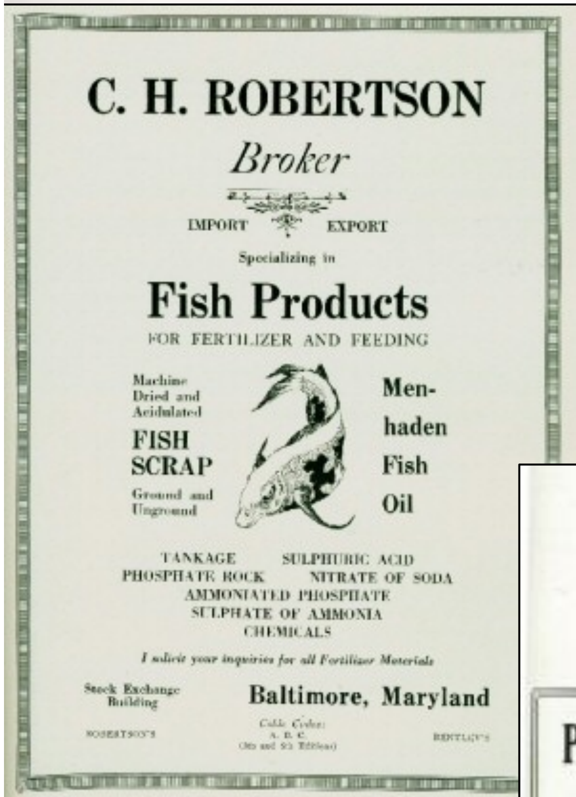
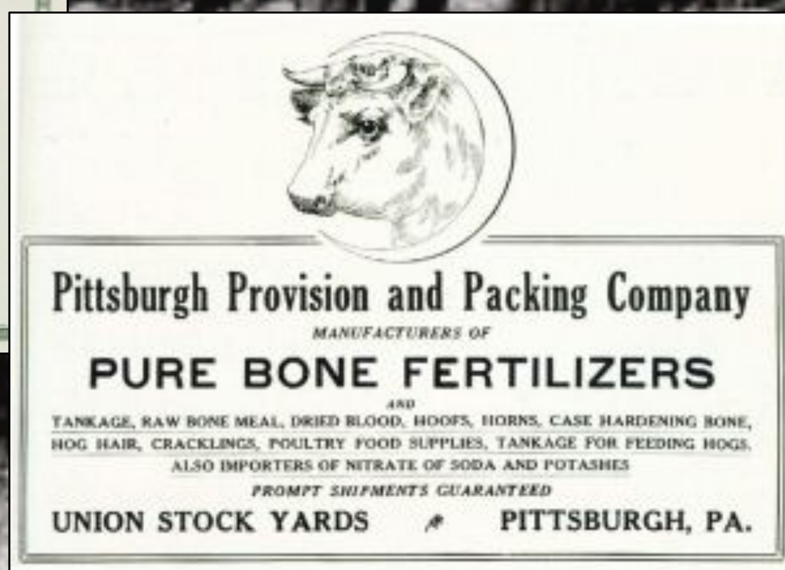
Nutrient management to nutrient stewardship

Robert M Norton[1] and Terry L Roberts[2]
1. Regional Director IPNI, Australia and New Zealand
2. President, IPNI, Atlanta, GA.

ASA Meeting, Armidale, October 2012.

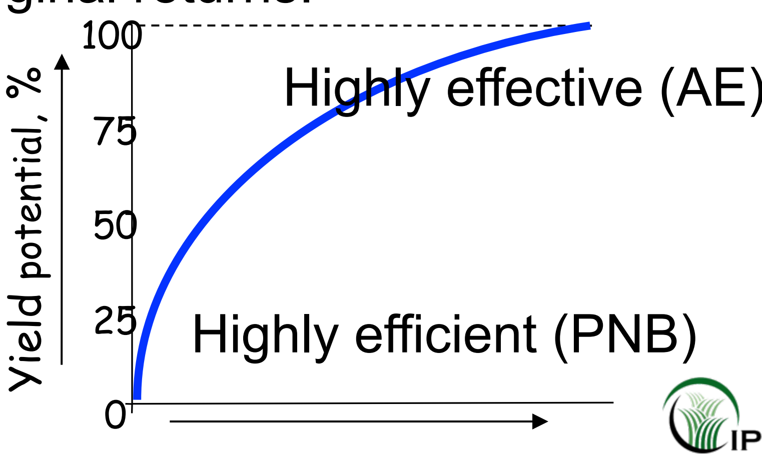
Nutrients have always been important in agriculture





From maximum yield to economic return

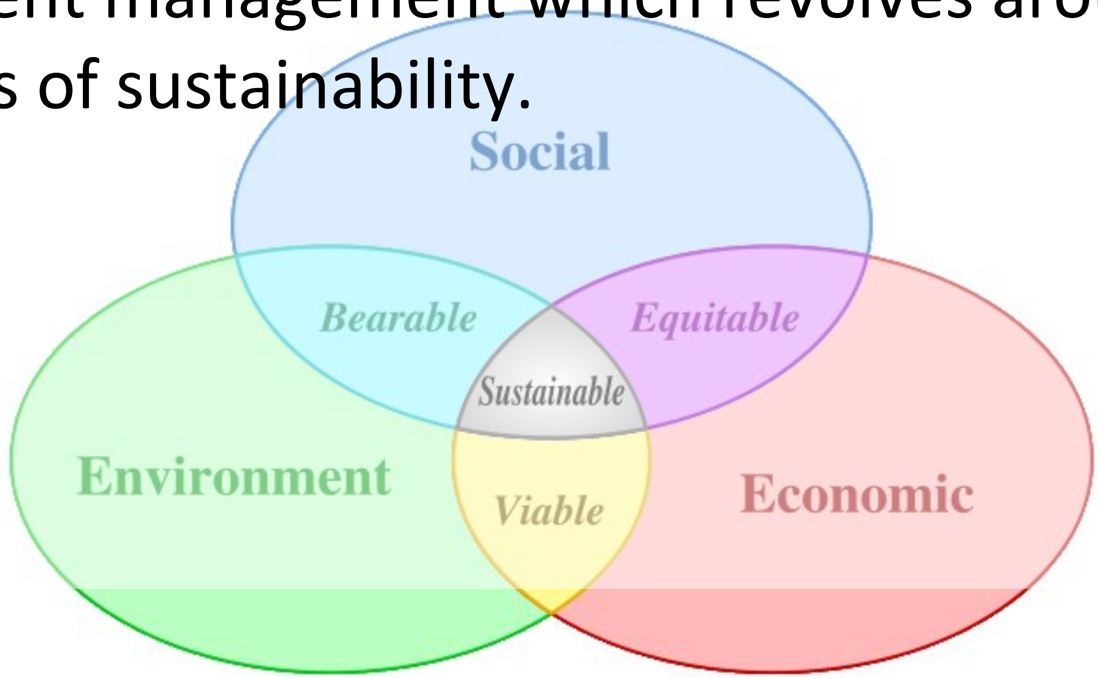
- Earliest work looked at using fertilizer to get the highest yield
  - Fertilizer relatively cheap – soils very responsive.
  - Sub & Super era & the “Super” bounty
  - Maximum production rates
- Development of resource economics
  - Marginal returns considered where the added cost was balanced against the added return – equi-marginal returns.
  - Economic rational rates
  - Add in “other values”
    - Difficult to value “environment”



Sustainability goals

- Many stakeholders interested in nutrient management
  - Farmers, crop advisers and consultants, policymakers, consumers, and general public

- Stakeholders have different expectations of nutrient management which revolves around the pillars of sustainability.



Best Management Practices (BMPs)

Definition - Research proven practices that have been tested through farmer implementation to optimize production potential, input efficiency, and environmental protection (Griffith and Murphy 1991).

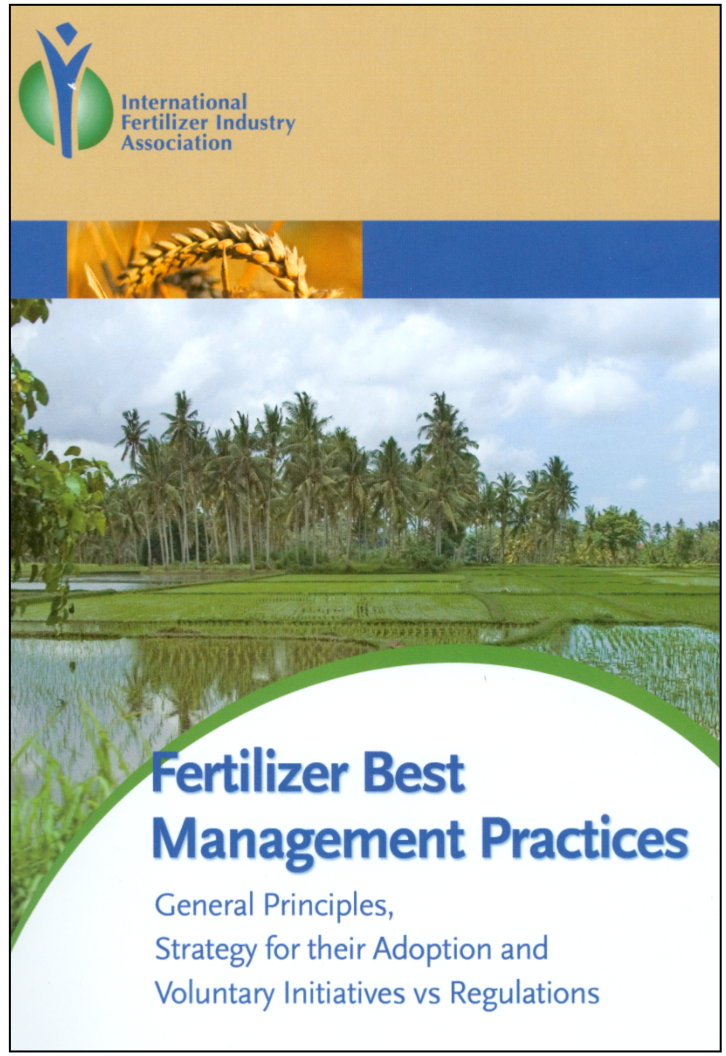
- Fertilizer best management practices, integrated plant nutrient management, integrated soil fertility management, code of best agricultural practices, site-specific nutrient management, etc.
- ***Goal — ensure plant nutrients are use efficiently and effectively in ways that are beneficial to society without adversely impacting our environment.***

IPNI

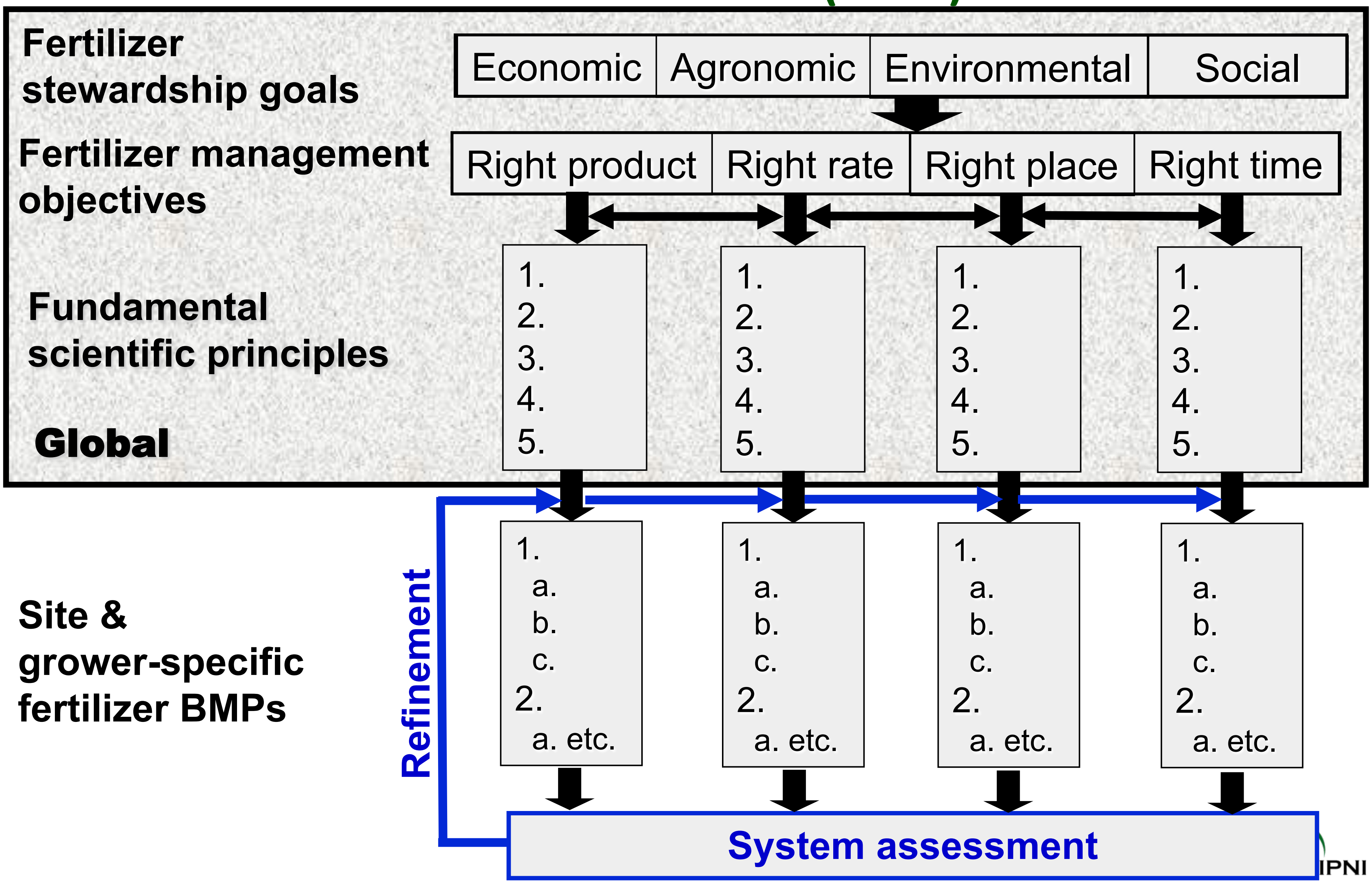
International Fertilizer Industry Association (IFA) initiative on fertilizer BMPs

- International workshop in Brussels (2007) to define principles of FBMPs and a strategy for wider adoption

- IPNI VP Paul Fixen … idea of a global framework from which FBMPs could be adopted



Global Fertilizer BMP framework (2007)



One potential global framework with FBMP example.

Fertilizer stewardship goals

Economic	Agronomic	Environmental	Social

Fertilizer management objectives

Right product	Right rate	Right place	Right time

Fundamental scientific principles

1. Assess soil nutrient supply
2. Assess non-soil nutrient sources
3. Assess plant demand
4. Predict fertilizer use efficiency
5. Consider soil resource impacts

Global

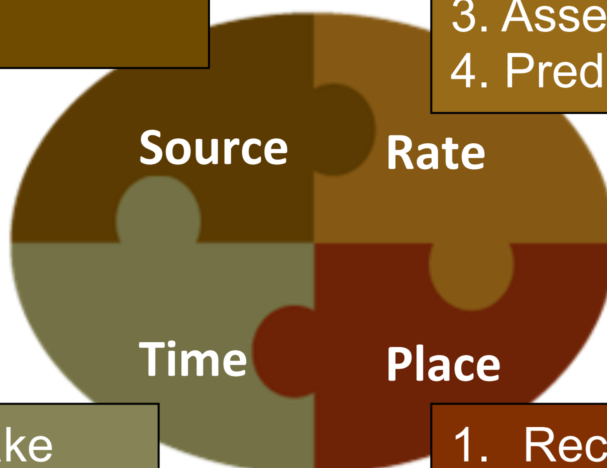
Site & grower-specific fertilizer BMPs

1. Assess soil nutrient supply
    a. Use Mehlich III soil test for P, K, and Zn with target levels of 25, 150, and 1 ppm, respectively based on annual 0-15 cm soil samples.
    b. Use omission plots for determination of soil N and S supply.
    c. Etc.

The basic scientific principles of managing crop nutrients are universal

1. Supply in plant available forms
2. Suit soil properties
3. Recognize synergisms among elements
4. Blend compatibility

1. Appropriately assess soil nutrient supply
2. Assess all available indigenous nutrient sources
3. Assess plant demand
4. Predict fertilizer use efficiency



1. Assess timing of crop uptake
2. Assess dynamics of soil nutrient supply
3. Recognize timing of weather factors
4. Evaluate logistics of operations

1. Recognize root-soil dynamics
2. Manage spatial variability
3. Fit needs of tillage system
4. Limit potential off-field transport

A Global Framework for Fertilizer BMPs

By T.W. Bruulsema, C. Witt, Fernando García, Shutian Li, T. Nagendra Rao, Fang Chen, and S. Ivanova

This paper describes a framework designed to facilitate development and adoption of best management practices (BMPs) for fertilizer use, and to advance the understanding of how these practices contribute to the goals of sustainable development. The framework guides the application of scientific principles to determine which BMPs can be adapted to local conditions at the practical level.

At the farm level, cropping systems are managed for multiple objectives. Best management practices are those that most closely attain those objectives. Management of fertilizer use falls within a larger agronomic context of cropping system management. A framework is helpful for describing how BMPs for fertilizer use fit in with those for the agronomic system.

The goals of sustainable development, in the general sense, comprise equal emphasis on economic, social, and ecological aspects (Brundtland, 1987). Such development is essential to provide for the needs of current and future generations. At the farm level, however, it is difficult to relate specific crop management practices to these three general aspects. Four management objectives are applicable to the practical farm level of all cropping systems (Witt, 2003). These four objectives are productivity, profitability, cropping system sustainability, and a favorable biophysical and social environment (PPSE). They relate to each other as illustrated in **Figure 1**.

Fertilizer use BMPs comprise an interlinked subset of crop management BMPs. For a fertilizer use practice to be considered "best", it must harmonize with the other agronomic practices in providing an optimum combination of the four objectives, PPSE. It follows that the development, evaluation, and refinement of BMPs at the farm level must consider all four objectives, as must selection of indicators reflecting their combined impact at the regional, national, or global level. Appropriate indicators for use at different scales are further discussed below in the section on performance indicators.

Figure 1. Illustration of a global framework for BMPs for fertilizer use. Fertilizer use BMPs–applying the right nutrient source at the right rate, time, and place–integrate with agronomic BMPs selected to achieve crop management objectives of productivity, profitability, sustainability, and environmental health. A balanced complement of indicators is needed to reflect the influence of fertilizer BMPs on the four crop management objectives at the farm level, and on the economic, ecological, and social goals for sustainable development on the broader scale for regional public policies.

Cropping System Management Objectives

Productivity. For cropping systems, the primary measure of productivity is yield per unit area of cropland per unit of time. Productivity should be considered in terms of all resources, or production factors, involved. Several indicators describing production and input use efficiencies are probably required to properly evaluate productivity.

Profitability. Profitability is determined by the difference between the value of the produce (gross benefit or revenue) and the cost of production. Its primary measure is net benefit per unit of cropland per unit of time. The profitability gain of a specific management practice is the increase in gross revenue it generates, less its marginal cost.

Sustainability. Sustainability—at the level of the cropping system—refers to the influence of time on the resources involved. A sustainable production system is one in which the quality (or efficiency) of the resources used does not diminish over time, so that "outputs do not decrease when inputs are not increased" (Monteith, 1990).

Environment (biophysical and social). Crop production systems have a wide range of effects on surrounding ecosystems through material losses to water and air. Specific effects can be limited to some extent by practices designed to optimize efficiency of resource use. Management choices at the farm level, when aggregated, also influence the social environment through demand for labor, working conditions, changes in ecosystem services, etc.

Fertilizer Management Objectives

Fertilizer use BMPs essentially support the four objectives identified for cropping systems management and can be aptly described as the selection of the right source for application at the right rate, time, and place (Roberts, 2007). Fertilizer source, rate, timing, and placement are interdependent, and are also interlinked with the set of agronomic management practices applied in the cropping system, as illustrated in **Figure 1**.

Scientific Principles

Specific scientific principles apply to crop and fertilizer use BMPs as a group and individually. These principles are

Abbreviations and notes for this article: N = nitrogen; P = phosphorus; K = potassium.

ifa Agriculture

AgCom/09/44
A/09/116
August 2009

The Global "4R" Nutrient Stewardship Framework

Developing Fertilizer Best Management Practices for Delivering Economic, Social and Environmental Benefits

Paper drafted by the IFA Task Force on Fertilizer Best Management Practices

International Fertilizer Industry Association (IFA) - 28, rue Marbeuf - 75008 Paris - France
Tel. +33 1 53 93 05 00 - Fax +33 1 53 93 05 45/47 - ifa@fertilizer.org - www.fertilizer.org

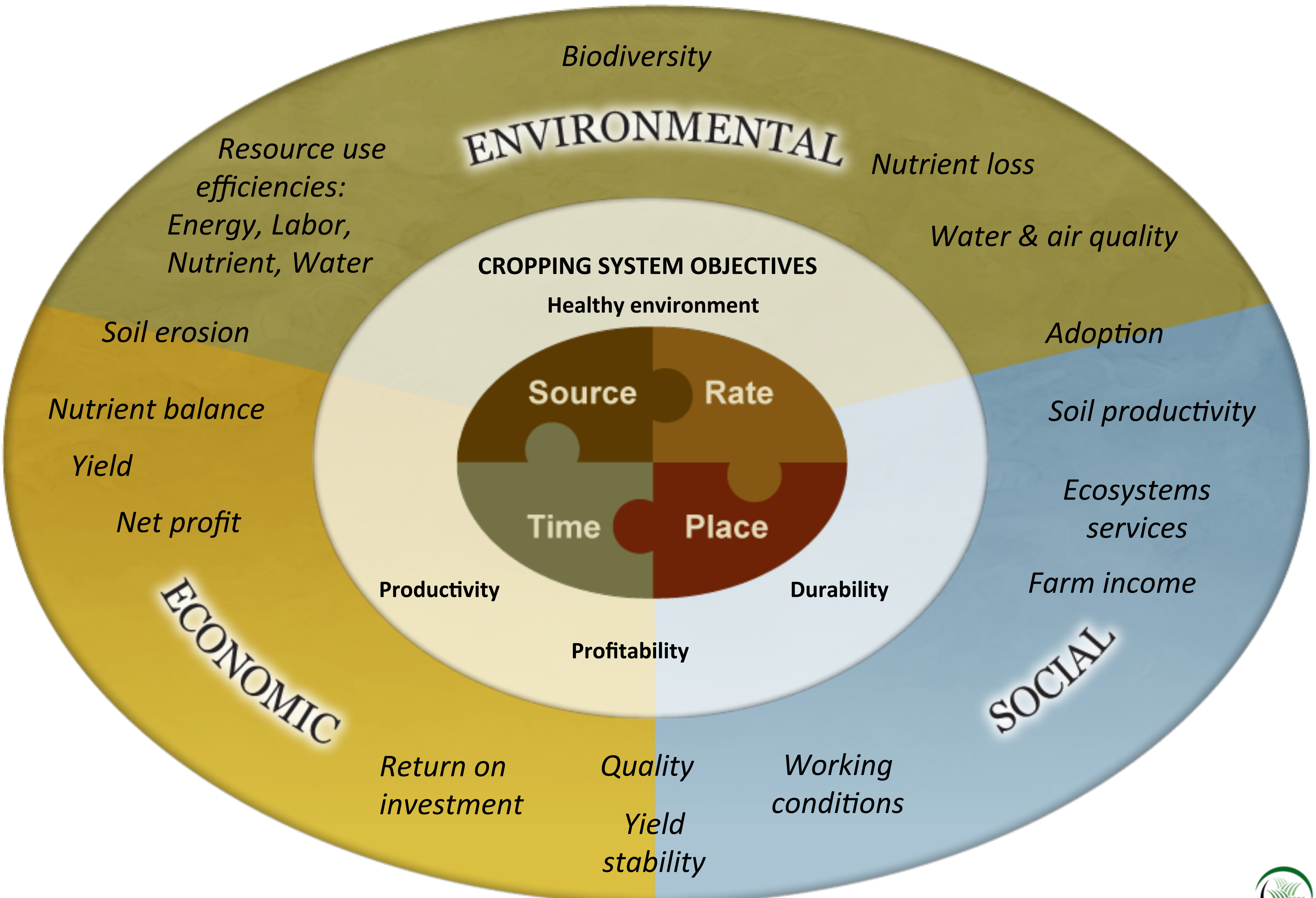
The concept was further developed by IPNI scientists (Bruulsema et al. 2008)

The framework is intended to aid the development and adoption of nutrient BMPs that meet **<u>sustainable development goals</u>**

4R nutrient stewardship

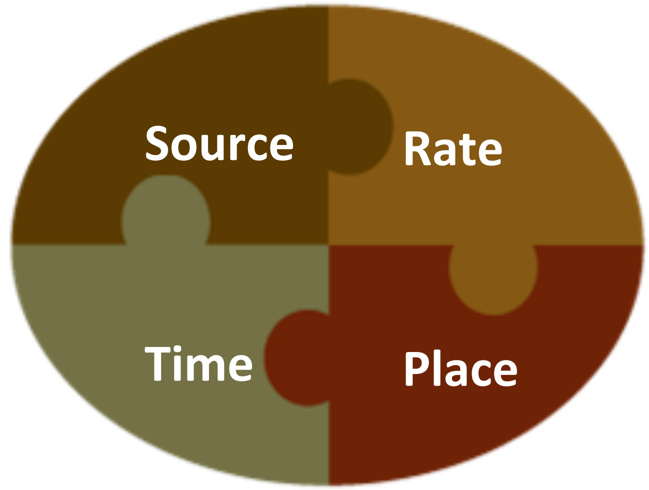
IPNI

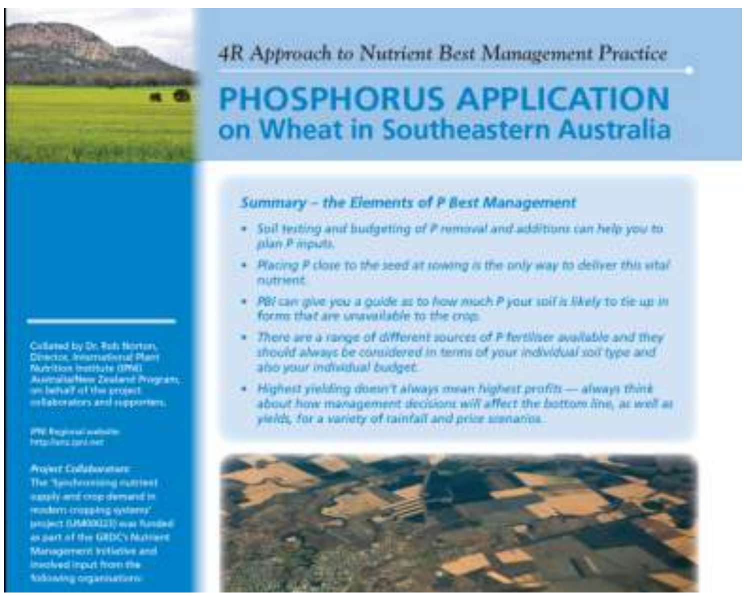
4R Nutrient Stewardship



4R Nutrient Stewardship

- The 4Rs are the foundation and guiding principles of nutrient BMPs (Roberts 2007)
- Approach is simple … apply the correct nutrient in the amount needed, timed, and placed to meet crop demand





4R Approach to Nutrient Best Management Practice

PHOSPHORUS APPLICATION on Wheat in Southeastern Australia

Summary – the Elements of P Best Management

- *Soil testing and budgeting of P removal and additions can help you to plan P inputs.*
- *Placing P close to the seed at sowing is the only way to deliver this vital nutrient.*
- *PBI can give you a guide as to how much P your soil is likely to tie up in forms that are unavailable to the crop.*
- *There are a range of different sources of P fertiliser available and they should always be considered in terms of your individual soil type and also your individual budget.*
- *Highest yielding doesn't always mean highest profits — always think about how management decisions will affect the bottom line, as well as yields, for a variety of rainfall and price scenarios.*

Collated by Dr. Rob Norton, Director, International Plant Nutrition Institute (IPNI) Australia/New Zealand Program, on behalf of the project collaborators and supporters.

The 4R's is both
• a process (what needs to be considered)
and
•an outcome (how the pieces fit together)

IPNI

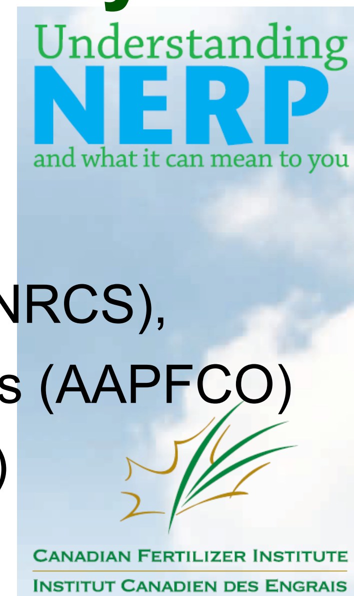
Right source, rate, time, and place

- science-based principles
- not static
- Interdependent & applied in farming systems

- The 4Rs provide flexibility to nutrient management recognizing that FBMPs are site and crop specific depending on soils, climatic conditions, crop and cropping history, and management expertise, and can be applied in large-scale, extensive agriculture or small family farms.

- *Ignorance more frequently begets confidence than does knowledge.*
  - *Charles Darwin*

Role of 4Rs in nutrient use regulatory and policy developments



- Endorsed by:
  - USDA's Natural Resources Conservation Service (NRCS),
  - Association of American Plant Food Control Officials (AAPFCO)
  - Conservation Technology Information Center (CITC)
  - American Farm Bureau Federation (AFBF)
- Being implemented within the Alberta's N_2O reduction protocol (NERP) and under consideration in other provinces
- In Australia
  - Endorsed by AFSA & incorporated into FertCare Training
  - Underpins the "Fert$mart" Dairy Australia project.
  - Adopted by DAFWA to lead into their nutrient management pubs.

F I F A

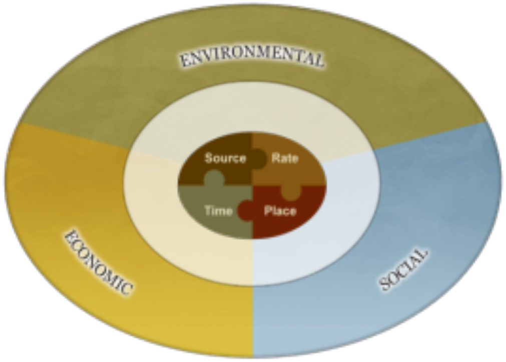
IPNI

4R Nutrient Stewardship

Know your fertilizer rights

By Tom Bruulsema, International Plant Nutrition Institute, Guelph, ON, Canada; ***Jerry Lemunyon***, USDA-NRCS, Fort Worth, TX; and ***Bill Herz***, The Fertilizer Institute, Washington, DC

Crops & Soils 42(2): Mar-Apr 2009



The four fertilizer rights: Selecting the right source

By Robert Mikkelsen, International Plant Nutrition Institute, Merced, CA; ***Greg Schwab***, University of Kentucky, Lexington; and ***Gyles Randall***, University of Minnesota, Waseca

Crops & Soils 42(3): May-Jun 2009

http://www.ipni.net/4r

Selecting the right fertilizer rate: A component of 4R nutrient stewardship

By S.B. Phillips, International Plant Nutrition Institute, Owens Cross Roads, AL; ***J.J. Camberato***, Purdue University, West Lafayette, IN; and ***D. Leikam***, Fluid Fertilizer Foundation, Manhattan, KS

Crops & Soils 42(4): Jul-Aug 2009

The four fertilizer rights: timing

By W.M. Stewart, International Plant Nutrition Institute, Norcross, GA; ***J.E. Sawyer***, Iowa State University, Ames, IA; and ***M.M. Alley***, Virginia Tech, Blacksburg, VA

Crops & Soils 42(5): Sep-Oct 2009

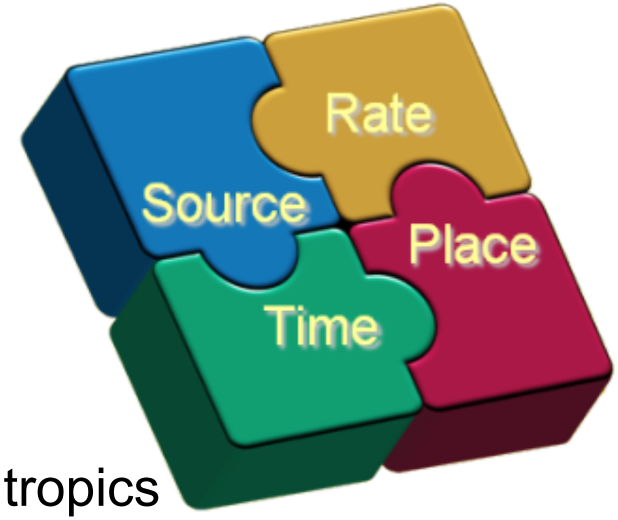
Know Your Fertilizer Rights: Right Place

by T.S. Murrell (IPNI), G.P. Lafond (AAFC), and T.J. Vyn (Purdue U.)

Crops & Soils 42(6): Nov-Dec 2009

IPNI

Concluding Comments



- Manage or be managed
- Regulations on nutrient management
  - Reef Regulations on sugar industry in the wet tropics
  - Use of soluble P fertilizers on the Swan coastal plain.
  - Fertilizer management in the Mississippi Basin.
  - N application in UK.
  - Regulations on N use on particular dairy pastures in New Zealand.
- Right source, right rate, right time, and right place is a simple slogan that integrates a century of science and experience into nutrient stewardship.
- Research backstops the principles of 4Rs with science, but the stakeholders decide what is right.

IPNI