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Supporting responsible and profitable

use of fertilizer nutrients in Myanmar

by **Thomas Oberthür**, Director and **Tin Aye Maung**, Advisor, International Plant Nutrition Institute (IPNI) Southeast Asia Programme

Since 2013, Canpotex and IPNI have been engaged in Myanmar to introduce concepts and principles of responsible crop nutrition. This was initially achieved through a series of seminars dedicated to agricultural decision-makers in government, universities and crop associations. Subsequently, commodity-specific field handbooks were produced in Burmese language to further disseminate basic crop nutrition knowledge among fertilizer dealers and farmers. As part of this engagement, in 2017, we conducted an assessment of opportunities for responsible fertilizer market development. The assessment was informed by secondary land use and production statistics and, deep field intelligence, generated using a participatory approach adapted by IPNI to the local conditions.

The authors with a local agricultural expert. Ginger in Southern Shan State (Photo: T. Oberthür)

Myanmar is an agricultural country and agriculture is the backbone of its economy. The agricultural sector including livestock contributes 28.6% of GDP and employs 61.2% of the labour force. Total land area is about 67.7 mn hectares and the total arable land area is 17.7 mn hectares. There are about 12 mn hectares of net agricultural land area in Myanmar. Under varying topography, climate and soil types, more than 60 crops are grown, mainly by smallholders. Fertilizer and manure are not commonly applied in smallholder cropping systems, although in recent years, fertilizer use is increasing.

Potatoes have been placed by hand, fertilizer added manually, before field workers cover both (Photo: T. Oberthür)

There are three seasons; (1) hot season from mid-February to mid-May, (2) rainy season from mid-May to mid-October and (3) cold and dry season from mid-October to mid-February. The annual precipitation varies between about 5,000 mm along the coastal regions and less than 1,000 mm in the centre of the country. In many parts, the temperature rises above 38°C during the hot season and, averages between 21-26°C during the cold season. The three seasons enable farmers to cultivate various crops at different times of the year. The main farming season for most of the country is the monsoon period.

Crop portfolio

Agricultural land can be grouped into (1) lowlands and (2) uplands. Farmers grow mostly rice in the lowlands. Rain-fed agriculture is predominant in Myanmar, but irrigation is used when available. The irrigable area is about 2.14 mn hectares, or about 16% of net sown area. Uplands are characterized by diverse land use systems and often low soil fertility. Large parts of the uplands have low pH soils with low phosphorus (P) status and potential for aluminum toxicity. However, the greatest potential for future increases in agriculture production lies in the uplands. Maize, sugarcane, groundnut, potato, chili, tomato and onion are the most important upland crops, but farmers also grow upland rice for home consumption.

> *"Agricultural land can be grouped into lowlands and uplands*

Approximately 7.2 mn ha of rice, 4.4 mn ha of pulses, 1.6 mn ha of sesame, and 0.95 mn ha of groundnut and 0.47 mn ha of maize are grown in the country. Rice is cultivated twice a year in many parts of major rice-growing regions such as Ayeyarwaddy, Bago and Mandalay. Rice-rice and rice-pulses-rice are common cropping systems. Management priority until now is usually given to rice. Farmers may also grow sesame and groundnut before rice with little inputs. Pulses are the largest exported agricultural commodity from Myanmar: mainly black gram, green gram, pigeon peas and chickpeas. Crop yields are low. The average national yields are 3.8 t/ha for rice, 1.1 t/ha for pulses, 0.59 t/ha for sesame, 1.6 t/ha for groundnut and 3.9 t/ha for maize respectively.

Deep market intelligence approach

There are several ways to generate agricultural indicators, ranging from a single criterion to long lists of variables to criteria elicited from the stakeholders themselves. We used locally appropriate indicators and criteria elicited from farmers, extension agents and fertilizer dealers to generate deep market intelligence (DMI). Facilitated by representatives of local government organizations, we visited agricultural communities in the Irrawaddy Delta, the Mandalay agricultural production area and Southern Shan State.

Emphasis was given to the most important crops in each region, eliciting knowledge related to the management of these crops within the cropping system. We focused on resource use in good and bad years, with 'good' and 'bad' defined in terms of agricultural production and price. Responses identified different farm enterprises and income sources that farmers relied upon, and their relative importance in good and bad years. Fertilizer market development activities have the potential to reduce 'bad' year outcomes and increase return on investment in years approximating what farmers describe as 'good'. Solutions for prioritized problems related to crop production, processing and marketing can then be identified with clear, positive impacts on the ability of farmers to use fertilizer to improve their income.

The data also helped us understand farmers' motivations to improve

Table 1. Estimated nutrients removed by rice, maize, potato, chili and watermelon in 2015/16

Crops	Estimated nutrient removal by focused crops (t) in Myanmar					
	N	P	K	Ca	Mg	S
Rice	393150	73388	99598	7863	26210	20968
Maize	27268.8	5069.2	6642.4	699.2	1573.2	2272.4
Potato	1512	168	2016	168	168	168
Chili (dry)	3024	352.8	3326.4	302.4	151.2	100.8
Watermelon	1990.4	373.2	2114.8	248.8	124.4	248.8

agriculture, willingness to invest in fertilizer and obstacles to such investment. Farmers also reported on the relative income earned from key crops and the cost to produce them, as well as the relative importance of pest and diseases, lack of water, soil quality to key crops and the relative allocation of fertilizer to key crops. Farmer generated insights were complemented with those from small group interviews of extension agents. One-to-one interviews with fertilizer dealers/retailers were conducted to understand the currently available fertilizer product portfolio, the supply chain structure, and the dealer business model. Responses provided clarity in nutrient sales vis-à-vis nutrient demand by main crops grown in the region, and customer support provided by the dealers (financing and knowledge).

Nutrient removal

The target crops included maize and watermelon (Mandalay region), rice, pulses and chili (Ayeyarwady Region), and potato and maize (Southern Shan State). When other important crops were identified in the field, we included them in the interviews. Table 1 shows the national potential for nutrient use in target crops, estimated by the amount of nutrient removal (derived from total production and nutrient content in harvested parts).

In Figure 1 we give an example of data collection from rice growers in the township of Pyin Oo Lwin (Mandalay), where cereal-based cropping systems are common. Cropping systems include Monsoon rice (irrigated/rainfed), wheat, Monsoon maize, niger (*Guizotia abyssinica*) and flowers/vegetables. Of the participating farmers, 100% grow rice and 90% maize. About 40% also grow vegetables, chili and flowers and some grow groundnut (35%).

It shows that rice farmers allocated most resources to their farm and food regardless of 'good' and 'bad' income years. Their resource allocation towards education, health and others tended to remain constant in 'good' and 'bad' income years. In 'bad' years resource allocation towards farm operation was increased at the expense of housing, indicating a willingness and understanding to maintain the farm business sustainable. This behavioral pattern is consistent across regions and farming systems, indicating a first, clear opportunity for responsible, joint market development between the fertilizer industry and the farming community.

Figure 1. Resource allocation (%) towards education, health, farm, housing, food and others by rice farmers in Pyin Oo Lwin Township, Mandalay.

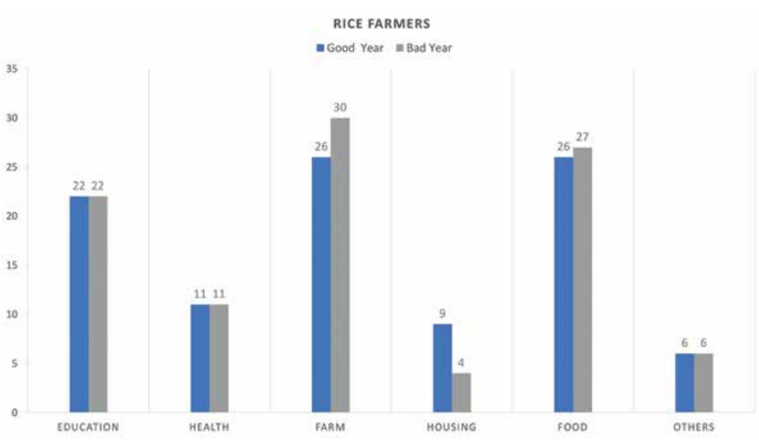
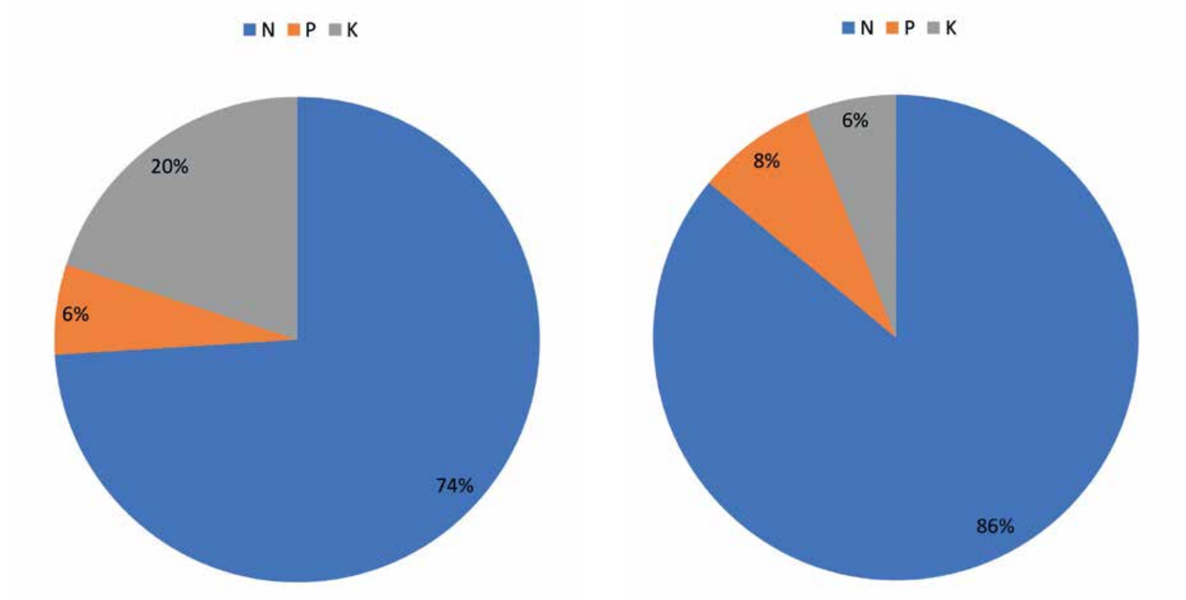


Figure 2. Relative quantities of N, P, and K fertilizers sold in dealer shops in Zalun town (a, left) and Ingapu town (b, right), in the Ayeyarwaddy region of Myanmar.



An example of responses from interviews with fertilizer dealers is summarized in Figure 2a and 2b. Dealers in Ayeyarwaddy townships usually sell a variety of agri-inputs including fertilizers. The narrow fertilizer product portfolio commonly includes urea, low density NPK compounds, TSP and KCl. Best sellers are urea and NPK compounds, usually 10-10-5 and 15-15-15. The graphs illustrate the relative proportions of N, P, K nutrients sold by fertilizer dealers: nutrient proportions delivered by a typical dealer are not adequate to supply the demand by most crops grown in the respective regions. Again, this is a common trend across major agricultural production areas in the country.

Market development opportunities

Joint analyses and interpretation of secondary context information (official and unofficial data on fundamentals in land use, production, markets) and quantitative / qualitative insights from the DMI (nutrient use and availability, on-farm cash flows, respective knowledge by farmers, extension agents and dealers) allows us to generate potential opportunities that support the development of sustainable fertilizer markets.

Nutrient supply opportunities: Table 2 summarizes the fertilizers / nutrients supplied by agri-input dealers. Urea and NPK compounds

Table 2. Sales portfolios of selected fertilizer dealers visited, and proportions of N, P and K in these portfolios (Scenario 1, 15-15-15 NPK, Scenario 2, 10-10-05 NPK).

	Fertilizers Sold (%)				Scenario 1			Scenario 2		
	Urea	TSP	KCl	NPK	% of N	% of P	% of K	% of N	% of P	% of K
Dealer 1	60	7	3	30	78.8	8.2	13.0	84.8	7.4	7.8
Dealer 2	40	0	5	55	67.1	9.1	23.8	76.6	7.7	15.7
Dealer 3	60	10	5	15	80.1	7.9	12.0	83.2	7.5	9.3
Dealer 4	45	10	5	40	66.7	12.5	20.8	73.7	12.2	14.1
Dealer 5	45	0	5	30	75.2	5.9	19.0	82.1	4.5	13.4
Dealer 6	70	10	0	20	85.9	8.0	6.1	90.3	7.5	2.2
Dealer 7	50	5	5	40	72.1	8.9	18.9	79.4	8.0	12.6
Dealer 8	40	10	10	40	62.2	11.7	26.1	67.9	11.2	20.9

Table 3: Nutrient requirements by major Myanmar agricultural crops at an achievable yield level, and the proportions of N, P and K of total removals.

Crop	Yield (t/ha)	N (kg/ha)	P (kg/ha)	K (kg/ha)	% of N	% of P	% of K
Rice	6	120	15.3	41.5	67.9	8.6	23.5
Maize	8	130	17.4	49.8	65.9	8.8	25.2
Sugarcane	100	300	39.2	249.0	51.0	6.7	42.3
Groundnut	2.5	50	34.9	49.8	37.1	25.9	37.0
Mung bean	2	40	34.9	49.8	32.1	28.0	39.9
Potato	35	100	34.9	83.0	45.9	16	38.1
Chili	3	120	47.1	114.5	42.6	16.7	40.7
Cabbage	20	200	52.4	99.6	56.8	14.9	28.3

are popular, TSP reaches up to 10%, while the availability of KCl is low. Sales of other products are even less. Actual percentages of nutrients (N, P, K) within these portfolios are given for two scenarios: Scenario 1 contains 15-15-15, scenario 2 the more popular 10-10-05. In portfolio 1, N ranges from 60% to more than 85% and in portfolio 2, 68% to over 90%. Potassium seldom makes up more than 20% of nutrients sold. On the other hand, most crops require at least 20% of potassium (see table 3). Many in fact, require between 25-40% of potassium in a balanced application. Likewise, crops require more than 50kg of N per hectare, even at low yield levels (except for N fixing mung beans and groundnuts). Higher yields require more than 100 kg of N per hectare to replace the removed nitrogen. Requirements for P within a fertilizer application range between 10-50 kg per hectare. At low yield levels, all crops benefit from at least 25 kg of potassium per hectare. At higher yield levels, all crops require more than 40 kg of K per ha in a balanced application.

We therefore suggest:

- For bulk commodities such as rice and maize, to focus first on balanced nutrition, then after two or three cropping seasons, on increasing nutrient rates. This provides the opportunity to introduce improved low-density compound fertilizers for rice and maize with adequate nutrient composition.
- For cash crops, including chili, sugarcane and cabbage, a parallel strategy of adequate rates and proportions of nutrients. For these crops, higher density/higher value compounds may be used and or low-density compounds complemented with potassium.
- Cash crops including pulses are likely to benefit from the introduction of a fertilization regime comprising low density compounds complemented with potassium.
- All crops will benefit from concerted efforts with focus on the role of potassium, with other nutrients supplied in adequate amounts. In general, potassium is severely under supplied, and likely to generate the highest return on investment.

Chili is carefully being planted (Photo: T. Oberthür).

Cropping systems opportunities: For the identification of promising cropping systems, we use relative return on investment in fertilizer, production input/output cost ratios, perceived cropping risks and unrealized yield potential. Achievable increases in rice yield are in most cases between 1.0-2.0 t per hectare, with highest potential in the Ayeyarwaddy Delta. Possible yield increases for pulses are in the range of 0.5-1.0 t per hectare, which is significant. Yield gaps in maize range from 1.0-4.0 t per hectare. Highest return on investment in improved nutrition is expected for these crops in Southern Shan State and the Ayeyarwaddy Delta. Considering these findings, we suggest that robust market development opportunities for nutrition exist in: (1) rice, pulse system development in the Ayeyarwaddy Delta and (2) maize development in Southern Shan State. Both opportunities provide an economy of scale, the possibility to rapidly adapt and deploy fertilizer recommendation software (IPNI Nutrient Expert Software). They also provide scope for significant potassium and phosphorus market development. Here, it is important to note, that we advocate pulses as the entry point for change in nutrition management. Pulses provide a robust return on investment and allow rice to benefit from systematic pulse nutrition. This is in contrast to current management strategies, which in our opinion are not favorable for farmers.

Tomatoes are being sorted and packed for the nearby market (Photo: T. Oberthür)

> **"Farmers are aware that significant yield increases depend on both cultural and technological changes**

Cash crop opportunities: Potential yield increases in chili are in most cases between 1.0-1.5 t dry chili per hectare. Yield gaps are largest in the Ayeyarwaddy Delta. Possible yield increases for potato are expected in the range of 10.0-15.0 t per hectare, which is significant. Yield gaps in cabbage are about 2.0 t per hectare. Increasing tomato yields by about 10.0 t per hectare is feasible in both Southern Shan State and Ayeyarwaddy Delta. Sugarcane yields may be increased by about 1.5 t per hectare. Current ratios of input costs to output returns are favorable for chili, potato and tomato. Returns on investment in potato are consistent and stable. Favorable returns on investment are also expected for cabbage, potato and sugarcane. Cropping risks for chili farmers are low in Southern Shan State but moderate to high in the Ayeyarwaddy Delta. Potato and tomato have particularly high cropping risks. Cabbage and sugarcane cropping risks are low and occasionally moderate. Considering the potential return on investment, the magnitude of exploitable yield gaps and cropping risks, we conclude that market development opportunities exist in chili and cabbage, and potentially tomato if nearby markets are accessible - pest and diseases can be controlled. Sugarcane may be considered where labour and markets are no constraints. Most of these crops appreciate higher density/higher value compound fertilizers, while sugarcane provides an opportunity for low density compounds coupled with potassium sources. A potassium awareness campaign is considered useful in these systems.

Knowledge development opportunities: Farmers' attitude towards fertilizer use is positive. Deep intelligence reveals that resource allocation into farming is considered important even under difficult conditions. Farmers are aware that significant yield increases depend on both cultural and technological changes. Field missions also reveal that farmers are brand and quality conscious. At the same time, insights show that farmers find it difficult to manage their farms as a business. For any change process to be successful, farmers need more knowledge as to how to manage fertilizer in such a way that return on investment is likely. The required knowledge base must be: (1) locally specific, (2) relevant to the needs of small-scale farmers and their suppliers, and (3) reflect the complexities farmers face.

However, where will this knowledge come from? Conventionally, it is 'passed down' to farmers from experts in the department of agriculture or similar organizations. Field missions show however, that nutrition knowledge of extension agents and fertilizer dealers is limited and patchy, and 'top-down' knowledge transfer inadequate. Hence, farmers must be the hub of knowledge generation and growth in the production system because they currently bear most of the risk. Hence, risk sharing is essential for successful and deep market penetration. Suppliers must engage with farmers as partners in the development of improved fertilizer use strategies and the underlying knowledge base. Farmers need suppliers to work with them to reduce the uncertainty of investment. This is most likely achieved through on-farm trials that support joint learning by farmers and suppliers. ■