is recommended to investigate the degree of local adaptation in *Loka Pere*, genomics of the variety, genotype x environment interactions, the plants disease resistance, its medicinal value and the development

of its value chain. If pest limitations can be overcome and its value chain properly developed, *Loka Pere* appears to be a farmers' variety with high potential for regional development. The strengthening of traditional knowledge related to its cultivation and use can aid in its reintegration into regional food systems.

ACKNOWLEDGEMENTS

We would like to thank all the farmers and community members who participated in our study, and the communities in Adolang, Adolang Dhua, and Betteng for their hospitality and support. Thank you to the West Sulawesi Institute for Implementation of Agricultural Instrument Standards; the Majene District Institute for Agriculture, Livestock, and Plantations; and the Majene District Institute for Capital Investment and One-Stop Integrated Services for logistical support.

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