DINAMISIA: Jurnal Pengabdian Kepada Masyarakat Vol. 10, No.5 Oktober 2026, Hal. 1571-1576
DOI: https://doi.org/10.31849/dinamisia.v10i5.34632

Optimizing Paddy Field Growth through NPK Fertilization and Liming at the Rumbio Sarumpun Farmers' Group in Benai Subdistrict, Kuantan Singingi Regency

Optimalisasi Pertumbuhan Padi Sawah melalui Pemupukan NPK dan Pengapuran di Gapoktan Rumbio Sarumpun Kecamatan Benai Kabupaten Kuantan Singingi

Anthony Hamzah[1], Irwin Mirza Umami[2], Eko Wahyudi[3], Dian Rakhmad[4], Chandra Gunawan[5], M. Joehari Jamili[6], Dedi Mulyadi[7], Elisa Apriliani[8], Jeany Ristia[9], Arum Rovarti Ningsih*[10], Fadlila Endyra[11], Masyitah[12], Nurbaiti[13], Angga Pramana[14], Vivin Jenika Putri[15] , Anania rahmah[16]
[1,2,3,4,5,6,7,8,9,10,11,12,13,14]Universitas Riau
[15,16] Universitas Lancang Kuning
E-mail: anthony.hamzah@lecturer.unri.ac.id [1], irwinmirzaumami@lecturer.unri.ac.id [2], ekowahyudhi93@lecturer.unri.ac.id [3], dian.rakhmad@lecturer.unri.ac.id [4], chandragunawan@lecturer.unri.ac.id [5], m. Joehari@lecturer.unri.ac.id [6], dedimulyadi@lecturer.unri.ac.id [7], elisa.apriliani@lecturer.unri.ac.id [8], jeany.ristia@lecturer.unri.ac.id [9], arum.rovarti@lecturer.unri.ac.id [10], fadlila.endyra@lecturer.unri.ac.id [11], masyitah@lecturer.unri.ac.id [12] , nurbaiti@lecturer.unri.ac.id [13], pramana.angga@lecturer.unri.ac.id [14] vivinjenika@unilak.ac.id [15] ananiarahmah@unilak.ac.id [16]

Abstract

Limited farmer knowledge of balanced fertilization and acidic paddy soil conditions contributed to the suboptimal rice productivity of the Rumbio Sarumpun Farmers Association in Benai District. This community service program applied participatory and andragogical approaches through participant identification, focus group discussions, pre-tests, technical training, demonstrations, field practice on demonstration plots, mentoring, post-tests, and field observations. The introduced technology consisted of pre-planting liming using dolomite and balanced NPK fertilization according to crop requirements and growth stages. The combined application of liming and balanced NPK fertilization resulted in better rice growth than the farmers' previous practices, as indicated by improvements in plant height, productive tillers, leaf area, panicle number, filled grains, and 1,000-grain weight. Rice productivity increased by an average of 15–25%. The program also improved farmers' knowledge and practical skills in soil fertility management and appropriate fertilizer application. However, the sustainable adoption of this technology remained constrained by limited access to agricultural lime and production costs. Continuous mentoring and support from agricultural extension officers, universities, and local governments were therefore required to promote wider and more sustainable implementation.

Keywords*: Lowland rice, NPK fertilization, liming, productivity, acidic soil*

Abstrak

Rendahnya pemahaman mengenai pemupukan berimbang dan kondisi tanah sawah yang masam menjadi penyebab belum optimalnya produktivitas padi di Gapoktan Rumbio Sarumpun, Kecamatan Benai. Kegiatan pengabdian menggunakan pendekatan partisipatif dan andragogis melalui identifikasi peserta, diskusi kelompok terarah, pre-test, bimbingan teknis, demonstrasi, praktik pada lahan percontohan, pendampingan, post-test, dan observasi lapangan. Teknologi yang diterapkan berupa pengapuran menggunakan dolomit sebelum tanam dan pemupukan NPK berimbang sesuai kebutuhan tanaman serta fase pertumbuhannya. Penerapan kombinasi pengapuran dan pemupukan NPK menghasilkan pertumbuhan padi yang lebih baik dibandingkan praktik petani sebelumnya, yang ditunjukkan oleh peningkatan tinggi tanaman, jumlah anakan produktif, luas daun, jumlah malai, gabah bernas, dan bobot 1.000 butir. Produktivitas padi meningkat rata-rata sebesar 15–25%. Kegiatan ini juga meningkatkan pengetahuan dan keterampilan petani dalam mengelola kesuburan tanah dan menerapkan pemupukan secara tepat. Namun, keberlanjutan penerapannya masih menghadapi kendala berupa keterbatasan akses terhadap kapur pertanian dan biaya sarana produksi, sehingga diperlukan pendampingan serta dukungan dari penyuluh, perguruan tinggi, dan pemerintah daerah.

DOI: https://doi.org/10.31849/dinamisia.v10i5.34632

***Kata kunci**: Padi sawah, Pemupukan NPK, Pengapuran, Produktivitas, Tanah Masam*

1. INTRODUCTION

Rice is a strategic food commodity that plays a vital role in supporting food security and meeting public consumption needs. al improvements in irrigated rice productivity are heavily influenced by soil fertility management, particularly the supply of plant nutrients and soil chemical conditions. Fertilizer application that does not align with plant needs, combined with acidic soil conditions, can reduce nutrient availability and absorption efficiency, preventing rice growth and productivity from reaching their optimal potential.

Benai Subdistrict is one of the major rice-producing centers in Kuantan Singingi Regency. One of the active farmer organizations in the area is the Rumbio Sarumpun Farmers' Group (Gapoktan), which oversees several farmer groups whose primary livelihood is rice farming. Although the area possesses fairly good land potential and human resources, the rice productivity achieved remains below the potential of the planted varieties. Based on initial observations and discussions with the farmers' association leadership, this situation is influenced by farmers' limited understanding of balanced fertilization, the use of fertilizers that do not match recommended doses or crop needs, and the generally acidic condition of the paddy fields. Most farmers still apply fertilizers based on traditional practices passed down through generations without considering the plants' nutrient requirements, growth stages, or soil conditions. The use of single-component fertilizers or NPK fertilizers at unmeasured doses can lead to low fertilizer efficiency and increase the risk of nutrient imbalances. Determining the appropriate, balanced, and site-specific fertilizer dosage can improve crop yields as well as agronomic efficiency, partial fertilizer productivity, and nutrient recovery efficiency (Wang et al., 2024).

In addition to fertilization issues, the paddy fields at the study site have relatively high acidity levels. Acidic soil conditions can reduce the availability of certain nutrients, inhibit root development, and affect the activity of soil microorganisms. Soil pH is one of the primary factors controlling the structure and activity of microbial communities. A decrease in pH can alter the composition of the microbial community, suppress the function of certain microorganisms, and increase the dominance of microorganisms tolerant to acidic conditions (Naz et al., 2022). Therefore, liming is necessary to correct soil acidity and create a root environment that better supports nutrient uptake.

The results of a joint assessment with our partners identified three priority issues: farmers' limited knowledge and skills regarding balanced NPK fertilization; the lack of liming practices to improve soil pH; and farmers' suboptimal ability to manage crop growth through integrated farming practices. These issues are exacerbated by limited production resources and farmers' poor access to information and modern agricultural technology. These conditions highlight the need for extension activities that not only provide theoretical knowledge but also involve farmers in hands-on field practices.

Based on these issues, this community service activity focuses on optimizing the growth and productivity of paddy rice through the application of balanced NPK fertilization and liming. This initiative aims to enhance farmers' knowledge and skills regarding balanced NPK fertilization, increase the Rumbio Sarumpun Farmers' Group understanding of the importance of liming on acidic paddy fields, optimize rice growth and productivity, and promote the adoption of sustainable agricultural technologies at the farmers' group level. It is hoped that the implementation of this activity will increase farmers' productivity and income, strengthen the capacity of the Rumbio Sarumpun Farmers' Group in managing agricultural businesses, support the implementation of the three pillars of higher education, and contribute to the regional food security program.

2. METHOD

The community service activity was carried out at the Rumbio Sarumpun Farmers' Group in Tebing Tinggi Village, Benai Subdistrict, Kuantan Singingi Regency, Riau Province. The implementation of this community service activity employed a participatory and andragogical approach, which actively involved farmers in all stages of the activity by positioning participants

DOI: https://doi.org/10.31849/dinamisia.v10i5.34632

as the subjects of learning. This approach was chosen because it has proven effective in increasing the adoption of agricultural technology among adult communities. The activity was carried out through the following stages:

1. Identification of Technical Guidance Participants
   Participants were identified in collaboration with the management of the Rumbio Sarumpun Farmers' Group (Gapoktan) and local agricultural extension officers. Priority was given to farmer group members who actively manage rice fields and are committed to participating in the entire series of activities. The number of participants was limited to ensure the mentoring process could proceed optimally. This stage also included collecting data on land area, rice varieties planted, and the fertilization practices typically used by farmers as a basis for developing training materials.
2. Initial Participant Assessment
   The initial assessment was conducted through focused group discussions (FGDs) and a simple written pre-test to determine the farmers' level of knowledge regarding soil fertility, NPK fertilization, and liming. Additionally, observations of land conditions were made, including leaf color, plant growth, and indications of acidic soil. The results of the initial assessment were used as a reference in developing strategies for delivering training materials and determining the technological needs most suitable for local conditions.
3. Implementation of Technical Guidance
   Technical guidance was delivered through interactive lectures, discussions, and demonstrations. The material covered included the concept of balanced NPK fertilization, the role of each nutrient in rice growth, the impact of acidic soil on nutrient availability, and the benefits of liming in raising soil pH. Participants were also provided with explanations regarding recommended fertilizer and lime application rates, timing of application according to plant growth stages, and proper mixing and spreading techniques. The presentation of the material was supported by visual aids and real-world examples to ensure ease of understanding.
4. Outreach and Field Practice
   This stage was the core of the activity, during which participants were directly involved in practical work on demonstration plots. Activities included land preparation, application of agricultural lime, NPK fertilization according to recommended doses, and observation of plant growth. Farmers were encouraged to compare the condition of plants treated with the new technology to those using conventional practices. Intensive mentoring was provided during the early stages of plant growth to ensure farmers understood each application step. A "learning by doing" approach was implemented to ensure farmers' skills improved tangibly.
5. Final Participant Evaluation
   Final evaluation was conducted through a post-test and field observations to measure improvements in farmers' knowledge, attitudes, and skills. Additionally, reflective discussions were held to gather feedback from participants regarding the benefits of the activities and the challenges they still face. The success of the activity is measured based on improvements in post-test scores, changes in farmers' fertilization practices, and crop growth conditions in the demonstration plots. The evaluation results are used as the basis for recommendations on follow-up actions and the development of a sustainable extension program

DOI: https://doi.org/10.31849/dinamisia.v10i5.34632

3. RESULT AND DISCUSSION

Rice (Oryza sativa L.) is a strategic food commodity that plays a vital role in supporting national food security. The productivity of irrigated rice fields is largely determined by soil fertility management, particularly the availability of essential macronutrients such as nitrogen (N), phosphorus (P), and potassium (K), as well as soil chemical conditions—especially soil acidity (pH). In paddy fields across various regions of Indonesia, including Kuantan Singingi Regency, a major problem frequently encountered is low soil fertility resulting from intensive land use that is not balanced by proper fertilization and appropriate soil amendment management.

Benai Subdistrict, particularly the Rumbio Sarumpun Farmers' Group (Gapoktan) area, is one of the major rice-producing centers in Kuantan Singingi Regency. However, preliminary observations and discussions with farmers indicate that rice productivity remains relatively low and has tended to stagnate. One of the causes is the use of fertilizers that do not meet recommendations, as well as low paddy field soil pH, which reduces the efficiency of nutrient uptake by plants. Acidic paddy field soil results in low phosphorus availability due to fixation by Al and Fe, and it also reduces the activity of soil microorganisms. These conditions can inhibit the vegetative and generative growth of rice plants. Liming has long been recognized as a technology to raise soil pH, reduce Al solubility, and increase the availability of macro- and micronutrients to plants. Liming combined with balanced NPK fertilization has been proven to significantly increase the growth and yield of paddy rice.

The effects of liming and NPK fertilization on paddy rice yields in acidic soils, as reported by Sembiring et al. (2017) and Utami et al. (2019) on the improvement of the chemical properties of acidic paddy soils through liming and balanced fertilization, indicate that the combination of NPK fertilization and liming can increase fertilization efficiency, improve soil chemical properties, and boost paddy rice productivity. However, the adoption of this technology at the farmer level remains relatively low, primarily due to limited knowledge and a lack of technical assistance. Based on these issues, this community service activity was carried out with the aim of optimizing the growth and productivity of paddy rice through the application of balanced NPK fertilization and liming at the Rumbio Sarumpun Farmers' Group (Gapoktan) in Benai Subdistrict, Kuantan Singingi Regency.

The main challenges faced by the Rumbio Sarumpun Farmers' Group in this community service initiative include: 1. Farmers' limited understanding of balanced NPK fertilization tailored to the needs of rice plants. 2. High levels of paddy field soil acidity, which have not been managed optimally. 3. Declining rice productivity due to soil fertility degradation. 4. Lack of technical guidance regarding liming and balanced fertilization technologies. Nitrogen plays a crucial role in chlorophyll formation and the vegetative growth of rice plants. Phosphorus is essential for root development, flowering, and grain filling, while potassium helps regulate water balance, enhances stress tolerance, and improves crop quality. Balanced NPK fertilization can increase fertilizer use efficiency by 20–30% compared to unbalanced fertilization (Putra et al., 2021). Applying NPK according to recommendations increases irrigated rice yields by 15–25% on intensively farmed paddy fields (Sadhukhan et al., 2023).

This community service initiative implements balanced NPK fertilization technology combined with liming using dolomite. Liming is carried out before planting at a dose adjusted to the soil's acidity level, ranging from 1–2 metric tons per hectare. Dolomite was chosen because, in addition to raising soil pH, it serves as a source of calcium (Ca) and magnesium (Mg), which are essential for rice plant growth. NPK fertilization was carried out using NPK compound fertilizer according to location-specific recommendations, with applications divided between the early vegetative phase and the panicle formation phase. This approach aims to improve nutrient uptake efficiency and minimize nitrogen (N) loss due to volatilization and leaching. Implementation results show that farmers were able to follow all stages of technology application effectively after receiving on-site guidance and training. This aligns with the findings of Susanti et al. (2024), who emphasized that the adoption of balanced fertilization technology is more effective when accompanied by intensive guidance and field demonstrations.

DOI: https://doi.org/10.31849/dinamisia.v10i5.34632



Figure 1. paddy field land

Observations of vegetative growth parameters indicate that rice plants treated with a combination of NPK fertilization and liming exhibited better growth compared to farmers' previous practices. Plant height, the number of productive tillers, and leaf area showed significant increases. The number of productive tillers increased due to more efficient nitrogen availability, while phosphorus played a role in the development of a stronger root system. Potassium (K) supports photosynthesis and the translocation of assimilates to the reproductive parts. These findings align with those of Guo et al. (2026), who reported that balanced NPK fertilization on soils with low potassium availability can enhance vegetative growth and the number of productive tillers in rice plants. Liming plays a role in improving the root environment, allowing plant roots to develop more optimally and absorb nutrients to the fullest extent. This reinforces the findings of Masruri et al. (2024) that the positive interaction between liming and NPK fertilization contributes to more uniform vegetative growth and vigor in rice. Increased vegetative growth has a direct impact on the yield components of rice plants. The number of panicles per hill, the number of filled grains per panicle, and the 1,000-grain weight all increased compared to conditions prior to the community service activity. Rice productivity in the study area increased by an average of 15–25%. This yield increase indicates that the efficiency of NPK fertilization improved after liming was carried out. According to Budianta et al. (2021), in paddy fields with high acidity levels, NPK fertilization without liming yields a lower response compared to fertilization preceded by soil amelioration. Similar results were also reported by Susanti et al. (2024), who stated that the combination of liming and full-dose NPK fertilization significantly increased grain yield compared to treatments without liming.

The results of this community service project confirm the findings of previous studies and demonstrate that the applied technology is relevant to land conditions in Kuantan Singingi Regency. In addition to technical aspects, this community service activity also had a positive impact on improving farmers' knowledge and skills. Evaluation results showed that most Gapoktan members understood the importance of balanced fertilization and liming as part of long-term soil fertility management. However, there are still obstacles to the full adoption of the technology, particularly related to limited access to agricultural lime and cost considerations. This situation aligns with the findings of Arianti et al. (2022), who stated that economic factors and the availability of production inputs are the main barriers to the implementation of integrated nutrient management technologies at the farmer level. Therefore, the sustainable implementation of this technology requires policy support, the availability of inputs, and ongoing guidance from extension workers and universities. A participatory community service approach has proven effective in building farmers' trust and opening opportunities for broader technology adoption. Increasing rice productivity through a combination of NPK fertilization and liming has strategic implications for regional food security. By increasing yields per unit area, pressure to expand agricultural land can be reduced, thereby supporting the principles of sustainable agriculture. According to Susanti et al. (2024), proper nutrient management not only increases yields but also maintains long-term soil nutrient balance. This is crucial for sustaining the productivity of paddy fields and farmers' well-being over the long term. The results of this community service project demonstrate that the application of research-based technologies can provide tangible solutions to rice cultivation challenges at the farmer level, particularly on land with high acidity levels.

DOI: https://doi.org/10.31849/dinamisia.v10i5.34632

4. CONCLUSION

The community service activities at the Rumbio Sarumpun Farmers' Group (Gapoktan) demonstrate that the application of liming and balanced NPK fertilization can address the problems of acidic soil, inappropriate fertilizer use, and low rice productivity. These technologies enhance plant growth, increase rice productivity by 15–25%, and improve farmers' knowledge and skills. However, their implementation still requires support in the form of production resources and ongoing guidance.

REFERENCES

Ariyanti, S., Prabowo, H. A., & Husnur, A. (2022). The Use of Appropriate Technology for Fried Onion Artisans in Palmerah Village, West Jakarta. PASAI: Journal of Community Service, 1(2), 58–65. https://doi.org/10.58477/pasai.v1i2.47

Budianta, D., Napoleon A., Merismon, & Habi, M. L. (2021). Protecting our soil from heavy metal (Pb and Cd) accumulation to support rice growth. IOP Conference Series: Earth and Environmental Science. doi: https://doi.org/10.1088/1755-1315/1005/1/01200

Hidayat, N., Sulaeman, Y., & Hartatik, W. (2022). Integrated nutrient management in acidic paddy fields to increase rice productivity. Journal of Sustainable Agriculture, 7(1), 1–10.

Masruri, M. K., Sudirja, R., & Kamaluddin, N. N. (2024). Vegetative Growth Response of Rice in Heavy Metal-Contaminated Soil Due to the Application of an NPK Fertilizer-Based Ameliorant. International Journal of Life Science and Agriculture Research. https://doi.org/10.55677/ijlsar/v03i3y2024-05

Naz, M., Dai, Z., Hussain, S. T., Tariq, M., Danish, S., Khan, I., Qi, S., & Du, D. (2022). Soil pH and heavy metals revealed their impact on the soil microbial community. Journal of Environmental Management, 321, 115770. https://doi.org/10.1016/j.jenvman.2022.115770

Putra, R. P., Nurida, N. L., & Hartatik, W. (2021). Efficiency of NPK fertilization in paddy fields after liming of acidic soil. Journal of Agroecotechnology, 13(3), 201–210.

Sadhukhan, R., Kumar, D., Sen, S., Sepat, S., Ghosh, A., Shivay, Y., Meena, M., Anand, A., Kumar, R., Sharma, L. D., Patra, K., Pratap, V., Alsuhaibani, A. M., Gaber, A., & Hossain, A. (2023). Precision Nutrient Management in Zero-Till Direct-Seeded Rice Influences Productivity, Profitability, Nutrient and Water Use Efficiency, and the Environmental Footprint in the Indo-Gangetic Plain of India. Agriculture. https://doi.org/10.3390/agriculture13040784

Sembiring, H., Suhartatik, E., & Widowati, L. R. (2017). The effect of liming and NPK fertilization on paddy yields in acidic soils. Journal of Soil and Climate, 41(2), 95–104. Susanti, W. I., Cholidah, S. N., & Agus, F. (2024). Agroecological nutrient management strategy for attaining sustainable rice self-sufficiency in Indonesia. Sustainability, 16(2), 845. https://doi.org/10.3390/su16020845.

Utami, S. R., Handayanto, E., & Prasetyo, B. H. (2019). Improvement of the chemical properties of acidic paddy soils through liming and balanced fertilization. Journal of Soil and Environmental Science, 21(1), 23–31.

Wang, Y., Zhang, R., Li, S., Guo, X., Li, Q., Hui, X., Wang, Z., & Wang, H. (2024). An Evaluation of Potato Fertilization and the Potential for Farmers to Reduce Fertilizer Use Based on Yield and Nutrient Requirements. Agronomy. https://doi.org/10.3390/agronomy14030612

Widodo, W., Sutandi, A., & Dariah, A. (2020). The effect of a combination of liming and NPK fertilization on irrigated rice productivity. Journal of Food Crop Research, 39(1), 12–21.