Earth's Future

Supporting Information for

Realising the Circular Phosphorus Economy delivers for Sustainable Development Goals

Michael Walsh[1], Gerhard Schenk[2], Susanne Schmidt[1]

[1]School of Agriculture and Food Sciences, [2]School of Chemistry and Molecular Biosciences, The University of Queensland, Brisbane, 4067, Queensland, Australia

Contents of this file

Table 1 of 1

Additional Supporting Information (Files uploaded separately)

Table 1 Circular Phosphorus Economy contributions to Sustainable Development Goals (SDGs) sub-categories

Introduction

Table 1 is supporting information for Figure 7 *Circular Phosphorus Economy*, and how adopting this system can contribute to achieving the Sustainable Development Goals

Supporting Information

Table 1: Circular Phosphorus Economy contributions to Sustainable Development Goals (SDGs) sub-categories (United Nations, 2021)

#	SDG and sub-category	Explanation	Achieved through:		
			Nutrient Recovery Facilities	Valorisation Technologies	Sustainable Agriculture and Soil Management
		<u>Immediate</u> SDG targets met (in ascending SDG number order)			
2.3	By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and input, knowledge, financial services, markets and opportunities and value addition to non-farm employment	Precision fertiliser management has the ability to substantially increase food production and offer small-scale farmers the opportunity to produce surplus goods. Moreover, a CPE would promote fertiliser security, education and knowledge into nutrient stewardship, access to financial services including grants, carbon schemes and sponsorships, and provide local skilled and unskilled job opportunities		✓	✓
2.4	By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought,	Introducing soil and phosphorus management schemes can help mitigate the effects of climate change respective to soil erosion and the succeeding implications to marine environments. Moreover, producing higher yields through soil fertility can reduce the need for agricultural land expansion and ecosystem loss	✓	✓	✓

	flooding and other disasters and that progressively improve land and soil quality				
6.3	Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	The development of nutrient recovery facilities can circumnavigate untreated wastewater destined for local marine environments. Furthermore, the use of valorisation technologies can help reduce ecological degradation through reducing mining excavation, fertiliser bi-production waste (phosphogypsum), and resources associated with fertiliser production	✓	✓	✓
6.a	By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies	Nutrient recovery facilities and valorisation technologies can be implemented through supportive cooperative and co-sponsorship programs. These partnerships are critical for encouraging sustainable practise and helping communities overcome financial barriers	✓	✓	
8.4	Improve progressively, through 2030, global resource efficiency consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead	Increasing agricultural output through enhanced management strategies and fertiliser application can contribute towards improving [agricultural] resource efficiencies and mitigate biodiversity loss through agricultural land expansion. Moreover, the CPE is aligned with the 10YFP, specifically Sustainable Lifestyles and Education, and Sustainable Food Systems		✓	✓
14.1	By 2025, prevent and significantly reduce marine pollution of all kinds, in particular	Nutrient recovery facilities, and improved soil and fertiliser management can help reduce nutrient loading and pollution into marine environments	✓		✓

	from land-based activities, including marine debris and nutrient pollution				
17.16	Enhance the Global Partnership for Sustainable Development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the Sustainable Development Goals in all countries, in particular developing countries	Developing cooperative partnerships which include all facets of knowledge and stakeholders in critical for the development of sustainable systems including a CPE	✓	✓	✓
	<u>Contributing</u> towards SDG targets (in ascending SDG number order)				
1.5	By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters	Implementing soil and phosphorus management strategies can help mitigate the consequences of climate change including extreme weather events and eutrophication intensification. Domestication of resources can decrease the necessity of foreign trade and therefore reduce economic shocks and its implications to food production.		✓	✓
2.1	By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round	Increasing resources such as fertilisers and education can help promote sustainable agriculture which can provide sufficient foods all year round		✓	✓
2.2	By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and	Malnutrition can be mitigated through (i) food production diversification, and (ii) food biofortification through increasing soil integrity			✓

	address the nutritional needs of adolescent girls, pregnant and lactating women and older persons	and nutrient profile through the use of nutrient rich fertilisers			
2.a	Increase investment, including through enhanced international cooperation, in rural infrastructure, agriculture research and extension services, technology development and plant and livestock gene banks in order to enhance	Attracting investment for waste recovery and valorisation technologies through cooperative and co-sponsorship programs. Furthermore, bridging the gap between farmer and science through education and resource facilitation	✓	✓	✓
3.9	By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	Reducing sewage and nutrient rich sediments entering waterbodies can drastically reduce the transmission of faecal and waterborne diseases. Moreover, the reduction of heavy metal contamination (e.g. cadmium) from fertilisers	✓		✓
6.b	Support and strengthen the participation of local communities in improving water and sanitation management	Improved water quality can be achieved through the mitigation of raw sewage entering local waterbodies through nutrient recovery facilities. Moreover, sustainable agricultural practises can reduce run-off and erosion causing eutrophication	✓		✓
9.1	Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	Nutrient recovery facilities and valorisation technologies can contribute to developing sustainable infrastructure which support economic development and human well-being. Moreover, domesticating production can contribute to equitable access among communities and individuals alike	✓	✓	
9.4	By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with	Developing and/or upgrading pre-existing infrastructure into a Circular Phosphorus Economy	✓	✓	

	increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities	can enhance the potential for use and recycling of phosphorus in a sustainable manner			
11.6	By 2030, Reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	Developing nutrient recovery facilities can contribute to lowering the environmental impact of cities and communities through the treatment of waste, especially sewage	✓		
12.5	By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse	With a focus on recycling and reuse, Valorisation Technologies can utilise the resources generated from Resource Recovery Facilities		✓	
12.a	Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production	The advancement of cooperative shareholder partnerships can enhance the sharing of knowledge, innovation, and strategies from developed to developing nations		✓	✓
15.5	Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species	Soil erosion and degradation reduces the fertility of agricultural soils leading to (i) eutrophication causing the destruction of marine life, and (ii) the clearing of natural habitats to pioneer fertile land causing biodiversity loss			✓
17.17	Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships	Cooperative shareholder partnerships including government, private, and academia can enhance resource sharing, knowledge, and innovation strategies	✓	✓	✓