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Communicating actionable nutrition science to farmers

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Food security is a global challenge facing humanity. Rising population, diminishing natural resources and the impact of climate change exacerbates the complex relationship between food supply and demand. Sustainable production of food and associated commodities from limited land and other resources to feed a 10 billion population would require frontier technologies and practices adopted at scale. The global food and nutritional security are intrinsically hinged to balanced plant nutrition.

Numerous studies, at global, regional and local scale, provide evidences that balanced fertilizer application improves quantity and quality of agricultural products. Many such studies have underscored that on-farm site-specific application of fertilizer at the right climate-soil-plant context reduces environmental impact of agricultural nutrient use and helps adapt to climate change impacts.

This article focuses on how the International Plant Nutrition Institute (IPNI) communicates plant nutrition knowledge to smallholder farmers in Asia and Africa, and the unique challenges associated with reaching large number of farmers for visible impact.

The challenge

A recent estimate based on 167 countries, which represents 96% of the world's population, 97% of the population active in agriculture and 90% of agricultural land worldwide, reported that there are about 570 million farms in the world. Of the estimated 570 million farms, 84% or over 475 million farms are less than two hectares in size. A large number of these farms are located in Asia and Africa. Smallholder farmers are a major part of the food security equation because they cultivate 80% of farmland and provide up to 80%

of the food in Asia and sub-Saharan Africa. In general, they have less resources, low access to knowledge and are risk averse. Transfer of crop nutrition knowledge in such scenarios requires continuous contact with many farmers who have variable resources, awareness of plant nutrition, production orientation and risk perception. There is rarely a silver bullet that caters to the need of all farmers, therefore continuous improvisation and multiple channels of contact are necessary for on the ground impact.

The response by IPNI

The IPNI, a not-for-profit organization supported by the world's leading fertilizer producers, focuses on improving crop productivity and farm profitability through sustainable use of plant nutrients. IPNI has a rich history of supporting a global plant nutrition research and education programmes



Figure 1. Supporting farmers to identify actionable interventions to apply fertilizer responsibly is at the heart of IPNI's communication efforts.



Figure 2. Dr. Oberthür having a conversation on crop nutrition with cocoa farmers in a learning farm in Sulawesi, Indonesia.

for over 80 years. Based out of Norcross, Georgia, IPNI programmes operate in more than 50 countries across the continents, contributing to plant nutrient management research and extension. IPNI's engagement is guided by the '4R Nutrient Stewardship Principles' of applying the right source of nutrients, at the right rate, at the right time and at the right place. This is at the core of IPNI's research and education programs. Defining and applying the 4Rs for appropriate crop-soil-climate context is expected to ensure optimum crop productivity and reasonable return on investment thereby reducing risk, and minimizing loss of nutrients from the rhizosphere to reduce environmental footprint. IPNI scientists join local researchers to define 4Rs for different crops and cropping systems that are grown under variable soils, tillage and crop establishment, water regimes and general crop management. IPNI programs operate in broad acreage as well as in smallholder production areas of the world. These two types of production areas have distinct differences in terms of number of people involved in farming, farm size, labour availability, farmer resource endowment, access to knowledge and use of modern agro-technologies. Locally relevant knowledge is communicated and disseminated through various mechanisms with the aim of reaching the end users for their on-farm implementation.

“IPNI uses multiple knowledge products and decision support tools

Knowledge development partnerships

Asia and Africa boast the majority of smallholder farmers in the world. Fertilizer use by smallholder farmers is, in general, often imbalanced and inadequate. Under- or over-fertilization is common. Consequently, crop yields are low and soil fertility depletion is prevalent. While in some countries and crops, imbalanced and over-use of certain nutrients have escalated environmental risks. Large number of smallholder farmers managing majority of farmland in Asia and Africa are a vital part of the economic, social and environmental sustainability of the food systems. How well smallholder farmers manage plant nutrients is critical in these geographies. Evidences suggest that smallholders could double crop yield by adopting improved nutrient management. Despite some scattered success, transferring improved plant nutrition knowledge to smallholder farmers to simultaneously address crop production and environmental issues has been a major challenge. The need to reach a very large number of farmers for up-scaling relevant messages can be overwhelming even to organizations with sizable outreach capacity.

One of the most important part of IPNI's global research and education/extension strategy is to identify and collaborate with the most relevant stakeholders at the regional level – usually organizations that have vested interests in solving the problem at hand. Right from the problem identification and conceptualization of research, partner collaborations are a vital part of our research execution, analysis of results, and finally distilling and packaging the research information in to usable output formats. Besides the advantage of tapping in to a collective intellectual capacity for problem solving, the necessary buy-in at the local level to the research program and outputs immensely help in knowledge dissemination.

Research programmes

Majority of IPNI's research programmes are executed in farmers' fields. These inclusive and co-shared researches (also termed participatory), with contributions from farmers, local agencies, researchers, fertilizer industry agronomists and IPNI scientists, ensure that most relevant

local plant nutrition problems are addressed that incentivizes various stakeholders. The major groups that we work with in Asia and Africa include:

- Farmers/farmer groups/farmer cooperatives
- Government extension system
- National Agricultural Research System (NARS)
- Fertilizer industry
- Commodity value chain partners
- International research and development organizations

Knowledge communication pathways

These groups provide support to research, and development of various knowledge products for out-scaling improved practices to the farmers. Packaging of improved nutrient management information in usable formats varies with target groups. With support from partners



Figure 3: One of IPNI's Smart Phone Apps on calculating nutrient removals.

The unique challenge is reaching large numbers of farmers

to facilitate knowledge transfer, IPNI deploys several pathways that communicate developed knowledge content effectively to farmers. The key pathways include:

- On-farm participatory research and demonstration
 - Examples are 4R learning sites that develop and demonstrate best nutrient management practices, or nutrient omission trials within farmer fields that assess and communicate the role of individual nutrients
- Advisory service support
 - Examples are crop nutrient deficiency photos, posters; radio and television, bulk SMS all of them give practicable and actionable advice to farmers
- Technical bulletins and industry journals
 - Examples are crop and nutrient specific brochures including those on nutrient deficiency identification and remediation; research with impact; 'Plant Nutrition Today', 'Better Crops Journal'
 - These communication outlets are designed to communicate tangible field evidence to partners of farmers (e.g. NGOs, service providers, and similar) so they systematically increase crop nutrition support to farmer clients
- Decision support tools and smartphone-based apps:
 - Examples are the nutrient expert fertilizer decision support tool; crop nutrient response tool, PlantCalc mobile app; nutrient expert mobile app
 - All of these are built so that they can be used either by farmers directly, or by their partners (e.g. extension agents, or fertilizer dealers)
 - We introduce further below the case of the nutrient expert fertilizer recommendation tool

IPNI has six programmes in Asia and Africa: China, Southeast Asia, South Asia, sub-Saharan Africa, West Africa

and North Africa. All of the IPNI programmes are based on regional requirement and are partnered with organizations to produce knowledge products to aid in easy dissemination of improved nutrient management practices. IPNI scientists focus strongly on developing knowledge and respective communication products that engage farmers directly, but in parallel also provide the opportunities for farmer support institutions including regional public and private sector to effectively reach farmers (see table 1). Although the type of knowledge products produced have a strong regional influence, some of them do cut across regional boundaries, institutional actors and language barriers.

Case example: Nutrient Expert tool communicates fertilizer recommendations

The Nutrient Expert (NE) decision support tool, a 4R compliant tool that rapidly provides field-specific fertilizer recommendation, with or without a soil test, is a great example. Since its development in 2008 by the Southeast Asia Program, IPNI has so far developed the NE tools for 6 crops (maize, wheat, rice, soybean, cassava, potato), for 18 countries (China, Philippines, Vietnam, Indonesia, Bangladesh, Nepal, India, Ethiopia, Kenya, Tanzania, Zimbabwe, Nigeria, Ghana, Togo, Burkina Faso, Algeria, Tunisia and Morocco), that are available in 8 languages (English, Chinese, Hindi, Bengali, Tagalog, Indonesian, Vietnamese, French). These tools in web and smartphone platforms have been successfully used and scaled up by the stakeholders in Asia and Africa to increase the likelihood of improved crop production and profitability, and reduced environmental risk from plant nutrients.

Table 1. Regional stakeholders and plant nutrition communication pathways: more asterisks indicate increasing importance of a communication pathway for a stakeholder.

Stakeholders	Farmer Groups/ Cooperatives	Local Extension	NARS	Fertilizer Industry	Value Chain Partners	NGO	International Development Agencies
On-farm Participatory Research & demonstration	***	***	***	***	**	*	***
Advisory Service Support		***		***	**	**	
Technical Bulletin		***	***	***			
Scientific Journal/ Articles			***	**	**	*	***
Decision Support Tools	**	***	***	***	**	**	***
Smartphone based	***	***		***		**	***
Online Services	**	**	***	***		*	**

Table 2 provides a break down of the number of farmers that IPNI reached directly with Nutrient Expert. These numbers obviously do not include

those generated by spontaneous dissemination without direct engagement of IPNI, or the use by partners organizations of IPNI.

Across all sites, compared with farmer's fertilizer practice, Nutrient Expert increased yield by 1.25, 0.84, and 0.78 t/ha and increased gross profit by 304, 214, and 234 USD/ha in maize, rice, and wheat, respectively. Average fertilizer P and K use with Nutrient Expert for all the three crops were mostly comparable with the farmer's rates, although rates varied from field to field and site to site. Nutrient Expert increased fertilizer K use consistently for maize and wheat; for rice, Nutrient Expert either increased or decreased the K application, depending on the country or region. NE balanced the application of nutrients depending on crop requirement and indigenous nutrient supply, resulting in increased nutrient use where farmers' rates were below the optimal and Nutrient Expert reduced the nutrient rates where farmers' rates were excessive.

IPNI uses multiple knowledge products and decision support tools, and leverages partner strengths to communicate plant nutrition science to farmers. Regions, where millions of smallholder farmers operate, it is impractical, if not impossible, for any single organization to reach the scale. Harmonizing our efforts with stakeholders, who have incentives to apply improved practices on-farm and using multiple strategies and tools provide the best possible chance of success on the ground. ■

Figure 4: The successful Nutrient Expert software is available in various languages and for various crops in several countries.

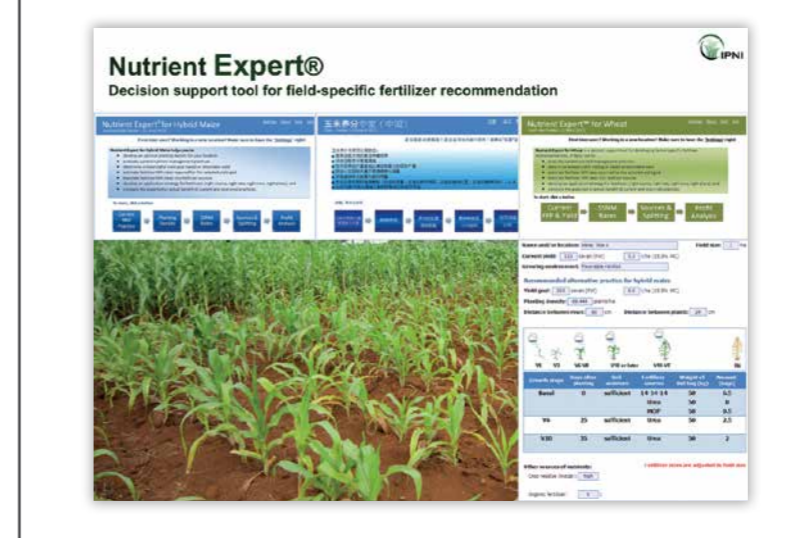


Table 2. On-farm impact of the Nutrient Expert fertilizer decision support tool in Asia and Africa

Country	Crops	Farmers reached directly
China	Maize, Wheat, Rice, Soybean, Potato	2346
South Asia	Maize, Wheat, Rice, Soybean	2452
Southeast Asia	Maize, Cassava, Sugarcane	4748
Northern Africa	Wheat	3964
Sub-Saharan Africa	Maize	12079
TOTAL		25589