

1 Nutrient Management

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1.1 Relevance and causes of yield gaps

Most rice farmers achieve less than 60% of the climatic and genetic yield potential at a particular site. A simple model can be used to illustrate the factors that explain the “yield gap” (Fig. 1).

The yield potential or maximum yield (Y_{\max}) is limited by climate and rice variety only, with all other factors at optimal levels. Y_{\max} fluctuates from year to year ($\pm 10\%$) because of

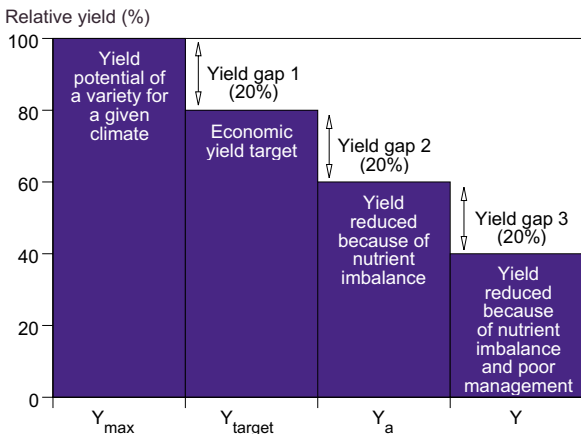


Fig 1. Example for the effect of nutrient and crop management on yield potential or maximum yield (Y_{\max}), yield target (Y_{target}), attainable yield (Y_a), and actual yield (Y).

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climate. For most rice-growing environments in tropical South and Southeast Asia, the Y_{\max} of currently grown high-yielding rice varieties is about 10 t/ha in the high-yielding season (HYS) and 7–8 t/ha in the low-yielding season (LYS). The attainable yield (Y_a) is the “nutrient-limited” yield that can be achieved with current farmers’ nutrient management practices but optimal water, pest, and general crop management. The maximum Y_a achieved by the best farmers is about 75–80% of Y_{\max} (i.e., 7–8 t/ha in an HYS and 5–6.5 t/ha in an LYS). Such an economic yield target (Y_{target} , Fig. 1) leaves a yield gap 1 of about 20–25% of Y_{\max} . In most cases, it is not economical to close this gap because of the large amount of inputs required and the high risk of crop failure because of lodging or pest attacks. In reality, Y_a is substantially lower in most farmers’ fields because of inefficient fertilizer N use or nutrient imbalances that result in a larger yield gap (yield gap 2) (Fig. 1).

The actual yield (Y) in farmers’ fields is often lower than Y_a because of constraints other than climate and nutrient supply, such as seed quality; weeds, pests, and diseases; mineral toxicities; and water supply (yield gap 3).

Understanding yield gaps is important because they result in

- ▶ reduced profit for farmers,
- ▶ reduced return on investments in rice research and development (e.g., irrigation facilities), and
- ▶ reduced rice production, resulting in food insecurity and increased requirements for rice imports.

Improved nutrient management can help to reduce yield gap 2 for the benefit of farmers and the country as a whole. The greatest benefit from improved nutrient management, however, is found on farms with good crop management and few pest problems. Farmers need to know what factors can be changed to increase productivity (knowledge-based

management) and should know that larger yield increases result when several constraints (e.g., pest and disease problems and inappropriate nutrient management) are overcome simultaneously.

Crop management

Many general crop management practices affect crop response to improved nutrient management.

Consider the following points:

- ▶ Use high-quality seed of a suitable high-yielding variety.
- ▶ Transplant young seedlings (e.g., 10–20 days old).
- ▶ Level the soil properly and maintain an appropriate water level over the whole field to achieve good crop uniformity. This reduces overall water requirements.
- ▶ Choose a suitable planting density to establish an efficient leaf canopy (e.g., 20–40 hills/m² with 1–3 plants/hill in transplanted rice and 80–120 kg seed per ha in broadcast, wet-seeded rice).
- ▶ Do not allow weeds to compete with rice plants for space, water, light, and nutrients.

The full potential of improved nutrient management can only be reached with good crop management.

Pests and diseases

Pests and diseases affect crop response to improved nutrient management by damaging the leaf canopy, the plant stem, and the grain. The most common pests in irrigated rice are sheath blight, bacterial leaf blight, stem rot, stem borer, tungro, brown planthopper, rats, and birds.

Consider the following points:

- ▶ Use varieties that are resistant to commonly occurring pests and diseases.

- ▶ Avoid excessive N fertilizer use to prevent the development of a lush green foliage that attracts pests and diseases.
- ▶ Before applying N fertilizer, assess the general crop stand, leaf color (using a leaf color chart), and pest and disease incidence.
- ▶ Damage by many diseases (e.g., brown leaf spot, sheath blight, bacterial leaf blight, stem rot, and blast) is greater where excessive N fertilizer and insufficient potassium (K) fertilizer have been used in rice crops affected by K deficiency.
- ▶ Practice integrated pest management (IPM) in cooperation with other farmers.

Efficient N fertilizer use and balanced nutrition minimize the risks of lodging, pests, and diseases.

Nutrient management

A yield target will be reached only when the correct amount of nutrients is supplied at the right time to match the crop's nutrient requirement during the season.

Efficient and cost-effective nutrient management strategies should aim to

- ▶ maximize crop uptake of nutrients from fertilizers and soil indigenous sources through good crop management practices,
- ▶ make full use of nutrients available in the form of straw, other crop residues, and animal manures,
- ▶ use mineral fertilizers as required to overcome specific nutrient limitations,
- ▶ minimize the risk of crop failure by selecting realistic and economic yield targets and practicing the efficient use of fertilizer and balanced nutrition, and
- ▶ maximize revenue by considering the cost of inputs, including labor, organic manure, and inorganic fertilizer.