

Customized Fertilizer: Site Specific Soil Nutrition

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SUMMARY

In India, the primary nutrients NPK play a crucial role in enhancing and sustaining agricultural productivity. However, the advancement of high-yielding systems is anticipated to worsen issues related to secondary and micronutrient deficiencies. This is not only due to the increased removal of larger quantities but also because of the application of substantial amounts of NPK to achieve higher yield goals. Consequently, intensive farming systems may lead to a negative nutrient balance and deficiencies in secondary and micronutrients. To achieve ambitious future targets, it is imperative to adopt a balanced fertilization approach, implement site-specific nutrient management, and utilize customized fertilizers. The creation of crop and site-specific ready-made customized fertilizers, grounded in scientific principles, could prove more effective in meeting plant requirements and improving nutrient use efficiency. This article aims to explore various aspects of customized fertilizers, including their necessity, production, standards, and potential benefits in the long run.

INTRODUCTION

Fertilizer efficiency varies across nutrients, such as 30-40% for nitrogen in rice and 50-60% in other cereals, 15-20% for phosphorus, 60-80% for potassium, 8-12% for sulfur, and most micronutrients below 5% (Rakshit, 2002). To address the serious issue of low crop response, recommended measures include balanced and sufficient fertilization of nitrogen, phosphorus, potassium, sulfur, zinc, boron, and iron. This involves establishing an Integrated Plant Nutrient Supply System (IPNS), creating reliable soil testing facilities, ensuring timely access to preferred fertilizer materials, providing high-quality seeds, promoting recommended agronomic practices, and offering farmers access to low-interest credit. Developing new and improved fertilizers is crucial for meeting the nutritional needs of the growing global population, ensuring sustainable food security, and protecting the environment. The key takeaway is the urgent need for innovative and enhanced fertilizers, particularly customized ones based on comprehensive soil-test-crop response studies tailored to diverse agro-ecological regions in the country.

What is Customized Fertilizer?

The Fertilizer (Control) Order of 1985, as established by the Central Fertilizer Committee, has incorporated customized fertilizers as a novel category. These fertilizers are tailored to specific areas, soils, and crops. Customized fertilizers serve as carriers of multiple nutrients, enabling the application of a comprehensive range of plant nutrients in appropriate proportions to meet the distinct requirements of crops during various growth stages. The formulation of customized fertilizers is influenced by factors such as soil fertility status, climate, and cropping patterns in a given region (Hegde *et al.*, 2007). These fertilizers are distinctive, being granulated and ready-to-use, developed through a comprehensive process that integrates scientific plant nutrition principles, soil information, extensive laboratory studies, and field research evaluations. While the development of customized fertilizers is a complex process, the outcomes are highly promising, optimizing nutrient utilization for quality crop yield, increased farm productivity, and enhanced profitability. Multi-nutrient carriers are created to encompass macro, secondary, and/or micro-nutrients derived from both inorganic and/or organic sources. These carriers are produced through a methodical granulation process, tailored to meet the nutritional requirements of a crop based on its location, soil conditions, and growth stage. The validation of this capability is ensured through a scientific crop model, and it is developed by a fertilizer manufacturing/marketing company with accreditation.

Advantages of Customized Fertilizer

The primary goal of customized fertilizers is to advance site-specific nutrient management, aiming for the optimal efficiency of applied nutrients in a cost-effective manner. These fertilizers can comprise a blend of nutrients from diverse sources, guided by soil test information and the specific requirements of the crop. The

formulation may include primary, secondary, and/or micronutrients, with some grades being 100% water-soluble to meet the needs of various crop growth stages based on research findings. The benefits of using customized fertilizers include:

- Supplying plant-available nutrients in adequate amounts and proper proportions.
- Being a soil-crop-climate-based fertilizer, less affected by soil, plant, and climatic conditions, resulting in increased nutrient uptake and reduced nutrient loss.
- Providing not only primary nutrients but also secondary and micronutrients.
- Reducing the cost of fertilizer application, ultimately lowering the overall cost of cultivation.
- Playing a crucial role in Site-Specific Nutrient Management and Precision Agriculture, enhancing the efficiency of applied nutrients in a cost-effective manner.
- Contributing to improved soil health through the development of site and crop-specific fertilizers.

Farmers are inclined to prefer customized fertilizers for the following reasons:

- Enhancing crop quality and productivity.
- Maximizing nutrient use efficiency.
- Customized to specific crops and areas based on soil fertility.
- Developed using a scientific database.
- Available in a ready-to-use form in a balanced manner.
- Improving soil fertility and being environmentally friendly.
- Adaptable to various field applications.

Methods of Production

The fertilizers industry, categorized as secondary chemical production, offers three manufacturing methodologies, ranging from the simplest to the more intricate:

- Bulk Blending
- Compound Granulation/Steam Granulation
- Complex/Chemical Granulation

These options are outlined in the FAI-NR (2011) and represent varying degrees of complexity in the fertilizer production process.

Bulk Blending

This method is the most straightforward and economical, involving the simple mixing of solid fertilizers in the necessary proportions to achieve the desired nutrient balance. An advantage is its suitability for smaller, decentralized production, allowing customization of the NPK ratio according to customer needs. Strict specifications on raw material size and shape contribute to high raw material costs, increasing the overall fertilizer cost. In India, the absence of such fertilizers and the impracticality of importing them with the specified physical attributes make bulk blending an unlikely option for customized fertilizers.

Compound Granulation/Steam Granulation

In this manufacturing process, all raw materials are in solid form, and granulation is achieved through agglomeration using water, steam, and heat in the dryer. It's important to note that labeling them as 'mixtures' is inaccurate, a term often misused. While bulk blends could be considered mixtures, compound NPK granulation falls into a different category. Positioned between the chemical route and bulk blending, this method offers greater flexibility in producing various fertilizer grades compared to chemical granulation, although not as much as bulk blends. Although the investment costs are higher than those for bulk blending, they are considerably more economical than establishing chemical granulation plants. This is because no additional costs are incurred in creating infrastructure for the storage and handling of chemicals. In fact, many Asian countries are adopting the steam/physical granulation route for NPK production, making compound granulation the most effective approach for promoting the availability of customized fertilizers in India.

Complex/Chemical Granulation

Chemical granulation, also referred to as 'slurry granulation' or 'complex granulation,' involves the production of NPK fertilizers primarily through a chemical reaction between ammonia and acid, resulting in the

formation of ammonium sulfate or ammonium nitrate salt. Subsequently, discrete K_2O is added, either in solid or liquid form in some plants, to granulate the mixture using the accretion plus agglomeration method. However, this technology has certain limitations:

- It requires a large-capacity plant, and the costs associated with establishing infrastructure for the storage and handling of acid and ammonia are substantial.
- Ideally, the plant should be located near a seashore to facilitate the convenient unloading of liquids such as phosphoric acid and, in some cases, ammonia.
- Due to its large-scale nature, the plant loses flexibility in producing a variety of fertilizer grades. Typically, only two grades can be manufactured using this type of plant, making it less convenient when multiple customized NPK grades need to be produced.

Formulations of Customized Fertilizers

Improving crop yield begins with optimizing the composition. The system generates a formula by considering the most cost-effective combination of accessible ingredients and minimizing the application rate to achieve a lower cost per acre. An illustration of these compositions includes 8:16:24:6:0.5:0.15, indicating the specific levels of N, P, K, S, Zn, and B, produced by Tata Chemical Limited. This formulation is customized for potato cultivation in Agra, Aligarh, and Farrukhabad districts in Uttar Pradesh (U.P). Another blend, 10:13:12:6:2:0, has been specifically developed for sweet sorghum farming in Nanded, Maharashtra. Similarly, Coromandel Industries Limited has obtained approval for two personalized formulations, 15:15:15:9:0.5:0.2 and 20:0:15:0:0:0.2, designed for groundnut cultivation in Anantapur and maize in Warangal districts of Andhra Pradesh (A.P). Fertilizers customized for basal application must be in granular form, with at least 90% of the material retained within the 1-4 mm IS sieve range. The portion passing through the sieve with a size less than 1 mm IS sieve should not surpass 5%, and the moisture content should be limited to 1.5%. Conversely, for foliar application, the grades should be entirely water-soluble, and the combined nutrient content should not be less than 30 units for all nutrients.

Opportunity of Customized Fertilizers

To address the concurrent challenges of ensuring food and nutritional security, customized fertilizers can embark on a significant initiative. Tailored fertilizers provide opportunities both in agronomy and marketing.

Agronomic Opportunity

The prevalent lack of micronutrients is identified as a key factor contributing to the stagnation of crop yields. Nevertheless, the inadequate utilization of micronutrients, stemming from incorrect dosage and application methods, dissuades farmers from incorporating them. With an increasing deficiency in micronutrients, farmers may encounter challenges in acquiring the necessary knowledge and skills to address these emerging issues. Customized fertilizers, being highly effective carriers of micronutrients, offer an outstanding opportunity to facilitate the convenient and regular application of micronutrients, along with enhancing their overall efficiency.

Marketing Opportunity

The fertilizer industry faces stringent regulations unlikely to ease soon. However, customized fertilizers are an exception due to favorable guidelines from the Government of India. This offers an opportunity for capable entrepreneurs and the fertilizer industry segment with the necessary fiscal and technological capabilities. Strict adherence to high production and marketing standards is crucial to avoid government scrutiny. Developing policies to prevent exploitation by non-serious players during fertilizer shortages poses a challenge for both the government and the customized fertilizers industry. The customized fertilizers industry faces a risk in investing significantly in modern manufacturing facilities without a long-term commitment from the government to maintain consistent policies. During fertilizer shortages, the government may prohibit the use of subsidized fertilizers for manufacturing customized ones, making the investment in manufacturing plants unviable. Global experience highlights the importance of robust policy and technological support for the success of the customized fertilizers industry. In agriculturally advanced countries, over 50% of fertilizers are customized, and in China, more than 40% are re-customized. In India, different NPK grades contribute to 15% or less of consumption, underscoring the potential of customized fertilizers to enhance fertilizer use efficiency and represent the future for the country.

CONCLUSION

Customized fertilizers offer a distinctive opportunity for serious manufacturers with scientific and technological capabilities, as recognized by liberal legal provisions from the Government of India. Economic viability in the market will be determined by the value added to farmers, allowing customized fertilizers to command premium pricing over conventional ones. Customized fertilizers aim to enhance fertilizer use efficiency through site-specific nutrient management, incorporating primary, secondary, and micro-nutrients based on soil testing and crop requirements. The use of 100% water-soluble fertilizers through drip fertigation is seen as a practical method to boost farm productivity. Encouraging the adoption of this technique and providing incentives to farmers using water-soluble fertilizers can enhance the quality of produce. Customized fertilizers mark a revolution, emphasizing Site-Specific Nutrient Management (SSNM) and Precision Agriculture. Collaboration between the fertilizer industry and national institutes is crucial to develop soil and crop-specific quality fertilizers, addressing nutrient deficiencies for improved crop response and higher productivity.

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