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WHAT DOES OUR BALANCED FERTILIZATION STUDY SAY?

INTRODUCTION

The Philippines is a net importer of inorganic fertilizers. Significant changes in the world market can greatly impact the country's fertilizer industry. In 2021-2022, the prices of fertilizer raw materials surged and global supply tightened because of the pandemic, China's export restrictions and the conflict between the two major producers of inorganic fertilizers, Russia and Ukraine (Baffes and Koh, 2022) contributed to these scenarios. Consequently, the domestic inorganic fertilizer prices swelled up (i.e., Muriate of Potash by 49%, Complete by 58%, Diammonium Phosphate by 61%, Ammophos by 63%, Ammosul by 77%, and Urea by 87%) in 2021-2022 from its level in 2019-2020 (Figure 1). In 2023, prices started to decrease but still above the 2019-2020 level.

The Department of Agriculture (DA), thus, intensified the promotion of the Balanced Fertilization Strategy (BFS) to urge farmers to reduce their reliance on expensive inorganic fertilizers.

This policy brief presents the effects of combining organic and inorganic fertilizers and biological materials on rice production. It further hopes to build on an alternative nutrient management strategy in the time of high fertilizer prices and soil-health degradation.

KEY POINTS

- Combining inorganic fertilizer with microbial inoculants (biofertilizers) and biostimulants may be another nutrient management option for farmers to improve soil health and gain more harvest. However, its adoption has to be guided by agricultural extension agents. Long-term effects should also be recognized to avoid further problems in the future.
- Establishing additional technology demonstration fields showcasing balanced fertilization strategies could be beneficial. This will assess the technology's viability in local conditions and provide a platform to demonstrate the application of biological materials and their yield effects to more farmers.
- As frontliners, extension agents need to be kept abreast of technologies such as biofertilizers and biostimulants. This will capacitate them in addressing farmers' concerns on this technology. Further, this will also help them appreciate and embrace the technology being brought to farmers.

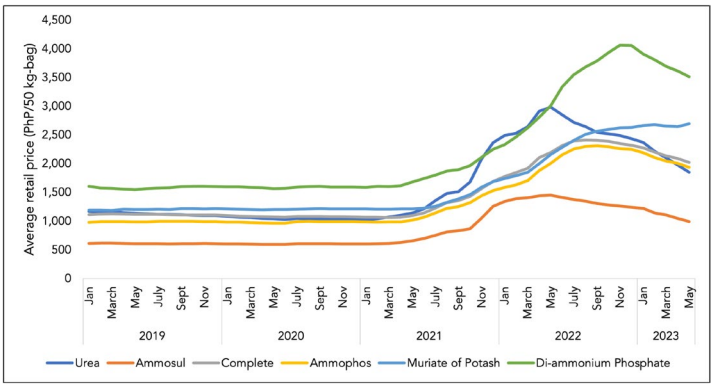

Figure 1. Average monthly retail prices of major fertilizer grades, Philippines, 2019-2023. (Source of basic data: Fertilizer and Pesticide Authority, 2023)

WHAT IS BALANCED FERTILIZATION STRATEGY?

The Balanced Fertilization Strategy (BFS) refers to the prudent use of inorganic and organic fertilizers and other fertilizer materials such as biofertilizers to sustain the nutritional requirement of crops and maintain soil health for long-term productivity (BSWM, 2022). The strategy follows the right Element, Amount, and Timing (E-A-T) of fertilizer application to build soil health and productivity, maintain soil fertility, lower fertilizer costs, and enhance nutrient-use efficiency. Hence, the BFS could mean better harvest for longer term for farmers and better soil-health condition.

There are various fertilizer products and materials available in the market. Some of these are inorganic and organic fertilizers, biofertilizers, and biostimulants. Table 1 summarizes the characteristics of each of type of fertilizer.

Application of inorganic and organic fertilizers in the soil can improve nutrient-use efficiency; thus, producing good yields (PhilRice, 2012). Meanwhile, combining inorganic fertilizers (in reduced amount) and biofertilizers can also result in better crop yields than when applied singly (Banayo et al., 2012; Zainnudin et al., 2022). However, some literature reported concerns on applying biofertilizer such as lack of public awareness and knowledge, regulation and standards, quality assurance, and established field effects (Hashem, 2001; Naveed et al., 2015).

EFFECTS OF BALANCED FERTILIZATION

Inorganic Fertilizer, Biofertilizers, and Biostimulants. The results presented in this section were based on the Fertilizer Derby project of the DA-PhilRice that measured the field performance of selected FPA-registered fertilizers and products. Different combinations of fertilizer materials were evaluated for yield, cost, and income effects from wet season (WS) 2020 to dry season (DS) 2023.

The project's field trials involved 5 nutrient management protocols (Table 2). Benchmark data were those gathered from farmers' field using farmers' own practice and from a control field managed using DA-PhilRice's best nutrient management practices. Meanwhile, Nutrient Management Protocols (NMP) 1-3 were managed by the participating fertilizer companies.

Yield. NMP 3 (inorganic fertilizers in reduced rate with biofertilizers and biostimulants) produced the highest average yield of 7.02t/ha in the DS (Figure 2). On one hand, farmers' practice produced the lowest yield in the same season. The control field that used pure inorganic fertilizer and recommended best management practices generated 5.43t/ha in the WS and 5.99t/ha yield in the DS.

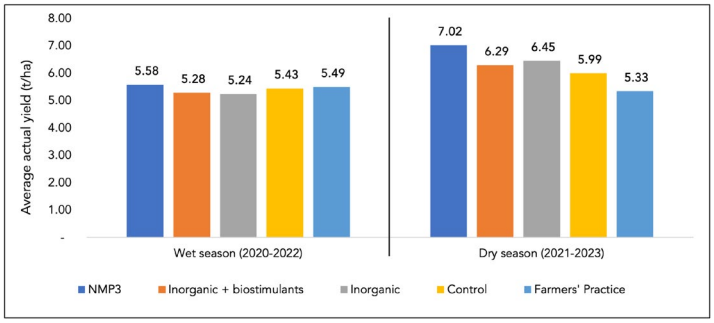

Figure 2. Average yield per fertilizer combination and season, 2020-2023. (Source: DA-PhilRice Fertilizer Derby Project)

Cost. NMP 3 (inorganic+biofertilizer and biostimulant) resulted in the lowest average production cost per hectare relative to the other fertilizer combinations in both seasons (Figure 3). This was followed by farmers' practice in the WS and by the control field in the DS. NMP 2 (inorganic+biostimulant) incurred the highest cost in the WS while NMP 1 (pure inorganic) in the DS.

Table 1. Common fertilizer products and biological materials available in the market.

Fertilizers and biological materials	Description
Inorganic fertilizers	• Any fertilizer product, either in solid or liquid form with major nutrients (NPK) supplied by inorganic/mineral or synthetic/chemical compounds (FPA, Blue Book, 2019).
Organic fertilizers	• Any product, in solid or liquid form, of plant or animal origin that has undergone substantial decomposition that can supply available nutrients to plants.
Biofertilizers or microbial inoculants	• Biologically active products containing an optimum population of one or a combination of active strains of bacteria, actinomycetes, algae, and fungi that are useful in N-fixation, decomposition of organic residues; solubilization of some essential nutrients such as phosphorus from the soil, increase the number of microorganisms and accelerate certain microbial processes, produce plant growth promoting substances that enhance crop growth, and serve as biocontrol agent against pest and diseases (FPA Blue Book, 2019; Mamaril et al., 2009).
Biostimulants	• Substances or microorganisms that "stimulate and enhance physiological process, nutrient efficiency, abiotic stress tolerance, and/or crop quality traits regardless of its nutrient content" (FPA, 2019). • Humic substances, protein hydrolysates, seaweed extracts, microbial inoculants, and inorganic compounds are some categories of biostimulants (FPA, 2019).

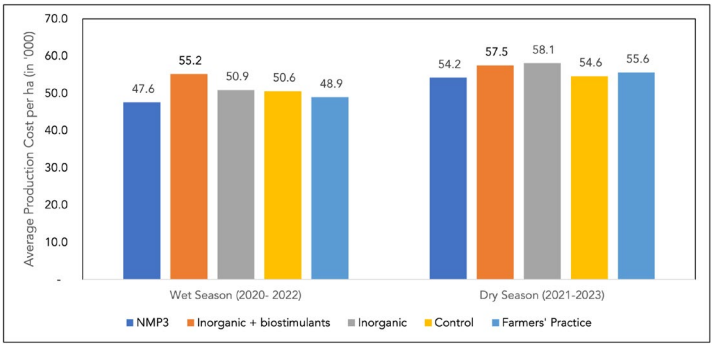

Figure 3. Average production cost by fertilizer combination and season, 2020-2023. (Source: DA-PhilRice Fertilizer Derby Project)

Biofertilizers such as Bio N and BioSol-P, priced at PhP100 per sack, are way cheaper than inorganic fertilizers. Only 5 packs of these are needed for 1ha. Experts estimate that the use of biofertilizer can help reduce Urea application by 2 bags per ha, which costs Php3,200. This can help farmers save about PhP2,700/ha.

Income. The NMP 3 (inorganic+biofertilizers and biostimulants) generated the highest net income amounting to PhP79,195/ha and PhP58,383/ha in the DS and WS, respectively (Figure 4). The lowest income, on one hand, was recorded from the farmers' practice amounting to PhP45,745 (DS) and PhP49,192/ha (WS) only.

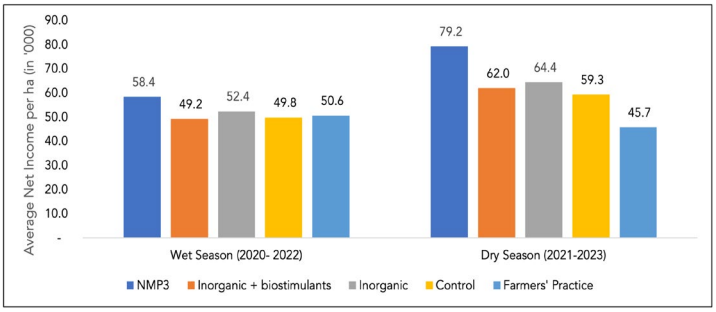

Figure 4. Average net income by fertilizer combination and season, 2020-2023. (Source: DA-PhilRice Fertilizer Derby Project)

Inorganic and organic fertilizers. Farmers may also adopt the combined application of inorganic and organic fertilizers as another BFS. A PhilRice study recommended this complementation to produce healthy soil and, eventually, obtain a yield that is almost at par with pure inorganic fertilizer. Similar to biofertilizers, organic matter allows microbes to transform chemical nutrients into their bioavailable forms; hence, promotes efficient absorption of nutrients (PhilRice, 2012).

HOW FAR ARE WE WHEN IT COMES TO BFS USE?

Based on the latest available Rice-based Farm Household Survey (RBFHS) data of the DA-PhilRice, the majority of farmers applied pure inorganic fertilizers. Only few combined inorganics with biological materials, such as organic (1-2%) and biofertilizers (0.1%) (Table 2). This implies that a great deal of work is needed to promote BFS.

Table 3. Percent distribution of farmers by fertilizer and microbial materials applied, WS 2016 and DS 2017.

Fertilizer and biological materials applied	Percent distribution	
	WS 2016 n=3,024	DS 2017 n=2,678
Inorganic	96	96
Inorganic+ biofertilizer	0.1	0.0
Inorganic+organic	2	1
Organic	0.3	0.2

*1.5% and 2% of the respondents in the WS 2016 and DS 2017, respectively, were fertilizer non-users.

Table 2. Fertilizer combinations tested in the PhilRice's Fertilizer Derby project, WS 2020-DS 2023.

	Application rates, timing, and methods used	
Nutrient management protocol	Nutrient management protocol	Biofertilizers/biostimulants
Farmers' practice	• 5 bags complete (7-14 DAT) • 1.5 bags urea (21-25 DAT) • 0.5 bag muriate of potash (45 DAT)	
Control	• 1-2kg zinc sulfate at seedbed (10 days after seedling) • 4.5 bags complete (10-14 DAT) • 2 bags urea (25-30 DAT) • 2 bags urea + 0.5-1 bag muriate of potash (45-55 DAT)	
Nutrient management protocol 1: inorganic (NMP1)	• 4 bags complete fertilizer with sulfur and zinc (7-10 DAT) • 2 bags urea and 1 bag ammophos (25-29 DAT) • 3 bags urea (42-50 DAT) • 1 bag urea (72 DAT during the dry season only)	
Nutrient management protocol 2: inorganic + biostimulants (NMP2)	• 4 bags complete or 3 bags complete + 1 bag urea or 16-20-0 (7-14 DAT) • 2 bags urea or 1 bag 16-20-0 + 2 bags 21-0-0 (21-35 DAT) • 2 bags urea + 1 bag muriate of potash (45-50 DAT)	Applied at different rates and intervals (5-65 DAT)
Nutrient management protocol 3: inorganic + biofertilizers and biostimulants (NMP3)	• 4 bags complete or 1 bag complete + 1 bag of urea (2-10 DAT) • 1.5 bags urea or 2 bags complete and 1 bag urea (28-35 DAT) • 0.5 bag muriate of potash (40-50 DAT)	• Seed treatment and seedbed application (20-22 DAT) and foliar application (30 DAT) • Foliar application (7-84 DAT) at 10-14 days interval

Source: Fertilizer Derby project of DA-PhilRice

CONCLUSION

Farmers can reduce use of inorganic fertilizers without affecting crop yield by adding biological materials (i.e., organic fertilizer, biofertilizer, biostimulants) to their nutrient management practices. This is a BFS that can improve soil health and, consequently, raise crop productivity.

However, the use of products such as biofertilizers and biostimulants has to be guided by extension workers. Instructions on its application vary by product. Some biofertilizers are applied through seed treatment (i.e., mixed during seed soaking) or foliar application only. Others require solution activation for a certain period before its application, which can be a tedious task for farmers. Instructions may be quite an issue for farmers.

The time-tested principle of "right fertilizer element, amount, and timing" matters. Using pure inorganic fertilizers at varying rates and timing of application resulted in different levels of yield, cost, and income. The reduced amount of inorganic fertilizer had to be paired with the right type and amount of biofertilizers and biostimulants. Farmers' yields can still be increased by pairing biological materials with inorganic fertilizers. To promote this BFS, the government or the private sector can create strategies such as setting up of technology demonstration fields.

CALL FOR ACTION

- Establish more technology demonstration fields showcasing balanced fertilization. This may serve as its viability check under a specific local condition. This could also spark interest among farmers to complement inorganic fertilizers with biological materials (i.e., organic, biofertilizer, biostimulants), especially that DA will support use of biofertilizers among farmers as announced through its Memorandum Order no. 32 in 2023 (i.e. Implementing guidelines on the distribution and use of biofertilizers).

- Continue evaluating biofertilizers and biostimulants. Location-specific evaluation can be pursued to determine their performance and adaptability in the local areas.

- Update agricultural extension agents on the science of biofertilizers and biostimulants. Additionally, experience in using these materials will further equip them in promoting the products. As frontliners, they need to be kept abreast of rice technologies to capacitate them in addressing famers' concerns on such products This will also help them appreciate and embrace the technology that is being brought to farmers.

- Invest in farmers' education through Farmer Field Schools (FFS) about alternative fertilizer products that could help promote plant growth. This may catalyze BFS adoption among farmers.

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ABOUT THE MATERIAL

Rice Science for Decision-Makers is published by the Department of Agriculture-Philippine Rice Research Institute (PhilRice). It synthesizes findings in rice science to help craft decisions relating to rice production and technology adoption and adaptation. It also provides recommendations that may offer policy triggers to relevant rice stakeholders in search of opportunities to share their knowledge on rice-related products.

The articles featured here aim to improve the competitiveness of the Filipino rice farmers and the Philippine rice industry through policy research and advocacy.

This policy brief presents the effects of combining inorganic fertilizers and biological materials on yield, production cost, and income of rice farmers in the hopes of creating an alternative nutrient management strategy.

For comments and requests for additional copies, please write to:
Socioeconomics Division
DA-Philippine Rice Research Institute
Maligaya, Science City of Muñoz, Nueva Ecija
Contact: prri.mail@philrice.gov.ph
PhilRice Text Center: 0917-111-7423

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Technical Team: Leylani M. Juliano, Wilfredo B. Collado, Jesusa C. Beltran, Michelle C. Quimbo, Aileen C. Litonjua, Marco Antonio M. Baltazar, Aerone Philippe G. Bautista, Jaime A. Manalo IV, Alice B. Mataia, Rowena G. Manalili, Jayvee C. Kitma
Editorial and Advisory Team: Karen Eloisa T. Barroga, Eduardo Jimmy P. Quilang
Design and Layout: Mark Joseph R. Zuñiga
Language Editor: Charisma Love G. Gonzales

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Philippine Rice Research Institute
Central Experiment Station
Maligaya, Science City of Muñoz, 3119 Nueva Ecija