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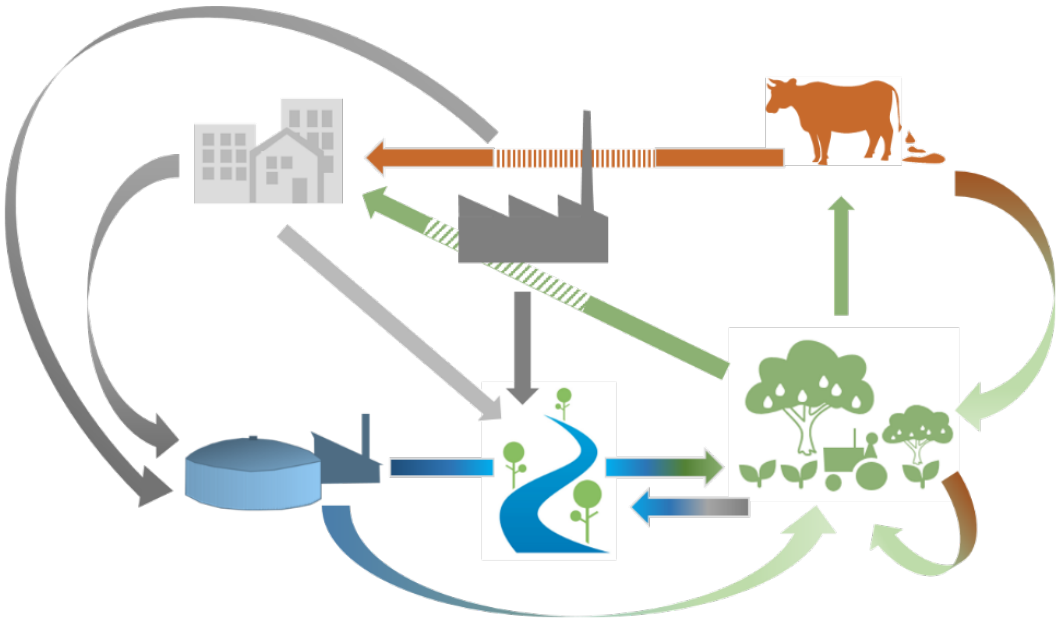
Project Report

Water Management in the context of circular agriculture: Colombia



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Structure of this Report

The purpose of this report is to present the findings of the project on 'water management within the context of circular agriculture' in Colombia. The results of this project may enhance the different ways of cooperation between Dutch and Colombian stakeholders looking for a more resilient and sustainable agrifood system.

The Report starts with a description of the context and background in Chapters 1 and 2. A general identification of key areas is developed in Chapter 3. In Chapter 4, the main barriers and opportunities, priorities and next steps to be addressed by the National Strategy of Circular Economy of Colombia related to an integrated water management for circular agriculture are depicted. In Chapter 5, several current circular practices in Colombia are described and finally, Chapter 7 provides a 'road map' that can be used as a guide when applying the developed concept to other countries.

Timeline

1. Discussion Note - Working draft (April - July, 2019)
2. Identification and first contact with Colombian (Skype, July-August, 2019)
3. Progress meeting with LNV (July, 2019)
4. Update the Discussion Note on basis of the stakeholder interaction (July-August, 2019)
5. Prospective Visit to Colombia to meet COL. stakeholders and EKN (22-27 September 2019)
6. Update the Discussion Note (good practices, workshop prep., project possibilities; August-November, 2019).
7. Workshop with COL. stakeholders (3rd and 4th December 2019) "Towards a strategy for water management in circular agriculture"
8. Final Report (February 2020)
9. Policy document (in Spanish) – "Hacia una Gestión Integral del Agua para una Agricultura Circular" (February 2020).

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1. Context

The visit of Dutch Prime Minister Mark Rutte and the Agriculture Minister Carola Schouten to Colombia in November 2018 has stressed the big potential of Colombia to become a strategic partner in the global trade of sustainable food, raw materials and basic agro-commodities both to The Netherlands and to the European Union (EU).

The Netherlands is one of the most important trading partners for Colombia (4th), with a total of 1.8 billion dollars in 2017, with an strong focus in agri-food commodities. There is a growing interest to increase sustainable agricultural trade between the two countries, since Dutch importers have committed to increase purchases of sustainable agricultural products for the next years.

In this regard, it is worth mentioning that two of the four pillars of the Dutch International Food Security Policy within the frame of the Development Cooperation Policy, are directly related with a more sustainable food production:

- Promoting inclusive and sustainable growth in the agricultural sector (with the goal of doubling productivity and / or income for 8 million family businesses while innovative and climate-smart solutions to make local agriculture climate-proof are applied).
- Realizing ecologically sustainable food systems (with the goal of making 7.5 million ha of agricultural land / meadows / fishing water more sustainable by facing with climate change, degradation of ecosystems with loss of functional biodiversity and depletion of (fresh) water resources).

The Netherlands, together with other European countries is also involved in the Amsterdam Declarations Partnership, with the overall ambition to enhance market uptake of sustainable commodities complementary to supporting production side measures in the countries of origin. This declaration affects product such as soya, palm oil or cocoa.

Looking for a more sustainable food production, the Ministry of Agriculture, Nature and Food Quality of The Netherlands (LNV) recently published "Agriculture, nature and food: valuable and connected The Netherlands as a leader in circular agriculture", in order to share its vision of the transition to a circular agriculture, where losses in the production chain are reduced to a minimum. The goal of the Ministry is to convert Dutch farmers in leaders of sustainable production, as the same time as they promote this strategy with their trading partners.

Circular agriculture is all about efficiency. By transforming the processes into a more efficient system, inputs and waste would be minimized. Water and nutrients are key factors for this, so long-term sustainability will only be reached by closing the loops of water and nutrients between the several sectors involved in the whole chain of food production.

Fitting with this vision and with an outward-looking approach, the Netherlands newly published the NIWA - Dutch International Water Ambition [1]. This strategy, a sequel of the previous 'International Water Ambition - IWA' from 2016, is focused on how the Netherlands cooperates to contribute to water security and water safety worldwide. The NIWA is a means to use Dutch water-related international policy instruments more coherently, serving as a platform for cooperation between public, private, social and knowledge partners. The common goal is to increase water security and water safety of more than one hundred million people worldwide by 2030. But for doing that, the NIWA is focusing more on the nexus of water, food and climate:.

> *"Food production cannot do without, but can be done with less water, and circular agriculture offers solutions to reduce this significantly".*

2. Background

2.1. Sustainability and Circular economy

In a growing and urbanised population world, where people is expected to reach 9.8 billion by 2050 [2], a new paradigm is required, in order to produce enough food to feed the world at the same time that threats to our environment, such as biodiversity loss, water, air and soil pollution or depletion of natural resources are seriously confronted.

The Brundtland Commission [3] described in the latest 80's the term sustainability as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The sustainable development is based in the so-called three pillars of sustainability: people, profit, and planet, looking for an economic and social development while guarantee the environment protection.

In addition to sustainable development, in the early 90's, Pearce and Turner [4] introduced the concept of Circular Economy, describing how the economy is influenced by the natural resources, as a provider of inputs for production and consumption and as a receptor of the waste generated. During this time, similar concepts that share the idea of closing loops, such as cradle-to cradle economy, looped and performance economy or blue economy have been introduced [5]. However, the most accepted definition for Circular Economy has been outlined by the Ellen MacArthur Foundation [6], as "an industrial economy that is restorative or regenerative by intention and design". The final objective is to move the economy and industrial production from the traditional linear approach, driven by the principles of "take, make, use and dispose" to a circular one, where waste re-enter in the system, limiting the dependency of raw materials and energy as well as the emission of greenhouse gases.

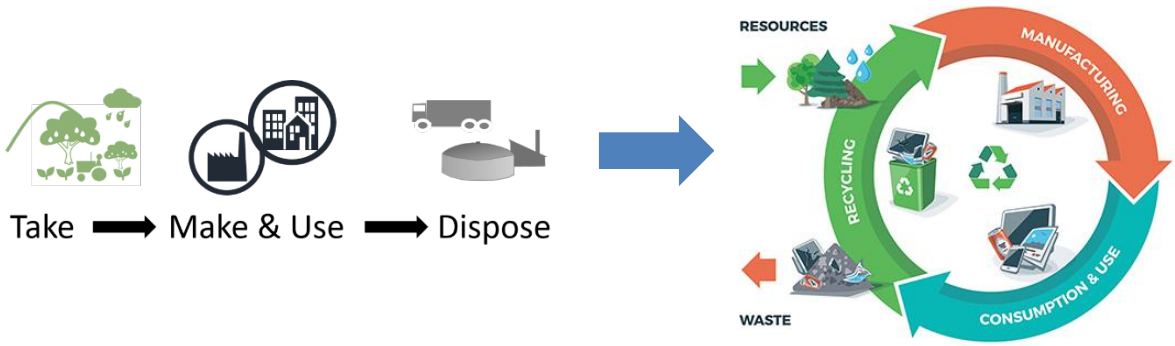


Figure 1. Linear and circular economy approach

During the past years the concept of circularity has gaining a large prominence between policymakers, industry and consumers. In December 2015, the European Commission adopted a Circular Economy Action Plan [7] with the aim to boost the growth of the European economy and to develop a carbon neutral, resource-efficient and competitive society. This action plan comprising a total of 54 actions covering production, consumption, waste management, market for secondary raw materials and several actions in sector such a plastics, food waste, critical raw materials, construction and demolition, biomass and bio-based materials, and innovation and investments. The evaluation of this action plan [8] showed how this strategy has helped put the EU back on a path of job creation, has opened up new business opportunities and has promoted for the first time a systemic approach across entire value chains, mainstreaming circular principles into plastic production and consumption, water management, food systems and the management of specific waste streams.

Agriculture, as a critical sector which provide food, feed, and bio-resources that sustain the economies, should be in the centre of any strategy of Circular Economy. These policies should seek a sustainable production of agricultural commodities using a minimal amount of external inputs, closing nutrient loops and reducing negative discharges to the environment.

2.2. Towards circular agriculture: the Dutch case [9]

The Netherlands, with a worldwide leading position in farming, horticulture and fisheries, is looking for a more responsible and sustainable food supply, with the conviction that the only way to secure the future food supplies is to make the transition to circular agriculture.

The Ministry of Agriculture, Nature and Food Quality (LNV) is aware of the challenges the transition to a circular agriculture will represent for the Dutch society, and specially for farmers, growers and fishermen, but also it is aware about their obligation to boost this transition in those supplier countries.

The current supply chain – with a beginning, an end and leaks within the chain – needs to be transformed into a system with minimal unnecessary losses. Closing as much as possible the loops between waste and inputs and keeping food safety as the key priority should be the guiding light.

The Dutch government's goal is to close the cycles of raw materials and resources at the lowest level by 2030, either nationally or internationally. For doing that, three supplementary objectives for a strong, sustainable food system are formulated:

1. The economic position of farmers, growers and fishermen in the supply chain should be such that they are able to earn a good income in circular agriculture, can innovate and can maintain and pass on healthy businesses.
2. More appreciation of food by individual consumers, large-scale users and the catering industry. Wastage should be avoided. The distance between primary producers and citizens must become smaller.
3. The Netherlands must retain a leading role in the innovation of production methods, both nationally and in global food markets. With Dutch knowledge and products, the Netherland can be an example for other countries when it comes to efficient production of food in circular processes, thus preventing and repairing damage to the ecosystem (water, soil, air).

Circular agriculture, also known as low external input farming, update the "old" idea of farming reuse into a broader scope, not just restricted to the farm boundaries but to a local, region or international context. The use of modern technology also allow to a more efficient reuse, where residues from the agricultural sector or the food supply chain should be re-used or re-processed into new (auxiliary) added value products which can enter in the agrifood system again. From the Strategy:

> *"In a circular agriculture system, arable farming, livestock farming and horticulture primarily use raw materials from each other's supply chains and waste flows from the food industry and food supply chains"*

In summary, circular agriculture should lead to less environmental pollution, better biodiversity, higher income to the farmer, less resources and food wasted, and less emissions of greenhouse gases.

Soil and water are key to circular agriculture. The first as a receptor, where most of the agricultural processes take place and the second as a driver, thanks to the transport capacity of nutrients and waste. A proper management of both elements will increase the resilience of the system, improving the availability of inputs (including nutrients, organic matter) and reducing environmental stress (including soil erosion, droughts, floods).

The Dutch strategy identifies 6 key points to raise the agri-food production into a circular system. Close the loops within and between those elements is essential to achieve circularity.

- *Nature and agriculture* – to transform towards a *nature-inclusive farming*, valuing the capacity of nature and biodiversity in the soil and on and around farms to close cycles and provide environmental services, such as pollination, soil fertility and increasing resistance to diseases and pests.
- *Livestock farming* –to reduce the size of nutrient cycles in the cattle feed sector and to close the loop at the lowest possible level. A minimization of losses from food, waste flows, carbon, energy and water is also desired.

- *Crop farming* – to attune cultivation to the capacity of the soil with increasing precision and with application of sophisticated farming plans, customised fertilisation and prevention of diseases, pests and weeds.
- *Horticulture* – to move towards a circular greenhouse close-by the consumption areas, where emissions into the soil, water and air are minimal and recycling and reuse of elements both from the greenhouse and from the surrounding (Greenport's) are maximum.
- *Fisheries* – to guarantee nature and the economy to be, and remain, in balance with each other, by preventing undesired bycatch, wastage and emissions, both for fishing and aquaculture.
- *Regional scale* – to strength the flows between the several sectors in order to enhance loops at different scales, from farm to higher levels (local, region, national or international).

To implement the circular agriculture strategy, the Netherlands is forced to look across national and European borders, since markets are internationals and circularity should not be restricted to local levels. As a strong trader, the Netherlands is in the position to influence sustainability in the countries of origin, having a favourable leverage effect on international environmental and nature-related goals and on biodiversity.

Innovation, training and knowledge dissemination is key to implement the transition to circular agriculture. A close collaboration between scientific and practical research, public and private parties as well as farmers, growers and other professionals of the agri-food sector is required to achieved the desired circularity. The knowledge that the Netherlands acquires in circular agriculture can help other countries to improve their arable and livestock farming. Furthermore, the Netherlands can bring its expertise and innovations to help tackle specific problems such as salinization, floods, drought or erosion.

2.3. Colombia is betting on Sustainability and Circular Economy

Colombia is leading sustainable development in Latin America, playing an important role for the adoption of the UN 2030 Agenda for Sustainable Development [10], emphasizing among other elements its concern on unsustainable consumption and production patterns and the effects of climate change and its impact on developing countries [11]. The Green Growth Policy of Colombia [12], launched in July 2018, strives to increase the productivity and economic competitiveness of the country, ensuring the sustainable use of natural and social capital while considering the potential impacts of climate change.

Launched in 2018, the National Strategy of Circular Economy of Colombia put the country in the spotlight of sustainable development in Latin America. This strategy, based in the 9R model (refuse, rethink, reduce, reuse, repair, refurbish, re-manufacture, repurpose, recycle and recovery), seeks to strengthen the model of economic, environmental and social development of the country. The strategy identifies and prioritizes the actions to be carried out to achieve the transformation towards 2030. To do that, 6 lines of actions, referring to the most relevant cycles are emphasises:

1. Material and industrial production
2. Packing
3. Optimization and use of biomass
4. Water cycle
5. Energy sources and use
6. Material management in urban areas

Although agriculture is recognised as the spine of Colombian economy, this sector is not explicit addressed in the Circular Economy Strategy. However, several links with the current lines of actions would be derived, mainly related with the cycles of biomass, water and materials from urban areas.

2.4. Role of water in circular agriculture

The role of water in agriculture varies per country or region, due to the climate and weather conditions prevailing at the production locations. Although irrigation is not required everywhere, a proper water management in agriculture is worldwide concern. Among other properties, water is an important connecting factor in circular agriculture by transporting nutrients but also as a potential source of pollution.

Any strategy that seeks to close the loops within agriculture deserve particular attention to the water (and nutrient) flows.

The constant water flow from cities, if reused, could reduce the dependency of farmers to water shortages. Effluents from different activities such as farming, husbandry, food processing or cities contain a large amount of organic compounds and nutrients. If these effluents are managed appropriately, could be an important source of nutrients for cropping, reducing the dependency of external fertilisers. But if no prevention actions are taken, could be a serious threat to the health of farmers and consumers and a potential source of pollution for the environment.

Among others, two strategies could be follow in relation with water flows for circular agriculture:

- Intensive treatments to eliminate pollutants, separate clean water and concentrate nutrients to be re-used for irrigation and fertilisation in valuable crops.
- Extensive treatment to use the capacity of nature to attenuate pollutants as the same time as non-food crops are produced.

3. Identification of key areas, overview

The circular agriculture dimension needs to be explored in a holistic approach in order to reap the benefits of circularity. The relation and flows between urban and rural areas at farm, local or regional scales should be identified, considering water and nutrients as key connecting elements between the different environmental compartments and sectors.

Many organic residues contained in effluents and waste from agriculture, animal husbandry, aquaculture urban areas, or industries are suitable for an agricultural valorisation as organic fertilizer or soil amendment due to their nutrient and organic matter contents (Figure 2). For example, animal manure, if properly applied on time, place and quantity, provides several land benefits such as increase of soil carbon, reduction of soil erosion and runoff, nitrate leaching or fertiliser requirement. Similar relations could be found within other sectors, such as food processing industries or urban areas and arable farming, where some of the waste streams could be re-used after conditioning for land application or irrigation. Wastewater reuse is gaining more and more prominence, not only in water scarce areas, where wastewater treatment plants could be a more reliable source of water for irrigation than freshwater but also in abundant water regions, since the substances present in those effluents could be an important source of nutrients reducing the dependency on external outputs. Arable farming itself produces also a large amount of crop residues that, when good residue management practices are applied, could play a critical role for the maintenance of the organic matter balance and nutrient cycles in the soil.

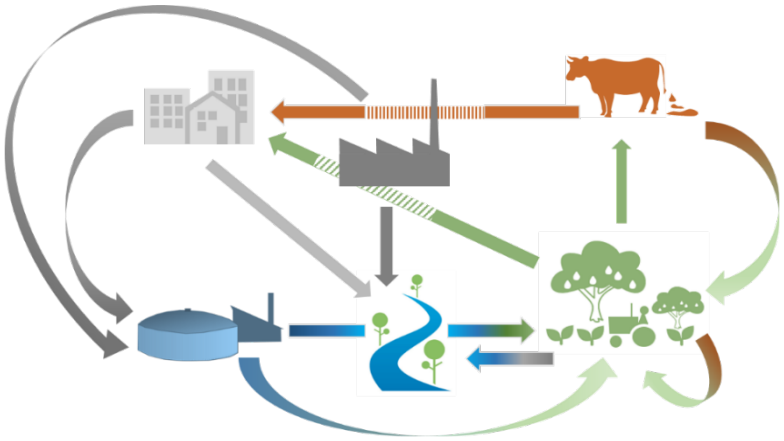


Figure 2. Elements in the symbiosis of agriculture-city-nature – the circular agriculture approach

Closing the loops of water and nutrients from different sectors would also lead to a reduction of environmental impacts at local level, by reducing the direct discharge of effluents on water bodies and enhancing the natural treatment capacity of soil and environment.

A first identification of the key issues to be considered in the implementation of a circular agriculture policy strategy in the context of Colombia is presented below. This identification is based in the information provided by the relevant stakeholders (Annex 1). For a better understanding, the different topics are grouped by sectors, although the flows and relation among them are depicted.

A. <u>Urban areas</u>

1. Cities

a. Reuse of treated waste water for irrigation.

- Description: Direct wastewater reuse, from wastewater treatment facilities, under the Colombian water reuse regulation (new rule under development).
- Objective: to produce safe food by reducing fresh water use and to limit urban water pollution by 'harvesting' nutrients in agriculture.
- Actions required: i) assess the potential of direct water reuse (more applicable in water scarce areas); ii) assess the influence of the new regulation (under development).
- Potential stakeholders to approach: Ministry of Environment (responsible), Ministry of Housing (responsible of sanitation), Ministry of agriculture, regional corporations, farmer organisation, cities, private sector (companies involved in the integral water cycle), consumer organisations.

b. Use of the organic fraction of urban waste for soil amendments

- Description: Use of treated organic wastes from different sources.
- Objective: reduce landfill waste and mineral fertiliser demand by composting the organic fraction of several waste sources (municipal solid waste, sewage sludge, etc.) for soil improvement and fertilisation.
- Actions required: i) promote organic waste separation; ii) valorisation of organic waste by composting; iii) nutrient recovery (P and N).
- Potential stakeholders to approach: Ministry of Housing (responsible), Ministry of Agriculture, Ministry of Environment, regional corporations, farmer organisations, consumer organisations, cities, private sector (companies involved in urban waste management), the Holland House Waste Window.

c. Indirect reuse of water for peri-urban irrigation

- Description: Use of water from peri-urban rivers receiving urban/industrial (treated)effluents for irrigation.
- Objective: promote safe peri-urban agriculture to feed the city; reduce the distance between agricultural areas and cities; guarantee safe food production; use natural capacity of soils and riparian ecosystem to improve water quality.
- Actions required: i) develop cost-effective technologies to pre-treat polluted water and limit the risk; ii) identify agricultural best practises to enhance natural purification.
- Potential stakeholders to approach: Ministry of Housing (responsible), Ministry of Agriculture, Ministry of Environment, regional corporations, neighbourhood associations, farmer organisations, consumer organisations, cities, private sector (companies involved in urban waste management).

2. Rural area

a. Water and sanitation at household/farm level

- Description: Treatment and reuse of household effluents and waste in rural or decentralised areas (farms).
- Objective: reduce water pollution at household level by the implementation of cost-effective technologies.
- Action required: i) Explore nature-based solutions to treat and reuse household effluents and waste (green filters, bio-gas, artificial wetlands).
- Potential stakeholders to approach: Ministry of Housing (responsible of sanitation), Ministry of Agriculture and Rural Development, Regional Corporations, 'Crop federations' (e.g. FNC, Fedepalma, Fedearroz, etc.).

B. <u>Industry</u>

a. Food processing

- Description: Direct reuse/treatment of liquids and solids waste streams from food processing facilities (sugar cane refining, palm or coffee central processing, horticulture packing and processing, beverage production, etc.).
- Objective: reduce water pollution from food processing facilities and valorisation of waste.
- Action required: i) promote the creation of agro-parks (flows between industries and agriculture); promote internal recycling at industrial level; ii) promote wastewater reuse for irrigation of surrounding irrigation areas; iii) composting of organic solid waste; iv) identification of potential high added-value products derived from food processing waste streams for market applications (nutrient recovery, bio-fuel production, cosmetic ingredients, etc.).
- Potential stakeholders to approach: Food and feed processing companies, breweries, others (by sectors).

C. Agriculture

a. *Arable farming*

- Description: reuse/treatment of effluent or crop residues from agriculture.
- Objective: reduce the dependency of agriculture on external outputs (fertiliser or soil improvers).
- Action required: i) identification of best agricultural practices for the proper management of biomass residues; ii) limit the discharge of agricultural effluent and promote collection, storage and reuse; iii) by-products valorisation.
- Potential stakeholders who are involved: Ministry of Agriculture; Agrosavia: Crop associations.

b. *Livestock*

- Description: reuse/treatment of livestock effluents (manure, pig slurry, etc.) for agriculture.
- Objective: reuse of animal waste for soil quality improvement (organic amendments and fertilisation; limit the environmental impact of livestock production (leaching of nutrients).
- Action required: identification of best agricultural practises for: i) collection, storage and re-use of solids and liquids waste in intensive livestock production; ii) rotational grazing to reduce excessive nutrient loads; iii) grazing of stubble to enhance nutrient distribution.
- Potential stakeholders to approach: Ministry of Agriculture; ICA; Meat and dairy producing companies.

c. *Inland aquaculture*

- Description: reuse/treatment of aquaculture effluents (water stream and sludge) for agriculture.
- Objective: reuse of water streams enriched with nutrients for irrigation; limit the environmental impact of aquaculture production (discharge of nutrients - eutrophication).
- Action required: identification of best agricultural practices for: i) collection, storage and re-use of solids and liquids waste in intensive aquaculture ponds; ii) identification of possibilities to use waste water (or a mix with fresh water) for aquaculture.
- Potential stakeholders to approach: Ministry of Agriculture; AUNAP.

D. Ecosystems

d. *Influence of waste (water) on the ecosystem*

- Description: human actions have a large impact on the ecosystem and it would be good to assess (in some way) the impact of waste water on the environment.
- Objective: to identify the main influence of 'waste water' on nature and biodiversity.
- Action required: (i) assess experience with human impact on the environment, and specifically of waste water; (ii) identify the boundaries (risks) of circular agriculture in terms of sustainability (e.g. taking care of environmental flow and preventing accumulation of final residues)
- Potential stakeholders to approach: Ministry of Environment; IDEAM.

e. *Provision of environmental services*

- Description: payment for the environmental services provided by the ecosystem/rural areas
- Objective: strength nature conservation by the valuation of the services provided by the environment and the rural areas associated.
- Action required: i) assess the potential market related with the provision of environmental services provided by the Ecosystem and the Rural areas associated in Colombia in the context of circular agriculture
- Potential stakeholders to approach: Ministry of Environment; Instituto Humboldt; SINA; IDEAM.

4. Barriers , opportunities, priorities and next steps

Together with Colombian stakeholders, a deeper discussion about the barriers, opportunities, priorities and next steps to be addressed by the National Strategy of Circular Economy of Colombia for water in the agricultural sector was developed. Those topics were discussed during the workshop entitled "*Hacia una Gestión Integral del Agua para una Agricultura Circular",* developed in Bogota the 3rd and 4th of December, 2019. During this workshop, more than 70 people from 30 institutions of Colombia and The Netherlands provided their feedback on a working group activity (see Annex 1).

4.1. Barriers and opportunities

A preliminary identification of barriers and opportunities to make water management in the Colombian agriculture more circular could be found below.

Table 1. Barriers and opportunities of water management for a circular agriculture

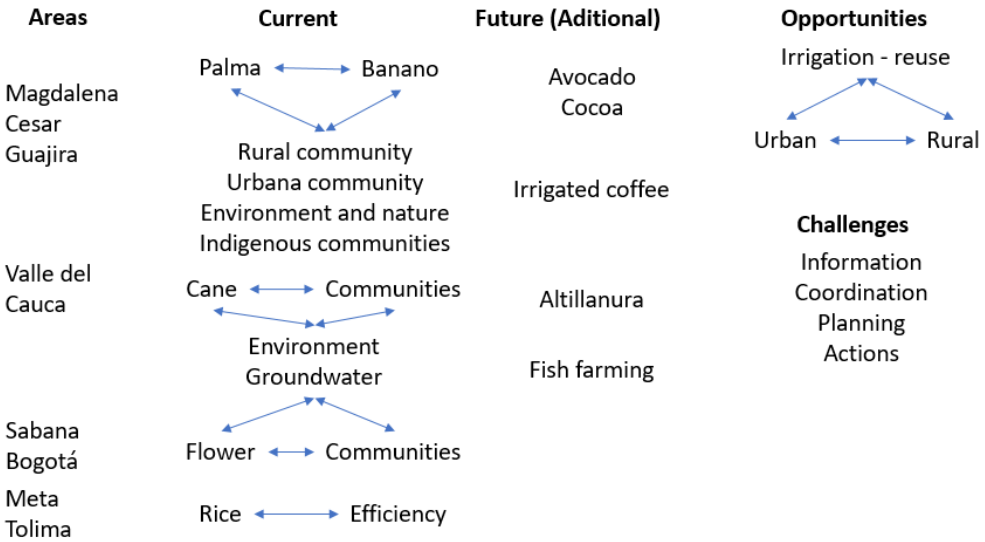
Barriers	***Opportunities***
Little interaction between government/private/knowledge institutions	Develop pilot projects based on scientific knowledge to support regulatory innovation
Resistance to change and fear to innovation	Boost the safe water reuse on a practical and efficiency way
Little opportunities to acquire technologies	Reduce water losses
Limited dissemination of the applied scientific knowledge	Develop own technologies and new business models
Lack of incentives and financing resources	Develop industrial symbiosis schemes for safe water reuse
Information and research gaps	Develop collaborative platforms for watershed management and strengthen monitoring systems
Lack of accredited laboratories and high costs	Exchange platform between supply and demand in EC
Water price and wrong perception of availability	Include externalities in the costs of water
Weak water governance, monitoring and control	Improve competitiveness by climate change adaptation
Procedures, costs and interpretations of the CARS / AA	Take advantage of anchor companies (RedES-CAR as a successful example)
Unwillingness of institutions to share information	

4.2. Priorities

Among other priorities, the challenges to bridge the information and knowledge gap, the need to setting up collaborative platforms to improve water governance, the development of new financial instruments and incentives and the identification of the required suitable technologies applied to circularity were highlighted.

A more detailed discussion was also developed for the following elements:

- Water quantity: priority areas, crops and opportunities



- Water quality: priority areas, crops and opportunities

Areas	Current	Additional Risk	Opportunities and challenges
Urban (big cities) & rural	Lack of treatments (organic, microbiological, PPcPs)	Rural exodus	Implementation of both sanitation and reuse projects Awareness raising (all stakeholders)
Mining	Legal & Illegal activities (metals and sediment)	New concessions	Connect flows (agriculture and livestock)
Livestock	Manure (nutrients) and deforestation	Expansion of agricultural frontier	Good practices (agri. sector)
Agriculture	Excess of fertilizer and pesticides		Reduce gap between knowledge and practice
Illicit activities	Deforestation, agrochemicals & fumigation (aerial eradication)	Fail of peace agreement	Regulatory innovation for control Monitoring

- Regulatory Opportunities

Actions	Objectives	To be considered
Adjust water price	Cost recovery (investment and operation) Water quality (treatments) Integrated Water Management	Water concessions
Revision of water related legal framework (update and integration)	Boost circularity Avoid double regulation (incoherence) Involve sectors affected	International regulation Knowledge based regulations
New water reuse regulation	More intended uses Clarification of concepts: reuse vs recycling Avoid risks	Regulatory innovation Criteria for exportation
Reduce bureaucracy and paperwork Control and monitoring	Fulfillment	Easier rules Online procedures

The most relevant conclusions from the discussions with the stakeholders could be stated as:

- There are relevant initiatives and research project running up in Colombia related with water management and circularity.
- The National Strategy of Circular Economy of Colombia has an explicit emphasis on water management for the agricultural sector, although the concept of circular agriculture is not specifically gathered.
- There is a necessity to review the current legal framework from a more circular perspective
- There is a large expectation on water reuse from several sectors.
- Dispersion and availability of information is a large limitation. It is essential to collect, share and validate it.
- Sharing projects, information and discussion spaces, such as the workshop developed, is essential to link all the actors involved.
- Water management in circular agriculture goes beyond water and directly involves soil and land management.

4.3. Next steps

Some potential next steps to boost circularity in the agricultural sector in Colombia were also identified during the stakeholder discussion:

- Elaboration of a policy document, to be coordinated by the Ministry of Environment of Colombia, with the support of WUR, the Embassy of the Kingdom of the Netherlands, Uniandes, Agrosavia and CATIE: "Hacia una Gestión Integral del Agua para una Agricultura Circular".
- Creation of a Reuse Advisory Board (task force): to discuss about new regulation, scientific evidences, good practices, business priorities and bring international expertise.
- Mapping circular initiatives to connect, articulate and identify existing and new opportunities.
- Living lab – a real scale water reuse experience in a small/medium city to test and show the suitability of circularity.

5. Current experiences of circularity[1]

5.1. Wastewater reuse in Colombia: an updated regulation

Colombia is one of the first Latin-American countries with a regulation on wastewater reuse. However, six years after the publication of the "Resolution Number 1207 from 2014 for the use of treated wastewater", only few initiatives are in place. As the Ministry of Environment recognises, the restrictive quality criteria, the deficit of capable and certified laboratories, the limitation of the intended activities for reuse and the unclearness of some concepts are key restricting factors behind the low implementation of wastewater reuse initiatives.

Tthe Ministry of Environment is looking to boost initiatives on wastewater reuse as a result of both the National Strategy on Circular Economy (2018) where the water cycle is one of the six pillars and the National Development Plan 2018-2022, where the objective 3 established the acceleration of the circular economy as a basis for waste reduction, reuse and recycling. Considering all of this and the great interest shown by different sectors about wastewater reuse, the Ministry of Environment of Colombia is updating the legislation, including new technical information provided by the sectors, and in close cooperation with other Ministries (such as the Ministry of Commerce, Industry, and Tourism, the Ministry of Agriculture and the Ministry of Housing) as well as local government.

The new legislation will put a special focus on the safe use of wastewater, differentiating between reuse and recycling and with new instruments for a better control and monitoring through a mandatory "concession". The new regulation will come as an open list of intended uses, by introducing a fit-for-purpose and risk management approach. The new legislation is planned to be ready by early 2020.

5.2. RedEs-CAR: a collaborative platform for an integrated water management

The Sustainable Business Platform (RedES-CAR, Red de Empresas Sosteinibles de Cundinamarca) is a Colombian alliance between the public, private and academia of the region of Cundinamarca. RedES-CAR promotes the sustainable productive transformation of companies through the application of change strategies in three pillars:

i) Cleaner Production, to promote cleaner production in the whole chain, led by anchor organizations and their suppliers, partners or customers;
ii) Industrial Symbiosis, to promote industrial symbiosis between groups of companies from various sectors and value chains; and
iii) Integrated Water Management, to promote integrated water management among groups of companies belonging to the same basin.

Circularity is one of the core components, looking for a more collaborative integration between companies and chains, both to manage their resources and wastes and to implement conservation strategies in their shared territory. For doing this, actors should understand that water is a shared resource and its availability depends on the natural conditions in terms of water supply and demand, land use, climate variability and vulnerability to climate change.

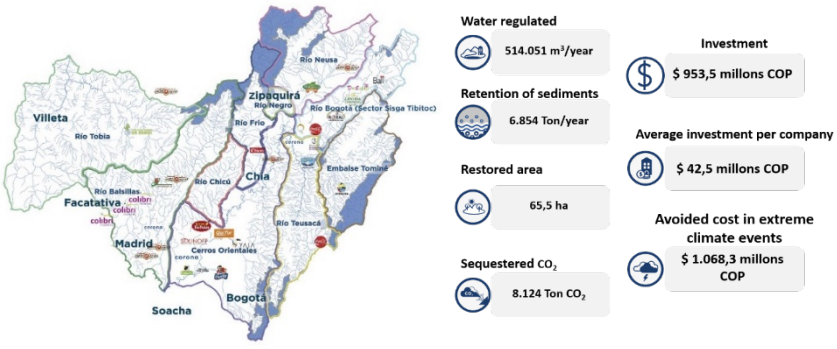


Figure 3. RedEs-Car results on pillar Integrated Water Management

[1] This section draws on the presentations in the Workshop - http://www.redescar.org/noticias/agua-para-una-agricultura-circular

Through collective actions aimed at improving the natural conditions of their territory, companies could improve their resilience and water security. In such a way, during the last 3 years, a total of 22 companies from several sectors formulated 10 projects related with groundwater recharge and restoration of protected areas, involving key ecosystems for the water security of the Bogotá River Basin.

5.3. Nature based solutions to treat effluents from coffee farms

The coffee sector is often blamed as one of the most water-polluting agricultural activities in Colombia, due to the effluents generated during the post-harvesting process. During this, the outer parts of the coffee cherry are removed from the endocarpal parchment by a physical and a fermentation process, resulting in two by-products: the pulp and a wastewater stream. Those products are characterised by a very high organic load, which usually is disposed into the water bodies, creating an important environmental impact, especially in areas with high concentration of coffee farms.

To minimize those impacts, some strategies have been developed in Colombia with a more circular perspective, facilitating the management of the pulp and allowing to reduce the volume of water used during the traditional post-harvesting process ("beneficio húmedo") from 40 L/kg dpc to less than 0.5 L/kg dpc. The pulp, if well managed, could be easily composted and applied to the field as fertiliser. Similarly, the effluents should be treated before they are discharged into the rivers or infiltrated in the soil. For doing that, several wastewater technologies are available, such as bio-digestors, modular anaerobic treatment system (MATS), up flow anaerobic filter (Skimmer-UAF) or Hydrolytic-Acidogenic reactors (H-AR). However, although they have shown their technical suitability, the cost, robustness, technical complexity or the time required for maintenance during the harvest season have made a broad implementation through smallholders very difficult.

The use of nature based solutions, such as vegetation filters ("filtros verdes"), could be a suitable solution to reduce the pressure onto local water resources. Those filters involve the application of the pre-treated effluent to a vegetated soil surface (guadal, vetiver grass, etc.) and relies on the soil attenuation capacity and plant uptake to remove potential wastewater contaminants at the same time as biomass is produced. From the experiments developed by Cenicafe and WUR, it could be stated that vegetation filters are a feasible solution able to remove most of the organic load to values lower than the current legislation. The biomass produced could be also used for grazing, as material for construction, CO_2 capture, or other intended purposes. From a practical perspective, it's important to note that less than 50-60 m^2 of land will be needed to treat the effluent from a typical Colombian coffee plantation (1.6 ha - 6000 Kg dpc/year), implying less than 0.5% of the total farm area. This technology is cheap, robust and demands little time for maintenance during the harvest season. The construction materials required (tanks and pipes) could be found in the local market, are light and easily transported to remote areas. Furthermore, this technology could be used to treat the effluents continuously produced at household level, reducing the environmental impact of the whole farm.

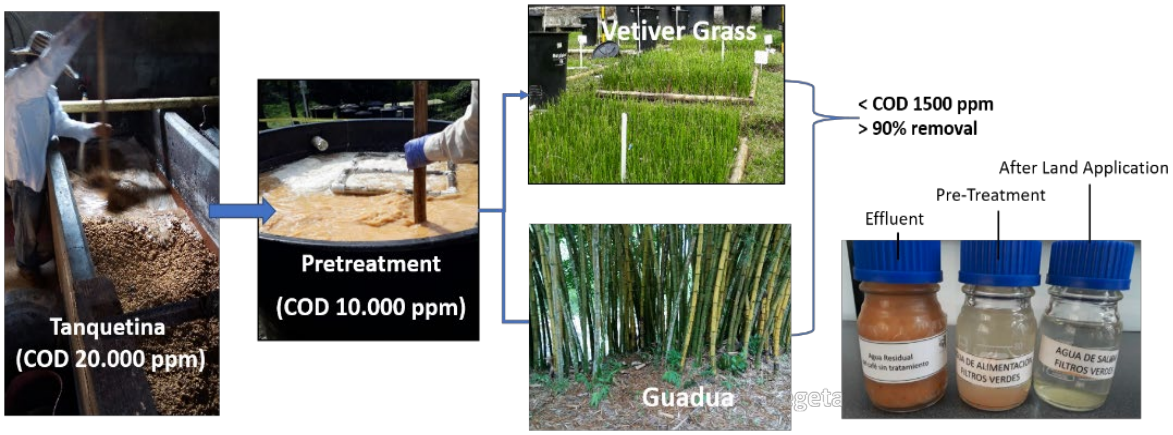


Figure 4. Vegetation filter to treat effluents from coffee farms

5.4. Influence of wastewater on peri urban agriculture

The Bogotá River currently suffers from major pollution coming from the industries located upstream the capital (mainly tanneries), but also from the untreated urban effluents discharge to its tributaries Salitre, Fucha and Tunjuelo. The lack of proper treatments in the metropolitan area of Bogota has a huge negative impact on the environment, but it is also a potential health risk when this water is used to irrigate the 13,000 ha of horticultural crops dependent on this water.

To understand the potential risk of the use of polluted water for irrigation, Agrosavia is carrying out research to characterise the pollutants presents in the water used for irrigation, their accumulation on the agricultural soils and their presence in the crop tissues. The final aim is to propose cheap and robust system to treat the water partially before applying to the crop.

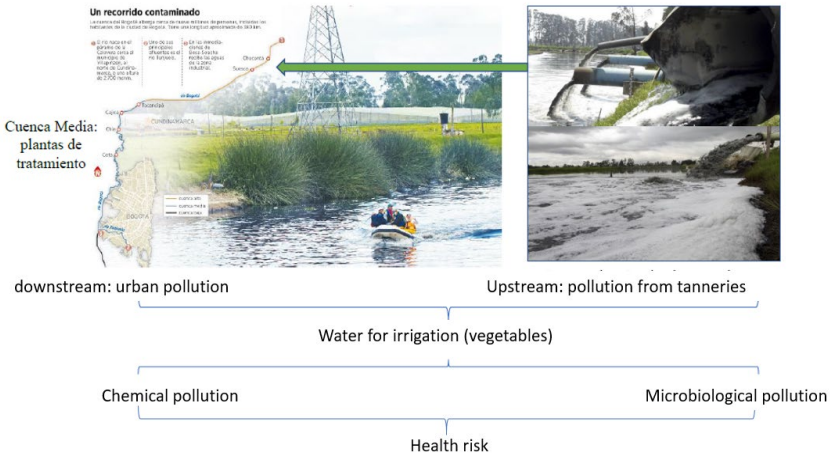


Figure 5. Main source of pollution of Bogotá River

The first step is to assess the microbiological, metals and pesticides concentration in several water, soil and tissue (lettuce) samples. The preliminary results show that in most of the water samples, the microbiological concentration (total coliforms and E. Coli) is much higher than the maximum values recommended by the international guides. Although the metal and pesticides concentration in water are below the maximum limits recommended, the accumulation effect in the soil produce that the tissue concentration of Cd and Pb is slightly higher than the limits. In case of pesticides, fungicides and insecticides are the most common, being in concentrations higher that the recommended in several cases.

Although further research is required, the presence of several potential harmful substances in the water, in the soil and in the plant tissue, would require the use of treatments to enhance the water quality before it is used for irrigation.

5.5. Circularity in the oil palm industry

With more than 0.5 million ha distributed between the 4 palm areas and with total oil palm production of around 1.6 million tons per year, Colombia is the 4th biggest producer around the world and the leader in Latin America.

Looking for a more sustainable production, the Colombian oil palm sector is doing a great effort to include a more circular approach during the whole production chain. Oil palm production requires inputs, such as land, water or nutrients, but also produce a large amount of organic waste. If those flows are closed, the environmental impacts of oil production could be minimised.

Located in Caribbean region (North of Colombia) and situated at the foot of the Sierra Nevada de Santa Marta, The Daabon business group visualizes Tequendama farm as a living system that includes: palm plantations, extraction mill, composting plant and bioenergy generation.

The biomass residues from the palm plantation and the extraction mill are composted in the biggest composting plant of Colombia (10.2 ha), producing around 2700 Ton of compost per month, to be used as a soil improver in the palm plantations and by local smallholders. The 'palm cake' is used to feed the buffalos. These animals extract the fruit from the plantations and generate manure that is required for the composting process.

Finally, the Palm Oil Mill Effluent (POME), characterised by a high organic load, is treated by an anaerobic digestor, producing methane and clean water. The methane is used to produce green energy, 7000 mW in 2019, exceeding the internal demand (carbon neutral) and shelling the excess to the local network. The 1.2 million m^3/year of treated water is applied to the 48.5 ha of palm plantation for irrigation.

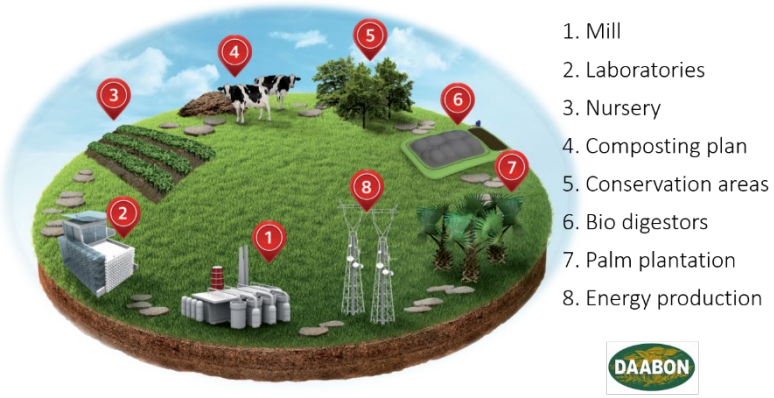


Figure 6. Tequendama farm

The environmental and economic benefits from this circular strategy are enormous, including saving of water for irrigation, reduction of pollution, soil improvement, saving of energy cost (70 million COP), energy selling (400 million COP) and selling of carbon credits (estimated in 2000 million COP).

6. Road map

One of the challenges to boost circularity is how to start the process, and it not a challenge in The Netherlands only. Although many countries do not include the concept of circular agriculture yet, already several related actions are being taken, either in their own circular or sustainable policies or in their traditional farming practises.

A first question to be addressed is how the concept of circular agriculture fits with the current agricultural policy framework of any country. For doing that, good stakeholder mapping is critical, in order to identify the most relevant actors. Agriculture and environment are usually concerns of separate institutions, and the engagement of anchor institutions (public, private and knowledge) is crucial.

A previous identification of the key areas will help to focus the discussion. This identification should be done in cooperation with the relevant stakeholders. It is often reality that institutions are working in isolation on common topics (and it is a fact that this even happens between departments from the same institution). The creation of links and spaces for interaction will boost the entire process towards circularity. Those common spaces will allow the stakeholders to share current practices, recognize barriers and opportunities and identify priorities. Surely, it is finally up to the national and local stakeholders and the anchor institutions to agree on next steps.

The process that was conducted during this project in Colombia, delivers experiences that may be helpful when trying to identify the possibilities to increase circularity in any other country. The road towards circularity may be winding and sometimes bumpy, but the end goal is clear (Figure 7).

Step 1: mapping of the policy domain. A first question to be addressed is how the concept of circular agriculture fits with the current agricultural and or economic policy framework of the country.

Step 2: identify the overall 'space of work/ context' in which circularity should be enhanced, which will include (but will not be limited to): river basin, climate, land, water and nature conditions, that need to be weighed against urban-rural and industrial development, for their social and economic status.

Step 3: stakeholder mapping

- Identification of stakeholders follows from the overall 'space of work/ context' in terms of conditions. The presence of large agricultural enterprises, factories, urban settlements, etc., will determine which stakeholders are inherently involved.
- Engage national anchor institutions.
- Involve Dutch agrifood sector.

Step 4: connect stakeholders and create the space for discussion. This will provide an overview of possibilities where to focus action.

Step 5: taking action required, which can involve:

- Assess the required legal framework.
- Identify barriers, opportunities and existing best practices (including promising technological developments).
- Identify missing data and knowledge and share information.
- Identify priorities.

Step 6: Way forward. It is well understood that application of the 'triple helix' or 'golden triangle' of Government, Research and Business, is highly useful in further advancing 'circularity, with every partner in the contributing from its own mandate:

- Government can contribute with e.g. taking away legal, institutional, and trade hurdles. It might also consider to provide seed-funding where Business would not be the logical funder.
- Business is highly required in the cooperation as it has the power to implement and to insert research findings into real-life business opportunities. It also may have access to venture capital if so required.
- Research will have to expand the knowledge required to make it happen.

It is envisaged that depending on the business opportunities that emerge, the champions of the most promising developments start taking joint action, with all partners contributing within their interest and mandate.

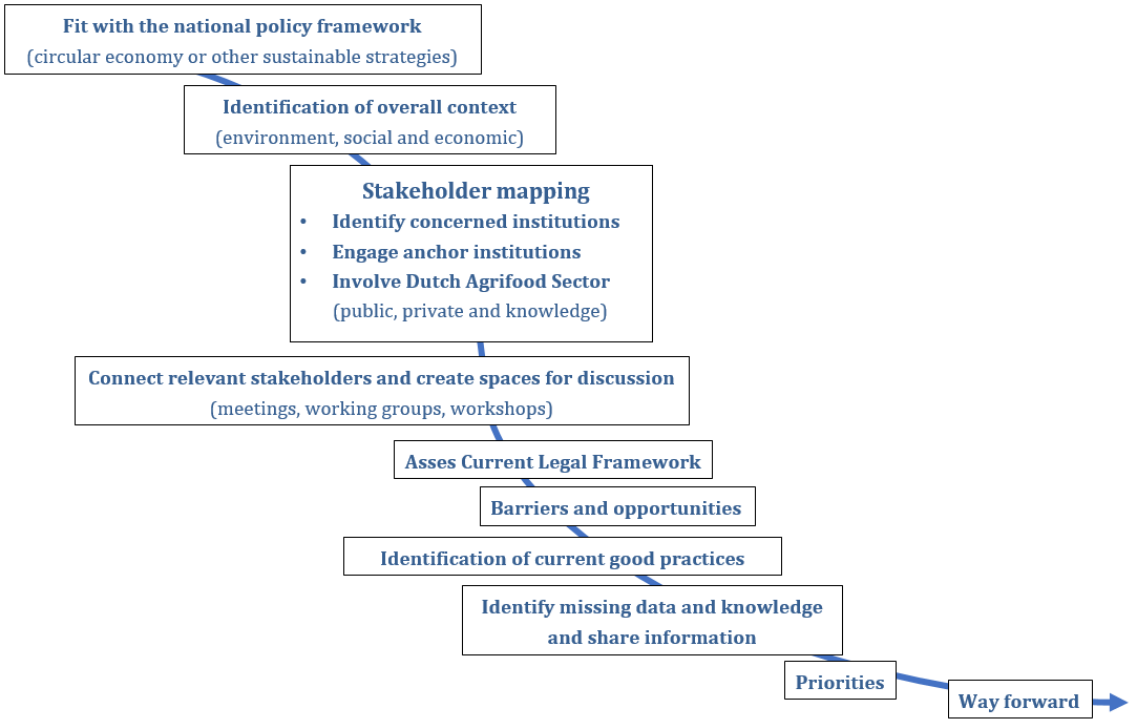


Figure 7. Possible steps to boost circular agriculture

In the Workshop (and its preparation) reported here, WUR went through the steps 1 - 4 and part of step 5, which proves that the approach was suitable to boost circularity in the agricultural sector in Colombia. Step 6 requires a next step to be taken, preferably by all involved.

7. References

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8. Annex

8.1. List of relevant stakeholders identified (institutional level)

A preliminary assessment of the relevant stakeholders to be considered on a circular agriculture strategy in Colombia is found below. The list is based in the institutions involved in the workshop co-organised by the project in December 2019, called "Towards a strategy for water management in circular agriculture".

Institution	*Type*	*Topic*
Ministry of Environment	National government	Responsible of the Circular Economy Strategy
Ministry of Agriculture	National government	Responsible for water demand (modules)
Ministry of Housing	National government	Responsible for urban wastewater
IDEAM - Institute of Hydrology, Meteorology and Environmental Studies	National government	National Water Assessment (ENA)
UPRA - Unit of rural and livestock planning	National government	Livestock planning
Instituto Alexander Von Humboldt	National government	Research on Biodiversity and environmental services
DNP - National Planning Department	National government	Develop the strategic vision in social, economic and environment
CAR - Corporación Autónoma Regional de Cundinamarca	Regional government	Regional management of environment and natural resources
CAM - Corporacion Autonoma Regional del Alto Magdalena	Regional government	Regional management of environment and natural resources
CVC - Corporación Autónoma Regional del Valle del Cauca	Regional government	Regional management of environment and natural resources
CORPAMAG - Corpoación Autónoma Regional del Magdalena	Regional government	Regional management of environment and natural resources
CORPOURABA - Corporación para el Desarrollo Sostenible del Urabá	Regional government	Regional management of environment and natural resources
CORPONOR - Corporación autónoma regional de la Frontera Nororiental	Regional government	Regional management of environment and natural resources
CORMACARENA - Corporación para el Desarrollo Sostenible de la Macarena	Regional government	Regional policy implementation and management for environment and natural resources
Federacion Nacional de cafeteros	Nat. Association	Farmer association of coffee
Asocaña	Nat. Association	Farmer association of sugarcane
Fedepalma	Nat. Association	Farmer association of oil palm
Augura	Nat. Association	Farmer association of banana
Fenalce	Nat. Association	Farmer association of cereals
Fedearroz	Nat. Association	Farmer association of rice
Fedepapa	Nat. Association	Farmer association of potatoes
Asocolflores	Nat. Association	Farmer association of flowers
ANDI - CNA (centro nacional del agua)	Nat. Association	National business association (national water center)
UNIANDES	Research/Education	Sustainable Industrial production
Agrosavia	Research/Education	Crop production
Univalle - Instituto CINARA	Research/Education	Wastewater treatment
CATIE - Centro Agronómico Tropical de Investigación y Enseñanza	International Research/Education	Tropical Agriculture
Solidaridad	NGO	Social and Environment
WWF	NGO	Environment
Daabon	Company	Palm production
Ecopetrol	Company	Oil extraction
The Coffee Quest	Company	Coffee production
Manuelita	Company	Palm production
Embassy of the Kingdom of the Netherlands in Bogota	Representative of the NL	Circular agriculture
Inspiragua/Dutch Water Authorities	Dutch Water boards	Water management
Dutch Delta Team	Dutch Top sector	Water management
WUR	Dutch Research/Education	Integrated water management and circularity

8.2. Agenda of the workshop

More detailed information about the results of workshop, including the presentations developed by the speakers could be found in the following link:

http://www.redescar.org/noticias/agua-para-una-agricultura-circular

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"Hacia una Gestión Integral del Agua para una Agricultura Circular"

Contexto

El tradicional "enfoque lineal" de la agricultura (es decir, extracción de recursos, uso y disposición de residuos) a menudo genera una alta presión sobre los recursos hídricos aguas abajo, tanto en términos de calidad como de cantidad. El agua contaminada de los ríos es tradicionalmente (re)utilizada por agricultores locales ubicados aguas abajo en la cuenca para regar productos agrícolas para la producción de alimentos. Esto conlleva un riesgo potencial (para la salud) para la cadena de alimentos. Si se pueden aplicar los principios de agricultura circular, se logrará una producción segura de alimentos al tiempo que se limitan los insumos necesarios (por ejemplo, agua, nutrientes, biomasa, energía). Esto conducirá a una simbiosis mejorada entre la agricultura y la naturaleza.

Colombia lidera el desarrollo sostenible en América Latina, desempeñando un papel importante para la adopción de la Agenda 2030 de las Naciones Unidas para el Desarrollo Sostenible. Lanzada en 2018, la Estrategia Nacional de Economía Circular de Colombia -ENEC- puso al país en el centro de atención del desarrollo sostenible. Esta estrategia, basada en la innovación, la información y el conocimiento, la tecnología, el ecodiseño y la simbiosis industrial, entre otros elementos, busca fortalecer el modelo de desarrollo económico, ambiental y social del país. La estrategia identifica y prioriza metas, indicadores y acciones que se llevarán a cabo para lograr la transformación de los actuales modelos de producción y consumo hacia la economía circular. Para ello, se enfatizan 6 líneas de acción, referidas a los ciclos más relevantes:

1. Flujo de materiales industriales y productos de uso masivo.
2. Flujo de materiales de envases y empaques.
3. Flujo de biomasa.
4. Flujo de agua.
5. Fuentes y aprovechamiento de energía.
6. Flujo de materiales de construcción.

Para desarrollar aún más la estrategia, el Ministerio de Ambiente y Desarrollo Sostenible (Minambiente) ha venido organizando Talleres Regionales de difusión de la ENEC y Jornadas Sectoriales de Economía Circular con el objetivo de dar a conocer la Estrategia e involucrar a los diversos actores público-privados involucrados en su implementación. En este contexto, el Minambiente organizó en agosto de 2019, la 1era Jornada de Economía Circular del Sector Agropecuario, donde se identificaron las oportunidades y barreras más relevantes desde la perspectiva de biomasa y energía, agua, y envases y empaques.

Objetivo

El objetivo de este taller es identificar los elementos más importantes de la ENEC para la gestión del agua en la agricultura circular, en entornos urbanos y rurales en Colombia.

Resultados esperados del taller

El taller dará como resultado:

- un informe de avance del taller que identifique:
  - Similitudes y diferencias entre la agricultura circular en Colombia y los Países Bajos.
  - Visibilización de buenas prácticas en Colombia

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- Oportunidades: áreas potenciales para el desarrollo de pilotos, en varias escalas, sectores y cadenas de valor
- Actores dispuestos a participar en los potenciales proyectos o pilotos.
- Programas de inversión hacia una "agricultura circular" y posibles mecanismos de financiación y medidas para alcanzarlos.
- Hoja de ruta (follow-up y responsables) a corto, medio y largo plazo

Agenda

Fecha: 3 y 4 de diciembre, 2019
Ubicación: UNIANDES, Bogotá.
3 de diciembre SD 704
4 de diciembre SD 714
Organizadores:
Ministerio de Medio Ambiente y Desarrollo Sostenible, Universidad de los Andes, Wageningen Environmental Research, Embajada de Holanda, CATIE y Agrosavia.

Programa

Hora	Día 1 – Sesión de apertura	Encargado
08.00	Registro. Día 1	
08.30	Palabras de apertura	Embajada de Los Países Bajos – Patricia de Vries UNIANDES Minambiente
08.50	Contexto y Propósito del Taller	Angel de Miguel (WUR)
09.00	Economía Circular en Colombia con énfasis en agua y agricultura	Silvia Juliana Vargas (Minambiente)
09:30	Política y estrategia de Agricultura Circular en los Países Bajos	Embajada de Los Países Bajos
09.50	Refrigerio	
10.10	Bloque 1: Gestión integral del Agua en Colombia • Perspectiva nacional del uso del agua en la agricultura. Análisis comparativo entre Estudio Nacional del Agua 2018 y Cuentas del Agua DANE. • Avances de proceso de determinación de módulos de consumo de agua agrícola	Diego Arevalo (ENA2018) y Diego Cobaleda (DANE) Minambiente (GIRH)
11.30	Bloque 2: La gestión del agua en la cuenca del río Bogotá • Gestión del agua en cuenca del río Bogotá • Impacto de la reutilización de aguas en el contexto de la agricultura circular en Bogotá • Floricultura de la sabana de Bogotá y su relación con la gestión del agua.	CAR Andrea Costanza (Agrosavia) Ximena Franco (Asocolflores)
12.30	Almuerzo	
14.00	Grupos de trabajo "identificación de temas y áreas prioritarias": • Identificación de zonas prioritarias, cultivos y oportunidades en términos de cantidad de agua • Identificación de zonas prioritarias, cultivos y oportunidades en términos de calidad de agua • Retos para superar la brecha de información y conocimiento	Todos (3 grupos)
15.40	Conclusiones y Recomendaciones	Diego Arevalo

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Hora	Día 2 – Hacia la circularidad: ejemplos y acciones futuras	Encargado
08.00	Registro. Día 2	
08.10	Las Autoridades Holandesas del Agua y su cooperación con Colombia (DWA)	Louis Bijlmakers (InspirAgua)
08.30	Una experiencia Eco Circular, el caso de Turrialba, Costa Rica	CATIE - Dra. Leida Mercado
09.00	Bloque 3: reúso de agua • Tecnologías apropiadas para la circularidad • Propuesta de modificación de resolución 1207/2014 de reúso de agua residuales tratadas. • Reúso de aguas de producción tratadas para la agricultura	Arjan Budding (WUR) Minambiente Ecopetrol - Agrosavia
10.10	Refrigerio	
10.30	RedES-CAR (UNIANDES): hacia la seguridad hídrica en el sector privado.	Alejandro Medina (UNIANDES)
10.50	Bloque 4: hacia la circularidad en el sector privado • Gestión del Agua en el sector del aceite de Palma (Cuenca del Magdalena) • Experiencia de circularidad Fedepalma – Asocaña • Experiencia de circularidad Sector Cafetero	Felipe Guerrero (Daabon) Fedepalma – Asocaña Ronald de Hommel (The Coffee Quest)
12.00	Almuerzo	
13.30	Grupos de trabajo "Instrumentos de la agricultura circular para el desarrollo de acciones futuras prometedoras": • Oportunidades normativas • Instrumentos Financieros e Incentivos • Tecnologías aplicadas a la circularidad	Todos (3 grupos)
15.10	Refrigerio	
15.30	Taller de plataformas colaborativas	Minambiente
16.30	Conclusiones y Recomendaciones	
17.00	Cierre por T.b.n.	

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