The *Rowot Sasak* Calendar as a Lunisolar System: Ethnoastronomy, Cultural Transformation, and Ecological Sustainability

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Abstract

The Rowot Sasak Calendar is an indigenous calendrical system that once connected ritual time, agricultural cycles, and ecological knowledge in Lombok. This article examines how Islamization and cultural acculturation gradually shifted the calendar from a lunisolar-stellar system to a predominantly lunar-religious system, thereby weakening its agrarian and seasonal functions. The study aims to explain the calendar's original astronomical structure, analyze the consequences of removing intercalation, and propose a culturally grounded model for restoring its ecological relevance. Using a qualitative-descriptive approach grounded in ethnoastronomy and religious-cultural studies, the research was conducted in East, North, Central, and West Lombok in 2025. Data were collected through participatory observation, semi-structured interviews with four key informants, analysis of warige manuscripts and local calendrical records, and comparative astronomical calculations. The findings show that omitting intercalation caused an annual drift of about 10 to 11 days. Reinstating a thirteenth-month mechanism can restore the calendar's lunisolar logic while preserving its religious, cultural, and social functions.

Keywords*: Rowot Sasak Calendar, lunisolar, cultural acculturation, tradition*

Introduction

The Sasak people of Lombok Island possess a rich body of cultural knowledge that regulates the relationship between human life, the natural environment, and religious practice. One important expression of this knowledge is the *Rowot Sasak* Calendar, a traditional calendrical system that has long functioned as a guide for ritual activities, agricultural rhythms, seasonal interpretation, and social life. In Sasak tradition, time is not only understood as a numerical sequence of days, months, and years. It is also read through natural signs, celestial phenomena, ritual cycles, and collective memory. Through this calendar, the Sasak community has developed a way of interpreting the movements of the Moon, the Sun, and the stars as part of a broader cultural system that connects cosmology, ecology, and spirituality.

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Historically, the *Rowot Sasak* Calendar developed from the local community's adaptation to geographical conditions, seasonal change, and agrarian needs. Its structure combines several astronomical references. The appearance of the *Rowot* star, commonly associated with the Pleiades, marks an important seasonal transition. The movement of the Sun relates to the cycle of seasons and agricultural activities. The phases of the Moon provide a temporal basis for religious rituals and monthly calculations. This combination suggests that the *Rowot Sasak* Calendar was not originally purely lunar. It was closer to a lunisolar-stellar system, in which stellar observation, solar seasonal markers, and lunar months interacted to guide both ecological and religious life. Irawan (2014)) explains that the *Rowot Sasak* Calendar combines the stars as a marker of the beginning of the year, the Sun as an indicator of seasons, and the Moon as the basis for Islamic religious rites. This structure shows that the calendar contains a complex body of indigenous astronomical knowledge. Similar studies on astronomical heritage also show that celestial objects and time-reckoning practices often become cultural instruments for interpreting environmental order and social life (Affairs & Observatory, 2020; Akhlaghi et al., 2025).

The development of Islam in Lombok introduced important changes to the structure and function of the *Rowot Sasak* Calendar. Islamic teachings did not eliminate local calendrical practices, but they gradually reshaped them through cultural acculturation. This influence is visible in the adoption of Hijri month names into Sasak usage. The term Bulan Mulut for Rabiul Awal, for instance, is associated with the commemoration of the Prophet's birth. Mirat is related to Rajab and the commemoration of Isra Mikraj, while Syaban is known as Bulan Rowah. The start of Muharram is also locally associated with the bubur taun tradition, which marks the start of the year in the *Rowot Sasak* Calendar (Irawan, 2014). These examples indicate that the *Rowot Sasak* Calendar became increasingly aligned with the Hijri system, especially in matters of ritual and religious observance. This process is consistent with studies on Sasak Islam, which show that Islamic practice in Lombok has developed through transition, dialectics, and negotiation with local traditions (Ribut et al., 2019; Sirnopati et al., 2022).

This process of Islamization created a significant transformation in the calendar's internal logic. The synchronization of the New Year and month names with the Hijri system gradually aligned the *Rowot Sasak* Calendar with a predominantly lunar structure. In the Hijri calendar, the lunar cycle determines the length of the month, which ranges from 29 to 30 days. A regular year contains 354 days, while a *Leap* year contains 355 days. When the *Rowot Sasak* Calendar followed this pattern without sufficient correction for the solar year, its seasonal function weakened. The lunar year is shorter than the solar year by approximately 10 to 11 days. Without intercalation, this difference causes the calendar to move backward relative to the seasonal cycle each year. As a result, a calendar that once functioned as an agrarian and ecological guide gradually became more limited to the domain of ritual time. This transformation illustrates how acculturation, especially Islamization, can shift a traditional calendar from a comprehensive time-keeping system into a more ritual-oriented instrument (Sirnopati et al., 2022). It also contributes to the

fading of local values related to environmental resilience and natural resource management based on traditional wisdom (Hastuti & Hafidh, 2025).

The weakening of the calendar's ecological function has important implications for the Sasak society. Traditional agrarian communities depend on temporal systems that can read seasonal change, guide planting time, and interpret natural phenomena. When the calendar loses its alignment with the solar cycle, its ability to regulate *mangse*, or seasonal divisions, becomes less reliable. This problem is not simply technical. It affects the transmission of indigenous ecological knowledge, the authority of traditional elders, and the continuity of local practices that once connected religious life with environmental sensitivity. The mismatch between lunar time and agricultural cycles has also been discussed in studies on local calendars, which show that traditional time-reckoning remains relevant because it maintains cultural identity and ecological orientation in modern society(Rofiuddin & Hakim, 2022). Similar concerns appear in studies on local ecological knowledge, which emphasize the importance of ancestral knowledge in preserving environmental balance amid climate change and social transformation (Faronny et al., 2024; Hastuti & Hafidh, 2025).

This article approaches the *Rowot Sasak* Calendar through three conceptual perspectives. The first is ethnoastronomy, which studies how a community observes, interprets, and uses celestial phenomena within its cultural system. This perspective is relevant because the *Rowot Sasak* Calendar uses the appearance of stars, the movement of the Sun, and the phases of the Moon as temporal references. Studies on astronomical tools and cultural astronomy show that astronomical knowledge can be transmitted not only through scientific calculation, but also through cultural practices, manuscripts, and educational media (Jiang et al., 2024; Safiai et al., 2021). The second is cultural acculturation, which explains how Islamic, Javanese, and Sasak elements interacted in the calendar's formation. Acculturation in this study is not understood as a simple replacement of local tradition by religion, but as a process of negotiation that changes the structure, meaning, and function of a cultural system. The third is indigenous ecological knowledge, which refers to local knowledge used to interpret environmental signs and regulate social practices related to agriculture, seasons, and natural resources. These three perspectives allow the *Rowot Sasak* Calendar to be analyzed as an astronomical, religious, and ecological system simultaneously.

Several studies have shown the importance of local knowledge systems in Lombok and other regions of Indonesia. Research on the Bau Nyale tradition in Lombok demonstrates how local calendrical knowledge integrates ecological awareness, communal cooperation, and collective religious meaning in responding to environmental change (Mutia et al., 2024). Ethnographic and ethnomathematical studies of Sasak traditional architecture also show that indigenous knowledge embeds values of balance, cooperation, and respect for social diversity within everyday practices (Fauzi et al., 2022). Beyond Lombok, the Lontara Pananrang of the Bugis people shows how traditional manuscripts guide agricultural timing and ecological interpretation (Rahmatia & Christomy, 2020). Traditional planting calendars in the Duhiadaa community of Gorontalo also illustrate how

local time-reckoning mediates collective decision-making, social harmony, and environmental adaptation ("Panggoba; Traditional Knowledge in The Planting Season Calendar of The Duhiadaa Pohuwato Gorontalo Indonesian Community," 2021). In another context, research on the Javanese traditional calendar and economic activity shows that shared temporal frameworks can influence social trust and market behavior (Suganda et al., 2020). These studies confirm that traditional calendars and related knowledge systems are not only markers of cultural identity. They also function as social instruments that support environmental awareness, cooperation, and cultural continuity.

Comparative studies on biocultural diversity further strengthen the argument that traditional calendars should be understood as inclusive knowledge systems that bridge scientific observation, cultural meaning, and social values (Franco et al., 2022). In many communities, calendars do not merely calculate time. They organize relations between humans, the environment, ritual obligations, and collective memory. This is why the *Rowot Sasak* Calendar is relevant to broader discussions on local wisdom, religious harmony, and cultural sustainability. It offers a case in which Islamic practice and indigenous astronomical knowledge do not necessarily stand in opposition. Instead, both can be understood as interacting systems that shape the way a community regulates ritual time and seasonal life.

More specific literature on the *Rowot Sasak* Calendar has provided an important foundation for this study. Irawan (2014) describes the basic components of the *Rowot Sasak* Calendar and explains its relation to stars, seasons, and Islamic ritual months. This work is central because it documents local terms, *warige* practices, and the role of the *Rowot* star in Sasak time-reckoning (Sado et al., 2023). Further identify the *Rowot Sasak* Calendar as a product of acculturation among Islamic, Javanese, and Sasak cultures. Their study provides an initial explanation of cultural interaction in the calendar's formation. The idea of reformulating a traditional calendar is also supported by studies showing that the integration of modern scientific methods with local knowledge can improve the accuracy, acceptability, and practical relevance of local knowledge systems (Faronny et al., 2024; Hasan, 2023; Saiful et al., 2022). However, these studies have not sufficiently reconstructed the lunisolar character of the *Rowot Sasak* Calendar through systematic astronomical analysis. They also have not examined intercalation as a key mechanism for maintaining seasonal alignment, nor evaluated how the restoration of a lunisolar framework could recover the calendar's ecological and cultural functions.

This study fills that gap by examining the *Rowot Sasak* Calendar as a lunisolar-stellar system whose ecological function weakened when intercalation was omitted. Existing studies have discussed acculturation, ritual use, ethnographic meaning, local Islamic practice, traditional ecological knowledge, and the role of technology in calendrical learning. However, few have analyzed how the calendar's astronomical structure changed, how the loss of intercalation produced seasonal drift, and how a lunisolar reformulation could restore its agrarian and cultural relevance. The main argument of this article is that the *Rowot Sasak* Calendar originally contained a more integrated temporal logic than its current lunar-dominant form suggests. Its reformulation does not require rejecting Islamic

ritual time. Rather, it requires restoring a correction mechanism that allows lunar months, solar seasons, and stellar markers to remain synchronized within a culturally acceptable framework.

Based on this problem, the article is guided by three research questions. First, what was the original astronomical structure of the *Rowot Sasak* Calendar as reflected in local knowledge, *warige* traditions, and calendrical practices? Second, how did Islamization and cultural acculturation transform the calendar into a predominantly lunar-religious system? Third, how can a lunisolar reformulation through intercalation restore the ecological, cultural, and religious functions of the *Rowot Sasak* Calendar? These questions are important because they position the calendar as a dynamic cultural system, not merely as a relic of the past.

The objective of this study is to analyze the transformation of the *Rowot Sasak* Calendar and to formulate a reconstruction model that remains grounded in Sasak cultural knowledge. More specifically, this article seeks to explain the calendar's original lunisolar-stellar structure, identify the consequences of removing intercalation, and propose a culturally inclusive model for restoring its seasonal relevance. By integrating ethnoastronomical analysis, religious-cultural interpretation, and local ecological knowledge, this study contributes to the broader discussion on religion and tradition, local wisdom, cultural sustainability, and social harmony in Indonesian society. The *Rowot Sasak* Calendar is therefore understood as a shared temporal system that can bridge Islamic ritual practice, indigenous astronomy, and ecological awareness in contemporary Lombok.

Research Method

This research is based on the constructivist paradigm, which views local knowledge systems as products of long interaction between humans, the environment, cosmological beliefs, and religious traditions. This paradigm was used because the *Rowot Sasak* Calendar is not only a technical system of time reckoning but also a cultural practice interpreted and maintained by Sasak communities across diverse social and ecological contexts. Within this framework, the study employed a qualitative-descriptive approach, supported by ethnoastronomical and historical analyses. This interdisciplinary design was chosen to explain the relationship between celestial phenomena, *warige* traditions, agricultural practices, religious observance, and cultural transformation.

The research was conducted in 2025 in four customary regions of Lombok Island, namely East Lombok, North Lombok, Central Lombok, and West Lombok. These regions were selected purposively because they represent different traditions of using the *Rowot Sasak* Calendar, *warige*, and local calendrical knowledge. Data were collected through participatory observation, semi-structured interviews, document study, and astronomical comparison. Observation focused on how communities interpret seasonal signs, determine ritual time, and read astronomical markers such as the appearance of the *Rowot* star, the phases of the Moon, and the position of the Sun. Interviews explored the history of the calendar, local calculation methods, religious and cultural interpretations, and the possibility of restoring intercalation. The document study included *warige* manuscripts,

lontar texts, local calendrical records, and documentation of rituals associated with the traditional calendar.

Table 1 Key Informants of the Research

Informant	Region	Social Role	Expertise	Selection Criterion
Kiyai Ratna	East Lombok	Sasak customary figure and Islamic religious figure	*Warige* and Sasak calendar	Mastery of Islamic-oriented calendrical practice
Raden Sawinggih	Bayan, North Lombok Regency	Cultural practitioner	Bayan calendar	Representation of local calendrical tradition
H. Ya'qum	Central Lombok	Customary elder	5-15-25 pattern and intercalation	Mastery of the lunisolar system
Romo Sikhi Sabahito	West Lombok	Sasak customary figure and Buddhist religious figure	*Warige* and Sasak calendar	Mastery of Buddhist-oriented calendrical practice

The research used voice recorders, cameras, field notes, and digital astronomical applications such as Stellarium. These tools were used to document interviews, record field observations, and compare informants' explanations with astronomical data, especially regarding the appearance of the Pleiades, lunar phases, and seasonal markers. The astronomical comparison did not replace local knowledge but served as an analytical tool for examining the relationship between indigenous astronomical interpretation and modern astronomical calculation.

Data analysis was carried out through open coding, thematic categorization, interpretive analysis, and triangulation. In the first stage, interview transcripts, field notes, and documents were coded according to recurring themes, including traditional astronomy, *warige* structure, ecological functions, Islamization, lunar transformation, intercalation, and calendar reformulation. In the second stage, these codes were grouped into broader thematic categories. In the third stage, the themes were interpreted through ethnoastronomical and religious-cultural perspectives. The final stage integrated field data, manuscript analysis, and astronomical calculation to formulate a reconstruction model of the *Rowot Sasak* Calendar. Data validity was strengthened through source triangulation, method triangulation, and comparison between oral information, written records, and astronomical data.

Ethical considerations were applied throughout the research process. Informants were informed about the purpose of the study before the interviews were conducted. Their explanations were used with consent, and culturally sensitive information was treated carefully through consultation with relevant customary and religious figures. This procedure was intended to respect local authority, protect informants' dignity, and ensure

that the reconstruction of the *Rowot Sasak* Calendar remained academically accountable and culturally responsible.

Results and Discussion

Historical Origins of the *Rowot Sasak* Calendar

The *Rowot Sasak* Calendar is rooted in the indigenous knowledge system of the Sasak people, particularly in the way they read celestial signs and natural phenomena as markers of time. The term *rowot* refers to the local Sasak designation for the Pleiades star cluster (Irawan, 2014). In local interpretation, the appearance of this star cluster has been associated with the flowering phase of *rowot* rice, a local rice variety with a long growth cycle. Community narratives explain that *rowot* rice begins to flower when the Pleiades becomes visible, while the absence of the star cluster indicates that the rice has not yet entered its flowering phase. This relation shows that the *Rowot Sasak* Calendar was not developed merely as a system for counting days, but as an ecological reading of the relationship between celestial phenomena and agrarian life.

Field interviews, however, show that the connection between the term *rowot* and the flowering phase of *rowot* rice still requires careful historical verification. Kiyai Ratna explained:

> "that no written source has yet been found that directly connects the term *rowot* with the flowering phase of *rowot* rice (interview with Ratna, 22 August 2025)."

Raden Sawinggih confirmed that:

> "*rowot* rice is indeed known as a long-lived rice variety and can be harvested up to twice in one season (interview with Sawinggih, 12 September 2025).

These two explanations show that the meaning of *rowot* is formed through a combination of oral memory, agrarian experience, and astronomical observation. The absence of direct written evidence does not weaken the cultural relevance of this interpretation. Instead, it shows that the calendar developed within a knowledge environment in which oral transmission, seasonal experience, and embodied observation were central.

The exact age of the *Rowot Sasak* Calendar has not been firmly established. Informants explained that:

> "the history of this calendar can only be traced through indirect cultural indicators, including the naming of wuku, which is associated with the reign of Rakai Mataram Sang Ratu Sanjaya, the first king of the Medang Kingdom in Central Java around 730 AD (interview with Ratna, 22 August 2025)."

Until now, no definite "year zero" has been found for the *Rowot Sasak* Calendar. For this reason, the Sasak people still refer to the *Hijri* or *Gregorian* year when designating years. Kiyai Ratna stated:

> "With regard to the designation of years, we still follow the Hijri or Gregorian year system, as the starting point for counting a distinct Sasak calendar year has not yet

been formally established. However, there have been efforts by RONTAL to revive this cultural calendar (interview with Ratna, 22 August 2025)."

This explanation shows that the *Rowot Sasak* Calendar has a different character from state-based or religious calendars, which usually begin with a fixed historical event. The *Rowot Sasak* Calendar was developed as a functional calendar, not primarily as a chronological calendar. Its earliest function was to read time through natural indicators, such as the blooming of randu trees, the appearance of certain plants, seasonal winds, rainfall patterns, and the visibility of celestial objects. (Irawan, 2014) explains that the calendar initially did not recognize formal groupings of months or numerical dates. The advent of Islam later necessitated a more structured monthly system because religious practices such as *Maulid*, fasting, and hajj required alignment with the *Hijri* calendar.

This historical pattern indicates that the *Rowot Sasak* Calendar was shaped by two temporal logics. The first was ecological and observational. It used celestial and environmental signs to regulate seasonal life. The second was religious and ritual. It adopted Hijri month names and lunar calculation to regulate Islamic worship. The interaction between these two temporal logics became the basis of the calendar's later transformation.

Structure of the *Rowot Sasak* Calendar

The *Rowot Sasak* Calendar combines stellar, solar, and lunar elements. This structure distinguishes it from calendars based solely on solar or lunar cycles. The stellar element is represented by the appearance of the Pleiades, which marks the beginning of the year and the transition from the rainy to the dry season. The solar element is reflected in the determination of *mangse*, namely, seasonal divisions related to agricultural and ecological activities. The lunar element is visible in the use of month names and dates that follow the Hijri system. This combination suggests that the *Rowot Sasak* Calendar originally operated as a lunisolar-stellar system.

Several local terms need clarification before discussing the calendar's structure. *Mangse* refers to the local seasonal division used to interpret natural and agricultural phases. *Warige*, also known locally as *wariga*, is a traditional board- or manuscript-based system containing symbols for determining auspicious times, daily characters, directions, and ritual timing. *Tike Lime* and *Tike Pituq* are two important components of the *warige* system. *Tike Lime* follows a cycle of *wuku* and weekly days, while *Tike Pituq* links weekdays to time categories derived from solar and lunar movements. Wong-wong is used to assess safe or unsafe conditions at certain times, while *Eder Nage* is used to determine directions considered appropriate or inappropriate for important activities.

The preparation of the *Rowot* almanac involved harmonizing Sasak *warige*, the *Hijri* calendar based on the *Mansyuriyah* school of *hisab*, and the *Gregorian* calendar (Irawan, 2014). The *warige* system includes four important elements:

"*Tike Lime*, *Tike Pituq*, *Wong-wong*, and *Eder Nage*. Each element has a specific function, but together they form a symbolic system for regulating daily and ritual life (interview with Ratna, 22 August 2025)."

Some *warige* records are also preserved in lontar manuscripts, which shows that the *Sasak* calendrical system exists not only in oral tradition, but also in written cultural sources (Irawan, 2014).

Tike Lime consists of 30 columns and 8 rows, forming 240 plots containing the names of *wuku* and days of the week. Each plot includes symbols that indicate the character of the day. This system reflects a 210-day cycle that can repeat into a 420-day rhythm without necessarily being tied to a specific month or date (Irawan, 2014). *Tike Pituq* contains 35 plots that connect seven weekdays with ten time periods based on the movements of the Sun and Moon. This combination produces five categories of meaning: *suwung*, *ketepuk*, *kale*, *meselur*, and *riski*. These categories are interpreted as guides for community activities (Irawan, 2014).

Wong-wong and *Eder Nage* complement this system. *Wong-wong* contains 30 symbolic pairs, each consisting of human figures or empty spaces. These symbols represent the number of days in the *Hijri* and Sasak months, namely 29 or 30 days. The community uses their combination to assess whether a certain time is safe or unsafe (Irawan, 2014). *Eder Nage* relates to directional orientation. It refers to the mythology of the dragon accompanying Dewi Anjani and the eight cardinal directions. In this system, people are advised not to face the dragon's head when carrying out important activities (Irawan, 2014). These components show that the *Rowot Sasak* Calendar is not limited to astronomical calculation. It also includes symbolic, mythological, and practical dimensions.

The use of the *Rowot Sasak* Calendar is not uniform across Lombok. In North Lombok, especially in Bayan, the calendar is strongly related to the timing of religious rituals and local Islamic traditions, such as *Maulid Adat*, *Lebaran Adat*, *Sewindu*, and other processions rooted in Sasak Islamic culture (interview with Sawinggih, 12 Septemebr 2025).

Raden Sawinggih explained:

"This calendar originally did not recognize named months; instead, the Sasak community used it by associating time with prevailing natural phenomena, such as the period when *kapok* trees were in bloom and other seasonal indicators"(interview with Sawinggih, 12 September 2025).

In East Lombok, the calendar is also used as a reference for sacred moments related to social and religious life. In Central Lombok and the southern part of West Lombok, however, the calendar functions more clearly as a customary and agrarian guide. It is used to determine the timing of rituals such as *Bau Nyale*, *Perang Timbung*, and other ceremonies that follow seasonal changes and agricultural activities (interview with Sabahito, 2 September 2025).

This variation shows that the *Rowot Sasak* Calendar functions as both a religious-cultural instrument and an ecological institution. It regulates relations among religiosity, nature, and social order.

Islamic Influence and Calendrical Transformation

The transformation of the *Rowot Sasak* Calendar is inseparable from Islamization. Islam did not erase the local calendar. It reshaped its structure and function. Before Islamic influence became dominant, the Sasak community used natural phenomena as temporal markers. After accepting Islam, the community needed to align its religious practices with the Hijri calendar. This need led to the adoption of Hijri month names into Sasak usage. Months such as Rabiul Awal, Rajab, Syaban, and Muharram were absorbed into local vocabulary and ritual practice through terms such as Bulan Mulut, Mirat, Bulan Rowah, and bubur taun (Irawan, 2014).

This transformation shows a process of cultural acculturation. The Sasak people did not simply abandon their local temporal system. They adjusted it to Islamic ritual needs. In this process, the *Rowot Sasak* Calendar gradually followed the lunar logic of the *Hijri* calendar. Odd months were counted as 30 days, while even months were counted as 29 days. *Leap* years followed the *Mansyuriyah hisab* pattern. The annual structure adopted the windu pattern with eight year names: *Alip*, *Ehe*, *Jimawal*, *Ze*, *Dal*, *Be*, *Wau*, and *Jimahir* (Sagala et al., 2024). In *Leap* years, the month of Zulhijjah consists of 30 days and is known as Alip Kelawu, while ordinary years are known as Alip Langkir (interview with Ratna, 22 August 2025).

The influence of Islam is also evident in daily time reckoning. Informants explained that the day in the *Rowot Sasak* Calendar is socially understood to change in the late afternoon, approaching sunset, although the practical calculation of day transition still follows the period after sunset. H. Ya'qum stated:

> "In Sasak tradition, the change of day begins in the late afternoon, approaching sunset; thus, Thursday evening is already counted as Friday" (interview with Yakum, 28 September 2025).

This explanation shows that the calendar embodies both Islamic and local temporal sensibilities. The Islamic aspect appears in the importance of sunset and lunar months. The local aspect appears in the customary interpretation of the afternoon as a vulnerable period that calls for the cessation of activities. This layered meaning strengthens the argument that the *Rowot Sasak* Calendar should not be understood as a purely astronomical system. It is a socio-religious system of time.

The problem emerged when the lunar aspect became dominant and intercalation was weakened or omitted. A lunar year of 354 or 355 days cannot remain aligned with solar seasons without correction. The difference between the lunar and solar year is about 10 to 11 days annually. If this difference is not corrected, month names and ritual periods gradually shift backward relative to the seasonal cycle. In religious practice, this movement is acceptable because the Hijri calendar is designed as a lunar calendar. In agrarian practice,

however, the same movement creates difficulty because planting time, rainfall, winds, and the appearance of ecological signs are connected to solar-seasonal cycles. This is the central reason why the *Rowot Sasak* Calendar lost part of its ecological function.

This finding aligns with studies on local calendars that show how traditional temporal systems remain relevant because they maintain cultural identity and ecological orientation in modern society (Rofiuddin & Hakim, 2022). It also relates to studies on Sasak Islam, which emphasize the dialectical relation between Islamic practice and local tradition (Ribut et al., 2019; Sirnopati et al., 2022). In the case of the *Rowot Sasak* Calendar, acculturation produced both cultural enrichment and structural tension. The enrichment is evident in the calendar's ability to incorporate Islamic ritual meaning. The tension appears when lunar ritual time weakens the calendar's ability to regulate seasonal and agrarian life.

Astronomical Analysis of the *Rowot Sasak* Calendar

Astronomically, the *Rowot Sasak* Calendar is built on three main foundations: the Moon, the Sun, and the stars. The Moon regulates the monthly structure and ritual time. The Sun regulates seasons and agricultural rhythm. The stars, especially the Pleiades (Pleiades), mark the beginning of the year and important seasonal transitions. This threefold structure makes the calendar different from a purely lunar system.

In the lunar aspect, the *Rowot Sasak* Calendar follows a pattern similar to the Hijri and Javanese-Islamic calendars. The year consists of regular and *Leap* years. A regular year contains 354 days, while a *Leap* year contains 355 days. The eight-year windu pattern places *Leap* years in the second, fifth, and eighth years. This produces a total of 2,835 days in one eight-year cycle:

[(5) + (3) = 1770 + 1065 = 2835]

Thus, the average length of a *Rowot* year in this pattern is:

[2835 = 354.375]

This structure is close to the Javanese-Islamic calendar, which also uses an eight-year cycle, *Leap* years in the second, fifth, and eighth years, and month lengths of 30 days for odd months and 29 days for even months (Kusuma et al., 2025). The similarity is also evident in year names, day names, and market-day patterns, although informants emphasized that this similarity should not be interpreted as mere imitation. Kiyai Ratna explained that the pattern reflects an inherited calendrical system shared by several communities in the archipelago (interview with Ratna, 22 August 2025; interview with Yakum, 28 September 2025).

The comparison with astronomical lunar data shows that the *Rowot Sasak* Calendar is relatively accurate as a lunar calendar. One synodic month averages approximately 29.53058796 days. In 120 years, the *Rowot* calculation produces:

[2835 = 42525]

Astronomically, 120 lunar years contain:

[12 = 42524.0496]

The difference is approximately one day in 120 years. Therefore, the hisab urfi-based *Rowot* pattern requires a one-day correction every 120 years. After this correction, the remaining difference becomes very small. This indicates that the *Rowot Sasak* Calendar has strong internal accuracy as a lunar calculation system.

The difficulty appears when the same system is used to regulate seasons. The *Rowot Sasak* Calendar has an average year length of 354.375 days, while the Gregorian tropical year has approximately 365.2425 days. The difference is:

[365.2425 - 354.375 = 10.8675]

This means that the lunar-based *Rowot* year moves backward against the solar year by approximately 10.8675 days each year. In three years, the accumulated difference becomes:

[10.8675 = 32.6025]

This accumulated drift is close to the length of one lunar month. Therefore, a lunisolar system requires an intercalary month, or a thirteenth month, in certain years to keep lunar months aligned with solar seasons. Without this correction, the appearance of *Rowot*, which should remain connected to the seasonal transition around May, gradually shifts backward.

This analysis confirms the hypothesis that the *Rowot Sasak* Calendar cannot function as an agrarian calendar if it only follows a lunar pattern. Its ecological function depends on the synchronization of the Moon, the Sun, and stellar markers. The lunar pattern is useful for ritual months, but the solar and stellar patterns are necessary for seasonal guidance. Therefore, the restoration of intercalation is not an arbitrary innovation. It is a logical requirement of a lunisolar-stellar system.

Table 2 Comparison of Calendar Stuctures

Calendar System	Astronomical Basis	*Leap*-Year Mechanism	Intercalation	Main Function
Hijri calendar	Lunar	*Leap* day in selected years	No thirteenth month	Islamic ritual time
Javanese-Islamic calendar	Lunar with local cycle	Windu cycle	No seasonal intercalation	Ritual and cultural timing
Balinese Saka calendar	Lunisolar	*Leap* month mechanism	Yes	Ritual and seasonal alignment
Rowot Sasak Calendar in early structure	Lunisolar-stellar	Local cycle and seasonal markers	Present or implied through correction	Ritual, agrarian, and ecological timing
Rowot Sasak Calendar in current lunar-dominant form	Lunar with residual stellar reference	Windu and Hijri-related cycle	Weak or omitted	Ritual and cultural timing

The comparison shows that the *Rowot Sasak* Calendar stands between several calendrical traditions. Like the Hijri calendar, it uses lunar months for ritual time. Like the Javanese-Islamic calendar, it uses windu patterns and year names. Like the Balinese Saka calendar, its agrarian logic requires alignment between lunar months and solar seasons.

This intermediate position explains why the *Rowot Sasak* Calendar should be reconstructed as a lunisolar-stellar system rather than treated as a purely lunar calendar.

Intercalation and Seasonal Drift

Intercalation is the central issue in the reconstruction of the *Rowot Sasak* Calendar. It refers to the insertion of an additional month into a calendar system to correct the difference between lunar and solar cycles. In a lunar calendar, one year is about 354 or 355 days. In a solar calendar, one year is about 365 days. Without intercalation, the lunar year shifts backward by about 10 to 11 days annually against the seasons. In a religious calendar such as the Hijri calendar, this shift is acceptable because its purpose is ritual rather than seasonal. In an agrarian calendar such as the *Rowot Sasak* Calendar, however, this shift causes functional problems.

The traditional 5-15-25 pattern shows local awareness of the annual drift between lunar and solar time. According to H. Ya'qum, the pattern reflects the ancestral method for maintaining harmony between the "upper month" and the "lower month," meaning the solar-Gregorian and lunar-Hijri references. He explained:

> "The five-fifteen-twenty-five pattern is indeed an inheritance from our ancestors, because the upper month and the lower month differ by approximately ten days each year" (interview with Yakum, 28 September 2025).

This explanation indicates that Sasak calendrical knowledge already recognized the difference between lunar and solar cycles. The pattern of 5-15-25 reflects a practical method for tracking the backward progression of lunar dates relative to the solar calendar. However, if this pattern is applied without intercalation, the correction remains incomplete. The calendar may still identify a recurring lunar date, but it cannot fully preserve Rowot's seasonal position.

The difference can be explained through a three-year cycle. If the lunar year shifts backward by about 10.8675 days per year, then after three years the accumulated shift becomes approximately 32.6025 days. This is close to one lunar month. Therefore, a thirteenth month is required in a particular year to return the calendar to its seasonal position. In the article's data, this pattern appears in the comparison of Hijri years and *Rowot* criteria:

Table 3 Comparison of the Hijri Year with the *Rowot Sasak* Calendar Criteria

No	Year Hijri	Criterion 2	Number of Months	Other Criteria
1	1446	*Rowot* Appears on the 5th day of the Hijri Month of May	13 Months	Hijri year divisible by 3
2	1447	*Rowot* Appears on the 15th day of the Hijri Month of May	12 Months	Hijri year not divisible by 3
3	1448	*Rowot* Appears on the 25th day of the Hijri Month of May	12 Months	Hijri year is not divisible by 3

This table shows that intercalation is not an external addition imposed on the *Rowot Sasak* Calendar. It is a correction that follows from the calendar's internal logic. The lunar

months move backward against the solar year. Rowot's appearance needs to remain connected to the seasonal transition. The thirteenth month provides the mechanism for maintaining that relationship.

The problem becomes clearer when the calculation of year transition is examined. According to Raden Sawinggih,

> the "*Alif* Tuesday *Pon*" year will last until 2037 CE, which coincides with 1459 AH (interview with Sawinggih, 12 September 2025).

In *hisab urfi* calculation, the determination can be expressed as follows:

[1458 = (48) + 18]

The number of days in 48 cycles is:

[48 = 510288]

The number of days in 18 years is:

[(18) + 7 = 6372 + 7 = 6379]

By adding the elapsed days and correction, the calculation indicates a day position that creates a difference between the *Rowot* pattern and the Hijri calendar. The article shows that the *Rowot Sasak* Calendar falls one day ahead in determining 1 Muharram 1459 AH, or 2037 CE. This difference occurs because the *Rowot* system does not fully correct the shift in the position of the Moon according to astronomical calculation.

A second calculation shows that the change from "*Alif* Tuesday *Pon*" to "*Alif* Monday *Pahing*" should occur in 2052 CE or 1475 AH. This can be expressed as:

[1474 = (49) + 4]

The number of days in 49 cycles is:

[49 = 520919]

The number of days in 4 years is:

[(4) + 1 = 1416 + 1 = 1417]

This calculation produces a different transition point from the one mentioned for 2037 CE. The comparison results in a difference of about 15 years. This difference shows that calendrical correction is needed for the *Rowot Sasak* Calendar to remain consistent with astronomical calculations and seasonal indicators.

The seasonal drift produced by the omission of intercalation has direct consequences for the *mangse* system. *Mangse* is not merely a named period. It is an ecological category that links natural signs, agricultural timing, rainfall, plant growth, animal behavior, and ritual life. When lunar calculations are performed backward without correction, *mangse* loses its precision as a seasonal marker. The calendar then becomes more closely tied to the Gregorian calendar for planting and harvest decisions. This weakens the authority of traditional ecological knowledge and reduces the role of elders as interpreters of natural signs.

Reformulation Model of the *Rowot Sasak* Calendar

The reformulation of the *Rowot Sasak* Calendar should be understood as a process of functional reconstruction. It does not aim to replace the Hijri calendar or challenge Islamic ritual time. It aims to restore the ecological and seasonal function of the Sasak cultural calendar. This distinction is important because the *Rowot Sasak* Calendar operates in a different domain from the Hijri calendar. The Hijri calendar regulates Islamic ritual time. The *Rowot Sasak* Calendar regulates the relation between ritual, culture, agriculture, and ecological signs in Sasak society.

The proposed reformulation is based on restoring intercalation via a thirteenth-month mechanism. The basic principle is that lunar months continue to regulate ritual and cultural timing, while the thirteenth month corrects the accumulated difference between lunar and solar cycles. This allows the calendar to remain close to the appearance of *Rowot* and other seasonal markers. The model follows the logic of a lunisolar system, in which the Moon governs the month, but the Sun governs the year and seasons. The Pleiades then serves as a stellar marker anchoring the beginning of the cycle in local astronomical tradition.

This model can be expressed through three basic principles. First, the calendar should retain its lunar-month structure because it has become part of the Sasak Islamic and cultural practice. Second, the calendar should maintain the appearance of *Rowot* as a marker of seasonal transition because this is the distinctive element of Sasak ethnoastronomy. Third, the calendar should include intercalation when the lunar cycle drifts too far from the solar-seasonal position. This correction allows the calendar to preserve both religious and ecological functions.

The reformulation also requires institutional mediation. The *Rowot* Nusantara Lombok Institute, or RONTAL, occupies a strategic position because it has already been involved in reviving and documenting the calendar. However, calendar reformulation cannot rely only on technical calculation. It must involve customary leaders, religious figures, cultural practitioners, and communities that still use *warige*. The presence of informants from Islamic, Buddhist, Bayan, and customary backgrounds in this study indicates that the *Rowot Sasak* Calendar is not owned by a single religious group. It is part of a broader Sasak cultural system. Therefore, the reformulation must be inclusive and dialogical.

The use of digital astronomical tools such as Stellarium can support this process. These tools can help verify the heliacal rising of the Pleiades, lunar phases, and seasonal positions. However, modern astronomical tools should not be positioned as replacements for local knowledge. They should serve as instruments for dialogue between indigenous astronomy and scientific calculation. This approach is consistent with studies showing that the integration of modern scientific methods and local knowledge can improve the accuracy and acceptability of calendrical systems (Faronny et al., 2024; Hasan, 2023; Saiful et al., 2022). It also aligns with the broader idea that astronomical heritage requires interdisciplinary interpretation (Franco et al., 2022).

At the same time, the reformulation may face social and theological negotiation. Some religious communities may regard the lunar Hijri structure as the most legitimate reference

for religious time. Others may worry that the insertion of a thirteenth month could be misunderstood as altering Islamic ritual calculation. This concern should be anticipated carefully. The reformulation should be framed not as a modification of the Hijri calendar, but as a restoration of the Sasak cultural calendar's ecological function. In this model, Islamic ritual months remain governed by the Hijri system, while the *Rowot Sasak* Calendar uses intercalation to maintain its local seasonal relevance. This distinction can reduce resistance and make the model more acceptable across religious communities.

The reformulation also requires clear terminology. The thirteenth month should be explained as a correction mechanism within the cultural calendar, not as an additional Islamic month. The calculation should be transparent, documented, and open to community deliberation. RONTAL and customary authorities can develop annual guidelines that show how lunar dates, solar seasons, and *Rowot* appearance are synchronized. This would allow the calendar to function as a shared temporal system rather than a source of contestation.

Cultural, Religious, and Ecological Implications

The reconstruction of the *Rowot Sasak* Calendar has broader implications for cultural sustainability. Cultural sustainability does not only mean preserving names, symbols, and rituals. It also means maintaining the knowledge system's function in contemporary life. If the *Rowot Sasak* Calendar is preserved only as a ritual symbol, while losing its ecological and agrarian functions, its sustainability will remain partial. A living calendar must remain useful for the community. It must help people understand their environment, regulate social life, and transmit knowledge across generations.

The ecological implication is especially important. Traditional calendars often serve as environmental archives. They record the relationships among rainfall, wind, plant growth, animal behavior, celestial appearances, and human activity. In the *Rowot Sasak* Calendar, this function appears in the *mangse* system. Each *mangse* is associated with specific natural signs. For example, the appearance of *Rowot* marks an important seasonal transition. *Kembang Komaq* refers to the appearance of certain flowers. *Nyale* relates to the emergence of sea worms along the southern coast. Tenggale marks the end of the seasonal cycle. These signs show that the calendar is an ecological knowledge system, not only a ritual timetable.

In the context of climate change, this function becomes more relevant. Traditional seasonal signs may shift due to changes in rainfall patterns, temperature, and ecological conditions. However, this does not make traditional calendars obsolete. Instead, it creates the need to reinterpret them through dialogue between local knowledge and scientific observation. Studies on Bau Nyale show that local traditions in Lombok can function as cultural mechanisms for responding to climate change through ecological awareness and communal cooperation (Mutia et al., 2024). Studies on local ecological knowledge also show that ancestral knowledge can support environmental preservation when it is adapted to contemporary conditions (Faronny et al., 2024; Hastuti & Hafidh, 2025). The *Rowot Sasak*

Calendar can contribute to this process by providing a culturally grounded framework for reading seasonal change.

The calendar also has implications for social harmony. Sasak society contains diverse religious and cultural expressions, including Islamic traditions, Buddhist communities, Bayan customary practices, and other local forms of religiosity. The *Rowot Sasak* Calendar can serve as a shared cultural reference because it is not limited to a single doctrinal framework. It connects religious practice with local wisdom, ecological knowledge, and collective identity. This is consistent with studies showing that local traditions in Sasak society can foster balance, cooperation, and respect for diversity (Fauzi et al., 2022; Ribut et al., 2019; Sirnopati et al., 2022).

From the perspective of indigenous science studies, the *Rowot Sasak* Calendar demonstrates that local communities develop systematic methods for observing and interpreting the sky. Their knowledge may not always be written in formal scientific language, but it contains empirical patterns built through long-term observation. The use of *Rowot*, Tenggale, lunar phases, seasonal signs, and *warige* symbols reflects a local epistemology of time. This epistemology challenges the assumption that scientific knowledge only exists in modern institutional forms. It shows that indigenous astronomy can contribute to the history of science, environmental humanities, and decolonial approaches to knowledge.

From an environmental governance perspective, the calendar can support community-based seasonal planning. If reconstructed carefully, it may help communities discuss planting time, ritual timing, ecological change, and cultural education. It can also serve as a medium for intergenerational learning. Younger Sasak generations can learn not only the names of rituals but also the underlying logic of observation. This is important because the loss of intercalation and the increasing reliance on the Gregorian calendar have reduced the habit of reading natural signs. The revitalization of the calendar can therefore strengthen local resilience by reconnecting social practice with ecological awareness.

The comparative evidence from other traditional calendars strengthens this argument. The *Lontara Pananrang* of the Bugis people guides agricultural timing through manuscript-based ecological knowledge (Rahmatia & Christomy, 2020). The *Duhiadaa* planting calendar in Gorontalo reflects collective decision-making and social responsibility in determining agricultural seasons ("*Panggoba* ; Traditional Knowledge in The Planting Season Calendar of The *Duhiadaa Pohuwato Gorontalo* Indonesian Community .," 2021). The Javanese traditional calendar has been shown to influence social trust and market behavior in economic contexts (Suganda et al., 2020). These examples show that traditional calendars function beyond ritual. They organize social relations, ecological interpretation, and practical decision-making.

The *Rowot Sasak* Calendar should therefore be interpreted as a dynamic cultural system. Its reformulation through intercalation is not a nostalgic return to the past. It is an effort to recover the calendar's internal logic so that it can function in the present. The challenge is to balance astronomical accuracy, religious sensitivity, cultural legitimacy, and ecological usefulness. If this balance can be achieved, the *Rowot Sasak* Calendar may serve

as a model for revitalizing indigenous calendrical knowledge in Indonesia. It can show how religion and local wisdom can interact constructively without erasing each other.

The findings of this study confirm that the *Rowot Sasak* Calendar originally contained an integrated temporal system based on the Moon, the Sun, and the stars. Islamization transformed this system by strengthening its lunar-religious dimension. This transformation enriched the calendar's ritual function but weakened its seasonal function when intercalation was omitted. The annual drift of about 10 to 11 days explains why the calendar gradually lost precision as an agrarian guide. Restoring intercalation through a thirteenth-month mechanism provides a way to recover the lunisolar-stellar logic of the calendar while preserving its religious and cultural meanings. In this sense, the *Rowot Sasak* Calendar is not merely a relic of local tradition. It is a living knowledge system that can support cultural sustainability, ecological awareness, and social harmony in contemporary Lombok.

Conclusion

This study confirms that the *Rowot Sasak* Calendar was originally structured as a lunisolar-stellar system in which lunar cycles, solar seasons, and the appearance of the *Rowot* star collectively regulated ritual life, agricultural activities, and ecological knowledge among the Sasak people. The process of Islamization and cultural acculturation gradually strengthened the calendar's lunar-religious dimension, particularly through its alignment with the Hijri calendar. However, the omission of intercalation weakened its ability to maintain seasonal accuracy. Without the thirteenth-month mechanism, the calendar experienced an annual drift of approximately 10 to 11 days against the solar cycle. This shift explains why the *Rowot Sasak* Calendar gradually lost its precision as a reference for *mangse*, planting time, and ecological observation, while becoming more dominant as a ritual and cultural calendar.

Theoretically, this study contributes to ethnoastronomical research by reconstructing the *Rowot Sasak* Calendar as an indigenous lunisolar-stellar system linking astronomy, religion, and ecological knowledge. Methodologically, it shows that qualitative fieldwork, *warige* analysis, oral information from customary and religious figures, and comparative astronomical calculation can be integrated to study traditional calendars. Practically, the study offers a reconstruction model by restoring intercalation as a culturally grounded way to revitalize indigenous ecological knowledge without displacing the calendar's religious and social functions. Future research may develop digital simulations of the *Rowot Sasak* Calendar, compare intercalation systems across traditional calendars in the Indonesian archipelago, and examine the calendar's relevance for climate adaptation and community-based environmental governance in Lombok.

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Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this manuscript, the authors used generative AI and AI-assisted technologies (OpenAI/ChatGPT) only to support the writing process, particularly for language refinement, sentence restructuring, academic phrasing, and improving the manuscript's clarity and coherence. These tools were not used to collect data, select informants, conduct interviews, interpret field findings, perform astronomical comparisons, code data, develop thematic categories, or formulate the study's analysis and conclusions.

All data collection, data analysis, interpretation, and validation processes were carried out independently by the authors and the research team. The authors critically reviewed, verified, and revised all AI-assisted outputs to ensure accuracy, originality, contextual appropriateness, and consistency with the research findings. The authors take full responsibility for the content, analysis, arguments, and final form of this article.

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