CIRCULAR ECONOMY

and Agribusiness Development

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

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About this publication

The aim of this publication is to introduce the work of United Nations Industrial Development Organization's Department of Agribusiness and how it supports circular economy development in the context of agro-industries. The publication highlights ways in which the agribusiness sector can facilitate the uptake of circular economy practices, creating shared prosperity, and contributing to improving environmental sustainability and advancing economic competitiveness in developing and middle-income countries.

Sustainable development is increasingly linked to our ability to overcome the prevailing linear pattern of resource extraction, manufacture, consumption and final disposal of material waste into the environment, also known as the "take-make-waste" approach. The need for system innovation towards a circular economy is essential in this regard, based on the principles to design waste and pollution out of the system, to keep products and materials longer in use, and to regenerate natural ecosystems.

The current COVID-19 pandemic is a reminder of the intimate relationship among humans, animals and the environment. The transmission pathways of diseases, such as COVID-19, from animals to humans, highlight the extent to which humans are placing pressures on the natural world with damaging consequences for all. [...] Once the health crisis is over, we cannot have business-as-usual practices that increase emissions and other environmental externalities like pressure on wildlife and biodiversity [...] A mutually beneficial symbiotic relation between humans and their surrounding ecosystems is inter alia the answer to more resilient economies and societies. Securing the global environmental commons requires living within planetary boundaries, conserving and sustainably managing globally shared resources and ecosystems, as well as their shared vulnerabilities and risks to promote human wellbeing." from the UN framework report on COVID-19:
Source: https://www.un.org/sites/un2.un.org/files/un_framework_report_on_covid-19.pdf

The Current Global Agriculture System and Planetary Boundaries

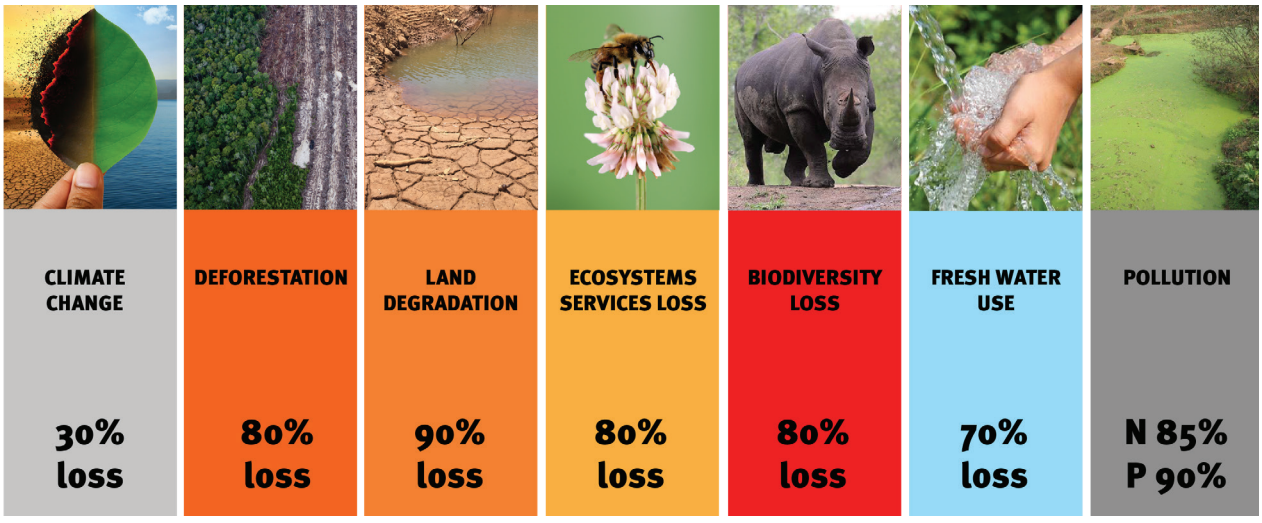
We all need air to breathe, clean water to drink, and hospitable climate patterns. However, human activity is pushing the boundaries of what our planet can provide. Our current linear model of consumption is pushing environmental limits outside which humanity can safely operate. Food systems are at the centre of this issue: it is at the same time exposed to the effects of a changing climate; and it is direct contributor to it. Our food production still relies on natural resources and their cycles as its primary input. Nutrient-rich soil, water and biodiversity provide the foundation for the ecosystems on which we depend that common established practices destroy.

Over the past century, the global food system expanded production faster than population growth. In parts of the world, productivity gains are passed to consumers, who are nowadays provided with more food than ever at relatively lower prices. Such expansion has nonetheless come with important trade-offs: dependency of food production on relatively inexpensive fossil fuels; the loss of biodiversity; farmland degradation through intensive practices; monoculture and increased pathogen susceptibility; eco-system destruction; and unsustainable water usage.

According to the Ellen MacArthur Foundation, for every dollar spent on food, society pays two dollars in health, environmental, and economic costs. Half these costs – totaling USD 5.7 trillion each year globally – are due to the way food is produced[1].

Today, agricultural land covers 50 per cent of earth's habitable surface and the sector contributes 25 to 30 per cent of greenhouse gas emissions. Furthermore, agribusiness is responsible for 80 per cent of deforestation, 90 per cent land degradation, 80 per cent of loss of ecosystem services and bio diversity, 70 per cent of consumption of fresh water and over 80 per cent of water pollution with nitrogen and phosphate. In terms of the ocean, 89 per cent of fisheries are over exploited or at full capacities.

The Food System's Impact on Natural Resources



[1] https://www.ellenmacarthurfoundation.org/explore/food-cities-the-circular-economy. Accessed 1 March 2020.

What is more, food demand is only growing. The rise of the middle class and urbanization are helping fuel demand for resource-intensive food products. Agricultural will need to double its output to feed the estimate nine billion people on earth by 2050. With the current rate of resource depletion, the current industrial food system is not sustainable.

If the world is to feed a growing population in a sustainable manner, a complete rethink of our approach to food production is needed.

Introducing circularity in economic processes

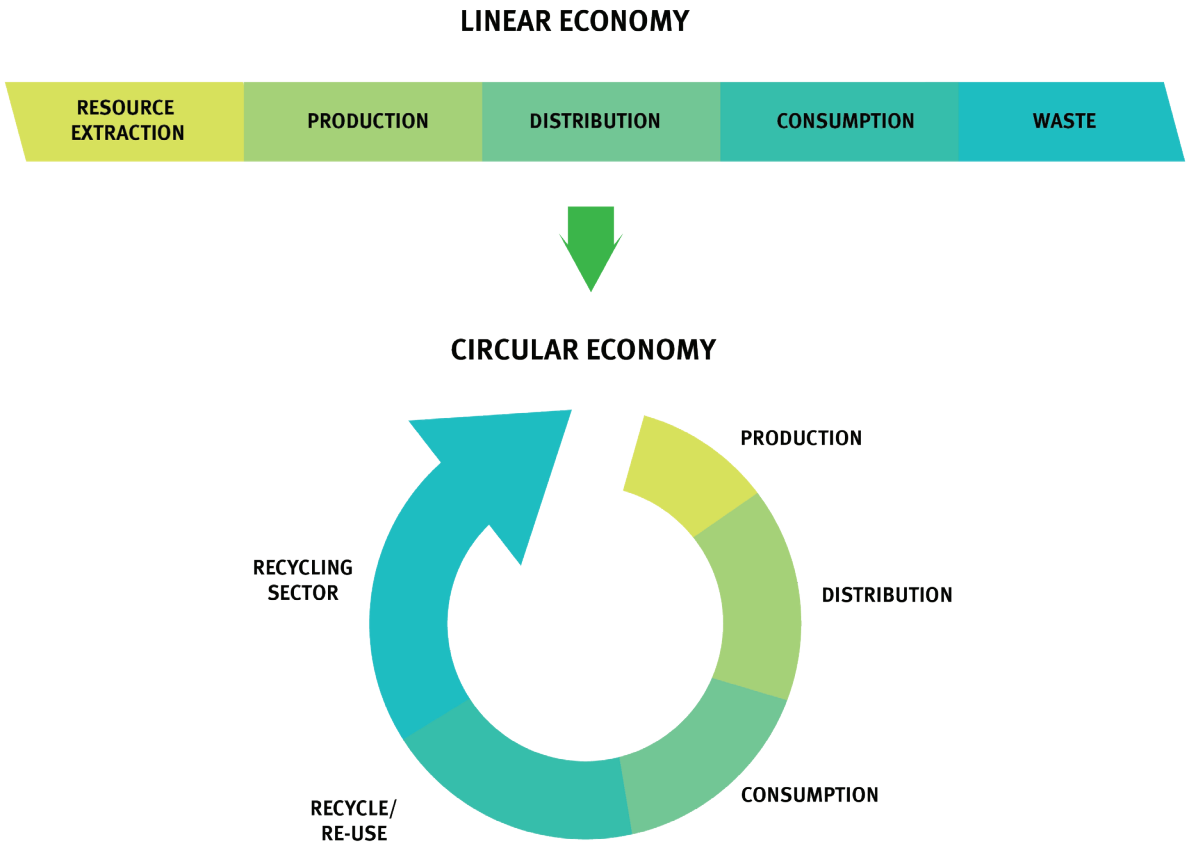
The circular economy principle addresses the "take-make-waste" approach by designing out waste and pollution, keeping products and material in use, and regenerating natural systems.

The closed loop concept is central to the circular economy, increasing a continuous flow of technical and biological materials in the value circle, keeping products, components and materials at their highest utility and value, while reducing waste to a minimum[2].

Resources may be circulated through a variety of routes, utilizing new technologies and creating new value chains and jobs.

From production and its inputs, to the final consumer, circular economy practices can be developed, leading from a linear flow of goods to a circular flow that avoids pollution, prolongs material use, captures value from waste and regenerate organic flows.

Linear versus Circular Economies



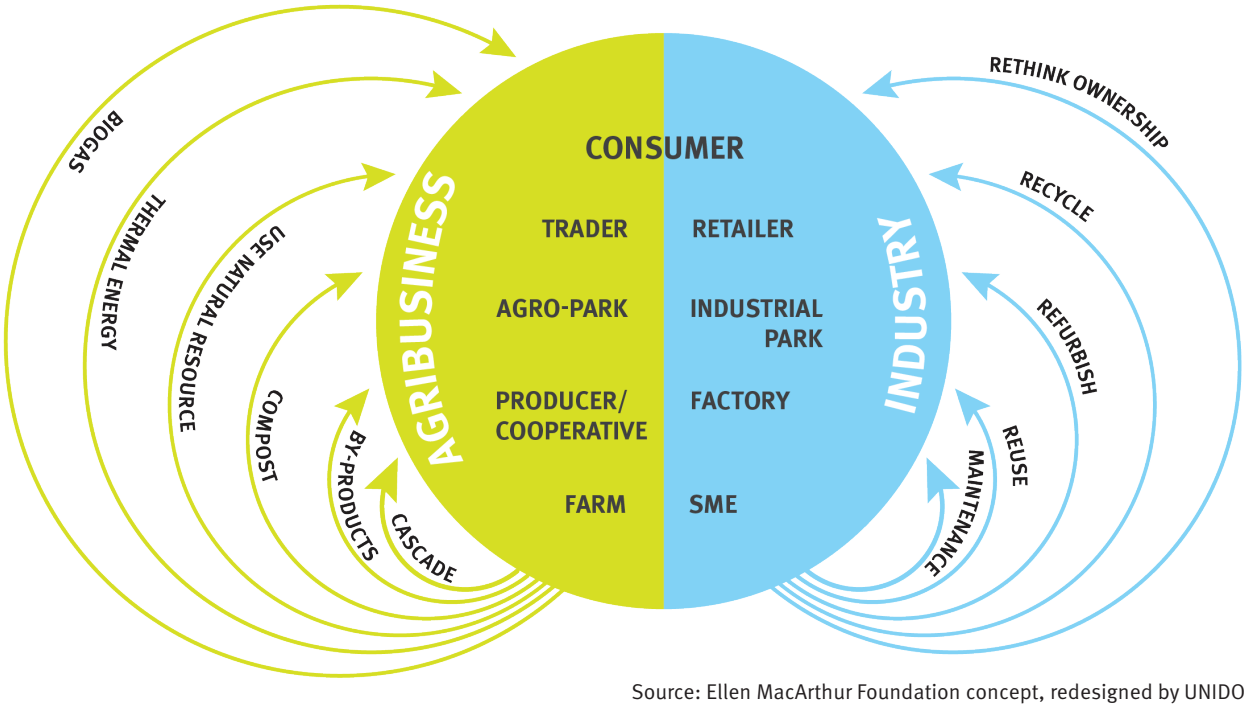
[2]. Ellen MacArthur Foundation 2013

Circular Economy and the Agribusiness Sector

In the agribusiness sector, two distinct cycles of circular mode are present: technical and biological. The **technical cycle** applies to agro-industrial technologies through maintaining, returning, renewing and reusing agri-processing technologies that support agricultural efficiency, while also minimizing waste and providing cost savings. New business models focusing on sharing capital-intensive machinery also allow for wider application and cost savings. It also applies to non-natural source of packaging, where reuse and recycle are prioritized.

As an example, the recent awareness of single use plastics and resulting bans of plastic bags are pushing food brands to rethink their packaging materials, providing new opportunities for renewable packaging entrepreneurs.

Technical and Biological Systems in the Circular Economy



Source: Ellen MacArthur Foundation concept, redesigned by UNIDO

The biological cycle recaptures value from waste in the system through the reuse of food, utilization of by-products and food waste, and nutrient recycling. Waste becomes the input to new products to support crop production, food processing, feed and energy, as well as the cosmetic and pharmaceutical industries. Closing input loops minimize discharges, reduces demand on resources, increases resource efficiency, creating circularity in agribusiness practices.

Reusing and recycling agricultural goods is not new, but technological progress has introduced new techniques or made others more efficient, opening ever more avenues for value-added practices. Furthermore the industrial size of the current food system provides economies of scale for waste valorization and by-products development.

The physiochemical property of waste suggests what value-added path the waste may take, such as high-energy content waste is suitable for renewable energy processes, whereas waste with a high concentration of nitrogen and phosphorus are suitable for organic fertilizers.

There are three principles of circular economy applicable to the agribusiness sector

Replace waste and pollution

1. **Pollution and waste are replaced** to become regenerative, avoiding damages to human health and the environment. The pollution of air, land and water should be avoided; petrol base and chemical products are replaced by natural products and renewable energy.

Preserve value over time

2. **Preserve the value over time** and design for durability, reuse, remanufacture and recycle in the technical cycle. Privilege the effective use of biological based material before it returns to the natural system. Therefore the principle is to gain value from waste, develop by-products that could serve as input or open new market opportunities. This component combined with entrepreneurship has the potential to create new job and business opportunities.

Avoid using non-renewable resources

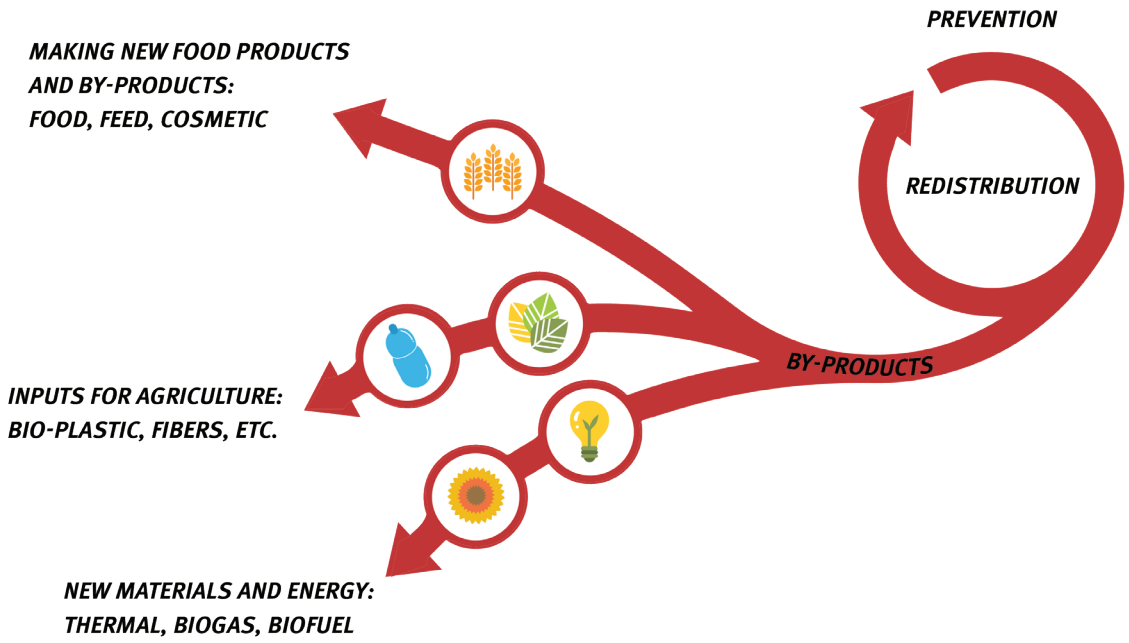
3. A circular system avoids the **use of non-renewable resources** and returns valuable nutrients to the sol to support natural regeneration.

All three principles cut across biological and technical processes and are applicable in all circular models. Nevertheless, in the food system the principle of replacing pollution and waste would translate into looking at agricultural input on the biological cycle choosing to replace chemical pesticides by organic, replacing monocultures, by polycultures, taking advantage of symbioses of plants as pest control,

The principle to preserve value over time refers mainly to the technical process, where we should privilege reusable packaging and preserve the value of mechanical and agri-processing equipment. Nevertheless, an essential component of environmental circularity is plant reproduction. There is no cycle that can be established on non-reproductive seeds. It is therefore a priority to choose true breeders instead of non-reproductive seeds as clones. Then cascade use of agriculture products is also an application of the principle.

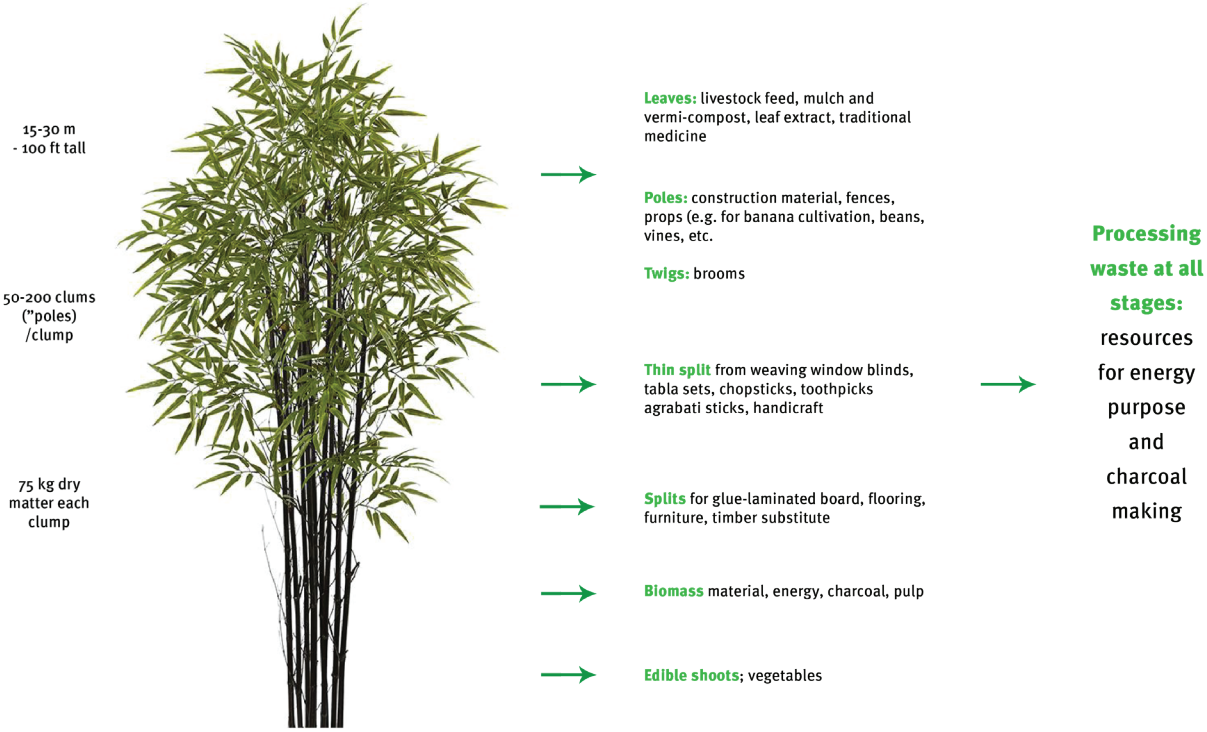
The principle to avoid non-renewable resources refers primarily to renewable energy, and food system provides well known opportunities to create energy with bio-digestion or bio-gasification . Furthermoreis also an essential component to use the ultima waste as soil amendment, nutrient and compost, aseverything becomes regenerative by essence.

Practically recapturing value from food waste takes the following alternatives:



Source: https://www.ellenmacarthurfoundation.org/explore/food-cities-the-circular-economy

Creating Value from Waste: Bamboo Example



Circular Economy and Job Creation

Not only does a circular economy approach addresses environmental challenges, it helps drive innovation, create new business practices and create new jobs through the utilization of agricultural wastes, by-products and co-products. National economies, entrepreneurs and employees will benefit, as they form new businesses and create new jobs to fill niches created by the circular economy, through resource recovery and remanufacturing. New technologies are able to convert food waste into organic fertilizers and biomaterials, to medicine and bioenergy. Such efforts are particularly well-suited for emerging economies that experience high food processing waste, and whose infrastructure is not yet developed and may be orientated to transform food processing waste. On the technical side, business opportunities are present in agritechnologies' repair and maintenance; reuse and redistribution; refurbishment and remanufacturing; and recycling3. The US Environmental Protection Agency estimates that for every 10,000 tonnes of used goods, re-use creates more jobs than traditional solutions.

The Ellen MacArthur Foundation estimates that by 2025 about $1 trillion per year of materials cost savings could be generated from circular business models.

Job Creation in the Circular Economy

3. M. Donner, R. Gohier and H. de Vries, A new circular business model typology for creating value from agro-waste, Science of the Total Environment (2020), https://doi.org/10.1016/j.scitotenv.2020.137065

Circular Economy and the Department of Agribusiness

Adopting circular economy practices will require a global systems-level approach comprising a range of actors spanning the public and private sectors. Furthermore, it needs to be taken at the design stage of the transformation process and be implemented at scale. Promoting an industrial approach at the crossroad of public and private sector, the Department of Agribusiness has an important role to play. The Department of Agribusiness delivers its services across three of UNIDO's enabling functions:

Technical cooperation: UNIDO supports Member States in the development of technical cooperation programmes, include specialized technical assessments, and environmental and social impact assessments. UNIDO also provides technical assistance services to implement circular economy projects and programmes, establishing innovative solutions and best practices, in order to support government in its uptake of circular economy practices. UNIDO monitors project activities for quality assurance and reports on implementation, identifying bottlenecks and providing solutions.

Analytical and research functions and policy advisory services: Solid, evidence-based analysis provides the foundation for sound advice, which in turn translates into appropriate circular economy strategies and policies for developing countries and economies in transition. Mainstreaming circular model in the economy and the industry will have to be supported by policy and standards. Institutional commitment is necessary to introduce a circular model at scale.

Convening and partnerships for knowledge transfer, networking and industrial cooperation: UNIDO's convening role brings Member States, the private sector, civil society and other partners together to exchange and disseminate knowledge and information, facilitate partnerships, forge common positions and plans of action . Activities include organizing regional forums, conferences, technical working groups or expert meetings,. Partnership with industry is at core of implementation of circular approach as it is only at scale that new value addition can be given to waste; and at the design stage where industrial products may be modified.

UNIDO Points of Entry for

1 Production with partners such as FAO and IFAD, the Department of Agribusiness promotes permaculture, agro-forestry, organic farming, peri-urban farming.

2 On the business side, the Department of Agribusiness designs and introduces new business models with:

- Platforms for sharing assets, ex: machines, storage and primary processing;
- Clusters to increase information flowacross the value-chain (e.g. certification, direct marketing and e-commerce based distribution models).
- Clusters to establish agri-processing hubs where economies of scale are reached

3 UNIDO Agri-busines supports reduction of post-harvest loss with:

- best practices, training delivery; and
- technology transfer.

4 The Deprtment of Agri-busines develops By-products, linking food with non-food value chains to utilize waste; and bring value to waste food as feed, material, compost or energy.

5 UNIDO Partnership enhances public-private partnership (PPP) for where investment, risks, responsibilities and rewards are shared between the public sector, the private sector and a development partner. Defining new circular model at all stage of the value chain requires a partnership at all level.

Circular Economy Support

6 The Department of Agribusiness in partnership with the Department of Energy provides technical assistance for biomass energy solutions with:

- anaerobic bio-digesters for humid waste processing, which creates biogas and compost
- gasifier for dry waste burning which creates energy heat and charcoal
- solar energy for food processing
- other renewable energy (hydropower, wind, solar PV) for agro-industrial process.

7 The Department of Agribusiness supports the application of biotechnologies in:

- food production and preservation,
- leather processing,
- production of bio-based polymers,
- construction materials or fibers,
- Entrepreneurship and skill transfer to create materials and products from waste.

8 The Department of Agribusiness rethinks the food system towards local value chain and Urban farming with:

- vertical farming practices
- reverted supply chain logistics for decreased Co2 emission and improved resource recovery.

9 The Department of Agribusiness works with stakeholders to introduce innovations in the agribusiness with:

- ICT for data analysis,
- spatial value chain mapping,
- precision agriculture with censors,
- commensurability of reporting,
- certification and quality control and industry 4.0.

Regional Industrial Clusters and Circular Economy

Regional Industrial Clusters (RICs) combine technical and business support facilities and services in one location, gaining economies of scale for the cluster resident businesses and allowing small business owners to access services and technologies that would otherwise be out of reach. The presence of administrative services, financial institutions, suppliers, customers and competitors helps create a context with increased access to credit, specialized knowledge and equipment and an innovation culture, facilitating experimentation and risk taking.

As an example, UNIDO is supporting the Government of Ethiopia in the development of RICs in selected regions.

RICs provide an ideal platform for the uptake of circular economy practices. Proximity to rural area allows companies specializing in agritech repair and maintenance; reuse and redistribution; refurbishment and remanufacturing and recycling, to be close to their customer base. On the biological side, clustering firms facilitates the development of by-products and waste products. Biofuels and renewable energies may also help provide energy to the RICs, further closing resource utilization loops.

The Department of Aagribusiness development has a division that concentrate on youth and entrepreneurship. If Circular economy creates new opportunities, its new thinking has to be disseminate and taught among young generation.

Urban Regenerative Farming and Local Value Chains

With estimates suggesting that 80 per cent of food will be consumed in cities by 2050, cities can significantly influence the way food is grown, particularly by interacting with producers in their peri-urban and rural surroundings. Regenerative approaches to food production will ensure the food that enters cities is cultivated in a way that enhances rather than degrades the environment, as well as creating many other systemic benefits.

In parallel, cities can use circular urban farming systems. Urban farming remains in its infancy, but growing interest in sourcing food locally is spurring growth. Urban farming may not replace outside growing, but it well complement the food system facing the increasing pressures of demographic growth coupled with land scarcity. New technologies are helping to make urban farming increasingly viable and a potential actor in food systems. Many urban farming initiatives are taking place in abandoned industrial lands, often making use of former warehouses to create a controlled environment to allow for year-round production. Urban farming has multiple advantages: by using less land, it reduce the need to clear forests to make way for cultivation land.

It also has the effect of bringing production in close proximity to increasingly urban consumers, savings in terms of transport and environmentally friendly less air transport-associated carbon footprint. Furthermore it is the opportunity to close the loop of the product cycle near the consumer, reducing food waste and recapturing value from waste .Further space is gained through building cultivation towers, vertically stacking greenhouses on top of each other. The combination of symbiotic plants has an effect of pest control , while sensors ensure that plants receive only what is needed in terms of nutrients and water. In a peri-urban situation, distance is reduced, and less packaging is needed to store and transport food. Greenhouses also present opportunities for employing circular economy practices through renewable energy use, rainwater collection, and reusing organic waste.

Through its work on industry 4.0 and on agricultural technologies, UNIDO is at the centre of innovation in the agritech sector where agribusiness and the latest technologies meet.

Biodiversity

Circular economy and biodiversity have a symbiotic relationship. Through mimicking natural processes, the circular economy approach breaks the linear pattern of consumption, reducing pressure on the environment, including biodiversity and its ecosystem services on which human life depends. This conservation result, from reduced natural resource extraction and carbon footprint helps support biodiversity. At the same time, the circular economy is dependent on biodiversity to provide the wide range of raw materials needed to produce the goods on which we rely today.

Today, apart from the deforestation free FSC label, biodiversity is not taken into consideration in food standards. The organic label refers often to the origin on the products, but not processing. Most agri-processing today still depends on fossil fuel or wood-energy, with adverse impact on deforestation and biodiversity which is not taken into consideration. For example, it is estimated, that one medium tree of 700kg is brunt in the production of 5l of the organic essential oil of cloves. Mainstreaming bio diversity in the industrial process is the urgent step to be taken to secure the diversity on the planet

concerted actions and public and private partnership is necessary to define new practices, monitor and assess the integration of biodiversity into ago-value chains and agri-business.

The Department of Agribusiness in Action

Case 1: Uganda

Uganda is the second largest producer of bananas in the world, with an estimated annual production of 10 million MT. Banana production occupies 30% of the cropped land. As such, banana production is a major source of rural income and bananas are an important staple and cash crop.

UNIDO's Action

The project has supported the closed-loop banana production through the conversion of banana waste to biofuel for the processing facilities as well as domestic use. The residue sludge created after extraction of biogas is high in bioavailable nutrients, and is therefore useful for banana cultivation.

Result

Transitioning to biogas as energy carrier involves a number of environmental and health benefits, including less air pollution, lower pressure on forest ecosystems to provide fuelwood, and less time required for fuelwood collection. Biogas digesters have the additional advantage beyond biogas production to preserve the nutrient content of input materials and to produce a residue with a high fertilizing effect.

Case 2: Kaolak, Senegal

This project is promoting integration within and between value chains, to use resources better and reduce post-harvest losses and waste. The introduction of innovative processing technologies including also renewable energy generation improves product value addition (therefore employment and income) while also facilitating adaptation to climate change.

UNIDO's Action

These examples will be used to showcase the feasibility of small-scale industrial production facilities, with potential for up-scaling to other regions and value chains. Each pilot project will include environmentally friendly technological packages for processing and storage of agricultural products applying

i. by-product and agricultural residue utilization as an input for local production of animal feed (silage, hay, fodder, etc.)
ii. bio-fertilizers (compost) and/or biomass to produce energy
iii. clean energy technologies in industrial processes (solar food processing technologies or solar water pumping).

Case 3: Integrated Agro-Industrial Parks

Integrated Agro-Industrial Parks Another biologic analogy in this context, is the concept of "industrial symbiosis", which describes the intentional clustering of mutually beneficial resource converting industries in a way that by- products and waste materials from one company, are used as input into another process. This is facilitated through the creation of industrial parks.

UNIDO is supporting the established of integrated agro-industrial parks (IAIP) throughout Africa. The IAIP is a geographic cluster of independent firms grouped together to gain economies of scale and positive externalities by sharing infrastructure and taking advantage of opportunities for bulk purchasing and selling, training courses and extension services.

The IAIPs offer an ideal platform for the concept of "industrial symbiosis", which describes the intentional clustering of mutually beneficial resource converting industries in a way that by-products and waste materials from one company, are used as input into another process.

UNIDO's Action

UNIDO has supported the establishment of IAIPs from conceptualization - feasibility studies, impact assessments, mapping agro clusters and site identification; to design and development - detailed engineering designs, environmental and social impact assessment, design review and masterplans; to technical assistance in their operational and management - industrial policy, management capacity building, food safety, quality infrastructure, investment promotion, contracting and interfacing between IAIPs and farming networks.

Results

Through its technical assistance, UNIDO leveraged additional funds from development partners, governments and the private sector for building and operationalizing the IAIPs, in addition to facilitating the creation and thousands of jobs for smallholder farmers linked to the IAIPs.

CONCLUSION

A rapid change in the current economic system is necessary as the take - make - dispose pattern of production – consumption reaches the limit of available resources of the planet.

Rethinking the model into a circular economy aiming at zero waste and zero pollution provides numerous advantages for the health, the economy and the environment in terms of jobs opportunities, material and cost saving, and biodiversity.

The transformation has to be thought at the design stage in order to replace pollution and waste, preserve the value over time and avoid using non-renewable resources. It is with the commitment of all stakeholders at all stage of the vale chain that the existing solutions will be able to be scaled up. Developing countries where circular model remains in current practice are at the forefront of potential change. UNIDO and its Agri-business development department is there to support the transition from linear to circular.

Circular agri-business solutions

Replace petrol-based products with natural products (packaging, cosmetics, etc.)

Reuse (cascade)

Recapture value from waste: integrate production of by-products

Rethink business model: packaging reusable, digitalization

Create energy from biomass waste

Reduce post-harvest loss

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria

Telephone: (+43-1) 26026-0, Fax: (+43-1) 26926-69

E-mail: unido@unido.org, Internet: www.unido.org