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Ethnomathematics study: Mathematical activities and concept embedded in the traditional farming activities in Lingko Lodok of Manggarai community

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Abstract

This study explores the ethnomathematical dimensions embedded in the rice-farming practices of the Wae Nakeng community within the *Lingko Lodok* system of Manggarai, Indonesia. Grounded in the premise that local cultural practices contain rich mathematical knowledge, the research aims to identify mathematical activities and school mathematics concepts embedded in field structure, farming stages, and the use of traditional tools and measurement systems. The study employed a qualitative ethnographic approach, collecting data through in-depth interviews, participant observations, and field documentation. The data were analyzed using an interactive model encompassing data reduction, data display, and conclusion drawing, with the coding process guided by Bishop's framework of mathematical activities. The findings reveal two major results. First, the farming practices demonstrate key mathematical activities, including counting, measuring, designing, locating, and explaining, as reflected in land division, seed preparation, planting patterns, irrigation management, and harvesting processes. Second, these activities embody various school mathematics concepts, such as arithmetic operations, ratio and proportional reasoning, linear functions, arithmetic sequences, geometric shapes and transformations, and standard and non-standard measurement. Overall, this study highlights the potential of *Lingko Lodok*-based ethnomathematics to inform meaningful mathematics instruction that bridges local knowledge with formal school curricula.

Keywords:
Culture, Ethnomathematics, Mathematical activity, Mathematics concept, Traditional farming

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1. INTRODUCTION

Mathematics, as both a human and cultural construct, has long been intertwined with the lived experiences and practices of diverse societies across the world. It does not emerge in isolation, but rather evolves through human interactions with their physical and social environments. As Bishop (1988) pointed out the social aspects of mathematics are manifested in five significant levels of cultural, societal, institutional, pedagogical, and individual scale. However, in modern educational systems, mathematics is often taught as an abstract, universal, and context-free body of knowledge (D'Ambrosio, 2007; Wedman & Bennet, 2026). This detachment has contributed to a widespread perception among students that mathematics is difficult, monotonous, and irrelevant to their daily lives (Dhungana et al., 2023; Sukestiyarno et al., 2023; Udil & Israfil, 2022). Consequently, students frequently struggle to establish meaningful connections between mathematical concepts taught in schools and the mathematical reasoning inherent in their everyday experiences (Banjo et al., 2025; Dominikus, Udil, et al., 2024; Madimabe et al., 2022). In many educational contexts, particularly in developing countries, this disconnects results in limited mathematical literacy, a lack of engagement, and poor transferability of mathematical knowledge (Cevikbas & Kaiser, 2021; Leton et al., 2025; Udil et al., 2025; Udil et al., 2024).

Ethnomathematics emerged as a response to this epistemological and pedagogical gap. Introduced by Ubiratan D'Ambrosio in the late 1970s, ethnomathematics advocates for the recognition of mathematics as a cultural product which embedded within the practices, artifacts, and worldviews of different societies (D'Ambrosio, 1985, 1999). Ethnomathematics can be understood as the study of how diverse cultural groups develop and apply mathematical ideas, practices, and techniques to understand, explain, and solve problems within their natural and socio-cultural environments (D'Ambrosio, 1985; Rosa & Orey, 2016). It reflects the dynamic relationship between mathematical thinking and cultural contexts (Bishop, 1988; Orey & Rosa, 2007), emphasizing mathematics as a human activity rooted in tradition, art, and lived experience (D'Ambrosio, 1999; Gravemeijer & Terwel, 2000; Rosa & Orey, 2013). It challenges the dominant notion of abstract, mechanistic, and culture-free mathematics by emphasizing the contextual nature of mathematical thinking.

Therefore, the ethnomathematical perspective values mathematical practices as cultural artifacts and activities, encompassing counting systems, spatial reasoning, measurement, design, and problem-solving strategies grounded in local traditions. Ethnomathematics serves not only as a descriptive framework for documenting cultural mathematics but also as a critical paradigm for understanding the plurality of mathematical knowledge systems (Meeran et al., 2024; Rosa & Orey, 2016). Bishop (1988) proposed that all human cultures engage in six universal mathematical activities: counting, measuring, locating, designing, playing, and explaining. These activities represent fundamental cognitive and social processes through which mathematical ideas are generated and transmitted across generations. They provide a conceptual bridge between cultural practices and mathematical reasoning, allowing researchers to identify implicit mathematical concepts within non-formal contexts. Within this study, the ethnomathematical lens is used to examine how the lodok system embodies mathematical ideas that are both contextually functional and symbolically meaningful to the Manggarai people.

In recent decades, ethnomathematics research has expanded significantly across the globe, examining mathematical ideas embedded in indigenous technologies, architecture, traditional games, weaving patterns, and agricultural systems (Batiibwe, 2024; Cervantes Barraza & Lisnani, 2025; Kusi & Bonyah, 2025; Kyeremeh et al., 2023; Nasrum et al., 2025). In Indonesia, the ethnomathematical movement has gained increasing attention since the early 2010s, driven by the country's rich cultural diversity and its need for contextually relevant mathematics education (Dewi et al., 2025; Endilina et al., 2025; Iffah et al., 2025). Research in this area has explored various cultural objects and activities, ranging from traditional houses, dances, games, batik patterns in Java and traditional woven fabric from others region, to the others cultural rituals (Hendriyanto et al., 2023). Despite this growing body of literature, there remains a noticeable geographic and thematic imbalance in the research landscape. Most ethnomathematics studies have been concentrated in western Indonesia, as this region has been the center of educational development in the country, supported by better access to academic institutions, research resources, and educational infrastructure (Iffah et al., 2025; Wibawa et al., 2025). The eastern regions remain largely underexplored and need greater attention to generate richer and more diverse ethnomathematical insights that potentially embody mathematical ideas (Dominikus, Udil, et al., 2023; Iffah et al., 2025). Moreover, while existing studies often focus on artistic or architectural artifacts (Iffah et al., 2025; Riski et al., 2024), there has been limited attention to agricultural systems and farming activities as living cultural practices that embody rich mathematical reasoning (Pathuddin et al., 2023). This limitation is particularly evident in studies of eastern Indonesian communities, including the Manggarai society, where the farming practices in *lingko lodok* represents a complex socio-cultural practice that integrates land organization, farming procedures, and the use of traditional tools and measurement units. Because such practices occur in real working contexts rather than in preserved artifacts, they require longer field observation and direct participation, which may explain why they have been less frequently investigated. Therefore, a focused study on the ethnomathematical aspects of agricultural activities in the *lingko lodok* is necessary to broaden the scope of ethnomathematics research and to reveal forms of mathematical reasoning that emerge in living cultural practices rather than in material artifacts alone.Manggarai is one of the culturally rich communities in East Nusa Tenggara, Indonesia, renowned for its diverse local traditions and authentic cultural expressions that reflect the community's deep connection to nature, social harmony, and ancestral wisdom. One of the cultural manifestations is the traditional farming practice in *lingko lodok* which stands out as a unique reflection of the Manggarai people's cosmological views, spatial reasoning, and collective agricultural practices. *Lingko lodok* refers to a traditional rice-field land characterized by circular and spider-web-like design radiating from a central point. The farming activities of Manggarai people in the *lingko lodok* encapsulate a cyclical process of agricultural activities that reflect both ecological wisdom and collective cooperation. Such characteristics indicate the presence of mathematical reasoning embedded in everyday cultural activities, making this farming system a meaningful context for ethnomathematical analysis. These practices collectively represent a rich repository of ethnomathematical knowledge, yet they remain undocumented and under-analyzed in existing literature.

To date, only a handful of ethnomathematical studies have addressed aspects of Manggarai culture, primarily focusing on traditional architecture (Dominikus, Madu, et al., 2023), traditional mats and woven fabrics (Hanim et al., 2019; Makur et al., 2020), and traditional dances (Dominikus, Madu, et al., 2024; Dominikus, Wiri, et al., 2024; Pangestuti et al., 2024). There is very limited attention has been given to the social practice like traditional farming activities in the *lingko lodok* agricultural system, despite its potential to illuminate mathematical reasoning deeply embedded in indigenous land management, spatial cognition, and social organization. Makur et al. (2019) have conducted ethnomathematical study on *lingko lodok* to explore how the mathematical reasoning and mathematics concept embedded in the practice of distributing land in *lingko lodok*. However, the previous ethnomathematical study focus on the land distribution aspect without further exploration of the farming practice in the *lingko lodok*. The absence of comprehensive research in this area presents a significant gap in both the ethnomathematics literature and the broader discourse on mathematics education grounded in local culture, specifically in term of farming activities in the *lingko lodok*.

Therefore, the present study aims to identify, analyze, and interpret the mathematical activities and concepts embedded in the farming activites in the *lingko lodok* of the Manggarai community. Specifically, it seeks to uncover how mathematical ideas are manifested in the form, process, tools, and measurement systems of traditional farming, and how these ideas reflect the universal mathematical activities and concepts. The findings are expected to bridge the gap between academic mathematics and lived cultural practices, providing insights into the development of contextually grounded pedagogical approaches and enriching the global dialogue on ethnomathematics as a field of interdisciplinary inquiry.

2. METHOD

2.1. Research Design

This study adopted a qualitative ethnographic research design to explore the mathematical activities, structures, and concepts embedded in the farming activities in the *lingko lodok* of the Manggarai community in East Nusa Tenggara, Indonesia. A qualitative approach, as defined by Creswell (2013) seeks to uncover how individuals or groups construct meaning around their cultural practices. While ethnography, as defined by Spradley (1979), seeks to describe and interpret the shared patterns of behavior, beliefs, knowledge, and activities of a cultural group within its natural setting according to the perspectives of the group member. In this research, ethnography enabled an in-depth exploration of how mathematics is intertwined with local farming practices, traditional tools and measurements, and the spatial organization of *lingko lodok* fields.

2.2. Research Location and Participants

The research was conducted in Wae Nakeng Village, located in West Manggarai Regency, East Nusa Tenggara Province, Indonesia. The site was purposively selected because it represents one of the few communities that still preserve the lodok system as a living agricultural tradition.

Participants were selected using purposive sampling to identify individuals possessing substantial knowledge of local agricultural traditions. Five informants participated in this study, including traditional elders, landowner farmer, male and female laborers who possess deep cultural knowledge and practice the farming activities in the *lingko lodok*. The inclusion of multiple participant groups ensured diverse perspectives across generational and functional roles in the farming community.

2.3. Data Collection Procedure

Data were collected over a four-month fieldwork period from January to April 2025 to correspond with the typical duration of the rice-farming cycle in the *Lingko Lodok* fields in Wae Nakeng village. Aligning the fieldwork with this full agricultural cycle was necessary to enable real-time observation of farming practices so that ethnomathematical activities embedded in each stage of the process could be documented authentically and comprehensively. In this qualitative ethnographic research, the researcher functioned as the central tool for gathering and interpreting information (Creswell, 2013), interacting directly with participants and the field environment to uncover the ethnomathematical dimensions embedded in farming practice in the *lingko lodok*. In addition, we used four primary methods for collecting the data namely participant observation, semi-structured interviews, visual documentation, and artifact analysis. Through the participant observation, the researcher was immersed in the community to observe and participate in the main stages of the farming cycle. This immersion allowed the researcher to capture the tacit knowledge, spatial reasoning, and cooperative interactions underlying the farming practice in the *lingko lodok* (Spradley, 1980). Semi-structured interviews were conducted with key informants to elicit local terminologies, beliefs, philosophy, steps, and interpretations of farming activities, tools, measurement, and proportional reasoning (Spradley, 1979). Interviews were conducted in both the Manggarai and Indonesian languages, recorded with consent, transcribed verbatim, and translated into English for analysis. The translation into English was carried out by the researchers who is fluent in Indonesian and familiar with the Manggarai language used in the research setting. To enhance the linguistic accuracy and consistency of the translated data, the initial translations were subsequently reviewed and refined using professional translation software. Visual documentations in the form of photographs, field sketches, and videos were collected to analyze the geometric and spatial structures of the *lingko lodok* fields. Artifact and literature analysis were conducted to understand the characteristics of the traditional tools and measuring systems.

2.4. Data Analysis

Data were analyzed using the interactive model of Miles et al. (2014), which includes three concurrent phases: data reduction, data display, and conclusion drawing. During data reduction, all field notes, transcripts, and images were systematically coded to identify activities, artifacts, and narratives related to mathematical thinking. These data were then categorized according to Bishop's (1988) six mathematical activities.

2.5. Trustworthiness and Ethical Considerations

To ensure trustworthiness, the credibility was established through prolonged engagement in the field, persistent observation, and member checking with key informants to validate interpretations. Triangulation across methods (observation, interview, documentation) and sources (elders, landowner, add farmers) strengthened data reliability.

Prior informed consent was sought from all participants, and community permissions were obtained verbally from traditional elders. The anonymity of participants was preserved, and all photographic data were used with explicit permission.

3. RESULTS AND DISCUSSION

3.1. Results

The farming practices of the Wae Nakeng community in West Manggarai Regency reflect a rich cultural system deeply embedded with ethnomathematical dimensions. The presence of ethnomathematics is reflected in the spider-web configuration of the *lingko lodok* fields, the mathematical reasoning that naturally emerges across all farming stages, and the culturally grounded use of traditional tools and local measurement systems. Accordingly, the following analysis elaborates on the diverse forms and activities of Manggarai rice farming that illuminate the interrelationship between local cultural practices and the underlying mathematical structures and concepts.

Mathematical aspect in the lingko lodok rice field

One of the most visible mathematical aspects of rice farming in the *lingko lodok* system of the Manggarai community is reflected in the distinctive spider-web shaped configuration of the agricultural fields. The Manggarai people refer to this traditional spatial form as *lingko lodok*. The lodok rice-field structure of the Wae Nakeng community represents a concrete expression of ethnomathematical knowledge consistent with Bishop's (1988) universal mathematical activities embedded in cultural practices. The geometric structure reflects activities such as designing, locating, measuring, and explaining. The designing activity is visible in the creation of a radial geometric pattern extending from the central point to the surrounding circle, forming a spider web-like configuration. The locating activity emerges through the spatial reasoning involved in identifying the central point and drawing radial segments in specific directions, demonstrating an implicit understanding of geometry and orientation. The activity of measuring found in determining the radius of the inner circle and the divisions along its circumference using the traditional moso unit. Furthermore, the explaining activity is evident in the transmission of the philosophical meaning of the lodok form, a symbol of harmony between humans, nature, and the God, integrating mathematical reasoning with cultural and spiritual values.

Figure 1. Geometric objects and shapes in the form of *lingko lodok* rice field

The findings of this study also indicate that the *lingko lodok* rice-field structure contains various mathematical concepts that are highly relevant to the school mathematics curriculum. Figure 1 illustrates the relationship between the *lingko lodok* field pattern and several geometric shapes and concepts. In general, the arrangement of lines and regions within the *lingko lodok* field reflects the concepts of points, lines, circles, radius, arcs, sectors, triangles, and trapezoids.

Mathematical aspect in the steps of farming activities

The farming activities of the Wae Nakeng and Manggarai communities generally consist of four major stages: (1) the preparation of seedlings and land, (2) the planting stage, (3) the crop maintenance stage, and (4) the harvesting and post-harvest stage.

Farming in the *lingko lodok* fields of the Wae Nakeng community begins with preparing rice seedlings and opening or plowing the land designated for the nursery. Typically, the nursery plots are rectangular, with dimensions varying depending on the total size of the rice fields to be planted. After preparing the nursery, farmers sow the seeds evenly. The seedlings are then allowed to grow for approximately 21 days before being transplanted across the entire agricultural area. During the growth period of the rice seedlings, approximately when the seedlings are 2 weeks old, farmers begin plowing, constructing the rice-field embankments, and preparing the main fields so that the land is ready for planting within the following week (around the seedlings' third week).

During the seedling and land preparation stage, activities such as determining the size of the nursery plot, plowing the field, and constructing the rice-field embankments represent concrete manifestations of the ethnomathematical activities of counting, measuring, and designing. The number of rice seedlings to be prepared is calculated based on its proportion to the total area of the land to be cultivated. This reflects counting activities in determining the quantity of seeds needed for a given land size. Similarly, farmers determine the size of the nursery plot using a specific proportion of the total agricultural land area, illustrating the activity of measuring. Furthermore, designing activity is clearly visible in the construction of the nursery plot, which is generally shaped as a quadrilateral (a trapezoid or a rectangle) and in the formation of straight-line embankments surrounding the field.

These practices demonstrate an intuitive understanding of mathematical concepts such as geometry, ratio, and informal measurement. In these processes, farmers implicitly apply concepts of length, width, area, and proportional reasoning when adjusting the size of the nursery plot and the number of seedlings to be planted according to the size of the land. Specifically, both the nursery-plot area and the quantity of seedlings exhibit a pattern of direct proportion, meaning that any increase or decrease in land area is followed by a consistent and linear change in these two variables. For instance, if a farmer cultivates a field with an area of k m², he may require m kg of seedlings that must first be prepared in a nursery plot with an area of n m². If the cultivated field area increases, the size of the nursery plot and the number of seedlings needed will increase proportionally, showing a direct linear relationship among these quantities. The proportional relationships between the number of seedlings (N_S) and nursery-plot area (A_{NP}) with respect to land area (A_L) can be expressed as:

$$N_s : A_L = m : k \text{ and } A_{NP} : A_L = n : k$$

These ratios indicate that both the number of seedlings and the size of the nursery plot can be systematically determined by maintaining their proportional relationship to the land area. Thus, if the farmer cultivates another field of p m2, the estimated number of seedlings and nursery-plot area can be calculated using the direct proportion formulas:

$$N_s = \left[\left(\frac{m}{k}\right) \times p\right] \text{ kg and } A_{NP} = \left[\left(\frac{n}{k}\right) \times p\right] \text{ m}^2$$

After preparing the seeds and rice fields, the second step is to plant the rice seeds throughout the rice fields, known as *rede*. This activity typically involves multiple workers, with the number depending on the size of the field, the estimated completion time, and the financial resources available. For example: a respondent with ¼-hectare field generally requires about four workers to complete the *rede* process in a single day.

The planting stage (*rede*) reflects the application of counting, measuring, and locating activities. Farmers carry out planting after the seedlings are approximately 21 days old. During this stage, they consider the number of workers needed, the estimated working time, and the required budget, which is demonstrating the presence of counting in the *rede* process. Measuring is evident when farmers estimate the spacing between seedlings, which is typically around *sa baka* (equal to the width of a handspan). Locating is also reflected in how farmers position each seedling. In this case, the seedlings are not planted randomly but arranged with careful attention to spacing and alignment to form straight and orderly rows of rice plants.

In connection with mathematics education, various school mathematical concepts can be identified in the *rede* stage. Counting the age of seedlings can be used to teach addition and subtraction. Determining the number of workers needed based on land size and estimated work duration also illustrates the application of ratio and proportion concepts. Interview with a farmer revealed that a ¼-hectare field requires about four workers to complete *rede* within a single day. This indicates that the relationship among land area (A_L), number of workers (x), and working time (t) can be expressed proportionally as follows.

$$A_L : x : t = 1 : 16 : 4$$

This proportion illustrates that land area is directly proportional to both the number of workers and the working time, while working time is inversely proportional to the number of workers. Using this proportional relationship, the estimated working time (t') can be calculated when the land area (A_L) and the number of workers (x') are known.

$$\frac{t'}{t} = \frac{A_L{}'}{A_L} \times \frac{x}{x'}$$

For example, if the land area ($A_L{}'$) is 2 hectares and 32 workers (x') are available, the estimated working time (t') is:

$$\frac{t'}{4} = \frac{2}{1} \times \frac{16}{32} \Rightarrow t' = 4 \text{ days}$$

Similarly, if the land area ($A_L{}'$) and the expected working time (t') are known, the required number of workers (x') can be calculated. For example, if the land area is ¼ hectare and the task must be completed in 2 days, then the required number of workers can be calculated as follow.

$$\frac{x'}{16} = \frac{(1/4)}{1} \times \frac{4}{2} \Rightarrow x' = 8 \text{ workers}$$

The determination of planting distance between seedlings also reflects the application of interval, distance, and consistent repetition of patterns across the field. This corresponds to the mathematical idea of an arithmetic sequence, where the equal planting distance represents the common difference (d) and the position of each planting point corresponds to the sequence's terms (Un). Students can be asked to calculate the length or width of a side of a rice-field plot when given information about planting distance and the number of planting points. In such cases, the length (p) of a side can be calculated using the formula for the n-th term of an arithmetic sequence (Un).

$$U_n = U_1 + (n-1)d$$

For instance, if one side of a plot contains 19 planting points with an equal spacing (d) of *sa baka* (approximately 15 cm), and the distance from the plot boundary to the outermost point is also *sa baka* (see Figure 2), then the length of that side equals to the 21-th term of an arithmetic sequence. It is from the 19 planting points and two points of the plot boundary.

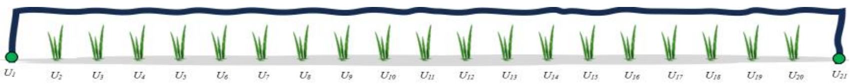


Figure 2. Arithmetic sequence in rice seedling planting patterns

Therefore, the length of the side can be calculated as follow.

$p = U_{21}$
$p = U_1 + (n-1)d$
$p = 0 + (21-1)15$
$p = 300 \text{ cm} = 3 \text{ m}$

After the *rede* activity, the rice field is maintained through irrigation, fertilization, and the removal of weeds (*tawi*). Approximately 3 - 4 weeks after planting, farmers conduct *tawi*, a weeding activity aimed at clearing unwanted plants that may hinder rice growth and development. One respondent shared that for a field of about 1 hectare, *tawi* is typically carried out by up to 12 workers and completed within 3 days. After *tawi*, the field continues to be maintained through fertilization, pest control, and sufficient irrigation.

Activities such as weeding (*tawi*), irrigation, spraying, and fertilization reveal the presence of *counting*, *measuring*, and *explaining* activities. *Counting* is evident when farmers calculate the age of the rice plants to determine the proper timing for *tawi*, fertilization, and spraying. Decisions regarding the amount and type of fertilizer or pesticide also involve *counting*. Farmers perform irrigation periodically at fixed time intervals, reflecting counting activities related to scheduling and frequency. *Measuring* is visible in how farmers determine fertilizer doses, the volume of pesticide mixtures, and the quantity of water needed for irrigation. These activities demonstrate practical understanding of measurement, volume, and water flow. Furthermore, *explaining* emerges through farmers' reasoning when estimating the amount of water required for optimal plant growth based on field size and weather conditions.

Several school mathematics concepts can be found in crop maintenance activities. Estimating rice-plant age for *tawi* illustrates the use of arithmetic operations. For example, if farmers perform *tawi* on day m and *rede* was carried out on day n, the plant age can be calculated as $u = m - n$. The ideal age for *tawi* is generally 14–21 days or depends on weed growth. Thus, the date for *tawi* can also be determined using the following linear inequality.

$$14 \leq m - n \leq 21$$

Determining fertilizer quantities shows understanding of direct proportion between fertilizer needs and land size. If a farmer needs a kg of fertilizer for b hectares, the ratio is $a : b$. In addition, mixing pesticide with water before application reflects measurement of volume, concentration ratios, and arithmetic operations.

Approximately 2 to 2½ months after *tawi*, the rice plants are ready to be harvested (*ako*). The *ako* activity involves cutting the rice stalks and placing them into sacks. In Manggarai traditional culture, *lepo* (woven from pandan leaves) was used in place of modern sacks. After harvesting, the next process is *rontok*, which is the separation of rice grains from their stalks. This is followed by *teter* (winnowing) and finally drying the rice (*pari*) until it is ready to be milled. For a 1-hectare field owned by one respondent, the harvesting (*ako*) and *rontok* activities were typically completed in one day with 25 female workers and 7 male workers.

The harvesting (*ako*) and post-harvest stages (such as *rontok*, *teter*, and *pari*) contain strong ethnomathematical dimensions. Activities involving *counting*, *measuring*, *locating*, and *explaining* appear throughout the harvesting and post-harvest processes. During these stages, farmers consider the age of the rice plants, the number of workers needed, estimated working time, and the required budget. These considerations reflect *counting* activities. Farmers also store harvested rice in sacks (*lepo*) of various sizes and perform post-harvest processes (such as *teter* and *pari*) using containers of different capacities (*roto*, *doku*, and *loce*). These practices demonstrate *measuring*, involving mass and volume measurement using various containers. Harvesting also requires *locating*, such as precisely positioning the sickle to cut the rice. Furthermore, *locating* becomes evident during *teter woja*, when farmers hold the *roto* or *doku* above their head at specific angles (slowly moving from 0° to 90°) so that rice grains fall while the wind separates them from husks, dust, and empty chaff. In the harvesting and post-harvest stages, farmers base their decisions on clear reasoning and explanations. For instance, when determining the right harvesting time, farmers not only calculate plant age but also assess rice maturity based on grain color and fullness.

In relation to school mathematics, the harvesting and post-harvest stages encompass several mathematical concepts, including linear models/functions, geometry, and geometric transformations. A linear model with three variables emerges when estimating the daily cost of harvesting. Farmers need to estimate the budget required for the harvest based on the number of male workers (x), female workers (y), and the daily consumption cost (z). The daily wage for male and female workers is typically predetermined. In the Wae Nakeng community, the daily wage for men is IDR 100,000 and for women is IDR 75,000. Thus, the total daily cost can be modeled as:

$$f(x, y, z) = 100{,}000x + 75{,}000y + z$$

During *teter*, the concept of angles becomes particularly apparent. The position of the *roto* or *doku* above the farmer's head forms various angles as it moves from 0° to 90°. The angle between the container and the farmer's head forms an acute angle (see Figure 3), which enables effective separation of the rice grains.

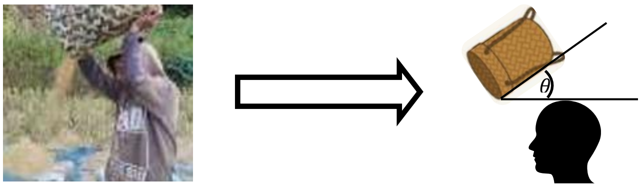


Figure 3. The position of roto during teter form an acute angle

Furthermore, the *teter* context can be used to teach students how to calculate arc length. If a farmer uses a *roto* with radius r and moves it through an angle θ radians, the arc length p traced by the *roto* is:

$$p = \left(\frac{\theta}{2\pi}\right) 2\pi r \rightarrow p = \theta r$$

Mathematical aspect in the traditional farming tools and measurement

In the agricultural practices of the Wae Nakeng and Manggarai communities, a variety of traditional tools and measurement systems are used. The traditional farming tools consist of the machete (*kope*), shovel (*bancik*), sickle (*kandong*), and containers like *roto*, *doku*, and *lepo*. These tools embody ethnomathematical elements embedded in local farming traditions. Generally, the *kope* is used to cut wood and branches on agricultural land. In the context of rice-field farming, it is also used to clean the bunds. The shovel (*bancik*) is used to build bunds, turn over the soil, and level the rice field after plowing. The sickle (*kandong*) is used for cutting grass and harvesting rice.

To support farming activities, the Wae Nakeng and Manggarai community also uses several traditional containers, including the basket (*roto*), winnowing tray (*doku*), and sack (*lepo*). The *roto* is used for storing harvested rice and for estimating its weight. It is made from bamboo that is about one year old (still relatively young), split into strips measuring between 1 and 1.5 cm. The *doku* is used for winnowing the rice to separate empty grains after threshing. The lepo is used to store and count harvested rice, and it is available in various sizes such as *lepo warang*, *lepo wega*, *lepo telu warang*, and *lepo beka*. Other traditional measurement units include *tongka* and *re cie*. The relationships among these units are summarized in the following Table 1.

Table 1. Traditional measurement used for counting the harvested rice

Unit	Relationship to the *tongka* unit
1 *tongka*	1 *tongka*
1 *lepo warang*	6 *tongka*
1 *lepo wega*	12 *tongka*
1 *lepo ca beka*	24 *tongka*

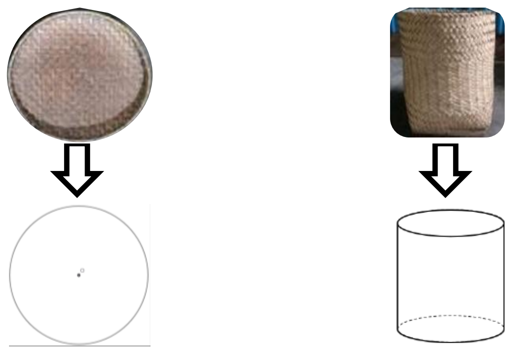
The use of various traditional tools and measurement systems in the rice-farming practices of the Wae Nakeng and Manggarai community reflects a close relationship with mathematical knowledge that has developed naturally within their cultural traditions. These tool and measurement unit represent several universal mathematical activities such as *counting*, *measuring*, *designing*, and *locating*. *Counting* and *measuring* are evident in the use of the *tongka* unit and different *lepo* sizes to estimate and compare harvest quantities. *Designing* appears in the crafting of tools such as the *kope*, *kandong*, *bancik*, *roto*, and *doku*, which are made with careful consideration of form and function. The use of these tools also requires precise positioning to achieve optimal results, reflecting the activity of *locating*. For instance, when cleaning rice-field bunds with the shovel, the farmer must position the shovel vertically to produce a straight and neat bund.

The relationship between traditional tools and measurement systems in the rice-farming activities and school mathematics concepts is clearly visible. The shapes of the tools represent various plane and solid geometric forms. For example, the shape of *kope* can be used to introduce a composite geometric figure combining two right trapezoid (see Figure 4a). The *bancik*, on the other hand, resembles a combination of an isosceles trapezoid and a rectangular (see Figure 4b).

(a) (b)

Figure 4. Illustration of geometric figure on the shape of (a) *kope*; and (b) *bancik*

Moreover, the circular shape of the *doku* (see Figure 5a) incorporates numerous mathematical concepts such as radius, circumference, arc length, and area of a circle. Meanwhile, the *roto* represents the three-dimensional form of an open cylinder (see Figure 5b).



(a) (b)

Figure 5. Illustration of geometric figures: (a) a circle in the shape of *doku*;
(b) an open cylinder in the shape of *roto*

The use of non-standard measurement units is also reflected in these traditional systems. Units such as *tongka* can be used to help students understand informal mass measurement before converting to standard units such as grams or kilograms. For instance, students can learn that one *tongka* of rice is roughly equivalent to 3–5 kg, allowing them to determine mass in standard units. Additionally, mathematical concepts such as arithmetic and algebra are embedded in systems like *tongka* and *lepo*, which illustrate ideas of multiples, ratios, and proportionality. The relationships among these units demonstrate multiplication, division, and unit conversion, aligning with foundational concepts in school algebra.

3.2. Discussion

The findings of this study show that the land configuration, stages of farming activities, and the use of various traditional tools and measurement units in the agricultural practices of the Wae Nakeng community in *Lingko Lodok* contain a wide range of mathematical activities, structures, and concepts. The *counting* activities are deeply embedded in nearly all farming stages, from estimating the number of rice seedlings, determining the age of rice plants for weeding, calculating workers needed, time and budget estimating, calculating the amount of fertilizer or pesticide, to counting the harvested rice. These activities align with Bishop's notion that counting is a universal cognitive and cultural activity emerging from the need to keep track of quantities in meaningful contexts (Bishop, 1988). The presence of counting activities across all stages of Wae Nakeng farming activities resonate with previous studies showing that farmers commonly engage in counting practices such as determining planting days, estimating seasons, and planning agricultural cycles (Ja'faruddin et al., 2025; Umbara et al., 2021). In addition, the counting activities within the farming practice of Wae Nakeng community is not merely computational but involves making informed decisions based on proportional relations, resource limitations, and temporal considerations which is reflecting context-dependent quantitative reasoning consistent with findings from ethnomathematics research in other agricultural societies (Pathuddin et al., 2023; Umbara et al., 2019).

Measuring emerged prominently through the use of traditional units and tools such as *moso*, *baka*, *tongka*, *warang*, *wega*, *beka*, *lepo*, *roto*, and *doku*. Measurement practices in the community include measuring the land area, estimating planting distances, determining fertilizer doses, calculating water volumes, and using traditional units to estimate harvest mass. Such practices reflect a culturally embedded measurement system that blends standard and non-standard units. Similar to other indigenous systems (Umbara et al., 2021; Yeban, 2024), these measurement activities reveal intuitive proportional reasoning and embodied mathematical understanding developed through long-term interaction with cultural tools and ecological environments (Bishop, 1988; Muhtadi et al., 2017). The Wae Nakeng community's reliance on bodily-based units (e.g., *sebaka* and *moso*) also resonates with previous research (Makur et al., 2019; Nurjanah et al., 2021; Suwarno et al., 2020), showing that ethnomathematical measurement systems offer valuable insights into embodied cognition in mathematics (Nemirovsky & Ferrara, 2009).

Designing is visible through the construction of geometric land patterns, irrigation structures, nursery plots, the iconic spider-web configuration of the *lingko lodok* fields, and the crafting of tools such as the *kope*, *kandong*, *bancik*, *roto*, and *doku*. These *designing* activities reflect mathematical processes integrating symmetry, balance, spatial optimization, and aesthetic-cultural meaning. The Wae Nakeng configuration of the *lingko lodok* mirrors findings in other ethnomathematical studies where agricultural land design reflects complex geometric and spatial reasoning embedded in cultural cosmologies (Fatoni et al., 2023; Makur et al., 2019; Sunardi et al., 2019). Moreover, the designing activity is reflected in the crafting of traditional farming tools aligns with earlier researches (Muhtadi et al., 2017; Nita et al., 2023; Padang & Lubis, 2023) showing that indigenous agricultural implements are deliberately constructed using culturally grounded mathematical principles.

Locating is also a key mathematical activity in the farming activities of Wae Nakeng community. Farmers engage in spatial reasoning when aligning planting rows, determining the center point for *lodok* division, orienting tools such as *kope* and *kandong*, and positioning the *roto* at specific angles during *teter*. These locating practices demonstrate spatial orientation, angular reasoning, and navigation skills similar to those documented in many communities for determining of location, positioning the tools, and placing the objects (Fatoni et al., 2023; Linling & Nuryadi, 2022; Sunardi et al., 2019).

Explaining is evident in the reasoning behind planting schedules, harvest timing, irrigation cycles, drying processes, and the philosophical interpretation of the *lingko lodok* structure. Such explanatory practices indicate that mathematical reasoning is embedded in socio-ecological decision-making processes (Bishop, 1988), consistent with research showing that cultural communities frequently engage in informal mathematical modeling and inferential reasoning to guide productive activities (Nasir et al., 2008; Umbara et al., 2025; Umbara et al., 2026).

From the perspective of school mathematics, the ethnomathematical practices identified encompass a wide range of mathematical domains. In arithmetic, operations such as addition, subtraction, multiplication, and division are apparent in calculating plant age, fertilizer quantities, seed counts, irrigation intervals, and wages. As found in several previous studies that identified the presence of basic arithmetic concepts in the farming activities of local communities (Ja'faruddin et al., 2025; Pathuddin et al., 2023; Suwarno et al., 2020). Moreover, the proportional calculations such as seedlings-land area ratios, fertilizer-land relationships, and worker-time allocations reflect foundational mathematics and arithmetic reasoning in real-world contexts (Hadi et al., 2025; Kusaeri et al., 2025; Umbara et al., 2021). In algebra, proportional reasoning, linear relationships, and three-variable linear models emerge in estimating work duration and harvesting costs. The function identified in the harvesting context exemplifies how algebraic relationships can be constructed from lived experiences, as also noted in previous studies (Borbon, 2022; Dosinaeng et al., 2020). In addition, the findings consistent with research advocating for culturally contextualized algebra instruction (Bardhan et al., 2025; Hanan & Sugiman, 2025; Vitoria & Monawati, 2020).

The geometric domain is richly represented in the *lingko lodok* field structure, planting patterns, tool shapes, and *teter* movements. Concepts include points, lines, circles, radius, sectors, triangles, trapezoids, angles, arc lengths, and rotational transformations. These findings align with the literature emphasizing the prevalence of geometric reasoning in traditional architectures, crafts, and land systems across different cultures (Borbon, 2022; Dominikus, Udil, et al., 2024; Prahmana & D'Ambrosio, 2020; Weldeana, 2016). The *lodok* fields, in particular, present a unique case of radial geometry and circle partitioning rooted in cultural meaning (Makur et al., 2019), offering robust opportunities for linking formal geometry with local practices. The identification of geometric objects and concepts embedded in farming practices within the *lingko lodok* system can be translated into ethnomathematics-based instructional designs that contextualize learning in students' experiences, making mathematics more meaningful and engaging while simultaneously strengthening mathematical conceptual understanding and improving learning outcomes (Madimabe et al., 2022; Shahbari & Daher, 2020; Sukestiyarno et al., 2023).

The pedagogical and didactic potential of these findings is substantial. Ethnomathematical knowledge from the Wae Nakeng community can be integrated into school mathematics to promote culturally responsive pedagogy (Hidayat et al., 2025; Rosa & Orey, 2013), enhance students' conceptual understanding, and strengthen the connection between mathematical ideas and students lived experiences (D'Ambrosio, 2018; Lipka et al., 2005; Nasir et al., 2008). The ethnomathematical knowledge from the farming practice of Wae Nakeng community have potential to be integrated into the design of school mathematics instruction (Azizah et al., 2024; Susanta et al., 2022). In addition, these ethnomathematical practices can be transformed into mathematical tasks aligned with Realistic Mathematics Education (Gravemeijer & Terwel, 2000). Furthermore, the strategic combination of ethnomathematics and Realistic Mathematics Education (RME), such as in the form of Ethno-RME approach, offers a meaningful instructional approach that situates learning within authentic cultural contexts, affirms students' identities by recognizing their heritage as a valid source of mathematical knowledge, and simultaneously strengthens their mathematical understanding, confidence, and competencies (Alghiffari et al., 2024; Prahmana et al., 2023; Pujiastuti et al., 2025).

4. CONCLUSION

This study concludes that the rice-farming practices of the Wae Nakeng community in the *Lingko Lodok* fields contain rich ethnomathematical knowledge reflected in land organization, farming procedures, and the use of traditional tools and measurement systems. The findings show that mathematical thinking naturally emerges in everyday agricultural activities, including counting, measuring, locating, designing, and explaining. These activities are closely related to various domains of school mathematics such as arithmetic, algebra, geometry, and measurement. The farming practices in *Lingko Lodok* provide an authentic context in which mathematical relationships are formed, used, and transmitted across generations. Furthermore, these findings affirm that everyday agricultural practices offer rich and authentic contexts for various domains of school mathematics.

The results confirm that local cultural practices function not only as socio-economic activities but also as informal mathematical systems developed through long-term community experience. This indicates that ethnomathematical knowledge can serve as a meaningful bridge between students' cultural backgrounds and formal mathematics learning. By connecting real-life practices with school mathematics concepts, learning can become more relevant, contextual, and conceptually meaningful for students.

Based on these findings, it is strongly recommended that educators, curriculum developers, and education policymakers begin to incorporate ethnomathematical contexts, such as the rice-farming practice in *Lingko Lodok*, into mathematics instruction. The use of culturally grounded contexts can support the development of contextual teaching materials, ethnomathematics-based learning designs, and culturally responsive pedagogy that enhances students' mathematical literacy and engagement. Immediate efforts to integrate local cultural knowledge into classroom practice are important not only to improve the quality of mathematics learning but also to preserve valuable indigenous knowledge as part of educational resources. Therefore, collaboration among researchers, teachers, and stakeholders is needed to implement these findings in curriculum development, instructional design, and classroom practice in a more systematic and sustainable way.

Despite these contributions, the study has limitations. The findings are based on a specific community in Wae Nakeng, and the cultural practices documented may not fully represent the diversity of Manggarai or other regions of eastern Indonesia. Future research could expand to comparative studies across different Manggarai communities or explore ethnomathematical elements in other cultural practices such as weaving, traditional architecture, or ceremonial systems. Quantitative or mixed-methods approaches could also be used to measure the pedagogical impact of integrating *Lingko Lodok*-based ethnomathematics into school curricula. Additionally, future researchers may develop and test instructional designs or Local Instruction Theories (LIT) derived from these findings to strengthen the link between ethnomathematical research and classroom practice.

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Declarations

Author Contribution	: PAU: Conceptualization, Data curation, Formal analysis, and Writing - original draft; T: Conceptualization, Formal analysis, and Methodology; EN: Project administration, Resources, Supervision, and Validation; AJ: Supervision, Validation, and Writing - review & editing; WSD: Data curation, and Methodology; SAW: Resources, Validation, and Writing - review & editing; SIL: Validation, Visualization, and Writing - review & editing.
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