Knowledge grows

February 2017

Our Position On

Circular Economy

Introduction

Traditionally, the economy is focused on manufacturing products at low cost, and providing them to the market for consumption and disposal of residues.

As the growing global population is expected to reach 9-10 billion people by 2050, it is becoming increasingly clear that the resource base to support the population is limited. This is reflected in the universal adoption by 193 UN member states of the Sustainable Development Goals (SDG), which includes a strong focus on resources.

Circular economy is one important response, aiming to improve resource management by moving away from the linear produce-consume-waste model into a circular one, e.g. by seeing waste rather as a raw material for renewable production.

The circular economy is described by the European Commission as: "In a circular economy the value of products and materials is maintained for as long as possible; waste and resource use are minimised, and resources are kept within the economy when a product has reached the end of its life, to be used again and again to create further value."

Applying the EU 'Waste hierarchy' and a circular approach to resource use throughout the value chains has a positive potential to optimize how virgin resources are allocated.

Circular approach to nutrients

Yara operates globally, and our markets include both the agricultural sector as well as industries. Yara's core business is producing and marketing crop nutrients to help farmers sustainably grow their business and feed a growing global population.

Crops need nutrients to grow. In total, 13 different nutrients are fundamentally important for crops' growth, in addition to water, CO_2 and sunshine. Of the 13 nutrients, crops consume the largest quantities of nitrogen (N), potash (K) and phosphorous (P). In discussions on circular economy for nutrients, N and P are most frequently on the agenda. Yara's core business is N nutrients, but Yara also markets the full range of 13 nutrients.

Today, plant available N is produced by reacting nitrogen from the air with hydrogen sourced from hydrocarbons, mostly natural gas, to form ammonia. P and K are sourced from mines and processed to make the minerals available to crops.

In Europe, about 11 million tons of N and 1-1.5 million tons of P are used annually[i]. The nutrients are used to improve farming efficiency and profitability, and at the global level they are needed to help feed the population while limiting deforestation.

Nutrients are lost both in direct processing, consumption on the field, post harvesting, and through the use as animal feed. At the end of the value chain, waste is created e.g. by large quantities of food that is wasted, municipal wastewater as well as manure – all of which are relatively rich in nutrients.

The EU principles of the waste hierarchy and circular economy can therefore be applied to nutrients in agricultural and food systems. The EU sets the following priority order for managing waste: "prevention, (preparing for) reuse, recycling, recovery and, as the least preferred option, disposal (which includes landfilling and incineration without energy recovery)."

Active dialogues are ongoing within the EU on classification and 'end of waste' criteria for secondary nutrient raw materials, including derived products (e.g. Struvite, Biochar, Ash and others). These materials will be considered in the new EU fertilizer regulation.

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Yara's position

Yara is actively engaged and researching opportunities for how we as a company can contribute to and benefit from a more circular economy. Yara welcomes the concept of circular economy and the development of the European Union's circular economy package.

We see the circular economy as an opportunity to improve sustainability performance in our markets, potentially leading to new business avenues. Through Yara's Vision and Mission statements, we clearly define that respecting and protecting the planet is part of our business. Some aspects are already part of Yara's way of doing business, while others are the subject of ongoing research or exploration:

- **Avoiding waste:** Optimizing production processes is an ongoing effort. Sharing knowledge and delivering tools to help farmers avoid nutrient losses from the field is the point where Yara may have the biggest impact.
- **Industrial symbiosis:** Smart set up of industrial production may optimize resource use across different industries.
- **Closing the cycle:** Nutrients appearing as waste through or at the end of the cycle can be assessed for re-use either directly or by processing, so long as food safety and farm value can be proven.

While much attention is directed at wastewater and other secondary raw material sources, Yara sees it as equally important for society to continue reducing food waste and not least providing the farmers better tools to reduce on-field losses of crop nutrients.

Working to close the nutrient cycle provides some inherent challenges which need to be addressed. Today, production of minerals for crop nutrition starts with concentrated, inorganic raw materials with consistent qualities. The nutrients are designed to be consumed by living organisms to support life.

From farmers' fields through processing, consumption and digestion, the nutrients are diluted and contaminated with other substances, many of which are not desirable in the food value chain. Today, using organic waste material for manufacturing of mineral fertilizer is not allowed under EU legislation for reasons of process- and food safety.

Proper analysis and processing is therefore essential, and it may be expected that many potential nutrient sources will not be profitable without legislative support.

Yara's research is performed under strict principles which we see as mandatory for a circular approach to nutrients from secondary raw materials:

- **Food safety is unnegotiable:** Yara will have strict quality criteria, ensuring we provide pure quality nutrients free of contaminants, and we will promote this approach as part of the regulatory framework.
- **Availability of nutrients:** Fertilizers are applied to soils to help crops grow. The nutrients in a circular economy must be in a form available to the plant to ensure added value to the farm.
- **Health, Safety and Environment:** In EU, the REACH regulation provides the framework for control of hazards and risks to workers and the environment. REACH must be applied also to products derived from secondary raw materials and any related production processes. Yara is not only committed to being legally compliant, but we also work actively within the fertilizer sector to promote high standards on environmental sustainability and worker safety throughout the value chain.

Current Yara cases

Across Yara's global operations, numerous cases exist where we are already taking on board the principles of the EU waste hierarchy and circular economy thinking. Examples include, but are not limited to the following:

Avoiding waste

Yara works on several fronts in production and in the markets, including helping farmers optimize the fertilizer application. On-farm losses of nutrients easily out scale most other losses in the value chain of bringing nutritious food to the consumer:

Yara's Megalab is an Internet-based, global system offering interpretation and nutrient recommendation services from chemical analysis of crop and soil samples.

Crop and site specific advice: Through agronomic R&D, Yara can provide advice on balanced crop nutrition, specific to the needs of the crops.

P-trap: Yara has developed the P-trap which reduces phosphorus run-off from fields by using gypsum which is left over from mining operations. Field trials in Finland document a 60% reduction in phosphorous losses.

Precision farming: Yara N-Sensor™ is mounted on top of a tractor, and it scans and analyzes the crops' need for nitrogen supply, adjusting nitrogen fertilizer application rates on-the-go. By applying the right amount, at the right place, at the right time, adjusting for in-field variations, more yield – of higher quality – per unit of fertilizer is achieved.

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Mining tailings: In the Lagamar phosphate mine in Brazil, Yara's JV Galvani has improved production volumes and profitability while reducing waste. This was done by using the mine's tailings pond as a source for phosphorous.

Industrial symbiosis

One industry's waste can be another industry's raw material. Co-designing processes can optimize resource use:

Hydrogen for ammonia: In Freeport, Yara and BASF are building an ammonia plant with an annual capacity of 750,000 tons. The raw materials are N from the air and hydrogen coming as a by-product from other industries.

Utilizing CO: In Porsgrunn, Norway, Yara's energy consumption is supplemented by carbon monoxide gas (CO) from a neighbor plant, where CO is a leftover substance from their processes.

Greener greenhouses: In Sluiskil, Netherland, Yara supplies warm water from the cooling of our processes as well as CO_2 to a greenhouse facility. The facility gets enhanced growing conditions for vegetables and can operate without using fossil fuel for heating.

Closing the cycle

Seeing waste as a secondary raw material brings in options for better resource use:

Mining from waste: In Siilinjärvi, Finland, a Yara phosphate (P) mine has entered in an agreement with another mining company. Here, Yara will use the mineral pyrite from the other mine's tailing ponds as a raw material to help extract P.

Nitrogen (N) recycling: In Norway, Yara works together with a VEAS waste water treatment plant to utilize the N content. Here, ammonium from the wastewater is processed into ammonium nitrate, which can be used in Yara's manufacturing of mineral nutrients.

[i] EU statistics and Fertilizers Europe: http://ec.europa.eu/eurostat/statistics-explained/index.php/Agri-environmental_indicator_-_mineral_fertiliser_consumption

About Yara

Yara's knowledge, products and solutions grow farmers', distributors' and industrial customers' businesses profitably and responsibly while protecting the earth's resources, food, and environment.

Our fertilizers, crop nutrition programs and technologies increase yields, improve product quality and reduce the environmental impact of agricultural practices. Our industrial and environmental solutions improve air quality by reducing emissions from industry and transportation, and serve as key ingredients in the production of a wide range of goods. Throughout our organization, we foster a culture that promotes the safety of our employees, contractors and societies. Founded in 1905 to solve emerging famine in Europe, today Yara has a worldwide presence with more than 15,000 employees and sales to more than 150 countries.

For further information, please contact:

Yara International ASA
Drammensveien 131
P.O.Box 343, Skøyen
N-0213 Oslo, Norway

www.yara.com