Recommendations for addressing quality issues of government rice reserve: Indonesia case study

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Abstract. The management of government rice reserves (GRR) is crucial for maintaining national food security. However, prolonged storage can lead to a decrease in rice quality. This study aimed to assess the characteristics of rice stored in the GRR warehouse and provide recommendations to address the issue of deteriorating rice quality. This study collected and analysed GRR samples, secondary data, and information from relevant policymakers and stakeholders. The results showed that the quality of GRR, when stored for extended periods of up to 27 months, had notably degraded and was not suitable for human consumption. The main recommendations withdrawn from this study were (1) it is necessary to reconsider the criteria that determine the deterioration of the GRR's quality as outlined in Minister of Agriculture Decree No. 45 of 2019, mainly moisture content and degree of milling; (2) GRR can be declared as low quality if it meets at least two parameters stated in the Ministerial Regulation, and it is not necessary to meet all four quality reduction parameters; and (3) the release of GRR can be initiated as soon as it has been stored for four months. This is aimed at preserving the quality of the GRR and minimising losses.

1 Introduction

Food is a basic necessity for society, and its provision will determine a country's economic, social, and political stability. Food security is a multidimensional and complex issue that requires strong policies based on stakeholder interactions [1]. Therefore, the Ministry of Agriculture of the Republic of Indonesia (MoA) has established a series of strategies to enhance food security. Short-term strategies include stabilising food prices and strengthening the establishment of staple food buffer stocks, while one of the long-term strategies involves reducing losses in major agricultural commodity yields [2]. Rice is one of the Indonesian strategic commodities that often triggers price fluctuations and inflation. To ensure food security, it is essential to focus on stabilising both food supply and prices. This can be accomplished by enhancing food reserves, which involves improving their quantity, quality, procurement methods, and distribution processes [3]. However, food reserve policies aimed

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at stabilising supply and prices have not been successful and fully operational due to various problems, including a lack of support for scientific studies.

Rice is a staple food for the majority of the Indonesian population. The demand for rice in Indonesia has steadily increased every year, which is in line with the growing population. Indonesia's high dependency on rice could pose a serious problem if rice availability falls short of demand. The Indonesian government, through Government Regulation No. 13 of 2016, has mandated PERUM BULOG, a state-owned enterprise, with responsibilities related to national food security, including (1) ensuring the stability of staple food prices, specifically rice, at both the producer and consumer levels, (2) managing the government's staple food reserves, (3) providing and distributing staple food to specific segments of the population, and (4) conducting rice imports in accordance with relevant regulations. Furthermore, Presidential Regulation No. 48 of 2016, concerning the Assignment to the State-Owned Company PERUM BULOG for National Food Security, reinforces PERUM BULOG's mandate to ensure the availability of food and stabilise food prices for both consumers and producers [4].

The Government Rice Reserve (GRR) is a stockpile of rice controlled and managed by the government through PERUM BULOG, with the purpose of addressing emergency disaster situations and post-disaster food insecurity. The utilisation of GRR includes responding to emergencies, providing social assistance, conducting market operations, and supporting international aid and cooperation efforts. The GRR can be achieved through the purchase of domestically produced rice as well as imports. During periods when rice supply is abundant in the market, market operations cannot be carried out to reduce the rice stock in storage. As a result, the government's rice reserves have often accumulated in warehouses for over a year. For example, based on data from the annual report, PERUM BULOG manages an average rice stock of 4-5 million tons each year. The rice procurement quantity ranges from 2 to 3 million tons, sourced from initial warehouse stocks and rice/paddy procurement. After distribution (including RASTRA, commercial sales, and others), the final stock in BULOG's warehouses for the years 2016-2018 were 1,672,000 tons, 921,000 tons, and 2,194,000 tons, respectively [3].

Prolonged rice storage can lead to a decline in rice quality, affecting its physical, chemical, and sensory characteristics. The market price of rice is primarily influenced by the visual characteristics of the grains, such as the shape and size of the kernels, translucency, and chalkiness. Rice with damaged kernels has an unappealing appearance and low market value. Similarly, a high level of chalkiness reduces market desirability [5]. Changes in the starch, protein, and fat contents of rice have been observed during storage [6]. The quality of stored food materials is greatly influenced by the initial quality of the raw materials, the storage system, and the introduction of preservatives during storage, such as insecticides, phosphine gas, or carbon dioxide. This is supported by the findings of Ranalli et al. [7], who reported that an aeration system with specific air humidity also has a positive effect on rice quality during storage. It was stated that the activity of microorganisms leads to a reduction in rice weight during storage. This microbial activity causes enzymatic reactions involving the oxidation of carbohydrates, proteins, and fats, resulting in the production of carbon dioxide, water vapour, and fats [8].

During the storage period, temperature and humidity are critical factors that can influence the physical, chemical, and cooking characteristics of rice depending on the implementation of Good Storage Practices. Various physicochemical and physiological changes take place, a phenomenon commonly referred to as ageing, which impacts the functional and eating qualities of rice. For instance, as rice ages, the texture of cooked rice tends to become fluffier and harder, with a decrease in the amount of leachate produced during cooking [9]. Ageing

also results in reduced solid loss, peak viscosity, breakdown, and adhesiveness, along with an increase in head rice yield, minimum cooking time, water absorption, volume expansion, pasting temperature, final viscosity, through viscosity, setback, and hardness [10]. Stored rice grains serve a dual purpose: they meet the ongoing annual consumption as a staple food and serve as crucial emergency provisions during natural disasters and unforeseen circumstances [11]. Consequently, maintaining the quality of rice grains is imperative to preserve their commercial value. However, due to unpredictable circumstances, the quality of stored rice grains frequently undergoes changes, with yellowing being a common occurrence during rice storage [12].

The release of low-quality rice from the GRR remains a subject of debate concerning its suitability for consumption and the timing of its release. Policies governing the release of low-quality rice are outlined in the Regulation of the Minister of Agriculture No. 38/2018 on the Management of Government Rice Reserves [13] and its derivative, Ministerial Regulation No. 45/2019 on the Criteria for Reducing the Quality of Government Rice Reserves [14]. In the former, it is stated that GRR can be released under the following circumstances: (1) when GRR has exceeded the minimum storage period of four months in PERUM BULOG warehouses, and (2) when it has the potential for or is experiencing a decrease in quality [13]. In the latter, the criteria for the decrease in rice quality are (1) moisture content > 14%, (2) broken grains > 20%, (3) degree of milling < 95%, and (4) off-odours, sourness, or other foreign odours [14]. There appears to be a lack of synchronisation between these two regulations, indicating a need for further examination.

The objective of this study was to analyse the following research questions. (1) Why is the release of GRR constrained, leading to rice stockpiling and the emergence of quality deterioration issues? (2) What recommendations are needed to resolve these issues so that the released rice remains suitable for human consumption?

2 Methodology

This study was conducted in 2020. The activities carried out included (1) field visits, (2) quality analysis of rice samples from GRR warehouses, (3) interviews with PERUM BULOG and relevant policy stakeholders, (4) literature review, and (5) compilation of secondary data. The data collected included both secondary and primary data. Secondary data encompass the year of GRR procurement, GRR shelf life, sampled GRR warehouse locations (Bojonegoro, Jember, Cirebon, Jakarta) obtained from PERUM BULOG, as well as parameters and rice quality grades based on the Indonesian National Standard (SNI). Primary data consisted of quality analysis results with parameters following SNI 6128:2015 and rice amylose content.

Eight rice samples were obtained through random sampling conducted by PERUM BULOG, taken from rice stored in four different GRR warehouse locations for a period of 9 to 27 months. The analysis followed the quality grade specifications of rice based on SNI 6128:2015. Additionally, an analysis of the amylose content of these rice samples was also performed.

The compilation of information, secondary data, and primary data was then carefully reviewed and analysed descriptively to form the basis for drafting policy recommendations. To gather additional information and enhance the study's findings, a Focus Group Discussion (FGD) was conducted and attended by relevant experts and policymakers. This FGD served as a forum for further development and refinement of the proposed policy recommendations.

3 Results and discussion

3.1 Procurement, maintenance, and release of GRR

The procurement of rice as Government Rice Reserves (GRR) follows standards, i.e., the medium quality standards outlined in SNI 6128:2015 regarding rice quality standards. When rice is received, the intake process is immediately followed by scheduling maintenance procedures, including monthly insecticide spraying to eliminate pests. Maintenance is conducted each time there is a new supply of paddy or rice.

The rice supplied to PERUM BULOG comes from both domestic sources and imports. Based on PERUM BULOG's observations, imported rice tended to have a longer shelf life than domestic rice. However, PERUM BULOG did not have laboratory analysis data for this rice upon arrival. The criteria used were primarily based on physical quality standards for medium-quality rice according to SNI 6128:2015 (Table 1). It is suspected that imported rice may fall into the category of non-sticky, with a high degree of milling (potentially 100%) and a maximum moisture content of 14%. During storage, alterations may occur in the chemical properties of rice, such as amylose content and moisture levels, which subsequently influence physical attributes like texture, particularly the stickiness of rice. Butt et al. [9] observed that as rice aged, the texture of cooked rice became fluffier and firmer, and there was a reduction in the amount of liquid released from cooked rice. Therefore, it is recommended that the rice be characterised when it is initially received at the warehouse. PERUM BULOG does not use the term "rejected rice" but rather refers to it as low-quality rice, which is not fit for consumption due to unpleasant characteristics such as being dusty, damaged, or contaminated.

Table 1. Classification and characteristics of rice quality according to SNI 6128:2015.

Characteristics	Quality threshold*	Quality grades			
		Premium	Medium		
			1	2	3
Degree of milling (%)	Min.	100	95	90	80
Moisture (%)	Max.	14	14	14	15
Head rice (%)	Min.	95	78	73	60
Broken rice (%)	Max.	5	20	25	35
Rice groats (%)	Max.	0	2	2	5
Red kernel (%)	Max.	0	2	3	3
Yellow/damaged kernel (%)	Max.	0	2	3	5
Chalky kernel (%)	Max.	0	2	3	5
Foreign matters (%)	Max.	0	0.02	0.05	0.2
Paddy grain (kernel/100g)	Max.	0	1	2	3

*Remarks: Min. = Minimum; Max. = Maximum

The mechanism for the release of GRR is governed by Regulation of the Minister of Agriculture No. 38 of 2018 regarding the Management of Government Rice Reserves. The release of GRR can occur under the following conditions: (1) GRR has exceeded the minimum storage period of four months in PERUM BULOG warehouses, and/or (2) it has the potential for or is experiencing a decrease in quality [13]. Furthermore, the criteria for the decrease in quality are stipulated in Ministerial Regulation No. 45 of 2019, which include (1) moisture content > 14%, (2) broken grains > 20%, (3) degree of milling < 95%, and (4) off-odours, sourness, or other foreign odours [14].

However, the PERUM BULOG is facing several challenges in the release of GRR, including:

(1) PERUM BULOG has been tasked with procuring rice from farmers' harvests. However, when this study was conducted, there were downstream policy changes that led to difficulties in distributing GRR. Previously, the Prosperous Rice for Welfare Assistance policy could facilitate the release of the GRR. However, this policy was discontinued in May 2019 and replaced by the Non-Cash Food Assistance Program provided to beneficiary groups every month through an electronic account mechanism via the Family Welfare Card, which is solely used to purchase food products [15]. After the implementation of the Non-Cash Food Assistance policy, the distribution of GRR became obstructed. In 2023, a global phenomenon known as El Niño occurred, resulting in prolonged droughts and crop failures, which in turn led to high rice prices. In response to this, the Indonesian Government launched a program for the GRR as food assistance to 21.353 million Beneficiary Families. This food assistance program was implemented in March, April, and June 2023 and will continue in October, November, and December 2023 [16]. Apart from serving as an effort to control food inflation, this food assistance program also contributes to the release of GRR, preventing stockpiling and reducing the risk of a decline in stored rice quality.

(2) There is an accumulation of GRR stored in PERUM BULOG warehouses with a shelf life of more than one year, and in some cases, up to 2-3 years (Table 2), but it could not be released because it did not meet the four criteria for quality reduction required in Ministerial Regulation No. 45/2019 as described previously, without stating the maximum storage time for the release of GRR. The conventional management of GRR in PERUM BULOG warehouses is likely to contribute to the accumulation of rice for more than one year and incur high costs. The stacking of sacks, manual counting, and inventory of rice sacks often lead to counting errors, necessitating a time-consuming and relatively expensive stocktake [17]. Therefore, it is recommended that modern logistics management practices be adopted/implemented. Improvements in facilities through modernisation and technological advancements are essential to enable the application of principles of effectiveness, efficiency, and unrestricted access in terms of time and space. The development of Rice Logistics 4.0 encompasses resource planning, warehouse management systems, transportation management systems, smart transportation systems, and information security [18].

(3) Initially, the government allocated funds for the procurement of GRR. However, currently, PERUM BULOG is required to procure GRR independently. On the other hand, PERUM BULOG has limited authority and flexibility in purchasing and releasing GRR due to strict legal mechanisms. The proper release of GRR before its quality deteriorates has the potential to result in reduced funds (selling at a low price) or loss of tonnage (reprocessing, exchange, donation), which requires compensation to ensure that the government's rice stock remains secure, both in terms of quantity and quality. Reprocessing is carried out on low-quality GRR to improve its quality. Reprocessing is conducted using several methods, including (1) blowing (low-quality GRR is subjected to air blowing to remove or reduce dust and odour), (2) soft polishing (low-quality GRR is passed through a polisher without pressure), (3) hard polishing (low-quality GRR is passed through a polisher with pressure), (4) hard polishing and misting (low-quality GRR is passed through a polisher and misted to eliminate dust, odour, and dull appearance), and (5) mixing (low-quality rice that has undergone reprocessing is blended with good-quality rice to produce rice of better quality that aligns with consumer preferences). Currently, the procedures for releasing the GRR and the reimbursement of the difference in values and tonnage appear to be non-operational.

3.2 Quality attributes of stored GRR

Previous research has primarily focused on the analysis of rice inventory in PERUM BULOG warehouses and has not directly addressed the changes in rice quality within BULOG warehouses. For instance, these studies include an analysis of the impact of government rice stock management policies on rice prices and the problems arising from these policies [3], the effect of rice stockpiling on pest populations and rice quality during storage [19], and an analysis of rice inventory control in the PERUM BULOG Subdivision Parepare [20]. Quality attributes of stored GRR samples obtained in the present study are shown in Table 2, which were then assessed according to the classification of rice quality specified in the National Standard SNI 6128:2015 (Table 1). Based on the information obtained from PERUM BULOG, both imported and domestic rice for GRR, upon entering the warehouse, had a medium-grade rice quality, with a maximum broken rice percentage of 20% (medium quality 1). Therefore, the rice initially had a milling degree of at least 95%, maximum moisture content of 14%, and maximum broken rice percentage of 20%. The results (Table 2) show that the moisture content of all GRR samples still met the standards. However, the percentages of head rice and broken rice no longer met these standards. Meanwhile, the percentage of rice groats stored for 9-14 months still met the SNI standards, while rice stored for 25-27 months no longer met the standards (Table 2).

Table 2. Physical quality characteristics of stored GRR samples.

Identity/ attributes	Rice code*							
	DN 2018	DN 2018	DN 2018	DN 2019	DN 2019	DN 2019	DN 2019	LN Pxxxxxx
Storage (month)	23	25	27	9	9	13	14	>24
Warehouse location	Bojo-negoro	Jember	Cirebon	Bojo-negoro	Jember	Jember	Cirebon	Jakarta
Moisture (%)	11.72	11.89	11.31	11.82	12.30	12.36	11.67	11.78
Head rice (%)	47.51	33.30	59.84	59.41	53.22	53.80	65.94	77.22
Broken rice (%)	48.85	59.64	37.55	40.36	46.63	46.11	34.04	22.51
Rice groats (%)	3.64	7.06	2.61	0.23	0.15	0.10	0.02	0.27
Red kernel (%)	0	0	0	0	0	1.01	0	0
Yellow kernel (%)	3.61	4.20	7.16	2.35	2.64	2.72	2.89	0.97
Chalky kernel (%)	0	0	0	0	0	0	0	0
Paddy grain (kernel/100g)	2	3	2	5	0	0	0	0
Foreign matters (%)	0	0	0	0	0	0	0	0
Degree of milling (%)	90	85	85	90	95	85	85	95

*Remarks: DN = domestically sourced rice; LN = imported/overseas sourced rice

All GRR samples were stored for more than 4 months, ranging from 9 to 27 months (Table 2). According to the Regulation of the Minister of Agriculture No. 38/2018 [13], all this rice stock should have been released. If the process of releasing GRR went smoothly and the replacement of stock was carried out as required, then the GRR inventory would consistently maintain its good quantity and quality. Nevertheless, in practice, rice stocks with the

conditions shown in Table 2 are still being stored in PERUM BULOG warehouses. Based on the Regulation of the Minister of Agriculture No. 45/2019 [14] regarding the criteria for the deterioration of GRR, it includes moisture content >14%, degree of milling < 95%, broken rice >20%, and the presence of musty, sour, or other foreign odours. All these criteria must be met for rice to be released. Table 1 shows that the percentage of broken rice in the eight rice samples ranged from 22.51% to 59.64%, indicating that all of them had deteriorated. The degree of milling was below 95% for all of them, except for the rice from the Jember warehouse stored for nine months and the rice from overseas (LN). Based on the degree of milling and broken grains, it appears that LN rice still had the best appearance among the eight samples tested. Meanwhile, the moisture content parameter ranged from 11.31% to 12.36%, indicating that all rice samples still met the GRR criterion, although some other rice characteristics did not meet GRR requirements. This may also imply that moisture in the warehouses was well controlled during storage. Previous studies have shown that rice stored for a long time experienced an increase in moisture content [21]. Therefore, further studies are required to determine whether moisture content should be included in the criteria for rice quality deterioration. For these reasons, if any one of the four characteristics has indicated a decline in rice quality, the GRR should be released, without waiting for all four characteristics to be met.

Rice storage conditions influence the quality of the resulting rice. The texture of rice after prolonged storage is softer and more tender [22]. Rice texture is influenced by amylose content. Rice with a lower amylose content has a softer or more tender texture [23]. The amylose content of GRR stored for 9-27 months ranged from 17.8 to 20.77% (Table 3). These findings suggest that rice could be categorised as having low amylose content, which leads to a tender rice texture. It is possible that there was a decrease in amylose content during storage. However, since there are no data available on the initial amylose content, conclusions about changes in amylose content during storage cannot be made.

Table 3. Amylose content of stored GRR samples.

Rice code	Storage duration (month)	Warehouse location	Amylose (%)
DN 2018	23	Bojonegoro	20,20
DN 2018	25	Jember	19,82
DN 2018	27	Cirebon	19,43
DN 2019	9	Bojonegoro	20,46
DN 2019	9	Jember	20,21
DN 2019	13	Jember	19,64
DN 2019	14	Cirebon	20,77
LN Pxxxxxxx	>24	DKI Jakarta	17,81

3.3 Review of the determination of the decline in the quality of GRR

Based on the analysis of primary and secondary data, literature review, and information obtained from experts during the FGD, the review results of the determination of deteriorated GRR are as follows:

- The Minister of Agriculture Regulation No. 38 of 2018 [13] clearly states that GRR can be released from warehouses after four months of storage. Based on this regulation, PERUM BULOG should be able to release rice. However, the Minister of Agriculture

Regulation No. 45 of 2019 [14] on the Criteria for the Deterioration of Government Rice Reserves requires that all four rice quality characteristics (as mentioned earlier) be met for rice to be released from warehouses. This study showed that a moisture content of >14% was not achieved, even though the rice had been stored in the warehouses for up to 27 months, and the other three characteristics showed a decline in rice quality (Table 1). Therefore, the criterion of moisture content >14% has been considered inappropriate as a determinant of quality deterioration and a reference for rice release.

- The SNI standards state that the determined parameters are absolute, meaning that if any one of them is not met, the rice is considered deteriorated. Therefore, if any one parameter shows a significant decline in rice quality, the GRR should be released, and it is not necessary to wait for all four parameters to decrease in quality.
- The procurement and release of GRR still do not consider eating and taste quality parameters. In fact, these characteristics also determine rice consumption preferences. Therefore, for eating and taste quality criteria, it is necessary to determine the amylose content in addition to sensory evaluation.

4 Conclusions

The technical regulations underlying the release of GRR, that is, Minister of Agriculture Regulation No. 38 of 2018 and Minister of Agriculture Regulation No. 45 of 2019, had not been operational as expected. As a result, the accumulated rice stocks were stored in PERUM BULOG warehouses for prolonged storage periods of more than a year. Based on Minister of Agriculture Regulation No. 38 of 2018, GRR can be taken out from storage warehouses following a four-month storage period so that the released GRR remains fit for human consumption. This also implies that GRR can be released before four months of storage if the rice quality has deteriorated. However, according to the Minister of Agriculture Regulation No. 45 of 2019, rice is considered to have deteriorated if it meets four conditions: moisture content >14%, degree of milling < 95%, broken grains >20%, and it has a musty, sour, or other foreign odour. This study showed that the moisture content of >14% was unlikely to be met, and only two conditions, broken rice and the presence of a musty odour were consistently met. Therefore, the underlying regulations need to be reviewed for operational purposes. The release of GRR not only needs to meet quality deterioration criteria but is also related to the availability of funds to replace the released rice to ensure that GRR is maintained in terms of both quantity and quality. Harmonisation of the underlying regulations is necessary to improve the management of GRR and safeguard national food security.

This study suggested that GRR can be declared of reduced quality if at least two parameters specified in Ministerial Regulation No. 45 of 2019 are met (not necessarily meeting all four quality deterioration parameters). GRR can be released as soon as it has been stored for four months. This is to maintain the safety and quality of rice and minimise losses due to quality deterioration and maintenance costs. A clear mechanism is needed to make Ministerial Regulation No. 38 of 2018 operational (eliminating the existence of GRR with prolonged storage) so that the rice released to the public still has acceptable safety and quality for consumption. The procurement of GRR in the form of paddy needs to be increased to ensure better traceability and quality of GRR. The release of GRR has the potential to reduce (initial) funds due to selling at a lower price or the loss of quantity due to processing, exchange, or aid. This needs to be anticipated by preparing replacement funds to ensure the safety of GRR in terms of both quantity and quality. Released GRR can also be processed into food products, such as flour and vermicelli, to increase its economic value while considering food quality and safety standards.

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