MANKIND QUARTERLY
Mankind Quarterly, 66(3), 574-591 2026 Spring Edition
ISSN: 0025-2344

Exploration of Local Knowledge of the Acehnese Agricultural Calendar, "Keuneunong"

Elza Surmaini[†] Abdul Manan[‡*] Yeli Sarvina[†] Yudi Riadi Fanggidae[†]
Rhino Ariefiansyah[§] Manguji Nababan[¶] Rahimah Embong[‖]

Abstract

Local knowledge in agricultural cultivation has been an integral part of farmers' lives for generations, playing a crucial role in fulfilling food needs and maintaining the balance of nature. However, much of this knowledge is being eroded by economic, political, cultural, and even climate changes. This study examines *keuneunong* as an Acehnese example, defining it as a calculation-based model that links natural indicators to the rice cultivation calendar. The novelty of study lies in its articulation of *keuneunong* as a hitherto unexplored functional twelve-period agricultural calendar that translates environmental signals into rice cultivation decisions. *Keuneunong* refers to a calculation method, and describes natural phenomena for each period of the rice cultivation calendar. This study applies a qualitative explanatory approach. Data collection was carried out through manuscript review and in-depth interviews with relevant agencies, key informants, and supporting informants. The results of the study delineate that *keuneunong* is a traditional Acehnese calendrical system describing the phases of activities in rice field cultivation. The data analysis reveals the function of this calendar as a traditional time reference for starting agricultural activities: when to start agricultural activities, to go fishing, and to go sailing. The calendrical system also describes seasonal phenomena and natural indicators as signs for certain agricultural activities. *Keuneunong* divides the year into 12 periods; each period characterized by certain natural phenomena including change of weather, animal behaviours, and time of sunrise and sunset. In Aceh, weather conditions are crucial for agricultural activities such as plowing the fields, sowing rice seedlings in the seedbed, planting young rice seedlings in the fields and harvesting, to avoid both pest infestation and water shortages in the fields. *Keuneunong* briefly explains weather signals to determine the exact time for starting these activities. By comprehending seasonal systems, people can also determine what secondary crops, such as sugar cane and tobacco, are suitable for certain periods. It also helps in determining the time for fishing and sailing. *Keuneunong* becomes an example of local sensibilities in maintaining harmonious life with nature; a valuable model to be adapted as a way to preserve nature and life in the modern era.

Keywords: Exploration, Local knowledge, Rice cultivation, Agricultural calendar, *Keuneunong*

1 Introduction

Each province of Indonesia, including Aceh, possesses a wide array of local wisdom, traditional technology, and folklore held by a community, which can include rules, prohibitions, and regulations governing the foundations of life (Surmaini et al. 2023). In Aceh, local wisdom plays a role in the management of natural resources and the environment to maintain the balance of nature and its sustainability (Levis et al. 2017; Tirivangasi & Tayengwa 2017). Such knowledge plays an important role in achieving food security (Septanti & Saptana 2020; Sumartias et al. 2019). For centuries, farmers have planned agricultural cultivation and conserved natural resources using local wisdom (Balehegn et al. 2019; Mafongoya & Ajayi 2017b; Sillitoe 2006). In Aceh agricultural communities, one local knowledge relating to agriculture is *Keuneunong*, a traditional calendrical system used to predict the start of the season, determine planting times, and select crops (Kijazi et al. 2013; Mapfumo et al. 2016; Mbewe et al. 2019; Radeny et al. 2019). Such system enables adjustments to the planting period, selection of drought-tolerant varieties, and irrigation practices (Son et al. 2019).

In Indonesia, local knowledge relating to nature and agriculture plays a significant role in preserving nature and maintaining harmony with nature. Local sensibilities relating to agriculture as Subak (traditional irrigation systems) in Bali, Pranataa Mangsa (determining planting seasons) in Java, Bondang (organic farming) in Asahan, North Sumatra,

[†] Center for Climate and Atmospheric Research, Jakarta, Indonesia
[‡] Universitas Islam Negeri (UIN) Ar-Raniry, Banda Aceh, Indonesia, and also a research fellow at the Faculty of Islamic Contemporary Studies of the University of Sultan Zainal Abidin (UniSZA), Terengganu, Malaysia
[§] Department of Anthropology, University of Indonesia, Depok, Indonesia
[¶] Center for Documentation and Study of Batak Culture, HKBP Nommensen University, North Sumatra, Indonesia
[‖] University of Sultan Zainal Abidin (UniSZA), Terengganu, Malaysia
* Corresponding author, email: abdul.manan@ar-raniry.ac.id

and Tudang Sipulung (determining planting times) in South Sulawesi (Limpo et al. 2022), have been described as eco-friendly agricultural systems. In Aceh, there is *keuneunong,* a calendrical system used to determine the time for agricultural activities. Unfortunately, much local knowledge is currently at risk of extinction or is being eroded due to environmental changes, economic, political, and cultural developments. This highlights the need for proper documentation and modernized transformation. *Keuneunong* was written in the Acehnese language using the Arabic alphabet. Now, only few people in Aceh can read and interpret the manuscripts. In addition, documentation has so far been merely digitalization of manuscripts with no modern adaptation. This situation endangers the knowledge contained in *keuneunong*.

In Aceh, farming affects all livelihoods, as stated in the proverb "the main source of income is farming and the main ruler of the land is the king." In other words, "rich by having gold is incomplete, rich by having grain is complete." In other words, wealth is not measured by gold, but by agricultural products and rice. Farmers use various customs to increase their harvest. One tradition in farming is the *uréh* tradition in the lowland of Aceh. This tradition is a community custom carried out individually to protect crops from pest attack by using a magical fence, such as eradicating pests and observing taboos from planting until the rice enters the barn, maintaining its vital energy so that the stomach is full of nutrition. In addition, it shows an ideal image of society (Manan 2016a). The *uréh* tradition is carried out from seeding to harvest in two forms: (1) amulets with the necessary objects, and (2) amulets alone. People in the interior use "modern" *uréh*, which is considered more efficient and effective. Furthermore, when local traditions are used as a way to introduce Islam, people begin to perceive the ritual as part of the Islamic tradition (Arifin & Manan 2018; Asyura et al. 2020; Manan et al. 2023; Satria et al. 2024).

In the face of climate change and the challenges it presents, there is growing awareness that scientific knowledge alone is not enough to solve the climate crisis (Finucane 2009; Mafongoya & Ajayi 2017a). Scientific knowledge needs to be adapted and combined with local knowledge to increase participation and effectiveness of its application. One impact of climate change is the shifting of the rainy season, which causes shifts in planting times and increases the intensity of extreme climate events. One climate change adaptation technology for determining planting times and climate risks such as flooding, drought, pest attacks, and plant diseases is the Planting Calendar, developed by the Ministry of Agriculture (Apriyana et al. 2021). This calender is widely used in modern agriculture, but it ignores natural symptoms as prompts to adjust the activities. *Keuneunong, however,* contains local sensibilities to natural symptoms such as animal behaviours (weather lore), constellation, and time of sunrise and sunset that allow the farmer to adjust the time of planting rice to obtain best results. It demonstrates how local sensibilities help in preserving harmonious life with nature; an aspect which is neglected by the Ministry of Agriculture's moden Planting Calender.

Studies on implementation of local knowledge in agricultural cultivation in various countries, including Indonesia, have begun to receive considerable attention. Furthermore, many applications of the local knowledge practiced by farmers is affordable and environmentally friendly. Most export markets now prefer organic agricultural products produced by local farmers, thus providing opportunities to increase their incomes (Limpo et al. 2022).

Each region in Indonesia has specific local knowledge in agricultural cultivation calendars, but only a small part is well documented, such as *Parlontara* in South Sulawesi (Irmayani et al. 2023; Limpo et al. 2022; Sari et al. 2017); *Pranatamangsa* in Java (Widyatmoko 2019); *Wariga* in Bali (Damayanti 2021; Wisnubroto 1998), and the *Papan Warige* of the Sasak community in Lombok (Awaludin 2019). However, such local knowledge is still very limited in terms of documentation and research studies. Reviving local knowledge collected from local communities and innovations adopted by farmers can illustrate natural resource management patterns for sustainable agricultural cultivation. Local knowledge and innovations adopted by farmers are collected, then compiled and analyzed into a more structured model of farmer knowledge that is easily applied by other communities. The system of understanding constructed and developed by farmers can serve as input to complement and enrich scientific knowledge (Joshi et al. 2004).

In western Indonesia, local knowledge of agricultural cultivation remains poorly documented. The Malay community in Ogan Ilir has the *Besahian* tradition for rice cultivation planning, the Rejang people in Bengkulu the *Sakea* tradition for restoring soil fertility, and there is the Salibu rice tradition in West Sumatra for improving crop yields. Parhalaan is a Batak calendar system used to determine auspicious and inauspicious days for activities, such as ceremonies for establishing a village, going to the fields and planting, and various other traditional ceremonies (Angerler 2021), but in general, information and studies on local wisdom are very limited.

The present research critically explores the local knowledge in the rice cultivation calendar *keuneunong* in Aceh, which has not been studied in depth and is threatened with extinction. *Keuneunong* is a local wisdom that uses natural signs, such as the moon, stars, plants, and animal behaviour, to determine the stages of rice cultivation, such as planting times, potential pest attacks, and harvest times (Manan 2013, 2022; Manan et al. 2022). This research aims to explore and develop a local knowledge model related to the rice cultivation calendar in Aceh Province. The characteristics of Acehnese local knowledge are reflected in two main pillars: religion and custom. These two pillars underpin local wisdom and values in facing a disaster. One form of indigenous and local knowledge of the Acehnese

people is *keuneunong* (Zainuddin & Agussabti 2010).

Local knowledge has taken root and become a guide for farmers' lives, passed down through generations. Especially in rice cultivation, all production processes, pre- and post-harvest, are imbued with local knowledge containing community values, norms, and traditions. In some regions, this local knowledge is well-documented, but in most other regions, such as western Indonesia, much local knowledge is at risk of extinction or is undergoing rapid erosion due to changes in environmental, economic, political, and cultural factors. On the other hand, much of the local knowledge practiced by farmers is inexpensive, environmentally friendly, and adapts to the availability of resources in the region. With the growing export market, which now favors organic agricultural products produced by local farmers, this presents an opportunity for farmers to increase their income. Studying and documenting local knowledge of the rice cultivation calendar in Aceh can help preventing the extinction of this tradition. The local data is collected, then compiled and analyzed into a more structured and fully documented *keuneunong* model of farmer knowledge so that it becomes a source of knowledge that can be studied and applied by other communities. Exploration of local knowledge of rice cultivation needs to be carried out to document, archive, and understand in a structured manner how this local knowledge is produced, managed, and utilized by the Acehnese people so that it can be utilized by policy makers and the community and passed down to the next generation.

2 Literature Review

Keuneunong is a central element of Acehnese cultural identity, reflecting the deep interconnection between humans, nature, and spirituality. Rooted in local wisdom theory, it represents a collective knowledge system transmitted across generations, functioning as a moral and ecological compass for Acehnese society (Abdullah 1993). Within the framework of cultural ecology theory, *keuneunong* manifests as an adaptive strategy by which communities interpret environmental patterns and sustain harmonious relationships with their ecosystems (Haeen & Nora 2005). Meanwhile, according to structural-functional theory, it contributes to maintaining social stability and cultural continuity through customary norms and rituals (Setyantoro 2007).

Practically, *keuneunong* serves as a traditional calendar that regulates agricultural and fishing activities, determining optimal seasons for planting, harvesting, and maritime expeditions. Its interpretation is entrusted to the *keujruen blang*, a "rice ritual specialist" who mediates between empirical observation and spiritual interpretation (Hermaliza 2008). This function illustrates the integration of environmental knowledge, religion and livelihood in Acehnese culture, where agricultural work is not merely economic but sacred. As Manan (2013) emphasizes, the Acehnese proverb "Worship is the most important act; agriculture is the most important livelihood" reflects the intertwining of faith, ecology, and identity. Despite modernization and the pressures of globalization, *keuneunong* continues to sustain the local community's resilience, particularly in environmental management and disaster mitigation (Lahudin 2024; Zulchaidir 2015).

The *keuneunong* system aligns with a broader spectrum of traditional agricultural calendars that embody ecological intelligence and spiritual cosmology. In Java, the Pranata Mangsa calendar structures planting and harvesting cycles based on solar movements and seasonal indicators. Studies have shown its relevance for climate change adaptation and the development of climate-smart farming strategies (Setiawan et al. 2021; Suprapto 2018; Utami & Setyorini 2020). In Bali, the Pawukon and Saka calendars integrate cosmological principles into the subak irrigation system, reflecting a balance between ritual, water management, and social cooperation (Geertz 1973; Lansing 2006).

Beyond Indonesia, several comparable systems demonstrate the universality of indigenous ecological knowledge. In the Philippines, the Kalendaryong mga Katutubo synchronizes lunar phases with agricultural cycles (Flores 2017), while Thailand's Boonserm calendar merges Buddhist rituals with rice cultivation (Boonserm 2016). In Japan, the Nōgyō reki has evolved from a lunar calendar to a hybrid model that combines traditional cues with meteorological data (Yano 2017). Similarly, the Tzolk'in and Haab' calendars of the ancient Maya integrated astronomical calculations into crop management (Milbrath 2020), and the Ethiopian traditional calendar continues to guide rain-fed farming practices (Tedla 2019).

Collectively, these studies demonstrate that traditional agricultural calendars serve as dynamic repositories of environmental knowledge. However, most research focuses on cultural documentation and ritual symbolism rather than the analytical modeling or predictive capacities of these systems (Gómez-Baggethun et al. 2021; Pretty et al. 2019). The absence of methodological integration between local calendars and modern environmental data systems underscores the need for deeper interdisciplinary exploration. *Keuneunong*, despite its ecological and cultural significance, remains underrepresented in contemporary scholarly discourse. Existing studies focus primarily on its ritual and social functions (Abdullah 1993; Manan 2013) without addressing its scientific or calculative potential for environmental prediction and agricultural planning. In contrast, the Pranata Mangsa and Pakuwon systems have been analyzed as climate-adaptive frameworks and incorporated into sustainable development discussions (Rachman & Prasetyo 2022; Setiawan 2019; Utami & Setyorini 2020).

This gap highlights an urgent need for research that conceptualizes *keuneunong* as a modern calculative model, an eco-focusing agricultural system capable of linking cultural logic with empirical environmental data. While global studies have explored the integration of indigenous ecological calendars into meteorological and sustainability frameworks (Berkes 2018; Gómez-Baggethun et al. 2021; IPBES 2019), *keuneunong* has not yet been scientifically mapped or modeled. Moreover, its unique integration of Islamic spirituality, environmental ethics, and local ecological indicators distinguishes it from other traditional systems and offers a promising foundation for localized sustainability science.

In a regional context, studying *keuneunong* can enhance Aceh's environmental governance through community-based adaptation strategies. At the national level, it contributes to Indonesia's broader efforts to revitalize indigenous knowledge for sustainable agriculture. Globally, this research aligns with international initiatives that recognize traditional ecological knowledge as a key asset for achieving climate resilience and sustainable development (UNESCO 2022).

Previous studies demonstrate that while traditional agricultural calendars across cultures have received scholarly attention (Setiawan et al. 2021; Suprapto 2018; Utami & Setyorini 2020), *keuneunong* remains insufficiently analyzed in terms of its scientific, calculative, and adaptive dimensions. Previous research has largely described its symbolic and ritual aspects (Manan 2013), but has not developed it as an analytical model for ecological forecasting or agricultural planning. Therefore, this study seeks to bridge that gap by critically examining *keuneunong* as a living system of environmental knowledge integrating cultural, spiritual, and ecological perspectives. By positioning *keuneunong* within interdisciplinary and global contexts, this research contributes both theoretically and practically to the understanding of how indigenous wisdom can inform modern sustainable development, particularly in the face of climate change and social transformation.

3 Methods

The research was conducted in South Aceh and Aceh Besar Regency, Aceh Province from March to June 2025. These two areas have the largest rice plantation and most of them are still traditionally managed, using *keuneunong* as agricultural calendar. Moreover, there is a recorded documentation of *keuneunong* in South Aceh in form of manuscripts; due to conflict and natural disaster there is no similar documentation in any other area of Aceh left. This study employed a qualitative approach through exploratory descriptive methodology, which aligns with the method's advantages in generating in-depth understanding of social phenomena (Creswell 2014; Manan 2021a). Exploratory research is necessary because of its creativity, flexibility, and open nature in treating diverse sources as important assets in collecting valuable data (Stebbins 2001). In this context, the data collection procedure is not limited by linear stages, so researchers have the freedom to navigate this process dynamically (Robson & McCartan 2016). The required information criteria are flexible and unstructured, with limited samples and qualitatively oriented data analysis (Maxwell 2013).

Data collection was conducted through discussions with relevant subjects, to obtain in-depth knowledge of the regional context and key informants (Patton 2014). This study adopted a purposive sampling technique in selecting respondents, ensuring that selected participants met specific criteria relevant to the research objectives (Etikan et al. 2016; Krathwohl 1993; Manan 2021a). Key informants and supporting informants were identified and selected using a snowball sampling technique to identify individuals who met specific criteria: knowledge of the local wisdom of *keuneunong*, known or practiced by the local community or farmers. Ten informants were from South Aceh (six from East Lhokbingkuang, Tapak Tuan and three from Alurambut, Lembah Sabil district, Southwest Aceh (before this area belonged to South Aceh). Ten informants were from Aceh Besar (Five from Lhoknga district and four from Ateuk Anggok village, Kuta Baro district). They are traditional elders, heads of farmer groups, *keujruen blang*, *tuha peut*, Imum Mukim, museum directors, meteorologists and extension workers from the agriculture service of South Aceh and Aceh Besar district.

The instruments included observation sheet, semi-structured interview guidance, field notes, digital voice recorder, photograph and video for documentation. The use of these instruments enabled deep data exploration toward agricultural practices by utilizing its prolog logic programming language integrated into a knowledge base (Manan 2021a, 2021b). In addition, direct observation was done to verify the field data obtained through interviews with respondents, as well as to understand the conditions that influence the research (Muljono 2022). The data were then analyzed qualitatively: data collection, data display, and conclusion drawing (Miles et al. 2019). It enabled the comprehensive remodelling of the *keuneunong*: the substantial aspects, practice, as well as its potential for adaptation as a modern agricultural calendar.

4 Results and Discussion

4.1 Keuneunong and Its System

Keuneunong is a system used by the Acehnese people to determine auspicious days for carrying out an activity or astrology used by the Acehnese to determine auspicious days for going down to the rice fields, for activities in the agricultural sector, maritime sector, or for carrying out traditional ceremonies. *Keuneunong* constitutes a distinctive embodiment of Acehnese local wisdom, integrating ecological knowledge, spiritual values, and socio-cultural norms into a coherent epistemological system. Etymologically derived from the Acehnese term *neunong*, meaning "to observe" or "to notice," it denotes the act of interpreting natural and celestial signs to determine appropriate times for agricultural and maritime activities.

The historical development of *keuneunong* can be traced to the agrarian communities of Aceh, where the synchronization of human livelihood with environmental rhythms was a prerequisite for survival. Over centuries, this knowledge evolved as a synthesis between pre-Islamic ecological cosmologies and Islamic philosophical teachings, producing a hybrid worldview that situates human beings as stewards within a divinely ordered natural system (Abdullah 1993; S. Hurgronje 1906; Manan 2013). The original author of *keuneunong* is debatable because there is no author explicitly stated in the manuscripts; the interviews indicated a similar notion. One informant stated:

> The keuneunong system was created by our indatu (ancestors of the Acehnese) to facilitate the community's simultaneous rice-planting activities. Failure to do so would raise concerns that some rice fields that were earlier in planting would be attacked by rats and other pests. Commencing rice-planting activities simultaneously would make pest control easier. During the favourable keunong season, all farmers would go to the fields to plant the rice (seumula). After harvest and during the off-season, livestock owners could let them out into the fields without worrying about disturbing others' rice crops. *(Salahuddin, 2025).*

Another informant said the same:

> The keuneunong system was created by our ancestors, but I don't really remember who made it, but it is clear that it was made by our ancestors, because in the past there were no records, unlike now, for the year it was made and the person who made it, but as far as I know, it was the first implemented during the reign of Sultan Iskandar Muda *(Saddam, 2025).*

Apart from that, the question regarding the origin of *keuneunong* as conveyed by another informant, Masykur is as follows:

> A more detailed version can be found in the book Sirajul Zhalam. A more concise version is found in the book of Tajul Mulk, but it's not as comprehensive. According to our current knowledge, it was created by Sheikh Abbas Kuta Karang, better known as Teungku Chik Kuta Karang. It was implemented during Teungku Chik's lifetime, and he died in 1898 *(Masykur, 2025).*

Structurally, *keuneunong* is organized through a complex interaction of cosmological, ecological, and social dimensions. Its operation is grounded in the observation of celestial and terrestrial indicators: the movement of the sun and moon, the behaviour of animals, the flowering of trees, the direction of winds, and the texture of clouds, all of which are interpreted as cues for agricultural timing and environmental prediction. Table 1 represents the general structure of *keuneunong.*

Table 1: General structure and contents of *keuneunong*.

Component	Description	Function in Society
Cosmological order	Observations of stars, sun, and moon, used to determine planting and harvesting periods.	Establishing agricultural and ritual calendars.
Natural signs	Phenomena like animal migration, flowering patterns, wind and wave changes.	Indicating climate variation and crop readiness.
Ritual dimension (pray within *keuneunong*)	Prayers, Qur'anic recitations, and rituals led by *keujruen blang* (rice ritual specialists).	Linking human actions with divine will and natural balance.
Social-organizational	Governed by the *keujruen blang* and village	Coordinates timing, irrigation,

Component	Description	Function in Society
aspect (*lembaga adat*)	elders under customary law (*hukum adat*).	and conflict resolution.

The cosmological order played a significant role in *keuneunong* as it was the common way to determine the seasons in Aceh. Acehnese tradition determined season and time of agricultural activities by observing the position of the Scorpion constellation (*bintang kala*). The cyclic appearance of Scorpion in the sky represented one sidereal period. During each of its orbits, the moon appears to pass through the constellation of Scorpion at certain times (Sulaiman & Abdullah 2018).

The Pleiades constellation, which is called the seven-star group (*bintang tujōh*), internationally recognized as the Pleiades or 'Seven Sisters' cluster (Awaludin 2019), plays a complementary role in determining the seasons (Wibowo 2000). In South-East Asian agricultural tradition, both constellations were used as reference of the good season for farming and sailing (Setiawan et al. 2021). The rise of both constellations represented good weather, steady winds, and moderate rain (Utami & Setyorini 2020). In the manuscript of *keuneunong,* the constellation represented by the Seven Stars as the *keujruen blang* is cited as follows:

> Bintang tujōh dijak malam — *Seven stars move at night*
>
> Teunget insan mandum lam donya — *All humans sleep in the world*
>
> Bintang tujōh dijak uroe — *Seven stars move in the day*
>
> Tron jak meugoe umat ube na — *Going to cultivate the farm all mankind*
>
> Bintang tujōh dijak ateh glee — *Seven stars move on the mountain*
>
> Pula padée pe yang suka — *Planting rice whatever you like*
>
> Bintang tujōh dijak u laôt — *Seven stars move to the sea*
>
> Tadrop ungkôt yang raya mata — *Catching fish which have big eyes*

Based on empirical observations by people in the past, the moon's synodic period does not align with weather changes. Instead, the moon's position in front of the Scorpion constellation aligns with weather changes and can be used as a reference. From there, the *keuneunong* system was born (Rahmalia 2022). Figure 1 (Scorpion constellation with Antares) shows the meeting between the moon and the Antares star which is considered a blessing by the Acehnese.

Figure 1: Scorpion constellation

In practice, *keuneunong* functions as a localized agricultural calendar grounded in environmental observation rather than fixed temporal systems. Farmers interpret indicators such as the appearance of particular constellations, wind patterns, bird migration, and flowering cycles to forecast the onset of planting or harvesting seasons. Fishermen rely on parallel cues — moon phases, tidal movements, and wind direction — to determine safe and productive fishing periods. The timing of *meugo blang* (the collective opening of rice fields), irrigation schedules, and harvest festivals follows the *keuneunong* cycle, emphasizing interdependence between ecological awareness and social cooperation. Ritual events such as *doa selamat blang* express gratitude for divine blessings and reaffirm communal solidarity, framing agriculture as both a livelihood and a spiritual duty (Lahudin 2024; Zulchaidir 2015).

When contrasted with other Southeast Asian traditional calendrical systems, *keuneunong* reveals both shared epistemological foundations and distinct structural and functional characteristics. The Javanese *Pranata Mangsa*, for instance, also links ecological cycles with agricultural timing but is organized into twelve fixed seasons based on climatic variation (Setiawan et al. 2021; Suprapto 2018). It exhibits a formalized structure — solar and phenological — intended for predictability across the agricultural year. In contrast, *keuneunong* operates through a fluid, situational interpretation of natural signs rather than rigid temporal segmentation, allowing dynamic adaptation to unpredictable weather and environmental change. While *Pranata Mangsa* emphasizes temporal precision, *keuneunong* emphasizes ecological sensitivity and contextual interpretation.

Similarly, the Balinese *Pawukon* and *Saka* calendars integrate astronomical observations with ritual obligations to align agricultural activity with temple ceremonies (Geertz 1973; Lansing 2006). These calendars exhibit high structural complexity combining lunar, solar, and ritual cycles, but their functions are predominantly ceremonial and cosmological. *Keuneunong*, in contrast, prioritizes functional ecology over ritual chronology: Its ceremonies reinforce environmental ethics but remain subordinated to practical decision-making about agriculture and fisheries. Thus, while Balinese systems codify cosmic order through fixed cycles, *keuneunong* embodies an adaptive ecological rationality that evolves with environmental variability.

The Thai *Phan Duan* and Vietnamese *Nông Lịch* systems also integrate lunar observations with Buddhist agricultural rituals (Boonserm 2016). These systems are largely astronomical and temporal, serving to maintain social harmony and coordinate community labour. By comparison, *keuneunong* is less dependent on astronomical counting and more grounded in empirical environmental feedback, a feature that makes it particularly relevant for understanding climate-responsive traditional knowledge. Its interpretive flexibility contrasts with the codified calendrical structures of Thailand and Vietnam, demonstrating a different logic of time: one that is ecological rather than mathematical, interpretive rather than prescriptive.

4.2 Keuneunong Calculation Method

The calculation of *keuneunong*, based on our investigation on the manuscript, was initially made based on ancient manuscripts written in the 19th century. These manuscripts contain notes on *keuneunong* written in three forms of writing: the first using Arabic, the second using Arabic Malay, which is written in Malay but using Arabic or Hijaiyah letters, and the third using Arabic Acehnese, which is written in Acehnese but written using Arabic or Hijaiyah letters. One of the manuscripts containing *keuneunong* is found in the Pedir Museum, written in 1313 H (1892 AD) in Arabic Malay (Figure 2). The year used for calculating *keuneunong* by the Acehnese people is the Hijriyah year as a reference calendar in carrying out Islamic religious worship. This also indicates that in all aspects of their lives the Acehnese people still adhere to Islamic law. The head of Pedir Museum said as follows:

The manuscript details how the *keuneunong* was recorded in ancient times using the Hijriyah calendar. This basis is not exactly the same as the *keuneunong* calculation used by the majority of the Acehnese today. However, there are similarities that will not change: the natural phenomena that occur during the *keuneunong*. One ancient manuscript explains how to determine the fall of the *keuneunong* based on natural changes, namely by observing the changing positions of the Kala star (Scorpion), the Three Stars (Orion), and the Seven Stars (Pleiades). The Acehnese people at that time identified the position of the stars by equating their positions with the position of the sun at the beginning and end of prayer times, such as: dawn, the end of *dhuhur*, and *maghrib*. This method was used to make it easier for people to remember (Masykur, 2025).

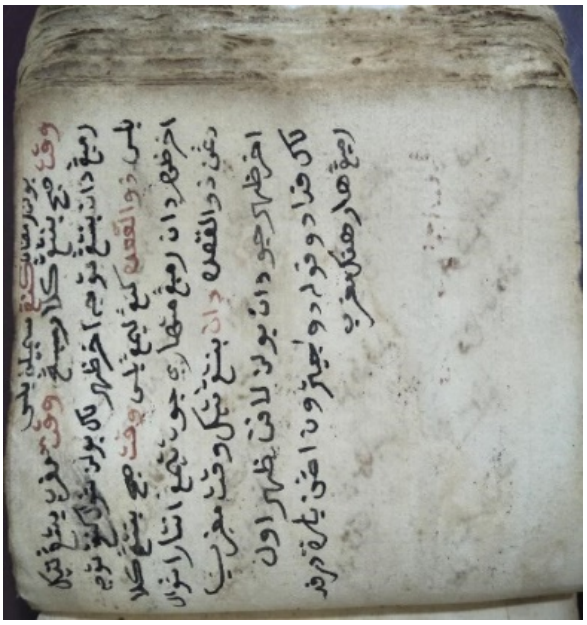

Figure 2: Manuscript about *keuneunong*. Source: Aceh Pedir Museum.

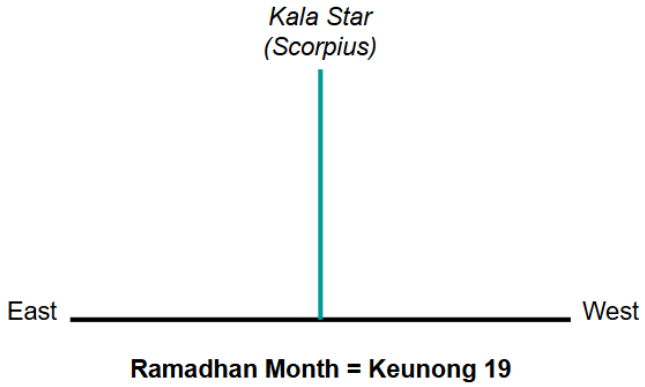

Figure 3: Illustration of the position of the Kala star at dawn showing *keunong* 19.

In the manuscript, the Acehnese people at that time determined the beginning *keuneunong* based on the month of Ramadhan. This is a blessed month when Muslims perform their religious duties for a full month. The month of Ramadhan will fall on *keunong* 19 (Figure 3) (KBBI n.d.).

If at sunset there are three stars (*Orion*) and the Seven Stars (*Pleiades*) are in the "end of *dhuhur*" position, namely at a height of 45° from the western horizon, then in the month of Syawal it will be *keunong* 17 (Museum Pedir n.d., p. 1) (Figure 4).

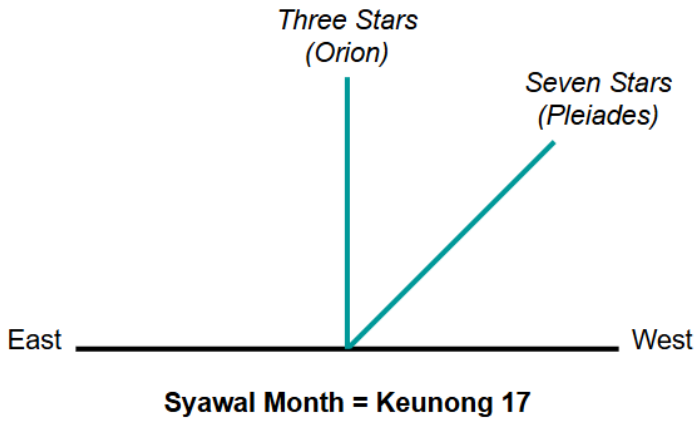

Figure 4: Illustration of the position of the three stars and the seven stars at sunset, showing *keunong* 17.

The month of Dzulqa'dah gets *keunong* 15 when at dawn the Scorpion star is in the "late midday" position while the sun is setting (Figure 5), namely when the sun is directly on the equator; in the year when the manuscript was written, this happened between Syawal and Dzulqa'dah. It corresponds to March–April, or to be precise March 21st (Museum Pedir n.d.).

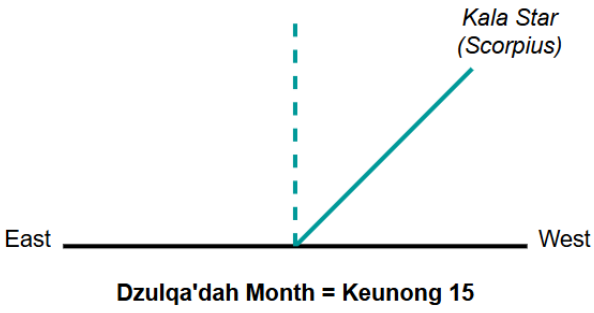

Figure 5: Illustration: Position of stars at the time of *keunong* 15.

Between the 8th day of the moon phase, when the moon is in the "early dhuhur" position (the position after the moon crosses the meridian) until the 22nd day of the moon phase, it is estimated that there will be a westerly wind blowing from the position of the setting sun, namely from midday until the time of Maghrib arrives (Museum Pedir n.d.).

The position of the moon based on the Hijriyah calendar relative to the Gregorian calendar is always shifting, therefore the estimated seasons in this calendar will continue to shift over a 33-year cycle (Richards 1998). During this 33-year period, climate patterns on Earth change due to the Earth's precession, also known as the Earth's spinning top. This change in climate patterns causes the wet and dry months to shift. Precession refers to the change in the direction of the Earth's axis of rotation relative to the plane of the ecliptic. The Earth's precession period is 26,000 years (Karttunen et al. 2017; Laskar et al. 2004). During this period, the tilt of the Earth's axis of rotation relative to the plane of the ecliptic changes from 21° (minimum) to 24° (maximum) (Berger 1988). Based on the manuscripts we collected (e.g., the one in Figure 6), the writing system in Aceh began in the 18th century. Most of the manuscripts we collected date from the 18th and 19th centuries. The year 1700 AD is the most frequently mentioned year (Masykur, 2025).

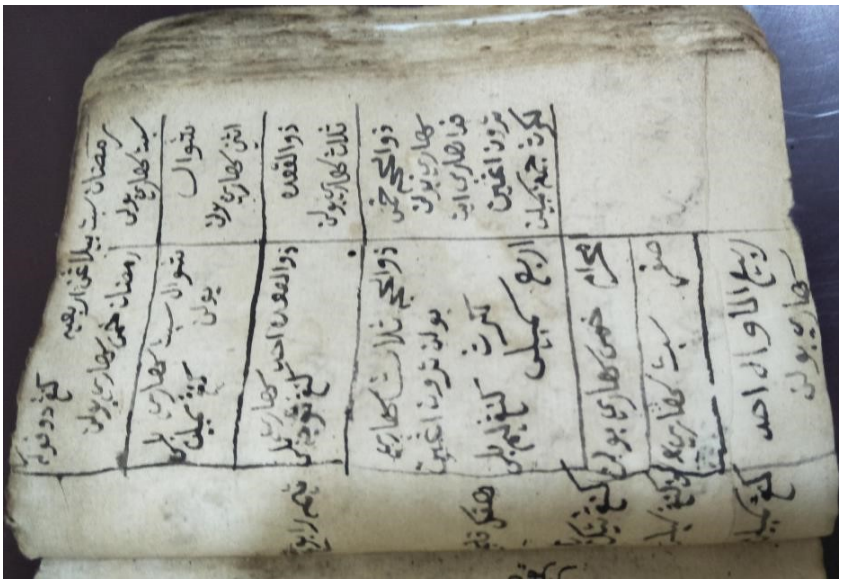

Figure 6: Manuscript about *keuneunong*. Source: Pedir Museum.

As stated in the manuscript, *keuneunong* can be read down to the details of determining the day of the week. This cycle will repeat itself every 6 years, the pattern of determining the day will change when the year changes and will return to the same pattern after 6 years. The determination can be seen from the table listed in the manuscript. The table shows how the setting of the moon can be determined. It shows it for two different years; the first is for the year 1313 H, which is the year the manuscript was written, and the second is to predict the *keuneunong* 6 years after that, namely 1319 H (or 1920 AD) (Rahmalia 2022).

The calendar used by the Acehnese people today is more varied than the original version. The Hijriyah calendar used before has now been adapted to the Gregorian calendar, as the Gregorian calendar was becoming more popular among the Acehnese people at that time. The first one was more complex, but the seasons change according to the Christian year and the Christian (Gregorian) calendar began to enter Aceh in the 1900s. In consequence, *Keuneunong* was adapted to the Gregorian calendar. The Islamic calendar is not based on the changing seasons on Earth, but on the changing phases of the moon. The Gregorian calendar is based on the changing seasons on Earth. The year consists of 365 days (366 in leap year), based on the Earth's orbit around the sun. Seasonal changes are based on the changing position of the sun in the sky, and are closest to the Gregorian calendar, which is why the Gregorian calendar is used today to make calculations easier (Rahmalia 2022).

Keuneunong always falls on odd numbers. The calculation formula for the months of the Gregorian calendar is now based on the number 25 minus 2 multiplied by the current month as follows (Mahmud et al. 1986):

$K = C - 2 \times B$ *Example:* $K = 25 - 2 \times 10$

K = season called kanai/keunong *"hitting" = 25 – 20 = 5*

C = the constant value = 25

B = Gregorian month

Thus, "hitting" 5 is from October. At this time the east season (*musém timu*) comes.

The result of multiplication creates a *keuneunong* "hitting". The number 25 comes when the moon rotates, there are phases of the moon whose basis is in QS. At-Taubah verse 36 in Allah's calendar, one year has 12 months. One year is the period of the seasons on earth, from summer to the next summer, from winter to the next winter. Then in that seasonal period the moon changes 12 times, so from summer to the next summer the moon changes 12 times, so we get one year is 12 months. A total of 12 months in the lunar calculation is 354 days. Then when the moon rotates in the sky we get a sidereal period of 27.3 days, while the synodic period is 29.5 days. In our local wisdom, the stars depart from the Kala star, returning to the Kala star again. When we take 354 days and divide it by 27.3, then we get the result 13. Dividing 354 by 29.5, we get the result 12. So, 12 + 13 = 25. We get 12 synodic months plus 13 sidereal months in one year. Next, 2 (2 times in a month) is subtracted from the number of months (25) (Zahrina 2013).

The origin of the constant number 25 can be explained as follows. As the moon orbits Earth, changes in its phases are visible when viewed from Earth. These changes in the moon's phases form the basis for calendar calculations, as stated in Surah At-Taubah, verse 36, which states that in Allah's calendar, a year consists of 12

months. A year is the periodicity of the seasons on Earth, from summer to the next summer, and from winter to the next winter. Then, in this periodicity of seasons, the moon changes 12 times, so from summer to the next summer, the moon changes 12 times, so that in a year there are 12 months (Choesin & Ramadhan 2015, p. 62). A total of 12 months in the lunar calendar have 354 days. As the moon orbits the sky, it experiences a sidereal period of 27.3 days and a synodic period of 29.5 days. In Acehnese local wisdom, the moon moves from star of time (Scorpius), back to star of time (Scorpius) again. When 354 days ago is divided by 27.3 then the result is 13. Then 354 is divided by 29.5 and the result is 12. So, 12 + 13 = 25. Therefore, the constant number is 25: 12 synodic months plus 13 sidereal months in 1 year. Then 2 is subtracted from the number of months 25 (2 times the month), then multiplied by the current month based on the Gregorian month and the result is the *keunong* that happened in that month (Rahmalia 2022).

> *What we use today is different from before. In the past we used the Hijriyah year, now we use the Gregorian year, because at that time the Gregorian year began to be popular among the people of Aceh, the early* keuneunong *was more complex, but because the seasons changed according to the Gregorian year and the Gregorian year began to enter Aceh in the 1800s, the* keuneunong *formula was made using the Gregorian year. The Hijriyah year is not based on changes in seasons on Earth, but based on changes in the phases of the moon. The Gregorian year is based on changes in seasons on Earth. One Gregorian year consists of 365 days based on the movement of the Earth around the sun. Seasonal changes are based on changes in the position of the sun in the Earth's sky, and it is closest to the Gregorian year, that's why the numbers are in Gregorian years in the* keuneunong *calculation. The numbers in the* keuneunong *are numbers related to the sidereal month, for example the number 1 in* keunong *1 in December is close to the date when the moon is in front of the Kala star, the* keuneunong *is a maximum of 23, starting from 1, 3, 5, 7, 9. . . etc. Why is the difference 2? It is because of the difference between the sidereal month and the synodic month, 27.3 and 29.5 (Zahrina 2013).*

4.3 Models and Natural Signs in Each Keuneunong

The natural signs that occur in each *keuneunong* can be seen in the following description:

1. Keunong Dua Ploh Lhee — "hitting twenty-three" (23) "Hitting twenty-three" begins in January. Rice has not turned perfectly yellow yet. The east wind (*musém timu*) begins blowing. The sea is not dangerous. It is a good time to sail from the capital to the north or east coast without risk and to catch fish at night.

2. Keunong Dua Ploh Sa — "hitting twenty-one" (21) "Hitting twenty-one" begins in February. This generally occurs during the rice harvest season (*musém seumeukoh*). In this month religious celebrations are held after the harvest when people go down to the rice fields called *khanduri blang* and *khanduri ule thôn* (*kenduri* at the "head of the year"). This is also the time for sowing or planting secondary crops such as tobacco and vegetables and is also the time for birds to mate. Next, the land clearing season begins, which is when the land is left unplanted with any crops (*musem luah blang*). Therefore, this is the end of the season when the land is fenced or closed.

3. Keunong Sikureung Blah — "hitting nineteen" (19) "Hitting nineteen" begins in March. The fields were abandoned. At this time, farmers left their fields free from rice cultivation for several months while livestock, such as buffalo, cows, sheep, goats, and so on, freely entered the rice fields to graze on the growing weeds. This time in Aceh is called *musém luah blang* ("wide field season"). Based on information obtained from farmers, *keunong* 23, 21, and 19 are the hatching times for harmful insect eggs, especially strong-smelling insects called *walang* (*geusong*). These insects grow on a type of fruit called *boh labu kumbung*, which grows in mountainous areas. When this fruit ripens and falls to the ground, the *geusong* leave it and begin descending from the mountains to search for young, unripe rice grains in the rice fields of the villagers (Manan 2013). Experts in the field of rice farming said that if there is no food for the *geusong* after 44 days, they will return to the mountains due to starvation and will die there. If the *geusong* have the opportunity to suck the rice milk, they will continue to breed and cause a lot of damage to the community's rice crops (Manan 2016a).

4. Keunong Tujōh Blah — "hitting seventeen" (17) "Hitting seventeen" is from April when the west season starts. The sugar cane at this time has already been blooming, but will not produce much juice. During this month and the next two months, a fish known as milkfish (*bungkuh*) is present in the coastal system. This is a marine brackish-water species, spawning in offshore waters and utilizing estuaries and lagoons as primary nursery habitat. These fish take a day to descend and two days to return, and this is the perfect time to catch them. *Khanduri laōt* (*kenduri* for the sea, Manan 2016b) is also carried out this month along the coastline. The west wind (*angin barat*) starts blowing,

preventing fishermen from going out to sea. Instead, they head to the fields to begin planting. Likewise, the sun reaches its peak during the day (C. S. Hurgronje 2019). Rain and strong winds are common, and lightning causes pollination in plants to often fail.

5. Keunong Limong Blah — "hitting fifteen" (15) "Hitting fifteen" is from May when the farmers start plowing (*meu ueu*) their farms for planting rice. Many brown plant hoppers (*geusong*) have appeared, while at sea there are high waves due to storm winds blowing from the west, accompanied by rain and lightning. At this time, fish eggs will hatch. It is said that when it reaches *keunong* 15 and *keunong* 17, certain fish that live in rivers and other freshwater habitats go to the estuary (*babah kuala*) to lay eggs and certain fish that live in the sea go near the beach or the edge of islands in the sea to lay eggs. Then waves will wash the eggs to the beach. The waves leave the fish eggs on the beach. The heat of the sand makes the fish eggs hatch by themselves. After hatching, they are carried back to the sea by large waves during *keunong* 15 because large waves form at this time. In certain rivers, *keuneunong limong blah* is the season for small fish called *lulo* that swim from downstream to upstream. Meanwhile, in the sea itself, it is the season for shrimp fly (*musém udeung sabèe*). In addition, wasp nests and Tempua bird nests are built lower (Daud 2014).

6. Keunong Lhee Blah — "hitting thirteen" (13) "Hitting thirteen" is from June. This is the month when people generally plow their rice fields and make rice seedbeds (*lheu bijeh*) and rice seed bunds (*ateung lheu bijéh*). This marks the end of the dry season. The trees begin to flower due to the west wind. When the west wind blows, the tree trunks shake and their branches rub each other. As a result, the hollow spaces in the tree trunks open and the wind penetrates the trunks, causing the trees to flower. The villagers call the west wind "the husband of the trees" because it pollinates the flowers of the fruit-bearing trees (Manan 2013). It is just like the "husband of the turtle is the south wind" because "when the south wind blows, the female turtles lay eggs".

7. Keunong Siblah — "hitting eleven" (11) "Hitting eleven" is from July. It is in this month that the rice seeds begin to be sown but unevenly or at slightly different intervals (*tabu jareung*). As previously known, some made their choice in the first, second or third part to sow these seeds at the relative brightness of the three stars that make up Orion's belt constellation. As the east winds last 5 to 7 days at *keunong* 23, also southwest wind during these days, it is safe to sail from the capital to the west coast because the west winds are starting to subside.

8. Keunong Sikureung — "hitting nine" (9) "Hitting nine" begins in August. It is said that at this time the "rice stars" (*bintang padé*) begin rising in the east and "seven stars" (*bintang tujôh*) have risen before the "rice stars" rise. During this month and the following month, certain species of land crabs called *bingkong*/*bingkrungkong* will be easy to find wandering around because it is difficult for them to find their hiding holes, so they start looking for a safe place to hide because it will rain heavily. Rice seeds (*pade bijéh*) can be sown evenly (*tabu rata*). Another sign is when the Syafa tree (*bak syafa*) is split, the caterpillar's head is facing up, not down, which indicates that the caterpillar will no longer eat the 'heart' of the Syafa tree. Village farmers believe that now is a safe time to sow rice seeds in their seedbed. If the caterpillar's head on the Syafa tree is still drooping, farmers do not plant rice seeds. This indicates that the caterpillar will eat the 'heart' of the Syafa tree. If village farmers plant rice seeds in the seedbed at this time, they will later be eaten by caterpillars because they have grown large before being transplanted to the rice fields.

9. Keunong Tujōh — "hitting seven" (7) "Hitting seven" begins in September. The farmers start planting sugar cane, cucumber and pepper in the dry fields while waiting for the rice seeds in the seedbeds to be moved to their rice fields. Sugarcane planted in this month is likely to give the same results as mentioned above in the case of *keunong* 17. The dog pack will bark very often during this period because they were having sex (*asèe meuseuntét*) and the whole village would be in an uproar. At this time, farmers begin planting various types of cucumbers and chilies in the dry land while waiting for the rice seedlings in the seedbed to be transferred to their fields. At noon, the sun reaches its highest point for the second time. Besides the lowlands, rice is also grown in the highlands near hills by clearing small forests for agricultural land called *ladang*. Planting rice in fields is done by first clearing a plot of land in the highlands near the forest. Then, after clearing, the farmers wait until the grass dries first. After 44 days, the land that is still unclean is burned. Planting rice in fields is done by using the *tajok* method, using a piece of stick that is sharpened at one end. Then, holes are made in the ground and the rice is inserted into them.

10. Keunong Limong — "hitting five" (5) "Hitting five" begins in October. At this time the transition from the west season to the east season begins, the fishermen hold *khanduri laot* (Manan 2016b). Storms, rain, and lightning can occur during this season, but they are not particularly strong or violent. Fishermen reap abundant harvests (Daud 2014). Fish that live in river habitats begin to swim to estuaries to spawn for the first time, approximately between September and October. Another indication is that mushrooms (*kulat*) begin to grow on rotting wood.

11. Keunong Lhee — "hitting three" (3) "Hitting three" begins in November. This is the most pleasant time to sail from the capital to the west coast. The sea waves are calmer, and although the wind blows everywhere, it is not strong. When it rains, the wind is also light. Another indication is that female sea turtles (*punyi*) begin crawling above the low tide line to lay their eggs on the shoreline in the sand at night. Catching tuna fish is more plentiful than usual at this time.

12. Keunong Sa — "hitting one" (1) "Hitting one" is from December. This cannot be observed because the sun and moon are both in the constellation Scorpion. The farmers have finished harvesting the rice. It starts to rain heavily. Floods often occur because at this time "storms" are followed by heavy rain. A very popular comparison is that whatever terrible noise is happening, it is usually related to rain because the locals believe that anyone exposed to this rain will fall ill with fever, flu, colds, and other illnesses. The toad clan exults during this *keunong*, as it is mating season for them.

From an environmental and anthropological perspective, *keuneunong* represents a knowledge-based adaptation system that embodies the dynamic interplay between ecological observation, collective memory, and adaptive decision-making. Rooted in centuries of empirical experience, it enables Acehnese communities to anticipate environmental variations such as floods, pest infestations and rainfall shifts, by interpreting signs from the atmosphere, flora, fauna, and celestial bodies. Unlike deterministic or top-down predictive systems, *keuneunong* operates through decentralized, observation-driven knowledge, providing exceptional flexibility in synchronizing agricultural and maritime activities with ecological rhythms at the micro-regional level.

As climatic variability in the Indian Ocean region increases, traditional indicators have become more erratic: Monsoon cycles are delayed, bird migrations no longer follow their usual patterns, and flowering phases are less synchronized. Despite this, *keuneunong* remains resilient through knowledge renewal: the community's continuous recalibration of environmental signs based on collective observation and intergenerational dialogue (Berkes 2018). This adaptability underscores its identity as a living model of experiential learning, capable of evolving in response to environmental uncertainty.

In comparative context, *keuneunong* shares conceptual parallels with other Southeast Asian traditional agricultural calendars such as Java's Pranata Mangsa, Bali's Pawukon, and Vietnam's Lịch Nông Nghiệp. The Pranata Mangsa divides the year into twelve phenological seasons, guiding agricultural activities based on rainfall and temperature patterns (Hidayat 2011). However, unlike Pranata Mangsa, which is largely anchored to the solar year, *keuneunong* is grounded in phenomenological observation. Similarly, while the Balinese *Pawukon* integrates ritual cosmology with agricultural timing, it follows a deterministic cycle, whereas *keuneunong* remains empirically interpretive and adaptive, refined continually through feedback from ecological events. Such flexibility makes it a distinctively responsive epistemology, one that privileges real-time adaptation over formal calendrical regularity.

This comparative lens reveals the scientific significance of *keuneunong*: It exemplifies a phenological intelligence system, a localized cognitive ecology that translates complex environmental cues into collective, actionable knowledge. It resonates with modern frameworks of adaptive co-management (Folke et al. 2021) and climate knowledge pluralism, emphasizing community participation and iterative learning as the foundation for sustainable development.

In contemporary terms, *keuneunong* offers valuable potential for modern adaptation strategies. Integrating its principles with digital meteorological systems and participatory GIS could produce hybrid predictive tools that combine empirical indigenous indicators with scientific data for enhanced local climate forecasting. Its structured knowledge of phenology and ecological signals can inform precision agriculture, guiding farmers in water management, pest control, and crop selection under changing climate regimes. Furthermore, formal documentation and digital archiving of *keuneunong* practices can ensure knowledge continuity.

Therefore, *keuneunong* should not be viewed merely as a cultural remnant but as a living epistemic framework that continues to shape Aceh's socio-ecological resilience. By bridging indigenous ecological intelligence with modern sustainability science, *keuneunong* stands as a compelling model of how traditional knowledge systems can inform contemporary climate adaptation, strengthen food sovereignty, and contribute meaningfully to the global discourse on resilient agroecosystems.

5 Conclusion

Keuneunong is the wisdom of the Acehnese and it also serves for community guidance in a social context. This local wisdom has been practiced for a long time, especially to determine auspicious days to begin farming activities, mainly planting rice. It is also used in maritime affairs and in traditional ceremonies. *Keuneunong* is more than just a tradition; it is a complex value system. This practice demonstrates how the Acehnese interact with nature and each other based on the principles of sustainability and balance.

The findings of this study demonstrate that *keuneunong* is not merely a traditional calendar for regulating agricultural and maritime activities, but a complex knowledge system that encapsulates the Acehnese worldview and adaptive relationship with their environment. It functions as an integrated framework of observation, belief, and communal coordination, in which ecological patterns, spiritual values, and social order are inseparably linked. Data derived from ethnographic observation and the interpretation of the surviving manuscript collections indicate that Keuneunong continues to guide local decision-making in farming, fishing, and ceremonial life, revealing a sophisticated system of ecological intelligence developed through centuries of interaction with natural cycles.

The complex values inherent in *keuneunong* manifest in the convergence of ecological awareness, ethical reflection, and collective responsibility. Ecological intelligence is reflected in the ability of communities to interpret environmental cues such as seasonal winds, plant flowering, and animal behavior as indicators for managing cultivation and harvest. This ecological dimension is intertwined with a moral and spiritual consciousness that positions human engagement with the environment as a reflection of divine order and ethical duty. At the same time, *keuneunong* sustains social cohesion through rituals, collective discussions, and intergenerational learning that bind the community into a shared system of knowledge production. These interrelated dimensions reveal *keuneunong* as a living epistemology in which the natural, moral, and social worlds are mutually reinforcing.

Within the broader Indonesian context, *keuneunong* contributes to a mosaic of indigenous ecological calendars that continue to regulate agricultural and maritime systems across the archipelago. It shares a conceptual affinity with the Javanese Pranata Mangsa and similar traditional calendrical systems found in other Southeast Asian societies, where environmental observation serves as a foundation for local adaptation strategies. Extending beyond its regional boundaries, *keuneunong* provides an exemplary model of how locally grounded systems of ecological reasoning can inform global discourses on sustainability, food security, and climate resilience.

To ensure the continuity and practical relevance of *keuneunong*, its preservation must extend beyond documentation toward institutional and educational integration. Policies that recognize its epistemic value and promote collaboration between traditional practitioners and scientific communities will strengthen both cultural heritage and adaptive capacity. Through such measures, *keuneunong* can serve as a bridge between indigenous wisdom and modern environmental management, demonstrating that local knowledge remains indispensable to the pursuit of sustainable development. It stands as a testament to the enduring capacity of human societies to align knowledge, belief, and collective action in sustaining the delicate balance between culture and nature.

Acknowledgement

This research was supported by the RIIM LPDP Grant and the National Research and Innovation Agency (BRIN), under grant numbers B-2065/II.7.5/KS.00/1/2025 and B-200/III.4/HK.01.00/1/2025. We also extend sincere gratitude to the Research Organization for Earth Sciences and Maritime, as well as to Universitas Islam Negeri (UIN) Ar-Raniry, Banda Aceh, for their valuable support and collaborations. We also thank all informants in South Aceh and Aceh Besar districts for their perceptive critical comments put forwards in several discussions. Many thanks go to Prof. Dr. Gerhard Meisenberg for proof-reading and Muhammad Arif Fadhilah, M.Pd for the English language editing.

References

Abdullah, I. (1993). *Kearifan Lokal dalam Budaya Aceh*. Dinas Kebudayaan.

Angerler, J. (2021). Indigenous knowledge about time-keeping: Astronomical aspects of the Batak calendar. *Indigenous Knowledge*, *1*(1), 1–5. 10.24198/ik.v1i1.32627

Apriyana, Y., Surmaini, E., Estiningtyas, W., Pramudia, A., Ramadhani, F., Suciantini, S., Susanti, E., Purnamayani, R., & Syahbuddin, H. (2021). The integrated cropping calendar information system: A coping mechanism to climate variability for sustainable agriculture in Indonesia. *Sustainability*, *13*(11), 6495. 10.3390/su13116495

Arifin, M., & Manan, A. (2018). Cultural traditions of *Khanduri Blang* in Reubee village, Aceh, Indonesia. *Jurnal Ilmiah Peuradeun*, *6*(3), 427. 10.26811/peuradeun.v6i3.243

Asyura, Manan, A., & Ruhamah (2020). Tradisi Ureh dalam bercocok tanam pada masyarakat desa Keude Krueng Sabee Kabupaten Aceh Jaya. *Indonesian Journal of Islamic History and Culture*, *1*(2), 148–167. 10.22373/ijihc.v1i2.676

Awaludin, M. (2019). Kalender rowot sasak (kalender tradisi masyarakat sasak). *AL-AFAQ: Jurnal Ilmu Falak dan Astronomi*, *1*(1), 89–101.

Balehegn, M., Balehey, S., Fu, C., & Liang, W. (2019). Indigenous weather and climate forecasting knowledge among Afar pastoralists of north eastern Ethiopia: Role in adaptation to weather and climate variability. *Pastoralism*, *9*(8), 1–14. 10.1186/s13570-019-0143-y

Berger, A. L. (1988). Milancovitch theory and climate. *Reviews of Geophysics*, *26*(4), 624–657.

Berkes, F. (2018). *Sacred Ecology* (4th ed.). Routledge.

Boonserm, S. (2016). Agricultural rituals and time reckoning in rural Thailand. *Asian Folklore Studies*, *75*(2), 185–202.

Choesin, E. M., & Ramadhan, H. A. (2015). *Keuneunong*: Learning from authority. *Antropologi Indonesia*, *2*, 99–106.

Creswell, J. W. (2014). *Research Design, Qualitative, Quantitative & Mixed Methods Approaches* (4th ed.). Sage.

Damayanti, A. F. (2021). The Bali WARIGA calculation system: An analysis of season determination in astronomic perspective (Doctoral dissertation). Universitas Islam Negeri Walisongo.

Daud, S. (2014). *Adat Meugoe*. Majelis Adat Aceh.

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, *5*(1).

Finucane, M. L. (2009). Why science alone won't solve the climate crisis: Managing climate risks in the Pacific. *Asia Pacific Issues*, *89*, 1–8.

Flores, M. (2017). Lunar agricultural calendars of the Philippine highlands. *Journal of Southeast Asian Studies*, *48*(3), 433–450.

Folke, C., Biggs, R., Norström, A., Reyers, B., & Rockström, J. (2021). Social-ecological resilience and biosphere-based sustainability science. *Ecology and Society*, *26*(3).

Geertz, C. (1973). *The Interpretation of Cultures*. Basic Books.

Gómez-Baggethun, E., Reyes-García, V., & Benyei, P. (2021). Traditional ecological knowledge and climate change adaptation. *Nature Sustainability*, *4*, 678–685.

Haeen, P., & Nora, L. (2005). *Ecology and Culture: Human Adaptation in Southeast Asia*. Cambridge University Press.

Hermaliza (2008). *Peran Keujruen Blang dalam Sistem Pertanian Aceh*. Ar-Raniry Press.

Hidayat, B. (2011). The sky and agro-bio-climatology of Java: Is there a need for critical re-evaluation due to environmental changes? In T. Nakamura, W. Orchiston, M. Soma, & R. Strom (Eds.), *Proceedings of the seventh international conference on oriental astronomy, 6–10 september 2010* (pp. 43–46). National Astronomical Observatory, Japan.

Hurgronje, C. S. (2019). *Orang Aceh: Budaya, Masyarakat, dan Politik Kolonial*. Divapress.

Hurgronje, S. (1906). *The Achehnese* (*II*). Brill.

IPBES (2019). Global assessment report on biodiversity and ecosystem services (tech. rep.). IPBES Secretariat.

Irmayani, Darmawan, Seelagama, P. K., Sukmayana, F. S., Rahbiah, S., & Dahliana, A. B. (2023). Identifying local knowledge and meaning of rural farming communities in the modernization era. *Indigenous Agriculture*, *1*(2), 67–78.

Joshi, P. K., Gulati, A., Birthal, P. S., & Tewari, L. (2004). Agriculture diversification in South Asia: Patterns, determinants and policy implications. *Economic and Political Weekly*, *39*(24), 2457–2467.

Karttunen, H., Kröger, P., Oja, H., Poutanen, M., & Donner, K. J. (2017). *Fundamental Astronomy* (6th ed.). Springer.

KBBI (n.d.). KBBI

Kijazi, A. L., Chang'a, L., Liwenga, E. T., & Nindi, S. (2013). The use of indigenous knowledge in weather and climate prediction in Mahenge and Ismani wards, Tanzania. *Journal of Geography and Regional Planning*, *3*(4), 66–72. 10.5897/jgrp2013.0386

Krathwohl, D. R. (1993). *Methods of Educational and Social Science Research: An Integrated Approach*. Longman.

Lahudin, S. (2024). Local knowledge and environmental resilience in Aceh. *Indonesian Journal of Environmental Studies*, *18*(1), 45–61.

Lansing, J. S. (2006). *Perfect Order: Recognizing Complexity in Bali's Water Temple Networks*. Princeton University Press.

Laskar, J., Robutel, P., Joutel, F., Gastineau, M., Correia, A. C. M., & Levrard, B. A. (2004). Long-term numerical solution for the Earth. *Icarus*, *170*(2), 343–364.

Levis, C., Costa, F. R. C., Bongers, F., Peña-Claros, M., Clement, C. R., Junqueira, A. B., & ter Steege, H. (2017). Persistent effects of pre-Columbian plant domestication on Amazonian forest composition. *Science*, *355*(6328), 925–931. 10.1126/science.aal0157

Limpo, S. Y., Fahmid, I. M., Fattah, A., Rauf, A. W., Surmaini, E., Muslimin, Saptana, Syahbuddin, H., & Andri, K. B. (2022). Integrating indigenous and scientific knowledge for decision making of rice farming in South Sulawesi, Indonesia. *Sustainability*, *14*(2952), 1–18. 10.3390/su14052952

Mafongoya, P. L., & Ajayi, O. C. (2017a). The future of indigenous knowledge systems and climate sciences. In O. C. Ajayi & P. L. Mafongoya (Eds.), *Indigenous Knowledge Systems and Climate Change Management in Africa* (pp. 309–314). CTA.

Mafongoya, P. L., & Ajayi, O. C. (2017b). Indigenous knowledge and climate change: Overview and basic propositions. In O. C. Ajayi & P. L. Mafongoya (Eds.), *Indigenous Knowledge Systems and Climate Change Management in Africa* (pp. 17–28). CTA.

Mahmud, Sjamsuddin, Suprapti, M., Bale, & Djenen (1986). *Pertumbuhan Pemukiman Masyarakat di Lingkungan Parairan Daerah Istimewa Aceh*. Proyek Inventarisasi dan Dokumentantasi Kebudayaan Daerah, Depdikbud.

Manan, A. (2013). Keuneunong. *Adabiya Journal*, *15*(29), 1–12.

Manan, A. (2016a). The ritual of farming in Indonesia (an ethnographic study in the Aneuk Jamee community in South Aceh – Sumatra). *Proceedings of 1st International Joint Conference Indonesia-Malaysia-Thailand-Philippines DRUGSTECH 2016*.

Manan, A. (2016b). The ritual of Khanduri Laot in lowland Aceh (an ethnographic study in south, west and south west Aceh). *MIQOT Journal*, *40*(2). 10.30821/miqot.v40i2.300

Manan, A. (2021a). *Metode Penelitian Etnografi*. AcehPo Publishing.

Manan, A. (2021b). Pregnancy and childbearing in Aceh, Indonesia (an ethnographic study in West Labuhan Haji). *Mankind Quarterly*, *62*(1), 10–31. 10.46469/mq.2021.62.1.2

Manan, A. (2022). Naming Acehnese babies. *Mankind Quarterly*, *62*(4), 687–711. 10.46469/mq.2022.62.4.7

Manan, A., Kamarullah, Salasiyah, C. I., & Champion, I. (2023). Religious perspectives on the origin of the Covid-19 pandemic: An analysis of a Sharia-based community. *Mankind Quarterly*, *63*(3), 458–482. 10.46469/mq.2023.63.3.6

Manan, A., Salasiyah, C. I., & Chairunnisak (2022). Paddy cultivation ritual in South Aceh, Indonesia: An ethnographic study in West Labuhan Haji. *Cogent Social Sciences*, *8*(1), 1–18. 10.1080/23311886.2022.2094075

Mapfumo, R. B., Murwira, A., Masocha, M., & Andriani, R. (2016). The relationship between satellite-derived indices and species diversity across African savanna ecosystems. *International Journal of Applied Earth Observation and Geoinformation*, *52*, 306–317. 10.1016/j.jag.2016.06.025

Maxwell, J. A. (2013). *Qualitative Research Design: An Interactive Approach* (3rd ed.). Sage.

Mbewe, M., Phiri, A., & Siyambango, N. (2019). Indigenous knowledge systems for local weather predictions: A case of Mukonchi chiefdom in Zambia. *Environment and Natural Resources Research*, *9*(2), 16. 10.5539/enrr.v9n2p16

Milbrath, S. (2020). Astronomy and the Mayan agricultural calendar. *Latin American Antiquity*, *31*(2), 189–207.

Miles, M. B., Huberman, A. M., & Saldana, J. (2019). *Qualitative Data Analysis: A Methods Sourcebook*. Sage.

Muljono, P. (2022). *Metodologi Penelitian Sosial*. IPB Press.

Museum Pedir (n.d.). Manuskrip museum pedir tahun 1313.

Patton, M. Q. (2014). *Qualitative Research & Evaluation Methods: Integrating Theory and Practice*. Sage.

Pretty, J., Adams, B., & Berkes, F. (2019). The intersections of knowledge: Traditional and scientific understandings of the environment. *Frontiers in Ecology and the Environment*, *17*(3), 150–159.

Rachman, S., & Prasetyo, D. (2022). Modeling traditional agricultural calendars for modern climate prediction. *Environmental Systems Research*, *11*(4), 155–168.

Radeny, M., Desalegn, A., Mubiru, D., Kyazze, F., Mahoo, H., Recha, J., Kimeli, P., & Solomon, D. (2019). Indigenous knowledge for seasonal weather and climate forecasting across East Africa. *Climatic Change*, *156*(4), 509–526. 10.1007/s10584-019-02476-9

Rahmalia (2022). *Sistem Keuneunong dalam Tradisi Penanggalan Masyarakat Aceh*.

Richards, E. G. (1998). *Mapping the Time: The Calendar and Its History*. Oxford University Press.

Robson, C., & McCartan, K. (2016). Postmodernism and extreme relativist approaches. In *Real World Research* (4th ed.). Hoboken.

Sari, I. P., Yulisman, Y., & Muslim, M. (2017). Laju pertumbuhan dan efisiensi pakan ikan nila (Oreochromis niloticus) yang dipelihara dalam kolam terpal yang dipuasakan secara periodik. *Jurnal Akuakultur Rawa Indonesia*, *5*(1), 45–55.

Satria, B., Manan, A., Kamarullah, Salasiyah, C. I., Juanita, & Fajri (2024). “We get healed immediately”: Preference for traditional healing in rural Indonesia. *Mankind Quarterly*, *65*(1), 1–16. 10.46469/mq.2024.65.1.4

Septanti, K. S., & Saptana, N. (2020). Potensi pemanfaatan kearifan lokal untuk menahan konversi lahan sawah ke nonsawah. *Forum Penelitian Agro Ekonomi*, *37*(1), 59–75. 10.21082/fae.v37n1.2019.59-75

Setiawan, A. (2019). Keputusasaan kritis dalam musik pascareformasi. *Jurnal Musik Dan Masyarakat*, *7*(1), 33–45. 10.22146/jmm.2019.033

Setiawan, A., Rachman, S., & Utami, I. (2021). The role of Pranata Mangsa in climate-smart farming. *Journal of Indonesian Agricultural Research*, *9*(4), 233–246.

Setyantoro, D. (2007). *Teori Fungsional dalam Kebudayaan Indonesia*. Kanisius.

Sillitoe, P. (2006). Ethnobiology and applied anthropology: Rapprochement of the academic with the practical. *Journal of the Royal Anthropological Institute*, *12*, S119–S142.

Son, H. N., Chi, D. T. L., & Kingsbury, A. (2019). Indigenous knowledge and climate change adaptation of ethnic minorities in the mountainous regions of Vietnam: A case study of the Yao people in Bac Kan province. *Agricultural Systems*, *176*, 102683. 10.1016/j.agsy.2019.102683

Stebbins, R. A. (2001). What is exploration? In R. A. Stebbins (Ed.), *Exploratory Research in the Social Sciences*. Sage.

Sulaiman, I., & Abdullah, M. (2018). Local wisdom in Acehnese agricultural systems: Knowledge, belief, and adaptation to environmental change. *Jurnal Antropologi Indonesia*, *39*(2), 145–160.

Sumartias, S., Komala, L., & Romli, R. (2019). Model of environmental communication over the Citarum river. *IOP Conference Series: Earth and Environmental Science*, *248*(1). 10.1088/1755-1315/248/1/012058

Suprapto, W. (2018). Pranata Mangsa as local knowledge for climate adaptation. *Indonesian Journal of Environmental Management*, *22*(3), 145–157.

Surmaini, E., Supriatin, L. S., & Sarvina, Y. (2023). *Teknologi dan Kearifan Lokal untuk Adaptasi Perubahan Iklim*. Penerbit BRIN. 10.55981/brin.901

Tedla, B. (2019). Indigenous calendars and sustainable agriculture in Ethiopia. *African Journal of Ecology*, *57*(4), 456–468.

Tirivangasi, H. M., & Tayengwa, D. (2017). Indigenous knowledge systems (IKS) and food security in South Africa: Is land reform a prerequisite? *Journal of Human Ecology*, *57*(3), 118–124. 10.1080/09709274.2017.1305637

UNESCO (2022). Local and indigenous knowledge systems (LINKS) programme: Knowledge for climate action (tech. rep.). UNESCO.

Utami, I., & Setyorini, D. (2020). Traditional calendar systems and climate adaptation in Java. *Sustainability Science*, *15*(6), 1421–1433.

Wibowo, A. B. (2000). *Sistem Pengetahuan Kenelayanan pada Masyarakat Nelayan Aceh Besar*. Balai Kajian Sejarah dan Nilai Traditional.

Widyatmoko, D. (2019). Strategi dan inovasi konservasi tumbuhan Indonesia untuk pemanfaatan secara berkelanjutan. *Seminar Nasional Pendidikan Biologi Dan Saintek (SNPBS) Ke-IV*, *102*(2), 377–385.

Wisnubroto, S. (1998). Pengenalan waktu tradisional Wariga menurut jabaran meteorologi dan pemanfaatannya. *Agromet*, *13*(1), 15–24.

Yano, K. (2017). The agricultural calendar in modern Japan: Tradition meets meteorology. *East Asian Science, Technology and Society*, *11*(3), 403–420.

Zahrina, C. (2013). Al-manak hijriah di Aceh no. 35/2013.

Zainuddin, M., & Agussabti (2010). *Budaya Kesiapsiagaan Masyarakat dalam Menghadapi Bencana, Studi Kasus di Desa Blang Oi Meuraxa Kota Banda Aceh dan Meunasah Raya Kabupaten Pidie*. Syiah Kuala University Press.

Zulchaidir, R. (2015). *Perubahan Iklim dan Adaptasi Nelayan Aceh*. Universitas Syiah Kuala Press.