Blueprint for Global Phosphorus Security

Preamble

Without phosphorus we cannot produce food. Yet even as pressure mounts on the world's critical main source – non-renewable phosphate rock – there is a startling lack of effective global governance surrounding its use and supply. If no one takes responsibility for ensuring phosphorus security, we can expect it to compromise our ability to feed a growing global population. Global phosphorus scarcity hit the mainstream international agenda several years ago, as phosphate prices increased by 800% in 2008.

While there is still much debate regarding the longevity of phosphate reserves, scientists and industry agree that there is a strong need for increased recycling, efficient use and reduced environmental dissemination of phosphorus throughout the food system due to the uncertainty surrounding future supplies, not least in relation to the inequitable geographical distribution of phosphate reserves which makes their supply vulnerable to geopolitical dynamics. The next step is for policy makers to develop effective policy frameworks to stimulate and support such sustainable phosphorus measures.

The *Blueprint for Global Phosphorus Security* is a key output from the 3rd Sustainable Phosphorus Summit (Feb-Mar 2012) hosted by the Global Phosphorus Research Initiative co-founder, the Institute for Sustainable Futures at the University of Technology, Sydney. Designed with input from delegates during Summit workshops and plenary sessions, the Blueprint outlines the principles, challenges and opportunities involved in achieving global phosphorus security. It recommends initiatives, strategies, roles and responsibilities to identified stakeholders. This document aims to encourage research and policy action in the field of phosphorus sustainability and bring attention to this emerging global sustainability challenge.

The target audience for this Blueprint includes governments, industry, researchers and the media.

Section 1: Objectives of a sustainable phosphorus future

A sustainable phosphorus future will depend on recognising that the continued availability of phosphorus fertiliser is essential to food security, and that inappropriate levels of phosphorus fertilizer use have a variety of ecological consequences. Phosphorus security means ensuring that all farmers have sufficient access to phosphorus to produce enough food to feed the global population. The sustainable use of phosphorus will require:

- the integrated, global and local management of phosphorus at all stages of the food system in a manner which ensures that the benefits and costs of its production and use are equitably distributed;
- improved efficiency to maximise productivity and minimise losses across the life cycle;
- farming innovation and farmer education to maximize sustainable phosphorus use;
- "closing the phosphorus loop", that is, promoting phosphorus recycling in ways that provide systemic benefits (such as more energy-effective and cost-effective food systems and reduced eutrophication problems);
- maximising knowledge transfer and communication between stakeholders and sectors, such as mining and fertilizer, agriculture and food, sanitation and the environment. This will require good data availability, including accurate information on phosphorus stocks and flows across all sectors; and
- incorporating phosphorus issues into dialogues regarding other essential nutrient resources, such as nitrogen, potassium and sulphur.

Section 2: Priority actions

This section outlines the priority actions that need to be pursued to achieve sustainable phosphorus production and use for food security. It includes existing actions that need to continue in an expanded form, actions that need to be initiated, and aspects of the current situation that are in urgent need of change.

2.1 Actions which need to be continued and further developed

In recent years – particularly since the 2008 phosphate commodities price spike – there has been a marked increase in awareness-raising and advocacy regarding the need to manage and use phosphorus more carefully, predominantly initiated by the phosphorus research/ scientific community and the phosphorus recycling/ efficiency industry. However these efforts to raise awareness need to be increased substantially and supported by action. In particular the following actions are needed:

- Many practical or technical steps that need to be taken as a priority – such as increasing recycling and efficiency – have already been identified by the phosphorus community. These include the recovery and re-use of phosphorus from waste (such as sewage[1]), the creation and maintenance of local closed loop systems, and the efficient use of phosphorus as a nutrient throughout the food production life cycle;
- Advocacy and awareness raising regarding phosphorus issues needs to increase, with a focus on policy-makers and key stakeholder groups;
- The interdisciplinary engagement of stakeholders needs to increase and there is a need for a long-term approach to decision-making on the use of phosphorus; and
- The linkage between research and policy will need to increase in order to ensure that the realities of the industry and the supply chain are recognised.

2.2 Actions which need to be initiated

Except for a few isolated examples, such as Sweden's target of 60% re-use of phosphorus from sewage on productive land by 2015 and recent EU resolutions calling for high levels of recovery[2], there is an absence of policy instruments to support and encourage the sustainable use and production of phosphorus. To address this, the following actions need to be taken:

- On a policy level, countries need to introduce legislation that provides incentives and policies that support sustainable approaches to supplying the world's need for phosphorus.

[1] There are currently over 30 processes for the recovery of phosphorus from wastewater, ranging from decentralised processes such as urine diverting toilets, through to centralised high-tech processes such as struvite recovery from wastewater treatment plants. There is no one-fit solution for all contexts (e.g. see Sartorius D. 2011, *Phosphorus Recovery from Wastewater – State-of-the-Art and Future Potential*, Water Environment Federation International Conference: Nutrient, Recovery and Management, Inside and Outside the Fence, January 9-12, 2011, Florida).

[2] In May 2012, the EU Parliament Resolution on a Resource-Efficient Europe voted on P recycling text – calling on the EU Commission "to draw up appropriate criteria and start pilot projects for phosphorus, with a view to achieving virtually 100% reuse by 2020 and optimizing their use and recycling; emphasizes that such pilot projects should receive direct funding from the EU". http://www.europarl.europa.eu/plenary/en/texts-adopted.html. In March 2013, the 1st European Sustainable Phosphorus Conference was held to 'raise awareness about the necessity for more sustainable phosphorus management on a European level, to facilitate the transition towards an enabling European environment in which less phosphorus is used and a sustainable market for recycled phosphorus can be created, and to further develop the phosphorus value chain throughout Europe'. The European Phosphorus Platform was launched as an outcome of the conference see http://www.phosphorusplatform.org/espc2013.html

- There needs to be strong support for sustainability-related, innovative phosphorus research, development, knowledge transfer and education. In particular this will involve:
    - investing in trials of phosphorus recovery systems
    - development of phosphorus-efficient crops
    - investing in region- and scale-appropriate technologies
    - understanding phosphorus dynamics and status in the soil, such as through soil testing, to better manage soils health
    - understanding how to use phosphorus fertilizer and organic phosphorus sources more effectively
    - research and extension to better understand and match phosphorus use and crop requirements
    - continued analysis and quantification of phosphate rock reserves
    - assessment of contaminants and extraction impacts of unexploited phosphate rock reserves
    - understanding the environmental impacts of land use changes as they relate to global and regional phosphorus flows.

2.3 Changes to practices and attitudes

It is clear that some practices and attitudes will need to change in order to achieve sustainable production and use of phosphorus. Some of these changes are attitudinal, some are policy-related, and others are practical measures. Areas requiring attention include:

- Estimates of global phosphate rock reserves and resources vary widely and the data on which these estimates are based is inadequate. Sound and transparent data is needed so that policy decisions can be based on more accurate information.
- Regulation regarding livestock production needs to be based on the nutrient assimilation capacity of surrounding arable land to manure. In many countries there is an excessive, and in some cases increasing, concentration of livestock production and hence manure.
- An understanding of the implications of changes in diet (that is, the embodied phosphorus, environmental and social impacts of different dietary and food choices).
- There is a need for greater understanding of the relationship between rates of phosphorus fertilizer application and the final outcomes in terms of sustenance and nutrition for humans.
- Currently, there is a lack of political action at the global level on the mining of phosphate rock and fertilizer issues. Appropriately designed policy tools such as market-based instruments are needed to increase the use of recovered phosphorus from mining and fertilizer processing, and more funding is needed for research, innovation and technology transfer to increase recovery rates and efficiency levels.

- There is a need to address the market failures associated with both the externalities of the extraction, processing and application of phosphate fertilizer (such as the life cycle energy cost of processing and transport), and the long-term resource constraints (such as equity of access to phosphate resources).
- There is a need to address the institutional disconnect between decision-making in other sectors (such as water and sanitation) and decision-making on phosphorus use efficiency at the local, national and international levels.
- In many countries, over-fertilisation is widespread. The application of phosphorus in fertiliser needs to be linked to an understanding of soil nutrition as well as an understanding of the nutritional requirements of the crops being cultivated.
- Changed attitudes to the use, recovery and reuse of phosphorus are needed. The practice of sending organic waste to landfill needs to end, coupled with a change from viewing animal manure, human excreta and biosolids as waste products to an understanding that they are a valuable resource. This will require appropriate and attentive management of contaminants in biosolids (including chemicals, pharmaceuticals, pollutants and hormones) to ensure that recycling these does not conflict with safety and quality objectives.

Section 3: Stakeholder roles and responsibilities

The roles and responsibilities of those who should be taking leadership on phosphorus security need to be more clearly defined. There are a large number of stakeholders at the global, national and local level that could play a role in responding to the challenge of global phosphorus security. These include government and corporate entities as well as NGOs. The following table outlines the roles and responsibilities of organisations and individuals that are, or could be involved in making decisions about how phosphorus is used and governed sustainably.

Level	Who?	How?
Intergovernmental	UN	• A UN-led global convention on phosphorus security
	FAO and UNCSD	• Strategic linkage of governments on the phosphorus issue, corporations and NGOs, auspicing an intergovernmental panel. FAO to take on phosphorus in the context of nutrients/food security/soil management.
	CGIAR	• Engagement in the discussion in relation to agricultural research, and incorporation in its mandate.
	GPRI	• Advocate for the creation of an intergovernmental panel on phosphorus security
	EU	• Integrate P management into policy, including the Water Framework Directive, Common Agricultural Policy and food policy. • Incorporate P in the research program for FP8
	WHO	• Engagement in the discussion in relation to reuse of human excreta and guidelines and support, and incorporation in its mandate.
National	National Governments[3]	• Leadership on developing effective and appropriate policies to support and stimulate sustainable phosphorus use • Improving transdisciplinary communication to achieve a mutual learning process that can positively affect P decisions guiding different sectors • Setting and enforcing targets • National coordination of efforts within a country • Coordinate universities and other research bodies to align research priorities • Require a small (and increasing) target percentage of phosphorus recycling, including requiring fertilisers to contain a specific percentage of recovered phosphorus • Shifting existing subsidies to recovered phosphorus resources and recovery processes • Promote good practice in the process of granting exploration and mining rights • Provide financial and political support and coordinate research • Policy regulation, including potential pricing and incentives

[3] Including the EU in the case of Europe.

Level	Who?	How?
National (continued)	National food and dietary standards agencies	• Consider appropriate dietary guidelines that consider environmental and phosphorus intensity as well as public health impacts.
	Departments of Agriculture	• Include P in food policy discussion (national food and agriculture plan) • Facilitate and support the development of less phosphorus intensive crop and livestock systems in developed and developing countries • Regulate and/or monitor fluxes of phosphorus within agriculture and between agriculture and other sectors upstream and downstream, e,g, erosion losses to water, phosphorus fertilizer inputs
	Consumer protection agencies	• Encourage and support labelling of products (e.g. phosphorus footprints)
	Departments of Health	• Support labelling with education • Create standards and guidelines to support safe and effective reuse of phosphorus from e.g. manure, biosolids and human excreta
	Environmental agency	• Identify problems, employ incentives, pricing of externalities, extension and capacity building, regulation and fines
	National research council/ organisation	• Support research programs, addressing sustainable phosphorus management
Regional	Municipalities and local councils	• Include considerations of phosphorus efficiency in planning and operations • Support urban and peri-urban agriculture production that takes advantage of recoverable local phosphorus sources such as food waste and sewage • Reduce organic solid waste to landfill and encourage the collection and treatment for productive reuse • Organise land use and agricultural production planning to reduce or avoid excess manure phosphorus
Finance industry and philanthropic sources	Donors, funding organisations and development banks	• Provide funding mechanisms for research and implementation of sustainable phosphorus measures
NGOs	IFDC	• Compile data, synthesis, verification
	General	• Set agendas, raise awareness of phosphorus challenge and sustainable solutions

Level	Who?	How?
Industry/private sector	General	• Exploration and research
	Fertilizer and mining industry	• Provide incentives for soil testing to increase phosphorus-use efficiency, become and remain informed • Apply research and innovation • Cooperate with the research and science sector • Implement programmes of environmental and social responsibility towards local communities and product users
	Food processors and retailers	• Reduce losses, cooperate with other parts of the food chain to improve the phosphorus value chain
	Food catering industry	• Encourage and support an awareness program
	Large seed companies	• Make phosphorus efficiency a priority
	Water industry	• Incorporate phosphorus recycling in research and development plans
	Waste disposal companies	• Encourage and support the increased productive reuse of organic solid waste and diversion from landfill
Farming sector	Farmers	• Adopt best management practices
	Farmer organisations	• Enforce directives on sustainable/ efficient phosphorus use
Research & Science	Universities and other research organisations	• Develop pilot projects for phosphorus efficiency an recycling practices and technologies, create frameworks for scaling up pilot projects • Conduct research, identify research gaps and communicate these • Capture and develop the new opportunities for phosphorus efficient agriculture in a location specific way • Incorporate food security and nutrient awareness into existing research agendas
	Rural Research & Development Organisations	• Incorporate phosphorus security in research plans
	NSPAG[4]	• Strategic guidance on national research agenda
	GPRI/ TRAPS	• Define/draft global research agenda
Media	National/ international Media	• Disseminate information, initiate debate
Individuals	Champions	• Extension and outreach to communicate knowledge on and motivate sustainable phosphorus use
	Science communicators	• School talks, media and university courses

[4] Australia's National Strategic Phosphorus Advisory Group, http://phosphorusfutures.net/australian-sustainable-phosphorus-futures/36-national-strategic-phosphorus-advisory-group-nspag

Section 4: Unresolved issues and knowledge gaps

This section identifies unresolved issues that need further discussion and/or investigation. In some cases there are differing views about the best course of action, and in others there are issues that need further exploration.

4.1 Global governance

- Should the sustainable phosphorus community seek UN support for research and communication on global phosphorus security? If so, who will take the necessary leadership?
- Is a coordinated global approach needed? If so, what is the best way to go about it? The situations in developed and developing countries are significantly different. If a global approach is adopted, what is the best way to take account of these differences and to share responsibilities in an equitable and effective manner?
- Is a new global organisation on phosphorus use the best approach? Is such a move feasible? Would it be better to work through the FAO or a similar existing body, and through existing regional and national organisations?
- Should equity of access to phosphorus be considered a human right? Recently the UN voted for water and sanitation to be considered human rights. Food is the next one being discussed. Should this include phosphorus? Is there a phosphorus birth right?

4.2 Regulations and targets

Are targets for phosphorus recycling needed? The case for targets is based on the argument that most recycling occurs because a regulator sets targets, stimulating recycling to increase even though in the initial stages it is not financially advantageous. According to this view, phosphorus recycling is not likely to happen unless targets are set, particularly because the key areas are farming and the wastewater industry, which are largely driven by regulations.

If targets are to be set, what is the best way to do so?

- One approach would be to explore a range of scenarios for future phosphorus use in different parts of the world. Relevant stakeholders could collaboratively discuss the merits and implications of various targets (rather than targets being imposed in a top-down manner).
- Targets may need to be specific if they are to succeed in encouraging recycling. For example, a manure surplus and associated water pollution in the Netherlands has led to a Dutch regulation[5] restricting phosphorus input on arable land and grassland. This policy implies that excess manure cannot be applied to the soil and alternatives need to be found for its reuse or disposal.
- How can targets best be set in ways that take into account differing local conditions? Sometimes authorities address the wrong problem based on the experiences of other countries. In some countries, the phosphorus deficiency is often due to erosion and not to the inadequate application of phosphorus fertilizer.

[5] A.J. de Buck, W. van Dijk, J.C. van Middelkoop, A.L. Smit, H. van Reuler and A. Evers (2012). Agricultural scenarios to reduce the national phosphorus surplus in the Netherlands. PPO report no. 466, Wageningen University, NL.

- Regarding regulation, what role can big donor countries play? Could their assistance to developing countries be conditional on stringent phosphorus recovery and pollution regulations which these donor countries also impose on their own use of phosphorus?

4.3 Subsidies, pricing and financial incentives

- Are subsidies ever warranted, and if so, under what conditions? It has been argued that subsidies encourage inefficiencies, for example, if it were not for phosphorus fertiliser subsidies in some countries, some farms would not be able to continue producing. There is debate about whether the use of subsidies has resulted in long-term benefits. For example, fertiliser subsidies may be necessary in Africa, but this disrupts market forces.

- If subsidies are to be applied, what is the best way to do so? Subsidies can be applied to many different areas, including start-up phases of testing, recycling, systems to reduce food waste, or farming as a function of quantity or remaining biodiversity. The application of subsidies in each of these areas is a separate issue.

- How can subsidies take account of different conditions associated with differing levels of development? The impact of subsidies is very different in developed and developing countries. Developing countries may need to support fertilizer use, whereas in developed countries the issues that need to be addressed are making use more rational, reducing food waste, etc.

- Is there a place for appropriately targeted financial incentives? Can there be reasonable ways to correct market failures?

- What is the best approach to the use of subsidies in the wastewater sector? The playing field is not level between existing centralised wastewater infrastructure and novel systems that explicitly seek to recover nutrients, energy and water. Historically, the former have tended to have larger resources and government/public support, compared to the latter which have little external support. Government utilities must collaborate with the private sector who have sometimes been more proactive in seeking novel systems and technologies to recover nutrients, water and energy.

- In the decentralised circumstances under which phosphorus is used in food production or produced in sanitation systems, what is the best way to incentivise efficiency, collection and re-use? The situation with energy systems (energy efficiency, renewable sources) is analogous to the situation with phosphorus. The lesson from the energy sector is that market failure is widespread and that companies and users need to be incentivised at every level.

4.4 The role of animal products in the food chain

- What is the best approach to the address the implications of food choices on phosphorus use? While it is correct to say that in general, meat, fish, seafood and dairy production is often more phosphorus-intensive than crop production, it is important that we don't oversimplify this issue. The impact of food choices on the use of phosphorus depends on the type of food, the amount consumed and the way in which it was produced. For example, the production of Australian grazed beef on unfertilized grasses does not involve large phosphorus inputs, whereas feedlot beef and dairy production does.

4.5 Interpreting and communicating phosphorus scarcity and security

- What are the messages that need to be highlighted? There are many reasons to come to the conclusion that the flow of phosphorus needs to be circular rather than linear. One of them is that the supply of phosphate rock is limited but this is only one of many messages that need to be communicated. Other reasons include pollution, contaminants, regional supply security, and the waste and costs associated with losses and inefficiencies. Does the message need to be about more than just quantities of phosphorus? What is the best way to nuance the message and not distil it into a slogan? The media often portray phosphorus scarcity or peak phosphorus as 'the year we will run out of phosphorus', rather than explain the complexity of the issue, which also includes access, geopolitics, economics and management dimensions of phosphorus scarcity.
- What is the best way to reach more people and communicate complexity more effectively to a wide audience? A partial answer may be to produce films, television programs, and other forms of widespread visual media, explaining the different aspects of the flow of phosphorus that shows linkages visually.
- What is the best way to maintain a global perspective while not neglecting the need for local action?
- How can we ensure the availability of comprehensive, accurate and trustworthy data? Who owns the data on phosphate reserves and phosphorus consumption? Our perceptions of the problem are mostly based on data from a single source, produced by the US Geological Survey, which often changes significantly from year to year (due in part to the non-transparent and non-standardised reporting from individual countries). Governance regarding transparent, reliable and independently produced and/or verified data is an important goal.
- Regardless of the debate on longevity of phosphate reserves, we still need to acknowledge the problem of unsustainable phosphorus use and seek efficient and equitable solutions[6].

[6] The German Environment Ministry for example recently decided to focus on phosphorus as one of four substances associated with raw material shortages (Bundesministerium fur Umwelt, Naturschutz und Reaktorsicherheit (BMU), 2012. Deutsches Ressourceneffizienzprogramm (ProgRess). www.bmu.de/N49641/.

Further resources

Sustainable P Summit resources

3rd Sustainable Phosphorus Summit, Sydney 2012
http://sustainablepsummit.net

Sustainable Phosphorus Summit, Phoenix 2011
https://sols.asu.edu/news-events/news/element-concern-phosphorus-food-and-our-future

Phosphorus and Global Food Security International Workshop, Linköping 2010
http://www.ep.liu.se/ecp/053/ecp10053.pdf

Time for policy action on global phosphorus security
http://theconversation.edu.au/time-for-policy-action-on-global-phosphorus-security-5594

Global Phosphorus Research Initiative (GPRI)
http://phosphorusfutures.net

Additional selected P resources

UNEP 2011 *Phosphorus & Food Production,* UNEP Yearbook: Emerging issues in our global environment.
www.unep.org/yearbook/2011/

Hague Centre for Strategic Studies 2012, *Risks & Opportunities in the Global Phosphate Rock Market.*
www.hcss.nl/reports/risks-and-opportunities-in-the-global-phosphate-rock-market-robust-strategies-in-times-of-uncertainty/116/

IFDC 2010, *World Phosphate Reserves & Resources.*
http://www.ifdc.org/Publications/Technical-Bulletins/T-75-World-Phosphate-Rock-Reserves-and-Resources/

Nature 2009, *The Disappearing Nutrient,* 461, 716-718.
www.nature.com/news/2009/091007/full/461716a.html

European Sustainable Phosphorus Platform & Scope Newsletter
www.phosphorusplatform.org

Acronyms used in this Blueprint

CGIAR Consultative Group on International Agricultural Research

FAO Food & Agricultural Organisation of the United Nations

FP8 8th EU Framework Programme (i.e. HORIZON 2020 – EU Framework Programme for Research & Innovation)

GPRI Global Phosphorus Research Initiative

IFDC International Fertilizer Development Centre

ISF Institute for Sustainable Futures

NSPAG National Strategic Phosphorus Advisory Group

RDCs Research and Development Centres

TraPs Transdisciplinary Processes for Sustainable Phosphorus Management; 2010–2015

UNCSD United Nations Conference on Sustainable Development

USDA US Department of Agriculture

WHO World Health Organisation of the United Nations