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Rice Farming Culture and Alcoholic Rice Beverage Industry - a New Framework and Plans for the Future
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Rice Farming and History of Making Traditional Indonesian Alcoholic Beverage

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ABSTRACT

Rice is the most important agricultural products in Indonesia, with over 200 million people relying on it as a staple food. The rice production has been fully supported by improved infrastructure, supply of seeds, fertilizers, research and development as well as government regulations in pricing. Its vulnerability to climate change requires adaptation strategies for irrigation, biotechnology, and cultivar selection. Recent forms of agricultural policy in Indonesia include the deployment and implementation of environmentally friendly technologies, with the aim to reduce the use of chemicals. The agricultural irrigation system that has existed since ancient times and is still relevant today is the Subak irrigation system; this system is able to maintain the existence of agricultural water and environmental sustainability. Rice production in Indonesia continues to increase from year to year and it reached 81.38 million tons in 2017, including glutinous rice. With the increase in population, the need for rice also increases both for food consumption and as raw materials for the food and non-food industries, as well as other forms of consumption. With the food self-sufficiency program, rice production will continue to be improved. Glutinous rice, both black and white, is widely used as a raw material for the production of alcoholic beverages (rice wine). Traditional alcoholic beverages are ancient art products that are found naturally. They become parts of human culture, tradition, and civilization as an integral part of many ceremonies, symbolism in rituals, and celebrations. Some of the traditional rice wine products in Indonesia such as brem, arak, and tuak were originally made for ceremonial/ritual and celebrations purposes but developed into a favorite drink and even have become a promising commercial product. Therefore, knowledge of fermentation technology, selection of raw materials, and a starter culture will provide better product quality. This can reduce losses and increase sales, so it is becoming a good source of revenue for the household, industry, state, and national levels. Furthermore, improvements in product performance, promotion, and marketing will have a positive impact on the development of alcoholic beverages with rice as the raw material in the future.

Keywords: Rice farming, subak, alcoholic beverage, rice wine.

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Rice Farming and History of Making Traditional Indonesian Alcoholic Beverage

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OUTLINE OF PRESENTATION

Introduction

Rice farming in Indonesia

History of traditional Indonesian alcoholic beverage

Making of traditional Indonesian alcoholic beverages

Conclusion
Indonesia is an archipelagic country that is widespread from 17,500 islands, with a population of 265,015,000 (BPS, 2018).

With a diverse tropical environment and plentiful annual precipitation. The volcanic origin of the archipelago provided vast areas of fertile soils which support both dense tropical rainforest and agriculture.

Rice is the most important staple food in Indonesia, with over 200 million people relying on rice as a staple food.

Indonesia ranks 3rd in the world in regards to total rice production but has also been the world’s 7th largest rice importer over the past 5 years (USDA, 2012).

Concurrently, domestic rice consumption has been increasing each year as a result of dietary changes associated with population growth and economic development, making Indonesia a leading global rice consumer (USDA, 2015).

Owing to the perennial shortfall of rice production, food security and the pursuit of national rice self-sufficiency have become predominant concerns of the Indonesian government.
Rice production & consumption in Indonesia

Historical rice yields and consumption

The highest rice production (2015) over than last 10 years (up 5.85%)

Production of paddy 2000-2015

Fig. 1.2 Production of paddy (2000-2015)

Source: BPS (2015)
Note: 2015 Data is second Forecast Figure (ARAM II)
To increase paddy production the Indonesian Government has carried out various efforts including increasing budgets, increasing human resources, providing fertilizer, developing integrated pest control, developing more productive and environmentally friendly farming methods, developing local and new varieties.

Climate change-resistant farming methods: Green Revolution, The System of Rice Intensification (SRI), and one of the old ways that are still relevant today is the Subak irrigation system.

In addition to increasing rice production (including glutinous rice), post-harvest handling, processing, and marketing of products are also being developed.

Traditional food and beverages that develop in the community, including fermented products, need to get the attention of all parties.

Fermented traditional drinks (alcoholic beverages) used in the past are used as a means of religious ceremonies / rituals, symbolism, celebrations, and finally become a favorite beverage that can be commercialized.
**Rice farming in Indonesia**

**History of rice farming in Indonesia**
- International Rice Research Institute (IRRI) scientists indicate that rice was first introduced to Indonesia in about 1500BC, and has been under continuous cultivation for the past 3,500 years. Rice is by far the most important food crop grown in Indonesia today (USDA, 2012).

**Rice farming area**
- Almost all islands in the Indonesian archipelago can be planted with rice, but the most are in Java, Sumatera, Sulawesi and Bali-Nusra. The total area of rice in Indonesia is 13.39 million Ha (Kementrian Pertanian, 2015).
- Total agricultural land in 2010 was estimated by the Indonesian government (BPS) at roughly 22 percent of the total land area in the country.

**Farming Methods**
- SRI in the field it is able to increase rice production significantly, provide good product quality, and achieve a high level of plant independence (Purwasasmita and Sutaryat, 2018).
- The “Green Revolution,” wherein new high-yielding cultivars were developed along with improved farming systems to significantly increase cropping intensity and yield (USDA, 2012).
- SUBAK a traditional irrigation system (Lansing, 2007).
Rice farming in Indonesia

The System of Rice Intensification (SRI)

- SRI is an evolving set of practices, principles, and philosophies aimed at increasing the productivity of irrigated rice by changing the management of plants, soil, water and nutrients.
- To increase Indonesia's productivity also has implemented The System of Rice Intensification (SRI) (Fig. 2.1). To succeed, still need a lot of adjustments and improvements.

Varieties

- New varieties have been developed that are adaptive to certain agroecosystems (BB Padi, 2017). Besides that the government is also still developing local varieties such as glutinous rice, brown rice, black rice that have certain advantages.

http://sri.ciifad.cornell.edu/

Fig. 2.1 Indonesia adaption of The System of Rice Intensification (SRI).
SUBAK is one of the rice farming irrigation systems in Indonesia

- Bali is in some ways typical of other agricultural areas in the region, but it is also a special case because of its distinctive economic and cultural environment dominated by tourism. In this environment, farmers are doubly marginalized. At the same time the island offers them unique market opportunities for premium and organic produce (MacRae, 2011).

- **Subak** is a traditional local organization concerned primarily with irrigation and the ritual aspects of rice production.

- The agricultural irrigation system that have existed since ancient times and still relevant today (Lansing, 1987).

- This system able to maintain the existence of agricultural water and environmental sustainability (Yuliana, *et al.* 2017)
In 1987, J. Stephen Lansing cooperate with farmers in Bali has redeveloped in the irrigation system/Subak irrigation becomes more effective. That way he can prove how the effectiveness and importance of Subak irrigation method in Bali.

Of the regions investigated in Indonesia, rice production in Bali has been the most efficient (Mariyono, 2014).

Since 2012 has become the UN recognized World Cultural Heritage for Education, Knowledge and Culture (UNESCO) (Kompas.com, 2012)

The determination as a World Cultural Heritage was welcomed by the government and the people of Bali. According to the filing, Subak in Bali which has an area of approximately 20,000 ha, consisting of a water control system that is in 5 districts of Badung, Bangli, Buleleng, Gianyar and Tabanan.

Subak model: The components of Subak is covering the forests that protect water supplies, landscapes of terraced rice fields that are connected by a system of canals, tunnels and dams, villages, temples of various sizes indicating the importance of water resources or water flowing through the temple declined irrigating water control system.
Figure 2.4. Landscape of traditional paddy *terasering* by *Subak* integrated system (*Subak Jatiluwih*). Paddy is cultivated near the river and hill at Petanu village.

[Link to image for landscape](https://www.goodnewsfromindonesia.id/2012/05/27/subak-the-unique-balinese-rice-farming-culture-designated-unesco-world-heritage)

[Link to image for landscape](http://berwisatadunia.blogspot.com/2016/02/jatiluwih-obyek-wisata-pemandangan.html)
**Figure 2.5.** 2\textsuperscript{nd} *Subak* Festival at Bugbug, Karangasem Regency, Bali.
In the past, along with the coming of civilization from India to Indonesia, there were many traditions which were carried along such as in terms of farming, postharvest handling, processing of agricultural products and traditions in religious rituals, celebrations, etc.

The religious text of the Vedas (Rig Veda) mentions at least one alcoholic beverage that might be related to wine (ura) is a type of rice wine fermented with honey (Sing et al., 2012).

About wine there are also at the Prambanan Temple reliefs, Borobudur Temple & other temples.

Fig. 3.2  A. Prambanan Temple Relief; B. The ceremony of Tawur Agung at Prambanan Temple.
Indonesians, especially Balinese, carry out the religious ceremonies in the form of offerings as a thank you for the success of harvesting agricultural products at certain times.

Hinduism people praying with Banten offerings are not only dedicated to the gods alone, for the Balinese also prepare offerings for the demons (bhūtas) to whom are given meat and alcoholic beverages.

Bantens consist of several meals, fruits and other food, which are then placed on one or more dishes.

Places the bantens for the Gods on high altars whereas he puts those for the Demons on the ground.

Before and after praying with offering, the “tetabuhan” (Tuak, Arak, Brem and Plain Water) are usually sprinkled.
“BANTEN” as Balinese offering

Fig. 3.4 Canang sari

Fig. 3.5 Segehan with *tape ketan* & *brem*

Fig. 3.6 The people bring offerings (*banten*) to the temple

http://www.booking-bali-villas.com/bali/bahasa-bali/
Praying with *metabuhan*

Fig. 3.7 A. containers for *Tuak*, *Arak*, *Brem*, and Water, B. When used in worship

http://www.pictame.com/tag/tetabuhan

**Fig. 3.8** Canang and segehan equipped with *tuak*, *arak*, *brem* and water (for *buta kala*)

**Fig. 3.9** Alcoholic beverage containers for a daily ritual
Food products and alcoholic beverages used in religious ceremonies, festivals and celebrations, etc.

Fig. 3.10  A. Shrine in Rice Field;  B. Performing religious rituals in the rice fields. (https://loisandgeorge2012.wordpress.com/tag/balineseceremonies/)

Fig. 3.11  Some Ribek: a religious ceremonies in barns or rice storage areas.
Tuak, Arak, & Brem in Bali as a means of religious ceremonies

Now it has developed into a favorite drink and even becomes an international drink.

- Since ancient times, local alcoholic drinks have been developed by indigenous people in the archipelago. Some panels in the 9th century of Borobudur Temple depicted drink sellers, small shops, and there were panels that depicted a building with people drinking (maybe alcoholic drinks), dancing and having fun, as if describing a tavern or inn.

- Initially alcoholic drinks were made for Hinduism ceremonies both in India, Indonesia including in Bali. Tuak, Arak and Brem are needed for tabuhan wasps (offerings) to the gods and “butha kala”.

- Brem, Arak and Tuak are popular drinks on the island of Bali which are predominantly Hindu. Brem is a brownish liquor with 5-14% alcohol. This product is exported to Japan and China.
The tradition of drinking alcoholic beverages in the past

Fig. 3.12  the tradition of drinking tuak

Fig. 3.13 Balinese Tuak (palm wine) container lid

Wooden palm wine container lid from Bali. This lid is placed on the top of a Bamboo container. Early 20th century


http://www.karlssonandwickman.com/tribal-art-page-2/stbkfhfj1gk3oy5omaynamhr5chlp0
### Table 4.1. Ethnic fermented alcoholic beverages of Indonesia

<table>
<thead>
<tr>
<th>Foods/Product name</th>
<th>Substrates/ Mayor ingredien</th>
<th>Nature and uses</th>
<th>Microorganisms</th>
<th>Regions of consumption in Indonesia</th>
<th>References</th>
<th>Appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuak (Toddy)</td>
<td>Juice of plant; Glutinous rice</td>
<td>Ritual Beverages</td>
<td>S. cerevisiae, C. tropicalis</td>
<td>North Sumatra, Nusa Tenggara Borneo, Bali, Lombok</td>
<td>Hermansyah et al. (2015)</td>
<td>Turbid drink Sour, sweet liquid,</td>
</tr>
<tr>
<td>Ballo</td>
<td>Juice of Nypa frutican (Nipah), Arenga piñata, Borassus flabellifer (lontar), rice</td>
<td>Beverages, celebration</td>
<td>S. cerevisiae</td>
<td>Sulawesi Selatan, Toraja,</td>
<td>Hermansyah et al. (2015)</td>
<td>Turbid drink Sour, sweet liquid,</td>
</tr>
<tr>
<td>Ciu Bekonang /Ciu Banyumas Spirit</td>
<td>Cane sugar, Palm sugar, omplong, tape singkong, water</td>
<td>Beverage, celebration</td>
<td>S. cerevisiae</td>
<td>Sukoharjo, Banyumas (Central of Java)</td>
<td><a href="https://sportourism.id/explore/mengintip-tradisi-pembuatan-ciu-di-desa-bekonang">https://sportourism.id/explore/mengintip-tradisi-pembuatan-ciu-di-desa-bekonang</a></td>
<td>Clear liquid alcohol</td>
</tr>
</tbody>
</table>
### Table 4.2 The constituent component of *ragi tape*

<table>
<thead>
<tr>
<th>Component</th>
<th>Amount (% of Rice)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>100</td>
</tr>
<tr>
<td>Garlic</td>
<td>0.50-18.70</td>
</tr>
<tr>
<td>White pepper</td>
<td>0.05-6.20</td>
</tr>
<tr>
<td>Galangal</td>
<td>2.50-50.00</td>
</tr>
<tr>
<td>Red chili</td>
<td>0.25-6.20</td>
</tr>
<tr>
<td>Cinnamon</td>
<td>0.05-3.50</td>
</tr>
<tr>
<td>Black pepper</td>
<td>0.30-2.50</td>
</tr>
<tr>
<td>Fennel</td>
<td>2.50-3.00</td>
</tr>
<tr>
<td>Sugar cane juices</td>
<td>1.00-12.50</td>
</tr>
<tr>
<td>Lime</td>
<td>2.50</td>
</tr>
<tr>
<td>Coconut water</td>
<td>50.00</td>
</tr>
</tbody>
</table>
Making Ragi & Tape Ketan

Traditions in the conventional handling, preservation and application of starter cultures

Fig. 4.1 Flow charts for the preparation of solid-fermented starters (Nuraida, 2016)
Ragi tape:
Weighs ± 3 g round flat shape, 1 pieces for 1 kg glutinous rice

Additional ingredient:
• Water
• Marinade
• Nutrient/ Mineral source

Composition of Glutinous Rice:
• Carbohydrate: 79.4% : 78%
• Protein: 6.7% : 7%
• Fat: 0.7% : 0.7%
• Ca: 0.012% : 0.010%
• Fe: 0.008% : 0.001%
• P: 0.148% : 0.148%
• Vitamin B: 0.0002%
• Water content: 12%
Various brands of ragi tape

Ragi Tape is a dry starter: (much ragi is sold without any brand name)
Ragi is off-white in color & shaped into small disks or flattened balls about 2-3 cm in diameter. Ragi tape is made from: Rice starch, garlic, chili, white pepper, fennel, etc.
Place: Cianjur, Cirebon, Solo, etc. (Java island).

Used for:
Making sticky tape and cassava tape: it tastes sweet, fragrant and tastes good
For Japanese ant feed: Japanese ants can be used as medicine when the Japanese ants are fed ragi tape
**Table 4.3 Microbiology of *ragi* tape**

<table>
<thead>
<tr>
<th>Microbial Group</th>
<th>Genera/Species</th>
<th>References</th>
<th>Genera/Species</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Molds</strong></td>
<td>Amylomyces rouxii</td>
<td>Ko (1972); Ardhana &amp; Fleet (1989)</td>
<td>Bacillus coagulans</td>
<td>Ardhana &amp; Fleet (1989)</td>
</tr>
<tr>
<td><strong>Yeast</strong></td>
<td><em>Endomycopsis</em></td>
<td>Ko (1972)</td>
<td><em>Clostridium perfringens</em></td>
<td>Sujaya et al., (2010)</td>
</tr>
<tr>
<td></td>
<td><em>Saccharomyces</em> sp.</td>
<td>Ko (1972); Saono et al. (74)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Asterotremella</em> humicola</td>
<td>Saono et al., (1974)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Candida</em> sp.</td>
<td>Saono et al., (1974)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>C. guilliermondii</em></td>
<td>Saono et al., (1974)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>C. japonica</em> (F. capsuligenum)</td>
<td>Saono et al., (1974)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>C. intermedia</em></td>
<td>Saono et al., (1974)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>C. parapsilosis</em></td>
<td>Saono et al., (1974)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>C. solani</em></td>
<td>Saono et al., (1974)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>C. pelliculosa</em></td>
<td>Saono et al., (1974); Ardhana &amp; Fleet (1989)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Flow chart of “tape ketan” production

- Tape ketan is a traditional Indonesian fermented food that is produced across Indonesia.
- Two types of tape ketan: black & white); with Pandanus amaryllifolius, etc.)

Fig. 4.4 Flow chart for the manufacture of Indonesian tape ketan (Saono et al. 1986; Nuraida & Owens, 2015)
### Table 4.5 Microbiology of tape ketan

<table>
<thead>
<tr>
<th>Microbial group</th>
<th>Genera/Species</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molds</td>
<td><em>Amylomyces rouxii</em> <em>(R. arrhizus)</em></td>
<td>Djien (1972); Cronk <em>et al.</em> (1977); Ardhana &amp; Fleet (1989) (Amylolitic)</td>
</tr>
<tr>
<td>Yeast</td>
<td><em>Hyphopichia burtonii</em> <em>(Endomycopsis burtonii)</em></td>
<td>Cronk <em>et al.</em> (1977):</td>
</tr>
<tr>
<td></td>
<td><em>Saccharomycopsis fibuligera</em> <em>(Endomycopsis fibuligera)</em></td>
<td>Djien (1972);</td>
</tr>
<tr>
<td></td>
<td><em>Candida beverwijkiae</em> <em>(C. pellicullosa)</em></td>
<td>Ardhana &amp; Fleet (1989) (as the dominant yeast in tape, amylolitic)</td>
</tr>
<tr>
<td></td>
<td><em>S. cerevisiae</em></td>
<td>Ardhana &amp; Fleet (1989)</td>
</tr>
<tr>
<td></td>
<td><em>Wickerhamomyces anomalus</em> <em>(Hansenula anomala)</em></td>
<td>Ardhana &amp; Fleet (1989) (intolerant of high ethanol)</td>
</tr>
<tr>
<td>Bacteria</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
4.2 BREM

The microbial ecology of tape fermentation

- *Brem* products are of two types: solid and liquid (lots of solid *brem* are produced in Java; liquid *brem* are produced in Bali and Lombok Island).

- Solid and liquid *brem* are made beginning with *tape ketan* fermentation (solid *brem*: white sticky rice; liquid *brem*: white and black sticky rice).

- Solid *brem* of fermented liquid is then cooked until a semi-viscous liquid is obtained and dried. Liquid *brem*: second fermented with *S. cerevisiae*, aging and bottled.

- Saccharification of starch and sugar fermentation occur simultaneously (parallel) due to the presence of *Aspergillus*, *Rhizopus* and other amylolytic fungal species, *Saccharomyces cerevisiae* and other yeasts.
Fig. 4.6 Flow chart of *Brem* Bali production
The microorganisms found in *ragi tape* include the fungi *Rhizopus*, *Mucor* and *Amylomyces*, the yeasts *Saccharomycopsis fibligera* and *Pichia anomala*, and various lactic acid bacteria (Holzapfel, 2002), although the predominant species in brem is *Saccharomyces cerevisiae*, which possesses high fermentation activity (Sujaya *et al*., 2004).

The *S. cerevisiae* strains were divided into four types based on the pattern of chromosomal DNA binding, and each type produced *brem* with different organic acids and volatile compounds when used as single strains (Sujaya *et al*., 2004).
4.3 ARAK

(White glutinous rice)

Fig. 4.8 Flow chart of ARAK production

- Fermentation I
- Pressing
- Distillation
- Aging, Adjusted & redistilled
- Filling & Bottling
- Labelling
- Packaging

- Fermentation stage II
- Yeast
- Ragi tape
- Washed and soaked
- Cooked / Steamed
- Cooling
- Collected
- Storage
- Distribution

ARAQ BALI
Rice-based "ARAK" products:

Dewi Sri, Pura, Nikki, Tiga Bintang, Legong, Jablay, etc.

Fig. 4.9 Various arak brands
Traditional ARAK production (palm juices)

Fig. 4.10 Flow chart for the Traditional Indonesian arak based palm juices

Palm juices

Collected

Filtration

Fermentation at room temperature with “lau” (coconut fibers), 3-4 d

Distillation

ARAK (35-40% alcohol)

De’Awa is a coconut palm-based Balinese Arak.

http://nowbali.co.id/the-indigenous-balinese-arak/

4.4 TUAK
(Fermented palm juices)

Palm juices

Collected

Filtration

Spontaneous fermentation at room temperature with lau (Coconut fibers) (4-6 h)

Fresh TUAK

Pasteurization

TUAK (Sweet palm wine)

Fig. 4.11 Tuak production
Their vulnerability to climate change requires adaptation strategies for irrigation and cultivars selection.

The recent forms of agricultural policy in Indonesia, which include the deployment and implementation of environmentally friendly technologies such as the SRI system, with the aim to reduce the use of chemicals.

The Subak irrigation system still able to maintain the existence of agricultural water and environmental sustainability.

The Indonesian government should use two approaches at both ends of the chain to achieve rice self-sufficiency. On the one hand, encouraging farmers to increase their production by stimulating technological innovation and by providing subsidized fertilizer. At the other end, the government tried to curb the consumption of people's rice.

Some of the traditional rice wine products in Indonesia such as arak, brem, and tuak were originally made for ceremonial, ritual symbolism and celebrations but developed into a favorite drink and even became a promising commercial product.

Knowledge of fermentation technology, selection of raw materials, starter culture, will provide better product quality and will be a positive impact on the development of alcoholic beverage.
Thank you very much for your attention

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http://www.mantrahindu.com/tag/tumpek-uduh/