

Improving Agricultural Productivity in Burkina Faso

Policies, practices and pathways for the reuse of sanitation by-products



FOREWORD

Burkina Faso faces major challenges related to access to water, sanitation and hygiene (WaSH), soil degradation and food insecurity. Yet, it is also home to several pioneering initiatives that demonstrate how excreta and wastewater can be safely reused in agriculture, strengthening both health and agricultural productivity. This report gives an overview of the soil fertility and sanitation challenges in Burkina, examines how the current institutional and regulatory framework address reuse of sanitation by-products, and summarizes findings from research and implementation to date.

A sister report, [Reducing Zoonosis Risks in Burkina Faso](#), studies how the risk of zoonotic diseases can be integrated into WaSH interventions, including to what extent legislation related to WaSH in Burkina Faso address the risks of diseases and infections being transmitted from animals to humans. Both reports are published by the SIANI expert group on WaSH and One Health in Burkina Faso.

The report *Improving Agricultural Productivity in Burkina Faso* is written by Momini MOYENGA and Dr Nongma ZONGO at the institute of Environmental and Agricultural Research of Burkina Faso (INERA), Marc K. YAMEOGO at WaterAid Burkina Faso and Linus DAGERSKOG at Stockholm Environment Institute (SEI).

EXECUTIVE SUMMARY

Access to safe drinking water, hygiene and sanitation (WaSH) remains a major challenge in Burkina Faso, particularly in rural areas, despite the efforts of public authorities and development partners. At the same time, nearly 31% of arable land is affected by severe degradation, driven by erosion, declining organic matter content, and intensive land use without sufficient organic and mineral amendments.

Recovering nutrients, organic matter and water from excreta, wastewater and other organic wastes represents an important complement to mineral inputs. Estimates suggest that plant nutrients found in human excreta in Burkina Faso is equivalent to 15 kg of chemical fertiliser per person per year, representing a total annual value of approximately 100–221 billion CFA francs for the entire population, depending on fertilizer prices.

This report, produced under the “One Health Approach to WaSH in Burkina Faso” project supported by SIANI, reviews how WaSH and agricultural policies, legal frameworks and programmes address the reuse of sanitation by-products, and presents important results from research and practical experiences with reuse in Burkina Faso.

The review of Burkina Faso’s policy, legal and institutional frameworks shows both strengths and weaknesses. The National Programme for the Sanitation of Wastewater and Excreta (PN-AEUE) aims for universal sanitation coverage by 2030 and explicitly includes “optimising the management and recovery of wastewater and faecal sludge”. A recent decree on autonomous sanitation regulates the entire on-site sanitation chain, from containment to reuse. However, detailed implementing regulations are still missing, and agricultural policies and fertiliser programmes continue to focus mainly on mineral fertilisers, with little explicit recognition of sanitation by-products as legitimate inputs.

On the practice side, Burkina Faso has more than two decades of experience with ecological sanitation (Ecosan). At least 13,800 urine-diverting dry toilets, known as Ecosan toilets in Burkina Faso, have been built since 2002 through 33 projects across the country. Trials with hygienised urine and faeces show that they can match or exceed mineral fertilisers in terms of crop yields. More recent work on the development of the “Clean and Green” framework illustrates how rural sanitation programmes can go beyond open defecation free (ODF) status to systematically manage health risks (Clean track) and recover resources for agriculture (Green track). Other initiatives in Burkina Faso – including composting and digestion of sludge and slaughterhouse waste, the national biogas programme and biochar research – further demonstrate the potential of reuse and the multiple options available.

Despite these promising experiences, reuse remains far from mainstream, especially for sanitation by-products. Key constraints include:

- limited treatment infrastructure and high costs for sanitation facilities;
- weak integration of reuse in agricultural policies, extension and input programmes;
- a lack of standards, certification and quality control for organic fertilisers;
- insufficient funding, technical follow-up and documentation of experiences;
- low awareness and limited practical guidance for farmers and local actors.

To strengthen the recovery of excreta in agriculture and enhance the sustainability of interventions, the report recommends action in five strategic areas:

1. Policy, regulations and guidance

- Fully implement the PN-AEUE, especially its objective on optimising resource valorisation.
- Develop ministerial orders (arrêtés) to operationalise the decree on autonomous sanitation, including treatment standards, certification systems and safety guidelines.
- Update agricultural policies and fertiliser programmes to recognise sanitation by-products as legitimate inputs and integrate them into extension and support schemes.
- Develop joint technical guidelines for safe and effective agronomic use of sanitation-derived fertilisers.
- Define a national vision and roadmap for safe reuse of sanitation by-products and other organic wastes
- Differentiate strategies for rural and urban areas: support short local loops in rural settings; enable regulated reuse value chains in urban contexts.

2. Awareness and capacity building

- Train WaSH actors, extension agents and agricultural professionals in safe management of sanitation by-products along the sanitation chain, including field application.
- Use farmer field schools, demonstration plots and practical guides to build farmers' skills and confidence in safe reuse.
- Conduct community-level campaigns to raise awareness of the agronomic, environmental and health benefits of safe reuse.

3. Research and innovation

- Support further applied reuse-related research on agronomic performance, environmental impacts and health risks under Burkina Faso's soil and farming conditions.
- Encourage innovation in context-adapted infrastructure and treatment options that reduce costs.

4. Finance and incentives

- Mobilise dedicated financing for sanitation infrastructure that enables safe resource recovery.
- Provide targeted incentives for farmers, cooperatives and entrepreneurs engaged in reuse.
- Explore the possibility to align resource recovery initiatives with climate, land restoration, and food security funding streams.

5. Partnerships and coordination

- Strengthen coordination between WaSH and agricultural institutions at national and local levels.
- Foster partnerships among government, civil society, research institutions and the private sector to scale up successful pilots.
- Further explore integrated community approaches, such as *Clean and Green*, that can be used to scale up productive sanitation in rural areas.

Excreta and organic waste recovery represents a strategic opportunity for Burkina Faso, with the potential to contribute simultaneously to soil restoration, food security, public health and environmental protection. Realising this potential will require an integrated, multisectoral effort that stimulates and aligns the "resource supply" role of sanitation with the "resource demand" of farming systems in both rural and urban contexts.

ACRONYMS AND ABBREVIATIONS

Acronyms and abbreviations	Meaning
ASPHF	Agro- Sylvo-Pastoral, Fisheries and Wildlife
CES/DRS	Water and Soil Conservation/Soil Protection and Restoration
CLTS	Community-Led Total Sanitation
CNT	National Transitional Council
CREPA	Regional Center for Drinking Water and Sanitation
C&G	Clean and Green framework
C/N	Carbon to Nitrogen Ratio
EAA	Water and Sanitation for Africa
ECOSAN	Ecological Sanitation
ESI (NIES)	Environmental and Social Impact Notice/ Notice d'Impact Environnemental et Social
ESIS (EIES)	Environmental and Social Impact Study/Etude d'Impact Environnemental et Social
EU	European Union
FAOSTAT	Food and Agriculture Organization of the United Nations statistics
FRSIT	National Forum for Scientific Research and Technological Innovation
INERA	Institute for Environmental and Agricultural Research
INSD	National Institute of Statistics and Demography
LORP	Orientation Law Relating to Pastoralism
MAHRASA	Ministry of Agriculture, Hydraulics, Animal Resources and Food Security
MAHRH	Ministry of Agriculture, Hydraulics and Fisheries Resources
MATD	Ministry of Territorial Administration and Decentralization
MEA	Ministry of Water and Sanitation
MEAHA	Ministry of Agriculture and Hydro-agricultural Development
MEE	Ministry of Water and Environment
MEEA	Ministry of the Environment, Water and Sanitation
MEF	Ministry of Economy and Finance
MUAFH	Ministry of Urban Planning, Land Affairs and Housing
NGO	Non-Governmental Organization
ODF	Open Defecation Free
PAGIFS	National Plan for Integrated Soil Fertility Management
PHA	Promotion of Hygiene and Sanitation
PHA-3R	Project for the Promotion of Hygiene and Sanitation in the South-Central, North-Central and North Regions of Burkina Faso
PN-AEP	National Drinking Water Supply Programme

PN-AEUE	National Programme for the Sanitation of Wastewater and Excreta
PN-AH	National Hydraulic Development Programme
PN-GIRE	National Programme for Integrated Water Resources Management
PNB-BF	National Biodigesters Programme of Burkina Faso
PNDD	National Sustainable Development Policy
PNDES	National Economic and Social Development Plan
PNE	National Water Policy
PNHP	National Public Hygiene Policy
PS EEA	Environment, Water and Sanitation Sector Policy
PSNA	National Sanitation Policy and Strategy
RND	National Development Framework
SEA (EES)	Strategic Environmental Assessment/Évaluation Environnementale Stratégique
SDDEP	Stormwater Drainage Master Plan
SDGs	Sustainable Development Goals
SDGDU	Urban Waste Management Master Plan
SDR	Rural Development Strategy
SEI	Stockholm Environment Institute
SMS	Safely Managed Sanitation
SNE	National Water Strategy
SNGIFS	National Strategy for Integrated Soil Fertility Management
SNRCRS	National Strategy for Soil Restoration, Conservation and Recovery
SNSA	National Food Security Strategy
SuSanA	Sustainable Sanitation Alliance
SSP	Steering and Support Programme
UNDESA	United Nations Department of Economic and Social Affairs
WaSH	Water Sanitation and Hygiene
WHO	World Health Organization

Table of Contents

EXECUTIVE SUMMARY	i
ACRONYMS AND ABBREVIATIONS	iv
LIST OF TABLES	viii
LIST OF FIGURES	ix
INTRODUCTION	1
Objectives	1
Methods	2
CHAPTER 1: SOIL FERTILITY CHALLENGES AND THE IMPORTANCE OF RECYCLING IN BURKINA FASO	3
1. 1. State and causes of tropical soil degradation	3
1. 2. Balances of mineral and organic elements in agricultural systems	3
1. 3. Relationship between mineral balances, agricultural productivity and food requirements	4
1. 4. Food transfers and nutrient flows in urban consumption centres	7
1.5. Agricultural intensification: use of organic matter, mineral fertilisers, new crop varieties and local knowledge.	8
1.6. Nutrient loss management (circular economy): Composting, production of biochar, organic, mineral and chemical amendments	9
1.7. Strategies and policies implemented for increasing agricultural production and sustainable soil/land management	10
1.8. Conclusion of Chapter 1	13
CHAPTER 2: POLICIES, POTENTIALS AND PRACTICES FOR EXCRETA, WASTEWATER AND DOMESTIC ORGANIC WASTE REUSE IN BURKINA FASO	14
2.1 Wastewater and excreta – policy, legal and institutional frameworks	14
2.1.1 Policies	14
2.1.2. Legal frameworks	16
2.1.3. Institutional aspects	16
2.1.4. National Programmes	17
2.2. Solid Waste – policies and legal framework	18
2.2.1. Policies	18
2.2.2. Legal and regulatory framework	18
2.3. Sanitation by-products in agricultural policies and legal frameworks	19
2.4. Assessments of available resources in human excreta	20
2.4.1. Content and fertilising value of human excreta and wastewater	20
2.4.2. Monetary values of nutrients available in human excreta	22
2.4.3. Agronomic performance of human excreta and wastewater	23
2.5. Experiences in the recovery and reuse of human excreta in Burkina Faso: ecological sanitation (Ecosan)	25
2.5.1 History of Ecosan in Burkina Faso	25
2.5.2 Lessons learned and recommendations to strengthen the sustainability of Ecosan interventions in Burkina Faso	28
2.5.3 Testimonies collected from Ecosan stakeholders	30
2.6. Recent development – the “Clean and Green” (C&G) framework	32
2.7 Experiences in Burkina Faso of other options for human excreta reuse	36
2.7.1. Composting	36
2.7.2. Biogas	36

2.5.5. Biochar	39
2. 8. Conclusion of chapter 2	39
CHAPTER 3: PATHWAYS TO MAINSTREAMING RESOURCE REUSE	40
3.1 Introduction	40
3.2. WaSH and agricultural sector perspectives on resource reuse	40
3.3 Rural and urban resource recovery and reuse loops	41
3.4 Insights from stakeholder consultation	41
3.5 Recommendations	42
BIBLIOGRAPHIC REFERENCES	44

LIST OF TABLES

Table 1: Quantities of cereals (wheat, rice, maize, millet and sorghum) in thousands of tons imported into Burkina Faso from 2010 to 2021-----	5
Table 2: Summary of texts and laws on the management of household solid waste in Burkina Faso -----	18
Table 3: Mineral element contents (g/l) and pH values of human urine -----	21
Table 4: Comparative analysis of ECOSAN feces with usual manures-----	21
Table 5: Heavy metal concentrations in human feces, urine and other products ($\mu\text{g/l}$ or $\mu\text{g/kg}$)-----	222
Table 6: Overview of ECOSAN projects identified in Burkina Faso between 2002-2024.-----	26
Table 7: Three studies and one learning event that informed the ECOSAN recommendations proposed in Dagerskog et al. (2020).-----	28
Table 8: Reports on Clean and productive village (VPP) in French-----	35

LIST OF FIGURES

Figure 1: Evolution of cereal production (rice, sorghum, maize and millet) in thousands of tones in Burkina Faso from 2010 to 2021. Source: FAOSTAT. -----	5
Figure 2: Food availability in quantity of cereals (kg / person / year) 2010 to 2021 (blé = wheat; riz = rice; mais = maize; mil = millet; sorgho = sorghum; somme = sum) (Source: FAOSTAT) -----	5
Figure 3: Evolution of the number (in millions) of undernourished people in Burkina Faso from 2000 to 2022. -----	6
Figure 4: Evolution of the prevalence of moderate or severe food insecurity in Burkina Faso by gender (hommes=men; femmes=women) during the period from 2014 to 2022. (Source: FAOSTAT)-----	7
Figure 5: Composting organic waste using a box or bin, alternating layers of manure and carbon rich material.-----	9
Figure 6: Quantities and types of fertilisers imported by Burkina Faso from 2002 to 2021 -----	12
Figure 7: Value of mineral fertiliser imports in thousands of US dollars by Burkina Faso from 2002 to 2021. Source: FAOSTAT -----	12
Figure 9: Participatory trials on lettuce with vegetable farmers in Ouagadougou (Ecosan_EU 1 project 2006-2009) evaluating the effect of hygienised human urine compared to urea (photos Moussa Bonzi) -----	24
Figure 10: Participatory trials on zucchini with vegetable farmers in Ouagadougou (Ecosan_EU 1 project 2006-2009), evaluating the effect of hygienised human urine compared to urea (photos Moussa Bonzi) -----	24
Figure 11: Effect of the contributions of hygienised urine and urea on corn production without (left photo) or with soil/water conservation measures (Zaï pits in this case) (right photo) (photos Moussa Bonzi). -----	25
Figure 12: Geographic location and indicative size of the projects listed in Table 6 -----	27
Figure 13: Mr Kourago Adama’s son shows the Ecosan latrine, with urine piped to a jerry can at the back (photo to the right) -----	32
Figure 14: Overview of the C&G framework. -----	33
Figure 15: The three regions of the PHA-3R programme, including the three VPP pilot villages -----	34
Figure 16: Dolomite-enriched compost pile (left) and a compost drying bed (right) -----	38

INTRODUCTION

Access to water, hygiene, and sanitation (WaSH) remains a serious problem in sub-Saharan Africa, especially in rural areas. This is not least true in Burkina Faso, despite the efforts by public authorities, technical, and financial partners to achieve the goal of 100% WaSH coverage by 2030, as set out in the National Wastewater and Excreta Sanitation Programme (PN-AEUE) for the period 2016–2030.

Better access to water, sanitation and hygiene would not just strengthen human health but could improve the living conditions of rural populations more broadly. Two important aspects to consider beyond conventional sanitation and hygiene services are (i) how to address health risks linked to the omnipresence of animals (including zoonoses where infections are transmitted from animals to humans) and, (ii) how to manage wastewater, excreta and other organic waste so that it can be used as a resource and increase agricultural production.

Recovering and reusing resources from wastewater, excreta and other organic waste in agricultural production is not a new idea. What is new is the availability of technologies and guidelines (e.g. WHO 2006) that make recovery safer, more efficient and economically attractive. When carried out in close collaboration with agricultural stakeholders, WaSH interventions can play a key role in closing resource loops – improving agricultural production and sustainability while protecting soils and water bodies.

This report explores how such synergies between sanitation and agriculture can be strengthened in Burkina Faso. It is structured in three chapters. The first chapter describes tropical soils, agricultural production systems, and the challenges of soil fertility and resource flows. The second chapter addresses excreta, wastewater and domestic waste management in Burkina Faso and provides an overview of current policies, regulations and state of implementation of WaSH and reuse. The third chapter makes recommendations for advancing the reuse agenda from WaSH and agricultural sector perspectives.

Objectives

This study aims to:

- Review Burkina Faso's existing political, legal, institutional, and programmatic frameworks for management of excreta and domestic waste, in both the WaSH and agricultural sectors.
- Document past experiences of research and implementation aimed at the recovery and reuse of human and animal excreta and organic waste
- Identify the constraints and needs of implementers and authorities to adopt more integrated interventions.

Methods

The report builds on a review and analysis of existing political, legal, institutional, and programmatic frameworks for management of excreta and domestic waste in the WaSH and agricultural sectors in Burkina Faso. Furthermore, a mapping of implemented projects related to the reuse of human and animal excreta in agriculture was carried out, building on and complementing previous studies. Some projects are described more in-depth and the experiences of people involved have been captured through five key informant interviews and at a stakeholder workshop.

CHAPTER 1: SOIL FERTILITY CHALLENGES AND THE IMPORTANCE OF RECYCLING IN BURKINA FASO

1.1. State and causes of tropical soil degradation

Land degradation is a serious and growing problem in Burkina Faso. A study by Maatman et al. (1998) indicated that approximately 24% of the country's arable land was degraded, and 20 years later another study put that number at 31% (MAARH, 2018). Soil degradation exacerbates the lack of arable land and makes it difficult to increase agricultural production and achieve food self-sufficiency.

Roose (1981) and Thiombiano (2000) show that land degradation processes result from a decline in the soil's vegetation cover, which makes the soil more exposed to intense rain, water runoff, and wind. The reduction in plant cover reduces the renewal of organic matter in the soil, causing permanent decline in soil fertility. There are several drivers behind Burkina Faso's accelerating land degradation including climate change and increasing human pressure on natural resources through practices like excessive land clearing, logging and continuous cultivation. The situation is further exacerbated by the country's rapidly increasing demography with an annual growth rate of 2.6%, corresponding to more than 600,000 people/year (UNDESA, 2022). This pressure on natural resources affects vegetation, water regimes (irregularities and poor spatio-temporal distribution of rainfall quantities, rainfall with high kinetic energy) and the physical state of the soil (water and wind erosion).

Burkina Faso's soils are marked by reduced fertility and low organic matter content, causing poor structural stability and low water retention capacity. One-third (36%) of the soils are tropical ferruginous soils with high levels of silts and fine sands and low organic matter content (3% under vegetation which under cultivation decreases sharply to 0.7%). In these soils, crusts are frequently formed, limiting water infiltration.

1.2. Balances of mineral and organic elements in agricultural systems

The problem is compounded by the common practice of exploiting the soil without adding fertilisers or amendments. The result is a rapid decline in the levels of chemical elements, especially nitrogen (N) and phosphorus (P), the two main limiting factors of production in Sub-Saharan Africa.

To maintain a balance of soil nutrients despite harvests of cultivated plants and losses from erosion, leaching and volatilization, the land will require regular inputs of nutrients from both organic and external sources. Furthermore, it is advisable to make organic restitutions to compensate for the loss by mineralisation of the organic matter of the soil which is rapidly depleted with cultivation.

Yet despite inputs of fertilisers, amendments, and symbiotic fixation, Sub-Saharan soils under cultivation usually present a negative nutrient balance. For example, the average

annual potassium balance indicates a deficit of 30 kg K₂O/ha/year in cotton cultivation; deficits of calcium and magnesium are also causes for concern though not of the same magnitude (Crétenet and Gourlt, 2016). In a review of the literature on nutrient balances in agricultural systems in Africa, Cobo et al. (2010) found that more than 75% of studies confirmed a negative trend in nitrogen and potassium balance, while 56% reported negative phosphorus balances.

In Burkina Faso, Bationo et al. (1998) estimated that on the 6.7 million hectares cultivated, the yearly losses in mineral elements were 95,000 tons of nitrogen, 28,000 tons of P₂O₅ and 79,000 tons of K₂O – equivalent to approximately 159 million US dollars in fertiliser value each year. These persistent deficits underline the urgency of improving nutrient management and recycling practices to sustain soil fertility.

1. 3. Relationship between mineral balances, agricultural productivity and food requirements

Soil nutrient deficiencies represent a major constraint to agricultural productivity in sub-Saharan Africa posing a potential threat to food security and agricultural sustainability while increasing the need for food imports.

Developing an effective plant nutrition policy requires:

- Assessment of local needs for fertilisers, including how plant nutrients can be sourced and combined:
- Local production and/or imports of fertilisers and raw materials.
- Provision of nutrient inputs at affordable prices relative to crop value;
- Efficient fertiliser distribution, marketing and credit facilities;
- Strong extension services and research (access to technology and knowledge)
- Supportive legislation

Currently, the use of mineral fertilisers varies considerably across regions in Burkina Faso, depending on crop type and production system. The highest application rates – often exceeding 110 kg N/ha – are found in favorable agro-climatic zones with good rainfall, particularly for cash crops such as cotton grown in rotation with cereals (maize) and in irrigated and lowland areas devoted to market gardening and rice cultivation. These areas face fewer constraints related to distribution, credit and market access and non-agricultural incomes also tend to be higher.

The positive effect of mineral fertilisers on crop yields is more evident when they are combined with organic manure (Alley and Vanlauwe, 2009; Vanlauwe and Dobermann, 2020). However, this practice is constrained by the limited supply of organic manure and the relatively high cost and low availability of mineral fertilisers.

Cereal production – comprising rice, maize, sorghum and millet – which form the dietary basis of the Burkinabe population, has remained relatively stable over the past years despite numerous government and donor-supported interventions such as input subsidies, equipment distribution and agricultural development programmes (Figure 1).

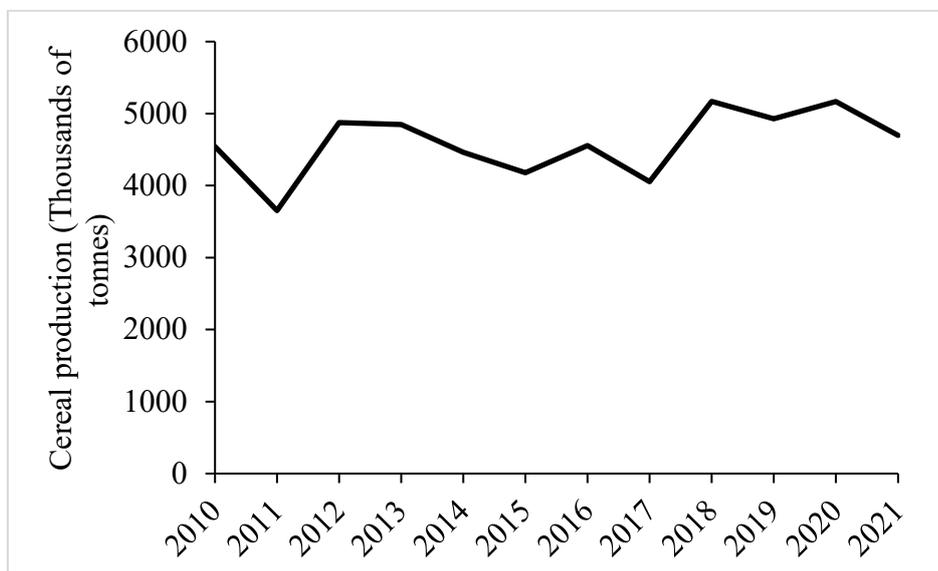


Figure 1: Evolution of cereal production (rice, sorghum, maize and millet) in thousands of tones in Burkina Faso from 2010 to 2021. Source: FAOSTAT.

Cereal imports have more than doubled in the period since 2010 (Table 1) contributing to overall cereal availability, which fluctuated between 191 and 224 kg per person per year with the lowest levels in the period 2019 – 2021 (Figure 2).

Table 1: Quantities of cereals (wheat, rice, maize, millet) in thousands of tons imported into Burkina Faso from 2010 to 2021 (Source: FAOSTAT)

Year	Grain imports in thousands of tones				Sum
	Wheat	Rice	Maiz e	Millet	
2010	179	371	1	0	551
2011	148	477	4	0	629
2012	200	641	9	0	850
2013	194	710	3	0	907
2014	191	583	5	0	779
2015	227	604	5	0	836
2016	264	777	3	0	1044
2017	292	699	5	0	996
2018	298	991	3	0	1292
2019	253	826	6	0	1085
2020	301	656	10	3	970

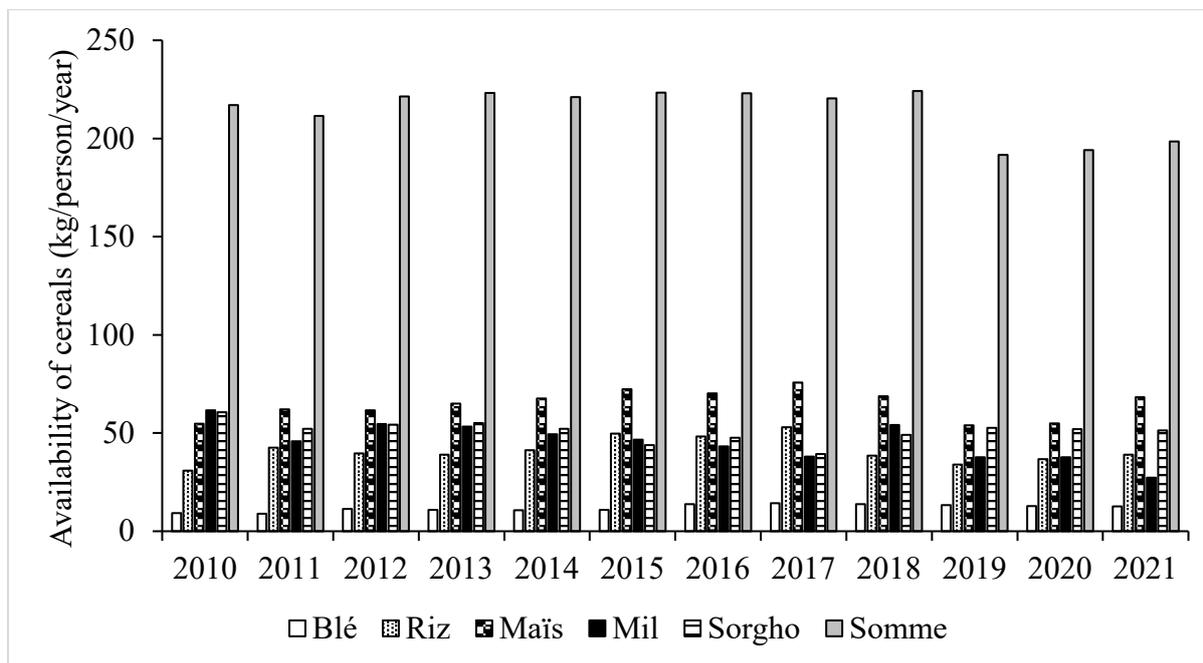


Figure 2: Food availability in quantity of cereals (kg / person / year) 2010 to 2021 (blé = wheat; riz = rice; maïs = maize; mil = millet; sorgho = sorghum; somme = sum) (Source: FAOSTAT)

However, as is shown in Figure 3, the years 2013–2022 have been marked by an increase in the number of people in a state of undernourishment and food shortages are recurring.

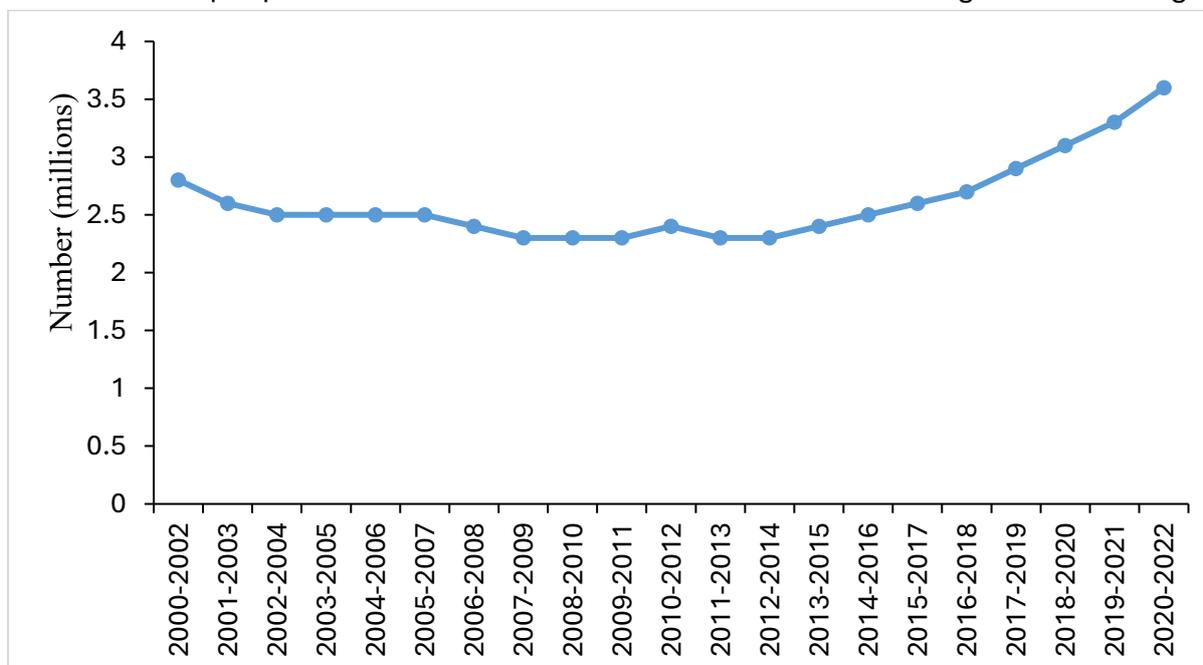


Figure 3: Evolution of the number (in millions) of undernourished people in Burkina Faso from 2000 to 2022. (Source: FAOSTAT)

This is explained by regional disparities in cereal production and the increased impact of climatic hazards on agriculture, especially in vulnerable regions. Between 2017 and 2021, the proportion of individuals consuming less food than is necessary for a normal, active, and healthy life rose significantly, reaching up to 60% among men (Figure 4).

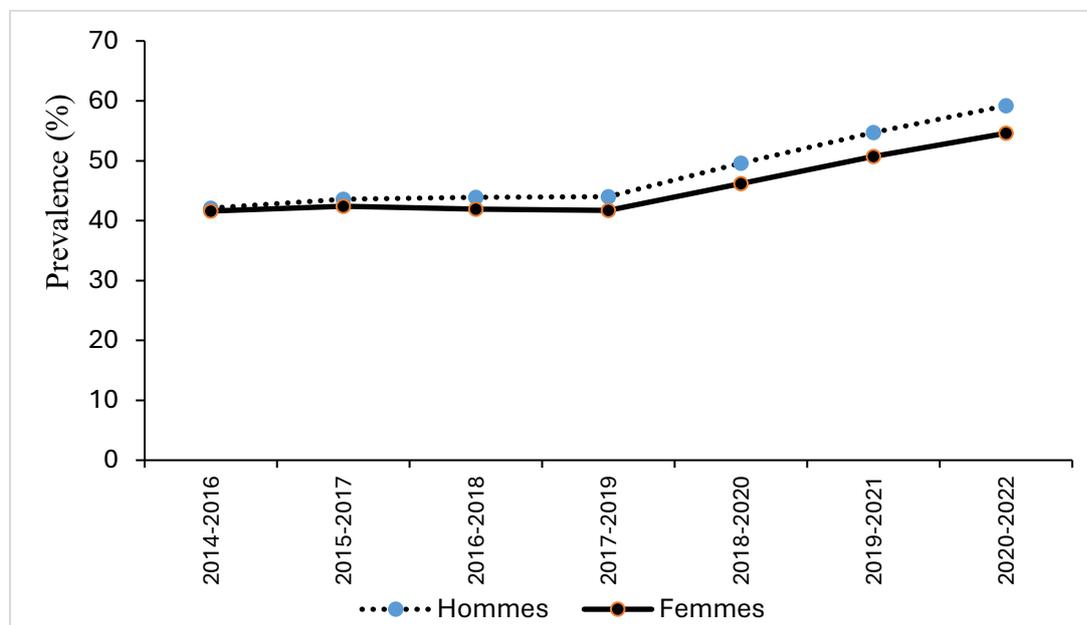


Figure 4: Evolution of the prevalence of moderate or severe food insecurity in Burkina Faso by gender (hommes=men; femmes=women) during the period from 2014 to 2022. (Source: FAOSTAT)

1. 4. Food transfers and nutrient flows in urban consumption centres

Urban food flows play a central role in linking rural production systems with urban consumption centers across sub-Saharan Africa. Karg et al. (2016) assessed food flows in Ouagadougou (Burkina Faso) and Tamalé (Ghana) and found that the main cereal-supplying areas for Ouagadougou – particularly maize and millet are located around Bobo-Dioulasso and Léo with additional supplies from Pouytenga and Fada N'gourma. The cereals found in the city of Ouagadougou thus originate from areas 200 to 600 km away. For maize, the daily quantities entering the city of Ouagadougou are estimated at 400 tonnes during the lean season and 804 tonnes during peak production periods. Rice is imported and comes from Asian countries. Approximately 435 to 572 tonnes of rice enter Ouagadougou per day. Millet quantities are estimated at between 150 and 165 tons per day, while sorghum quantities are between 24 and 100 tonnes per day.

In a subsequent study, Karg et al. (2018) examined the nutrient dimension of these food flows. They found that 40% of the nitrogen in the most common foods entering Ouagadougou originates from other countries and that cereals account for 50–60% of the inflows of nitrogen, phosphorus, and potassium. However, they estimated that only about 7% of the nutrients are returned to agricultural systems – the remainder is lost to the environment after consumption.

Urban centres such as Ouagadougou therefore function as major nutrient sinks, that remain largely untapped. A sustainable transformation of food and agricultural systems and urban should consider the possibilities of recovering and recycling nutrients and organic matter from urban organic waste streams – including human and animal excreta as well as organic waste – to re-establish circular flows between rural production zones and urban consumption centers.

1.5. Agricultural intensification: use of organic matter, mineral fertilisers, new crop varieties and local knowledge.

The use of improved varieties, mineral and/or organic fertilisers and endogenous or locally adaptable knowledge can intensify agriculture. In Burkina Faso, the work of Sedogo (1993), resulting from a long-term experiment initiated in 1960 at the Saria research station, shows that the yields of sorghum crops had been gradually declining as soils become more acid because of only mineral fertilisers being applied. Yields did however increase after the mineral fertilisers were combined with the use of manure. Based on these findings, the current recommendation for fertilising rainfed crops is to apply five tons per hectare of well-decomposed organic manure, either alone or in combination with mineral fertilisers. For irrigated crops, the recommended dose of organic manure is higher, averaging 15 tons per hectare.

Despite these recommendations, the actual use of organic manure remains low with one reason being that crop and livestock production are often practiced by different actors, limiting farmers access to manure. The evolution of organic manure application rates from 2012 to 2021 shows values of 1.7 to 5.5 tons per hectare on cereals, depending on the crop (MARA, 2022). Over the same period, the share of cultivated areas receiving organic amendments fluctuated between 15 to 27%, averaging about 21% overall.

Crop residues also play an important role as their return to the soil can partially compensate for nutrient exports through harvest. For rice, by-products such as husks can be recycled into biochar or charcoal briquettes, although the processing technology remains limited. Rice straw as well as legume residues from cowpea and peanuts are often used as livestock feed. Lompo (1993) found that 90% of the large cereal stalks (sorghum, maize and millet) were used as fuel while 7–9% is used for the construction of enclosures and palisades, as well as animal feed. Most residues are thus removed from fields during the dry season, by consumption of transhumant livestock or used as fuel or making enclosures leading to nutrient and organic matter export from the fields.

As for mineral fertilisers, their relatively high costs and low availability, especially with global crises such as COVID-19 and the Russo-Ukrainian war, make these inputs inaccessible to many producers, compromising development options.

1.6. Nutrient loss management (circular economy): Composting, production of biochar, organic, mineral and chemical amendments

1.6.1. Recycling of crop residues and amendments to cultivated soils

To enable recycling of agricultural residues, a range of processes and technologies have been developed, including composting of organic residues of animal and/or plant origin, as well as the production of biochar for non-compostable organic residues (corn cobs, cotton stalks, etc.).

Composting is a process of degradation of organic materials of plant and/or animal origin in aerobic conditions. This process involves successive microbial communities that generate heat and transform the biomass into humified and stabilised organic matter. Composting thus enables the recycling of organic waste into valuable soil amendments.

There are several types of composting. Depending on the local conditions and equipment available, it is possible to use pit composting, heap or windrow composting, box or bin composting (Figure 5), etc. In relation to the inputs or additions, there is vermicomposting, phospho-composting, etc. Pit composting and heap composting are the most practiced in Burkina Faso.



Figure 5: Composting organic waste using a box or bin, alternating layers of manure and carbon rich material.

The recommended pit compost design in Burkina Faso has a volume of 10 m³ (2.5 metres wide by 3 metres long with a depth of 1.3 metres). These pits will contain 1.3 to 1.7 tonnes of sorghum straw residues as well as 225 to 300 kilos of manure as composting starter (equivalent to about half of the annual manure production of one head of cattle or 10 goats/sheep that are penned overnight). At the end of composting, between 1.1 and 1.5 tonnes of compost (75% of the total weight) is obtained, which is sufficient to amend approximately 0.44 to 0.6 hectares of cropland.

Biochar production provides a complementary method for utilizing residues that are unsuitable for composting or animal feed. Biochar is produced through pyrolysis and yields is typically between 15–20% in dry weight depending on the feed stock used. Suitable materials include wood waste, cotton stalks, and rice husks.

1.6.2. Some experiences in the recovery of organic waste with agro-mineral additives in Burkina Faso

Considerable research has focused on enhancing the availability and effectiveness of organic amendments through composting urban solid waste enriched with agro-mineral resources like natural phosphate and dolomite. Studies, notably those by Soma (2008), explored both composting and anaerobic digestion of sorted landfill waste and fresh waste from the Ouagadougou slaughterhouse.

Aerobic composting showed that adding Burkina Phosphate or dolomite significantly accelerated decomposition and improved nutrient quality. The experiments revealed that a dose of 30 kg of Burkina Phosphate per tonne of slaughterhouse waste optimized decomposition. Urea addition also improved compost quality, albeit with slightly lower phosphorus availability than phosphate enrichment. Notably, pH values remained acidic in most composts unless dolomite was added, which raised the pH to more neutral levels.

Anaerobic digestion (methanisation) was also explored. Results confirmed that slaughterhouse waste is more suitable for biogas production, yielding up to 2.21 litres of biogas per kg of dry matter—much higher than traditional feedstocks such as sorghum straw and cow dung. Complementary research by Ouandaogo (2010) showed that phosphorus solubilisation from natural phosphates peaked at moderate doses (20–40 kg/tonne), enhancing phosphorus availability in compost and suggesting an optimal threshold beyond which solubility declines.

1.6.3. Improving the efficiency of the use of nutrients supplied

Nitrogen plays a central role in plant nutrition and growth. Plant nitrogen uptake can be improved through proper crop management and the selection of plant species. By synchronising the plant's nitrogen needs with fertiliser application, nitrogen uptake and therefore agricultural productivity can be improved. Several technologies can be used to support this goal:

- Localised/microdosing of fertilisers directly near the root zone;
- The use of slow-release fertilisers (deep placement of super-granulated fertiliser) to improve efficiency and reduce volatilisation;
- Split application of nitrogen fertilisers to better match plant uptake patterns.

1.7. Strategies and policies implemented for increasing agricultural production and sustainable soil/land management

The main driver of increased agricultural productivity is the adoption of innovative technologies and practices. To stimulate and sustain this process, governments implement agricultural policies guided by clear strategic frameworks that encourage and support

technological adoption. In Burkina Faso, these strategies emphasise sustainable land use management as well as the rehabilitation of already degraded land.

1.7.1. National Strategy for Integrated Soil Fertility Management

Restoring and improving soil fertility remains a major priority for sustainable agricultural production in Burkina Faso. These have been guided by the National Strategy for Integrated Soil Fertility Management (SNGIFS), centered around three pillars:

- The promotion of soil amendments such as Burkina Phosphate (BP), dolomite, and production and use of organic fertilisers;
- The promotion of complementary technologies such as soil and water conservation and soil rehabilitation;
- The market development of agricultural and livestock inputs and products.

The implementation plan of the SNGIFS strategy, developed in 2000, addressed these three pillars. This included the launch of 50,000 composting pits in 2001 to provide fertilization for nearly 75,000 hectares and increase yields by 20– 30%. However, the success of this operation has been mixed due to numerous difficulties related to compost production. There has for example not been enough water for watering composts, crop residues have sometimes instead been used for other purposes and there has not been enough of other forms of biodegradable residues. Other challenges have been the great need for labour, the weak connection between agriculture and livestock farming as well as a lack of transport. For the future, it is envisaged that compost production and marketing units can be established across the country.

Regarding mineral fertilisers, the quantities of imports and the costs related to the purchase and subsidies of these imports vary depending on the year and sometimes following experiences of food crises (Figure 6 and Figure 7). Poverty in rural areas and low agricultural incomes are key factors behind the low use of mineral fertilisers. For the past 20 years between 8 to 18 kg of fertilizer–nutrients has been applied per hectare of arable land in Burkina Faso (FAO stat). In recent years, a mineral fertiliser production plant has been set up that will use natural phosphates and benefit from the results of research on the valorisation of these phosphates.

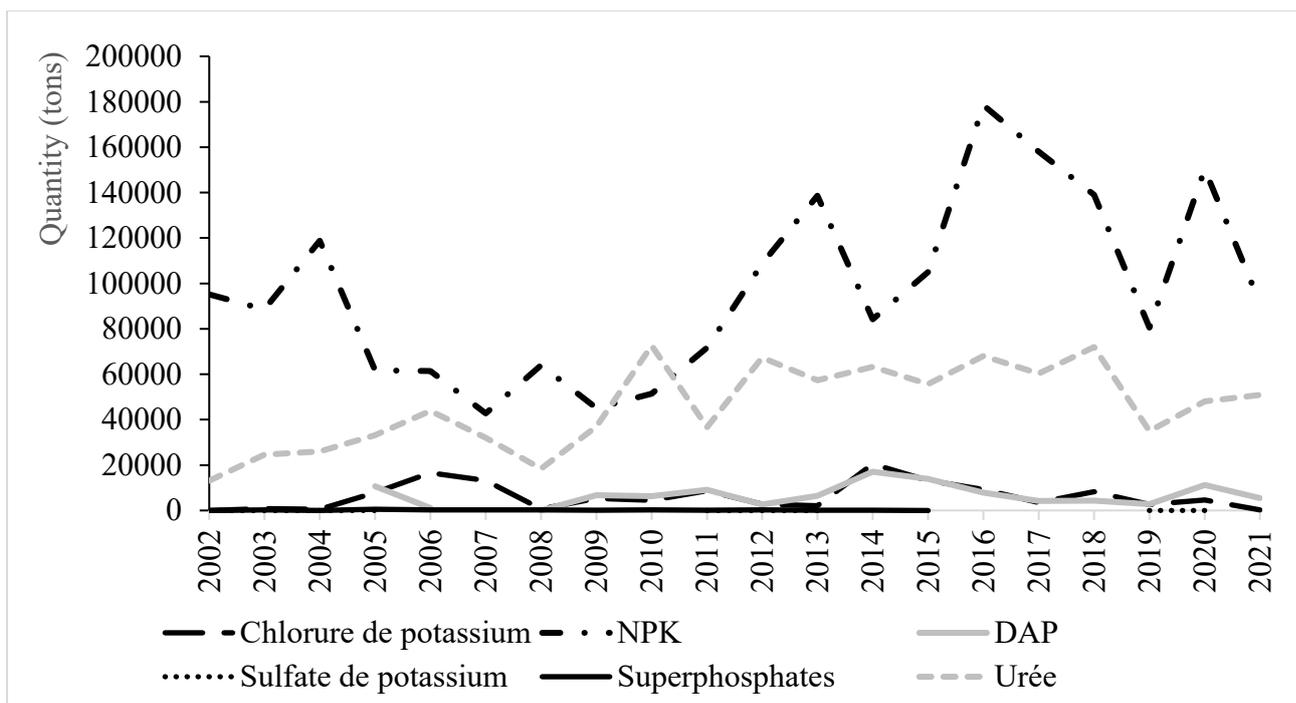


Figure 6: Quantities and types of fertilisers imported by Burkina Faso from 2002 to 2021

Source: FAOSTAT

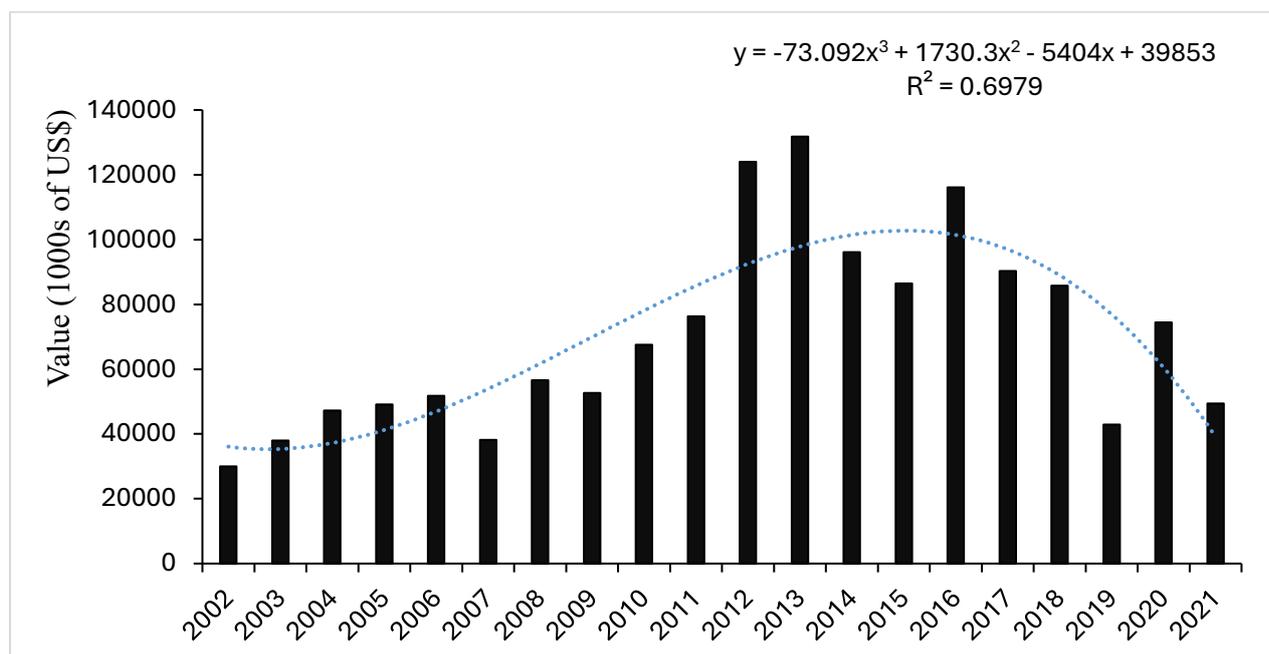


Figure 7: Value of mineral fertiliser imports in thousands of US dollars by Burkina Faso from 2002 to 2021. Source: FAOSTAT

1.7.2. National strategy for soil restoration, conservation and recovery

To curb land degradation and restore the productive capacity of degraded areas, a National Strategy for Soil Restoration, Conservation and Recovery in Burkina Faso (SN-RCRS) has been developed. Covering the period 2020–2024, this framework provides guidance and

coordination for interventions related to conservation, protection and restoration of soils in Burkina Faso.

The strategy is built around four strategic pillars:

(i) steering and support for activities to conserve, protect and restore soil and water, (ii) capacity building for support and advice to actors and producers, (iii) support for research and development and promotion of innovative cultivation techniques in soil and water conservation (CES) soil protection and restoration (DRS) and (iv) integration of activities and the scaling up of proven and adapted CES/DRS techniques. An action plan has been adopted, building on the four pillars of the SNRCRS strategy.

1.8. Conclusion of Chapter 1

The future of soil management in Burkina Faso remains uncertain amid growing pressure on natural resources, combined with low intensification of agricultural systems. Despite ongoing efforts to promote sustainable land management, rural poverty and fast population growth are likely to persist as underlying causes of land degradation, coupled with the recurring impacts of climate change.

Meeting the challenges of sustainable agricultural intensification will require restoring soil organic matter and replenishing mineral nutrients in cultivated soils. This involves identifying, quantifying and mobilising local organic waste resources for their safe and efficient recycling.

Research in Burkina Faso has already explored several recycling approaches, including composting and biochar production, for different waste streams. Yet it remains for producers to define and implement safe models of soil fertility management for different agricultural production systems, integrating the recycling of all forms of locally available wastes in line with the principle of resource circularity.

Among these wastes, resources recovered from sanitation and wastewater systems represent an emerging yet underexplored opportunity for nutrient, organic matter and water recycling. The next chapter examines the policies and practices related to the safe recovery and productive reuse of human excreta and wastewater in Burkina Faso.

CHAPTER 2: POLICIES, POTENTIALS AND PRACTICES FOR EXCRETA, WASTEWATER AND DOMESTIC ORGANIC WASTE REUSE IN BURKINA FASO

Over the past three decades, the water, sanitation and hygiene (WaSH) and solid waste management sectors in Burkina Faso have become increasingly structured and regulated through public policies, legal instruments, and institutional reform. This evolution has been accompanied by the creation of a number of national programmes that translate policy commitments into action.

In this chapter the frameworks for management of excreta/wastewater (2.1) and solid waste (2.2) are reviewed, followed by agriculture from a resource recovery and reuse perspective (2.3) and an assessment of resources available in human excreta (2.4).

Past ecological sanitation (Ecosan) experiences in Burkina Faso are then presented (2.5) followed by the recent development and piloting of the Clean and Green framework (2.6), and finally, some alternative options for excreta treatment and reuse (2.7).

2.1 Wastewater and excreta – policy, legal and institutional frameworks

2.1.1 Policies

The political framework governing the sanitation sector is defined primarily by the National Economic and Social Development Plan (PNDES), the Environment, Water and Sanitation Sector Policy (PS-EEA) and the National Water Strategy (SNE).

The National Economic and Social Development Plan (PNDES)

The National Economic and Social Development Plan (PNDES) was adopted in July 2016 as the national development planning framework for the period of 2016–2020 and was updated in 2021 for the period 2021–2025. Its overall objective is to restore security and peace, strengthen the nation's resilience, and structurally transform the Burkinabe economy, aiming for strong, sustainable, and inclusive growth.

Strategic Objective 3.6 focus on “improving the living environment and expanding access to drinking water, sanitation and quality energy services”. For sanitation, targets include increasing:

- the national rate of access to sanitation from 25% in 2020 to 33% in 2025 and
- the share of villages declared Open Defecation Free (ODF) from 20% in 2020 to 40% in 2025.
- the proportion of municipalities with a functional solid waste management system from 22% in 2019 to 35% in 2025.

The plan also highlights the need to optimise the management and recovery of wastewater and fecal sludge.

Sectoral policies

Under *Law 34-2018/AN* on the Steering and Management of Development, policies are developed at the sectoral level for ten years, while strategies are developed for five years and only concern intra-sectoral priority areas.

The Environment, Water and Sanitation Sector Policy (PS-EEA) 2018-2027 sets the overall objective of "Ensuring access to water and a healthy living environment and strengthening environmental governance and sustainable development with a view to improving the economic and social conditions of populations." Implementation relies on legal (legislative and regulatory texts), institutional (bodies, committees, etc.), financial (funds, taxes or fees) and operational (programmes, projects, strategies) means.

To operationalise the PS-EEA, a National Water Strategy (SNE) 2021-2025 was developed for the water and sanitation sub-sectors. The vision of the National Water Strategy is that "By 2025, the country's water resources are known, managed efficiently, and the right of universal access to water and sanitation is effective and contributes to the country's sustainable development."

Under sanitation, the SNE promotes participatory approaches including Community-Led Total Sanitation (CLTS) in rural areas and the Promotion of Hygiene and Sanitation (PHA) in schools and health centres, and supports social intermediation and behavioural-change monitoring. Recovery of sanitation by-products is also emphasised for sustainability.

Other relevant policies:

- The National Environmental Policy (2005) generally addresses the sustainable management of natural resources and a healthy living environment through preservation, integrated management of resources, the creation of environmental professions and the control of environmental quality.
- The National Public Hygiene Policy (2003) aims to ensure the conditions essential for survival, preventing diseases, create a favourable climate for the productivity of human activities, and guarantee comfort and the joy of living.
- The National Environmental Education and Eco-Citizenship Strategy aims to define the method for building public awareness and concern for the environment and related problems. It aims to equip people with the skills, motivation, and commitment to work individually and collectively to solve current environmental problems and prevent new ones from arising.

2.1.2. Legal frameworks

At the legal level, following Law No. 002-2001/AN of February 8, 2001, on water management, there has been extensive legislation and regulations related to water and sanitation. While additional regulatory instruments are still needed to support implementation, particularly on municipal level, the sector is now supported by a robust legal framework. Since 2015, the constitution has enshrined access to drinking water and sanitation as a fundamental right. For sanitation, specific legal instruments include:

- Law No. 006-2013/AN on the Environmental Code in Burkina Faso, constitutes the framework law for environmental protection because it determines the fundamental principles applicable to all environmental sectors. Article 6 stipulates that the competent public authorities should take all appropriate measures to clean up the environment.
- Order No. 2017-041/MEA/CAB adopting the document of the national programme for the sanitation of wastewater and excreta (PN-AEUE° 2016-2030)
- Order No. 2016-14/MEA/CAB approving the document of the governance programme for the Water and Sanitation sector in Burkina Faso.
- Order No. 2009-023/MATD/MEF/MAHRH defining the standard protocol between the State and municipalities for water supply and sanitation.
- Decree No. 2019-0320/PRES/PM/MEA/MINEFID/MATDC/MEEVCC/MS defining standards, criteria and indicators for access to sanitation which applies to the planning, construction of infrastructure and management of sanitation services in urban and rural areas.
- Decree No.2023-1248/PRES-TRANS/PM/MEEA/MATDS/MEFP/MSHP/MENAPLN/MUAFH regulates on-site sanitation of wastewater and excreta, across the full sanitation value chain, ie confinement, transport, treatment and reuse/recycling of wastewater and excreta.

2.1.3. Institutional aspects

Over the past two decades, institutional responsibility for water and sanitation in Burkina Faso has undergone several re-organisations reflecting national priorities. In the early 2000s, water and sanitation were managed under the Ministry of Agriculture, Water and Fisheries Resources, with sanitation receiving limited dedicated attention. In 2013, the government established a separate Ministry of Water, Hydraulic Planning and Sanitation, marking a significant step toward recognising sanitation as a distinct policy area. Since 2022, these

responsibilities have been consolidated under the Ministry of Environment, Water and Sanitation (MEEA), signalling a move toward more integrated governance of water, sanitation, and environmental management. According to the Environment, Water and Sanitation Sector Policy (PS-EEA), sanitation sector planning is to be led by MEEA in collaboration with the Ministry of Urban Planning.

2.1.4. National Programmes

At the programmatic level, the Burkinabe government, through the MEEA, has developed five national implementation programmes for the period 2016–2030, aligned with the National Water Strategy (SNE) and Sustainable Development Goal 6 (Ensuring availability and sustainable management of water and sanitation for all):

1. National Drinking Water Supply Programme (PN-AEP);
2. National Programme for Sanitation of Wastewater and Excreta (PN-AEUE);
3. National Programme for Integrated Water Resources Management (PN-GIRE);
4. Steering and Support Programme (SSP);
5. National Hydraulic Development Programme (PN-AH).

National Programme for the Sanitation of Wastewater and Excreta (PN-AEUE)

The PN-AEUE serves as the reference framework for all national interventions in the wastewater and excreta subsector up to 2030. Its overarching goal is to ensure sustainable management of wastewater and excreta, with Specific Objective 3 dedicated to “optimising the management and recovery of wastewater and excreta with a view to protecting environmental and social health.”

To operationalise this specific objective the MEEA developed the framework document “Management of the Wastewater and Excreta Value Chain in Burkina Faso 2022–2026” (MEEA, 2022). This document set out actions to develop legal and institutional frameworks to support all parts of the sanitation chain, as well as quantitative targets for evacuation, treatment and recovery of wastewater and fecal sludge.

The subsequent Decree No.2023-1248 on on-site sanitation systems, drew directly on this framework document, incorporating its main orientations and translating them into legally binding obligations. However, much of the decree still outlines “what should be done” rather than “how it will be done”, pending the adoption of detailed implementing regulations. These forthcoming regulations will define technical standards for on-site sanitation systems and sludge treatment, licensing and accreditation procedures for private operators, quality and safety norms for reuse of sanitation by-products, and mechanisms for cost recovery and resource mobilisation at communal level.

2.2. Solid Waste – policies and legal framework

2.2.1. Policies

Solid waste management has progressively gained importance in Burkina Faso's national development agenda. Within the National Economic and Social Development Plan (PNDES 2016–2020), the third strategic pillar sought strengthening urban sanitation systems by increasing the proportion of municipalities with a functional solid waste management system from 13% to 25%, expanding the number of cities with operational Stormwater Drainage Master Plans (SDDEP) and Urban Waste Management Master Plans (SDGDU) from two to forty-seven. These objectives were reaffirmed in the updated PNDES 2021–2025.

2.2.2. Legal and regulatory framework

Solid waste management is governed by an extensive legal and regulatory framework anchored in the Constitution, which enshrines the right to a healthy environment and makes protection, defense and promotion of the environment a duty for all (Article 29). This constitutional principle is elaborated through several key laws and decrees (Table 2).

Table 2: Summary of legislative and regulatory texts governing the management of household solid waste in Burkina Faso

At the legislative level	
Law No. 006-2013/AN of April 2, 2013 relating to the environmental code	In Article 49, the Environmental Code requires all producers, importers, distributors and transporters to recover waste generated by the materials or products they produce or sell. Similarly, its Article 53 requires authorisation to carry out collection, transport, treatment, recovery or disposal of waste.
Law No. 022-2005/year of May 24, 2005 relating to the public hygiene code in Burkina Faso	This law mandates all communities to implement an appropriate system for managing household waste (Article 12), and Article 15 stipulates that " <i>in urban areas, household waste and other similar waste must be placed in leak-proof, easy-to-handle containers or in dumps authorised by the competent municipal authorities.</i> "
Law No. 055-2004/year of December 21, 2004 , establishing the general code of local authorities in Burkina Faso	Determines under the terms of its article 89, the powers of the urban municipality to develop municipal actions plans for the environment, sanitation, pollution control and the collection and final disposal of household waste.
Law No. 017-2014/AN of May 20, 2014 , on the use of non-biodegradable plastic packaging and bags	Prohibits the production, importation and distribution of non-biodegradable plastic packaging and bags to further protect public health and hygiene, to preserve the quality of soil, water and air, to clean up the living environment of populations, and to promote the use of biodegradable plastic packaging and bags.
At the regulatory level	

Decree No. 98-323/PRES/PM/MATS/MIHU/MS/MTT of July 28, 1998 , regulating the collection, storage, transport, treatment and disposal of urban waste	Defines urban waste and conditions for collection, storage, transport, treatment and disposal. It requires any person who produces it to ensure its collection by the competent structures (article 6).
Decree No. 2015-1187 /PRES-TRANS/PM/MERH/MATD/MME/MS /MARHASA/MRA/MIC A/MHU/MIDT/MCT of October 22, 2015 , setting out the conditions and procedures for carrying out and validating the strategic environmental assessment, the study and the environmental and social impact statement,	Applies to policies, plans, projects, programmes, works, structures, developments, activities or any other initiative likely to have significant impacts on the environment. It determines the conditions and procedures for carrying out the strategic environmental assessment (SEA), the environmental and social impact study (ESIS) and the environmental and social impact notice (ESI) in accordance with the provisions of the Environmental Code.
Decree No. 2015-1203 /PRES-TRANS/PM/ MERH/MATD/MJDHPC of October 28, 2015 , establishing the terms of organization and conduct of environmental inspection	Sets out the responsibilities of inspectors of classified establishments and the procedures for environmental inspection in Burkina Faso in accordance with the provisions of the Environmental Code.
Decree No. 2008-009/PRES/PM/MS/MECV of January 10, 2008 , organizing the management of biomedical and similar waste	Biomedical waste produced must be subject to specific measures to prevent its dispersal into the receiving environment. Households must prohibit the mixing of medical waste with household waste.

2.3. Sanitation by-products in agricultural policies and legal frameworks

The rural sector and agricultural production in Burkina Faso are governed by several key legislative and strategic texts, including the Forestry, Environmental and Public Hygiene codes; the Orientation Law on Water Management; the Orientation Law on Pastoralism (LORP), the Rural Land Law; the Orientation Law on Agro-Sylvo-Pastoral, Fisheries and Wildlife (ASPHF). At the strategic level the main frameworks guiding the agricultural subsector are the National Water Policy (PNE) and the National Food Security Strategy (SNSA).

However, while these and other documents govern the management of natural resources and agricultural production, explicit references to the valorisation or reuse of sanitation by-products, such as wastewater, sludge and human excreta, remain absent:

- Law No. 026-2007, ensures fertiliser control in Burkina Faso with a focus on imported mineral fertilisers. The document does not address organic manure or sanitation by-products.

- The Rural Development Strategy (SDR) (2003–2014) has contributed to promoting organic manure (manure pits and compost heaps) as a means to improve soil fertility but made no mention of the recovery of sanitation by-products. Its successor, the SDR 2016–2025, continues this focus, referring to organic manure under Axis 1 – Strengthening food and nutritional security; and to water and sanitation under Axis 4 – Improving the living environment and access to drinking water, but does not link these domains or mention reuse of sanitation by-products.
- The Action Plan for Integrated Soil Fertility Management (PAGIFS) aims to sustain agricultural production while maintaining environmental quality. Its component "Promotion of Amendments and Complementary Technologies" encourages organic manure production through the transformation of agro-industrial and urban waste as well as crop residues. Again, the recovery and reuse of sanitation by-products are not explicitly included.

2.4. Assessments of available resources in human excreta

Conservation efforts in Burkina Faso's agricultural sector have focused on reducing nutrient losses in soils and recycle animal manure and plant residues. In contrast, relatively little attention has been given to recycling nutrients from food consumed by humans, which then are excreted as urine and feces. This section provides an overview of nutrient content, quantities and potential value of human excreta and wastewater in Burkina Faso.

2.4.1. Content and fertilising value of human excreta and wastewater

Wastewater and fecal sludge are the main by-products of conventional sanitation systems. Wastewater refers to feces and urine mixed with water, while fecal sludge, as defined in Burkina Faso, consists of biologically active materials from autonomous or semi-collective disposal systems such as latrines, public toilets, septic tanks and cess pools.

Autonomous (on-site) sanitation refers to the evacuation, collection and treatment of wastewater and excreta through household or institutional facilities (eg. toilets in homes, schools, and public places). Collective sanitation, in contrast, refers to centralized sewer systems that channel wastewater from multiple sources to a treatment plant where it is processed before being discharged into the environment or reused (e.g. for irrigation).

The capital city of Ouagadougou remains dominated by on-site systems. Approximately 4% of the population uses septic tanks, 1.8% double pits, 40.3% improved latrines, and 0.4% collective sanitation. Traditional latrines represent 50.5% of sanitation facilities and 3% of the population still practices open defecation.

The treatment option for fecal sludge in Burkina Faso has been unplanted drying beds which separate solids and liquids. The dried solids are often disposed of in landfills or co-

composted with household or process organic waste while the filtrate (liquid fraction) can be treated by lagooning before discharge. A fecal sludge treatment plant using biogas production was set up in the Kossodo area, but its operation has been problematic.

The volume of fecal sludge generated in Ouagadougou in 2019 was estimated at 1126 m³/d (Zoungrana, 2021). Of this, the treatment plants were only able to accommodate 159551 m³/yr which represents 39 % of the production, while the remainder was discharged untreated to the environment (Zoungrana, 2021).

Human excreta, urine and faeces, are nutrient-rich resources that, if safely managed, can substitute for mineral fertilisers. Urine composition is given in Table 3, including research from Burkina Faso (Kiba, 2011) and from Niger (Dagerskog and Bonzi, 2010). In these two cases nitrogen concentration in urine was 2.7 and 6 g N/l respectively, corresponding well to the “rule of thumb” of 3–7 g N/l as stated in the urine guidance document by Richert et al (2010).

Table 3: Mineral element contents (g/l) and pH values of human urine

N	P	K ⁺	Cl ⁻	Na ⁺	pH	References
2.8	0.2	1.2	-	-	-	Finland: Heinonen- Tanski et al. (2006)
7.4	0.3	16.2	-	9	-	South Africa: Mnkeni et al. (2008)
6.0	0.8	0.9	-	3.1	8.8	Niger: Dagerskog and Bonzi (2010)
2.7	0.37	0.31			8.9	Burkina Faso: Kiba, 2011

In Table 4 the nutrient concentration in human feces emptied from Ecosan toilets in Burkina Faso (toilets where ash is used as additive to feces to speed up sanitization) is compared with other common manures in Burkina Faso. Heavy metal concentrations (Table 5) indicate that levels in human excreta are comparable to, or lower than, those in animal manures.

Table 4: Comparative analysis of ECOSAN feces with usual manures (*Bonzi et al. 2014, **Gomgnimbou et al., 2016)

Substrates organic	N	P	K
	g.kg ⁻¹		
Cattle manure*	20	10	22
Sheep manure*	20	9	17
Poultry manure*	26	27	15
Ecosan human feces**	37	15	22

Table 5: Heavy metal concentrations in human feces, urine and other products ($\mu\text{g/l}$ or $\mu\text{g/kg}$)

Materials	Cu	Zn	Cr	Ni	Pb	Cd	References
Urine	67	30	7	5	1	0	Jönsson et al. (2004)
Urine*	5.2	–	6.1	154.0	15.2	154.3	Makaya (2015)
Human feces	6,667	65,000	122	450	122	62	WHO (2006)
Manure	5,220	26,640	684	630	184	23	Jönsson et al. (2004)
Sludge	716	6,420	18	49	13	7	WHO (2006)

Note: *urine collected in Burkina Faso in dry toilets

As for wastewater in Burkina Faso, studies by Sou (2009) and Dao et al. (2019) highlighted the fertilising potential of wastewater and the effects on vegetable crop yields. Sou (2009) reported the mineral element contents of wastewater at 32 mg/l of mineral nitrogen (N), 18 mg/l of phosphate (PO_4) and 27 mg/l of potassium (K). Dao et al., (2019) reported total concentrations in pretreated urban wastewater 6.49 mg/l N, 18 mg/l P and 51.9 mg/l of K. However, these waters also pose health risks due to the presence of pathogens, heavy metals and alkaline salts. These pollutants can directly affect the health of people and animals but also reduce soil quality and crop yields, if untreated or poorly managed.

2.4.2. Monetary values of nutrients available in human excreta

The potential fertiliser resources contained in human excreta are substantial, as over time what we ingest with our food and drinks is also what we excrete in terms of nutrients such as nitrogen (N), phosphorus (P) and potassium (K). The quantity of these elements excreted by humans can be estimated from data on protein consumption and illustrated for the case of Burkina Faso in Figure 8. Calculations reveal that the average Burkinabè excretes quantities of N, P and K equivalent to approximately 15 kg of mineral fertilisers per year, which in terms of monetary value represents approximately 4,400 to 9,800 CFA francs per person. Indeed, for an average-sized family in a rural area (household size = 5.6 according to INSD,2022), the annual quantity of N, P and K in urine and feces is equivalent to 80 kg of commercial fertilisers, which exceeds the average quantities used per hectare by agricultural producers. Also, at the national level, the quantities of nutrients available in human excreta in Burkina Faso exceed those currently applied as mineral fertilisers. The estimated value of these quantities of fertilising elements available in human excreta is approximately 100 to 221 billion CFA francs per year (~175–390 MUSD). In addition to the three major nutrients N, P, K, human excreta also contain other macro and micro elements that plants need as well as organic matter.

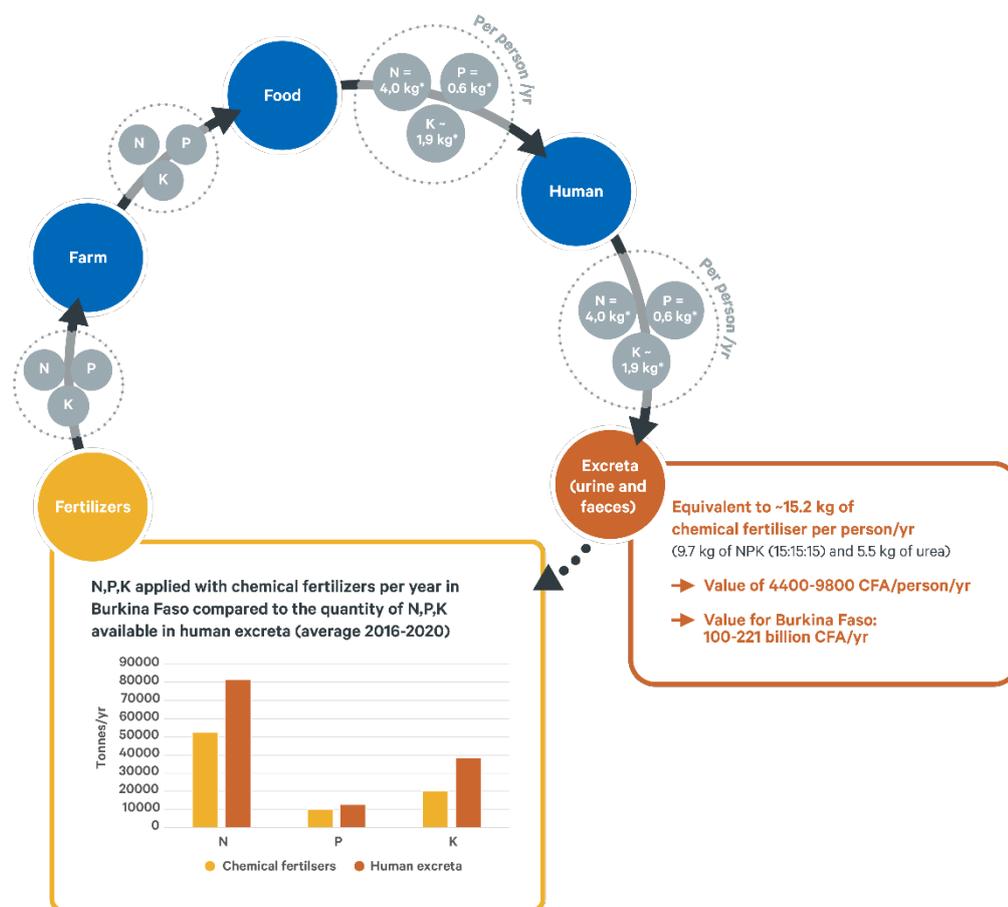


Figure 8: Illustration of the nutrient cycle from agricultural land to humans in Burkina Faso, including the potential quantity and value of nutrients in human excreta (source: Dagerskog et al. 2023)

2.4.3. Agronomic performance of human excreta and wastewater

Sanitised human excreta have significant impacts on productivity when applied at the rate of commonly used mineral fertilisers. Similarly, wastewater is a source of both water and nutrients.

In many Ecosan projects in Burkina Faso, the participatory evaluation of agronomic performance consisted of comparing the effect of human excreta fertilisation, in particular hygienised urine, with urea and also with the farmer's practice of low input agriculture. Results from such field tests with farmers, as well as guidance on doses and application of treated urine and faeces can be found in presentations¹ by Dr Moussa Bonzi from the

¹ See two presentations by Dr Bonzi:

- Agronomic R&G on urine and faeces in BF - what have we learnt after 8 years?
<https://www.slideserve.com/deirdre-wilson/dr-m-oussa-bonzi-inera-chef-de-departement-grm-sp> (visited 20251106)
- Experiences and opportunities for human excreta fertilizers in improving small scale agriculture:
<https://www.susana.org/resources/documents/default/3-3186-7-1524654530.pdf> (visited 20251106)

National Institute of Environmental and Agricultural Research (INERA) in Burkina Faso. The on-farm experiences show clearly that the nitrogen-rich urine can replace urea with similar or better yields for all crops tested (Fig. 9 and Fig. 10).



Figure 9: Participatory trials on lettuce with vegetable farmers in Ouagadougou (Ecosan_EU 1 project 2006-2009) evaluating the effect of hygienised human urine compared to urea (photos Moussa Bonzi)



Figure 10: Participatory trials on zucchini with vegetable farmers in Ouagadougou (Ecosan_EU 1 project 2006-2009), evaluating the effect of hygienised human urine compared to urea (photos Moussa Bonzi)

Combining fertilization (base fertilizer + urea or urine) with soil water conservation (SWC) can be highly beneficial as shown in the maize trials in Figure 11.



Figure 11: Effect of the contributions of hygienised urine and urea on corn production without (left photo) or with soil/water conservation measures (Zaï pits in this case) (right photo) (photos Moussa Bonzi).

More closely monitored experiments on eggplants in Burkina Faso also showed equal performance of urine and urea as source of nitrogen, while maize trials showed that sanitised faeces be used as base fertilizer as a source of phosphorous (Bonzi et al., 2011). The combined treatment of faeces as base fertilizer and urine as top dresser gave 2.15 ton maize/ha, outperforming the other treatments in this experiment, including the recommended dose of chemical fertilizer, which all gave less than 1.5 t/ha.

Regarding the use of wastewater in agriculture, Sou (2009) found that yields obtained from irrigated crops were very high and significantly higher than those from crops irrigated with unused water (control water). The yields of lettuce, carrots and eggplants were 3.4, 1.7 and 1.9 times those obtained with unused water, respectively. The substantial contribution of fertilising elements by wastewater explains these increases in yields. Dr Sou concluded that this attests to the interest of producers in using wastewater for vegetable irrigation.

2.5. Experiences in the recovery and reuse of human excreta in Burkina Faso: ecological sanitation (Ecosan)

2.5.1 History of Ecosan in Burkina Faso

Ecological sanitation, or Ecosan, refers to a sanitation system that aims to safely recycle nutrients, organic matter, and water for agricultural production, while minimizing the use of non-renewable resources (Kvarnström et al., 2012). In Burkina Faso, Ecosan has become closely associated with the double-vault latrines with urine diversion, which allow for effective hygienisation of both urine and faeces.

Since the introduction in Burkina Faso by Water and Sanitation for Africa (EAA, formerly known as CREPA) in 2002, this type of latrine and the recovery of hygienised urine and feces in agriculture have been part of many projects. Updating the inventory carried out by Dagerskog et al (2020), we were able to identify 33 distinct initiatives between 2002 and 2024 (Table 6). EAA implemented the initial projects under a regional programme of demonstration, research and training on ecological sanitation, financed by Sida. Building on this experience, there were notably five “large” projects of 1000 to 5000 latrines per project in the period 2006–2013, mostly financed by EU funds, including funds for food security (the Ecosan–EU 2 and Ecosan–EU 3 projects).

These projects represented a significant milestone, possibly the first time globally that agricultural funds were used to finance sanitation, reflecting a strong collaboration between EAA, the National Institute for Environmental and Agricultural Research (INERA) and the NGO Agro–Action.

After the institutional decline of EAA, most Ecosan projects have since 2012 been carried out with support from French decentralized cooperation, with the NGO Association Koassanga emerging as the main implementing actor in Burkina Faso.

Table 6: Overview of Ecosan projects identified in Burkina Faso between 2002-2024.

#	Location	Ecosan toilets	Start	End	Burkinabe Stakeholders Involved (beyond municipalities)	Information Available Online
1	Village of Sabtenga	100	2002	2008	EAA	
2	Commune of Saaba	50	2003	2004	EAA	
3	Commune of Tougan	55	2005	2008	EAA	
4	Villages around the municipality of Banfora	155	2006	2010	EAA	
5	Commune of Poa	40	2006	2007	EAA	
6	Ouagadougou (Ecosan_UE)	997	2006	2009	EAA, ONEA, GIZ	
7	Province of Kourittenga (30 villages) EcoSan_UE2	1350	2008	2011	EAA, INERA, ONEA	https://www.susana.org/_resources/documents/default/2-1033-en-ssp-use-of-urine-2010.pdf
8	Bobo Dioulasso (35 villages)	50	2009	2011	ADAE, BACIDE, EAA	https://www.pseau.org/outils/actions/action_resultat.php?acj =528&tout=1
9	Province of Tapoa	2	2010	2012	ACF et Fondation Ensemble	https://www.pseau.org/outils/actions/action_resultat.php?acj =856&tout=1
10a	Province of Boulgou (EcoSan_UE 3)	844	2010	2011	EAA, Agro–Action	
10b	Provinces of Boukierme and Sanguié (Ecosan_UE3)	804	2010	2011	EAA, Agro–Action	
11a	Province of Ouhitenga	2599	2010	2013	LVIA, EAA	
11b	Province of Boukierme	2413	2010	2013	LVIA, EAA	
12	Province of Kourittenga (EcoSan_UE4)	1000	2011	2014	EAA, INERA	
13	Commune of Doulougou	200	2012	2017	CEAS, EAA, Association Tel Taaba	https://www.pseau.org/outils/actions/action_resultat.php?acj =1411&tout=1
14	Village of Koassanga	75	2012	2014	Association Koassanga	https://www.pseau.org/outils/actions/action_resultat.php?acj =1478&tout=1
15	Commune of Réo	600	2013	2016	?	https://www.pseau.org/outils/actions/action_resultat.php?acj =1670&tout=1
16	Commune of Gayeri	60	2013	2014	Findima	https://www.pseau.org/outils/actions/action_resultat.php?acj =1577&tout=1
17	Commune of Kiémbara (village of Dio)	385	2013	2014	Fraternité pour le Développement de Dio	https://www.pseau.org/outils/actions/action_resultat.php?acj =1589&tout=1
18	Commune d'Imasgo (Kanyalé)	150	2013	2014	?	https://www.pseau.org/outils/actions/action_resultat.php?acj =1599&tout=1

19	Ouagadougou, périurbain	850	2013	2016	ACF, ONEA	https://www.pseau.org/outils/actions/action_resultat.php?acj=1918&tout=1
20	Kadiogo, ville of Koumléla	55	2014	2015	?	https://www.pseau.org/outils/actions/action_resultat.php?acj=1844&tout=1
21	Bobo-Dioulasso	250	2014	2016	?	https://www.pseau.org/outils/actions/action_resultat.php?acj=1675&tout=1
22	Commune of Douroula	1	2015	2016	CEAS	https://www.pseau.org/outils/actions/action_resultat.php?acj=2210&tout=1
23	Commune of Ziniaré	30	2015	2015	Association Koassanga	https://www.pseau.org/outils/actions/action_resultat.php?acj=2188&tout=1
24	Commune of Koupela	10	2016	2017	Comité de jumelage Grigny-Koupéla	https://www.pseau.org/outils/actions/action_resultat.php?acj=2352&tout=1
25	Ziniaré, Zimtanga, Tanghin Dassouri and Komki Ipala	70	2016	2017	Association Koassanga	https://www.pseau.org/outils/actions/action_resultat.php?acj=2358&tout=1
26	Communes of Boulsa, Kiendsom and Rapéla	141	2016	2016	Association Koassanga	https://www.pseau.org/outils/actions/action_resultat.php?acj=2355&tout=1
27	Commune of Koudougou	115	2018	2021	?	https://www.pseau.org/outils/actions/action_resultat.php?acj=2466&tout=1
28	Communes of Kombissiri, Doulougou, Toecé	160	2020	2024	NATURAMA, Welthungerhilfe	https://tinyurl.com/2n78jh47
29a	Village of Dapélogo (commune of Bindé)	18	2021	2022	WaterAid BF, EVI	https://www.sei.org/projects/clean-and-green/
29b	Village of Soundogo	17	2021	2022	WaterAid BF, EVI	-
29c	Village of Kirikodogo	4	2021	2022	WaterAid BF, EVI	-
30	Villages of municipality of Boussouma and Kaya	8	2022	2022	EAA	
31	Village of Dapélogo	20	2020	2023	Association Koassanga	
32	Commune of Partiaga	90	2022	2024	Association Koassanga	
33	Commune of Ziniaré	50	2023	2025	Association Koassanga	

In total, an estimated 13,818 Ecosan latrines were built in Burkina Faso between 2002 and 2024. However, it is likely that other initiatives exist and that the actual number of projects and latrines is higher.

In terms of geographical distribution, projects have been carried out in most regions of Burkina, but the highest concentration of initiatives is around Koudougou and Ouagadougou, in the centre of the country (Figure 12).

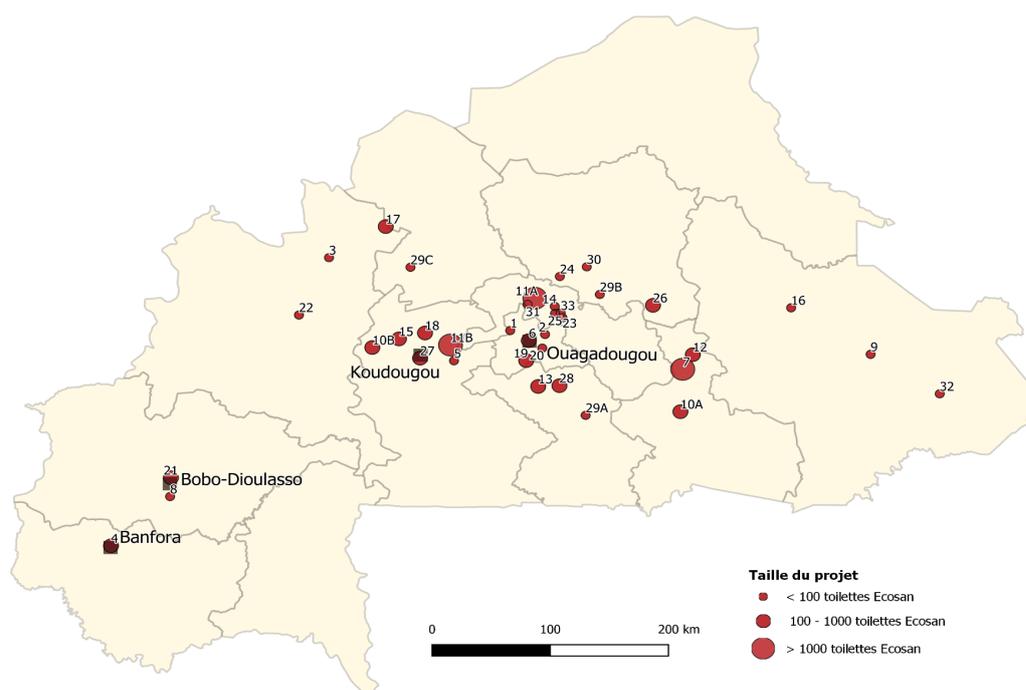


Figure 12: Geographic location and indicative size of the projects listed in Table 6.

2.5.2 Lessons learned and recommendations to strengthen the sustainability of Ecosan interventions in Burkina Faso

Between 2014 and 2018 several initiatives assessed the long-term performance and sustainability of Ecosan projects in Burkina Faso. A synthesis by Dagerskog et al. (2020) brought together findings from three studies and one multi-stakeholder learning workshop (Table 7). Together these efforts examined toilet functionality and use, hygiene practices and reuse of sanitation by-products, offering insights for strengthening Ecosan interventions.

Table 7: Learning initiatives informing Ecosan sustainability recommendations in Dagerskog et al. (2020).

Overview of the study/event	Projects in the study	Toilets visited	Years after the project end	Age of toilets (years)
2016 study conducted by SEI , revisiting 522 households from three major projects totaling 8,000 double-vault urine-diverting toilets. Household survey and observations on latrine condition. Published in Dickin et al. (2018) and in Land and Jonsson (2017).	EU-LVIA	295	2	3
	Ecosan_EU2	131	6	7
	Ecosan_EU3	96	5	6
Carrasco et al. (2014) from IRC evaluated the hygienic use of toilets and Ecosan fertilisers through a survey of 318 participants in a large Ecosan project.	EU-LVIA	318	Before project end	40% <1 yr 60% >2 yrs
Dakouré et al. (2017) and Traoré et al. (2017) reported a follow-up study of two of the eight households from the R&D project (AmeliEAUR).	AmeliEAUR	2	1	–
A two-day workshop was held in 2018 by the ACTEA knowledge network in Burkina Faso to discuss experiences	Ecosan projects with French funding	–	–	–

from Ecosan projects with French funding, aiming to identify potential improvements (ACTEA, 2018).

Based on these learning initiatives, Dagerskog et al. (2020) formulated 26 recommendations grouped under the five sustainability dimensions of the Sustainable Sanitation Alliance (SuSanA):

- Health and hygiene (7 recommendations)
- Environment and natural resources (6 recommendations)
- Technology and operation (5 recommendations)
- Financial and economic issues (2 recommendations)
- Sociocultural and institutional aspects (6 recommendations)

Some key recommendations from Dagerskog et al. (2020):

- **Promote consistent and inclusive use of Ecosan latrines:** Most women surveyed were reluctant to use the toilets during menstruation. Targeted awareness-raising is important to allay their fears and improve equitable access.
- **Facilitate practical urine management:** Many households struggle to store large volumes of urine over the dry season. Practical alternatives include adding urine to manure/composting pits or field application (in furrows that are covered) even during the dry season.
- **Strengthen agricultural training and reuse capacity:** Establish Farmer Field Schools focused on the safe reuse of hygienised urine and faeces. These build farmers' skills in applying Ecosan fertilisers effectively but can also stimulate demand for Ecosan toilets and motivate consistent toilet use to get more fertilisers. Also possible to incorporate complementary modules on soil-water conservation as well as composting techniques when relevant.
- **Encourage lower-cost alternatives to "Ecosan latrines":** Simplified systems such as alternating between two traditional pit latrines with urine collection through simple urinals may be more affordable while retaining reuse potential.

2.5.3 Testimonies collected from Ecosan stakeholders

The present capitalisation of experiences in resource recovery and reuse for agriculture provided an opportunity to gather insights from key informants – including a representative from Ministry of Agriculture, an Ecosan fertilizer entrepreneur and a farming household.

ACTOR IN AGRICULTURAL EXTENSION

Mr. SOME Hien Kpierenouor, Head of Agricultural Fertiliser Services Ministry of Agriculture, Animal Resources and Fisheries (MARA)

"Access to chemical fertilisers has become increasingly difficult, a situation worsened by developments in the international context. In recent times, we have observed a growing use of organic fertilisers, along with signs of adaptation in national policies – such as the 2023–2025 Agropastoral Offensive led by MARA.

In Burkina Faso, there are specific policy documents governing the promotion of fertilisers. Nevertheless, several challenges persist, including: (i) limited information and awareness among producers, promoters, and users of organic fertilisers; (ii) the lack of professionalisation and absence of technical certification for those producing and marketing organic fertilisers; (iii) lack of standardisation of organic fertilisers with no validated technical sheets approved by MARA outlining standard norms and application methods; (iv) limited understanding of the current regulatory framework governing the production, promotion, use, and control of organic fertilisers.

To support the ecological transition—meaning the shift from chemical fertilisers to organic fertilisers or the combination of both—and to encourage producers to adopt these practices for environmental protection and healthy agricultural production in Burkina Faso, the following actions are necessary:

- 1. Update technical documents (policies, strategies, laws, decrees, etc.) in line with the government's vision for agricultural policy and the transition to organic fertilisers.*
- 2. Advocate for the inclusion of standardized organic fertilisers in public procurement.*
- 3. Train and inform stakeholders about existing regulations related to the control and commercialization of fertilisers and pesticides.*
- 4. Support the professionalisation actors in the fertiliser sector by facilitating access to technical certification and compliance with the legal and regulatory framework governing the production, promotion, and use of organic fertilisers.*

5. *Develop and validate technical data sheets defining the norms and standards for classifying different types of fertilisers (organic fertilisers, compost, or soil amendments)”*

ECOSAN FERTILISER PROMOTER

Mr. KERE Pierre, President of the Namangb-Zanga Community Association (ACONAZ), Promoter of Ecosan fertilisers, Manager of the Wayalguin sanitation site, Ouagadougou

“Organic fertilisers have been increasingly sold for some time, with a peak especially during the rainy seasons, but political decisions remain insufficient to support promoters of organic fertilisers in Burkina.

The legal framework for the promotion of organic fertilisers in Burkina Faso is not understood by all stakeholders, resulting in the existence of a diversity of non-standardised organic fertilisers on the market, particularly on social networks.

I recommend (i) advocating for the adoption of texts and policies that support and prioritize organic fertilisers in public procurement, (ii) strengthening the professionalisation of developers and improving their understanding of applicable regulations; and (iii) enhancing communication on standardised organic fertilisers and disseminating research results more widely.”

BENEFICIARY AND USER OF ECOSAN LATRINE

Mr KOURAOGO Adama, Agricultural Producer; User of Ecosan latrines in the village of Toulgou Nakoomsé (Province of Koutitenga)

“I still use my Ecosan latrine (Figure 13), which I received as part of the Ecosan EU II project 15 years ago. It is still functional, and I am satisfied with the by-products from the Ecosan latrine used in agriculture. Compared to fields that are not amended with these by-products, there is a significant difference in yields. I harvest more when using Ecosan latrine by-products – that’s why I continue to maintain it.

The only challenges I face are the lack of small equipment (gloves, boots, disinfectants, jerrycans, etc.) for emptying the latrine. The absence of refresher training on Ecosan latrines, especially for household heads, means that many households who benefited from these latrines in the past can no longer use them, as the new heads of households have not received technical support.

We believe there is a need for renewed awareness-raising and support for beneficiaries, particularly through the provision of protective equipment."



Figure 13: Mr Kourago Adama's son shows the Ecosan latrine, with urine piped to a jerry can at the back (photo to the right).

These testimonies underscore that while Ecosan systems have demonstrated technical durability and agronomic benefits, their wider adoption is hindered by weak regulatory frameworks, insufficient professionalisation of the organic fertiliser sector, and limited farmer support.

2.6. Recent development – the “Clean and Green” (C&G) framework

Despite the large number of Ecosan projects in Burkina Faso, the scale-up and long-term sustainability of these initiatives remain constrained by socio-cultural, technical, economic, and institutional barriers. Past initiatives have offered mainly one technological option (the Ecosan latrine), relied heavily on subsidies for latrine construction, and underestimated the need for support to households in both latrine use and agricultural reuse of by-products.

To address some of these limitations, Stockholm Environment Institute (SEI) and WaterAid-Burkina Faso developed and piloted a new approach for implementing productive/ecological sanitation in rural areas, known as the Clean and Green (C&G) framework (Dagerskog et al., 2023). Rather than focusing on a specific technology, C&G sets out to improve the management of both risks and resources in the local environment, to strengthen health protection as well as agricultural production.

These objectives can be achieved through different technologies and practices. Although Ecosan latrines are highly effective for the collection and sanitization of human excreta, C&G recognises that other options may also be appropriate, such as traditional latrines that are supplemented with urinals to prevent urine from being lost in the latrine pits. Similarly, agricultural sustainability requires reuse of all local waste flows, including human and animal excreta, organic waste, ash and greywater (wastewater from kitchen, showers and laundry).

To align with Burkina Faso’s national policy for sanitation, C&G proposes two steps. First, basic access to sanitation and hygiene must be ensured, which in Burkina is achieved through Community-Led Total Sanitation (CLTS). The framework then expands along two complementary tracks (Figure 14):

- The Clean track focused on improved household and community waste management and improved food and water hygiene to reduce health risks
- The Green track focused on the safe recovery and reuse of water, nutrients and organic matter present in local wastes and residues.

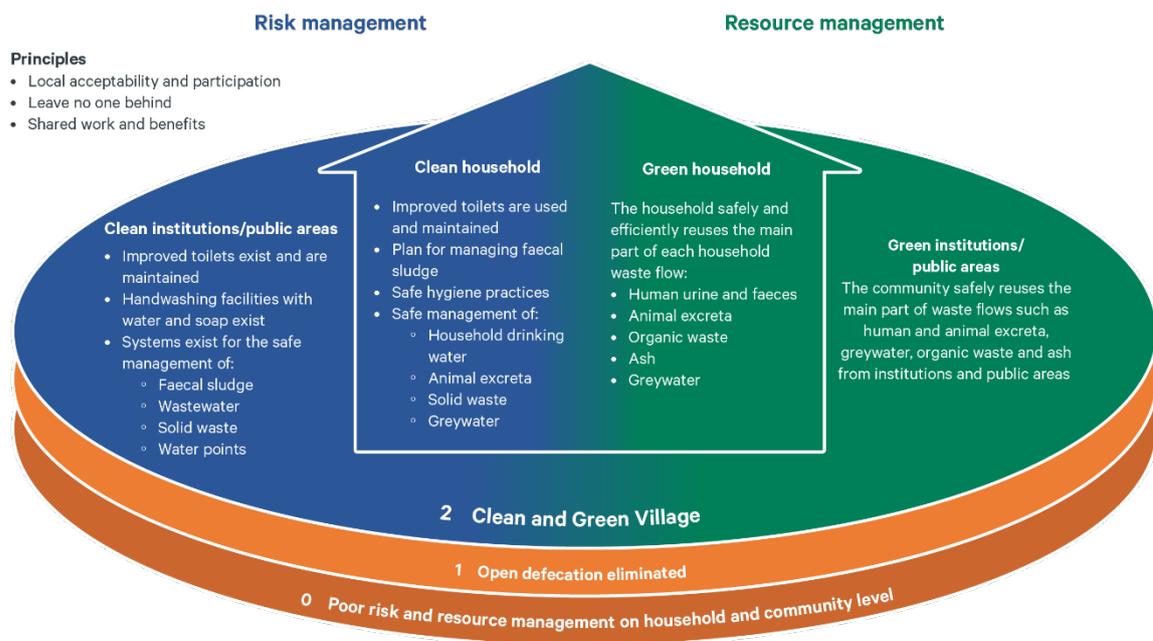


Figure 14: Overview of the C&G framework. Level 0 represents the baseline situation in many rural communities. Level 1 is often part of rural sanitation interventions and corresponds to open defecation-free status and basic and adoption of basic hygiene practices. At Level 2, ambitions expand toward comprehensive local risk management (Clean), and safe and productive waste management (Green) (source Dagerskog et al., 2023)

A first G&G pilot was implemented in Burkina Faso between 2020 and 2023 by WaterAid-BF, Eau-Vive International (EVI) and SEI in three villages, as an action research component of the PHA-3R programme (Figure 15).

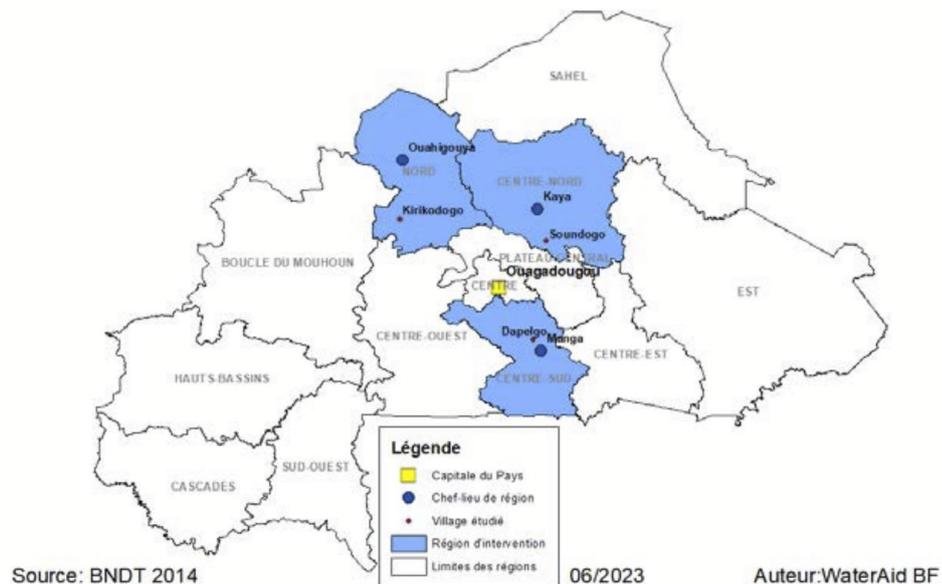


Figure 15: The three regions of the PHA-3R programme, including the three VPP pilot villages

The C&G implementation followed seven key steps after the achievement of ODF-certification:

1. Baseline study and anchoring: Assess community knowledge, attitudes and practices of communities to adapt the intervention and the tools accordingly.
2. "Waste resource" triggering: Create interest in systematic recovery of waste resources.
3. Create awareness and strengthen capacity by conducting community and household sessions on risk and resource management in the local context.
4. Adoption of different technological options and hygiene practices to protect health and enable safe reuse.
5. Establishment of farmer field schools for hands-on training on the reuse of human excreta, composting techniques and soil and water conservation where relevant.
6. Monitoring progress through self-assessment and home visits.
7. Recognition/certification for household and/or community Clean & Green status.

Although limited project duration meant that step 6 and 7 were not fully implemented, the experience yielded several important lessons:

- **Public health and agricultural benefits reinforce each other:** The C&G framework shows that going beyond conventional sanitation goals (such as eliminating open defecation) to include agricultural reuse of waste (human and animal excreta, greywater, etc.) strengthens community engagement. Rural communities, often facing

declining soil fertility and limited access to chemical fertilisers, can see the benefits of recycling for better yields and food security, while the process also improves the cleanliness of the home environment.

- **Success depends on participatory and context-adapted approaches:** C&G introduced participatory tools (resource flow mapping, farmer field schools) that helped identify risks and resources specific to each community. Rather than promoting a single technology, C&G supports technological neutrality, adapting solutions (Ecosan latrines, composting, traditional latrine + urinal, etc.) to local preferences, capacities, and constraints. This flexibility encourages community ownership and long-term adoption.
- **Scaling up requires political commitment and alignment with the agricultural sector:** Expanding C&G beyond pilot villages demands strong political will, including the integration of waste reuse into agricultural and environmental policies. Collaboration with agricultural services (extension agents, agronomists, INERA, etc.) is critical to ensure the safe, effective, and productive reuse of sanitation by-products.

Future C&G initiatives can draw on three reports that have been published in French in addition to other publications on the website² (Table 8).

Table 8. Reports on Clean and Green village (C&G) in French

Report title	Overview
Dagerskog et al (2023): Advancing the Clean and Green Village (C&G) Sanitation Framework to Improve Health and Agricultural Production: Perspectives from Burkina Faso	This brief presents the C&G framework, gives an overview of implementation tools and discusses the relevance and prospects of C&G in the rural context of Burkina Faso. Source: https://www.sei.org/publications/village-propre-productif-burkina-faso/
Dagerskog (2023): The Resource Flow Mapping Tool	The resource flow mapping tool helps participants to visualize resource flows and identify the strengths and weaknesses of their current system, as well as options to improve their situation. Source: https://www.sei.org/wp-content/uploads/2023/11/sei2023.056-exercice-flux-guide.pdf
Dagerskog and Liera (2023): Clean and Green Village –	Proposes indicators and methods for monitoring the components of the Clean and the Green track

² <https://www.sei.org/projects/clean-and-green/#publications>

In addition – a short film by WaterAid Burkina Faso is available here: <https://www.facebook.com/watch/?v=2017317968611267>

2.7 Experiences in Burkina Faso of other options for human excreta reuse

Beyond the use of hygienised urine and feces from urine diverting dry toilets, other excreta recovery processes have been explored in Burkina Faso, including composting, biogas production and biochar.

2.7.1. Composting

Composting of human excreta remain rare in Burkina Faso. However, Hema (2024) characterized dry sludge (from unplanted drying beds) from the cities of Bobo-Dioulasso and Ouagadougou, finding high levels of organic matter in 3-year old sludge and nutrient content with an average of 2.22% N, 1.42% P and 0.08% K for sludge aged > 3 years, with C/N ratios ranging from 9–12, i.e. similar ratios to those of composts. However, the slightly acidic pH (4.8–6.5) suggested the need for liming before agricultural application.

2.7.2. Biogas

Human feces can also serve as a source of renewable energy. According to a review by Rose et al (2015) a human produces typically 100–250 g/person/day of faeces (wet weight), with an average around 150 g/person/day. With an estimated 75% water content, this means 37.5 g/person/day dry weight. Bond et al (2011) estimates biogas potential of 0.35–0.5 m³/kg dry matter from human waste, which equates to annual biogas production of ~5–7 m³/year, or roughly 25–40 kWh/person per year in heat energy that can be directly used for cooking or lighting in household settings, or transformed to electricity through a generator in more centralised plants.

Tapping into this energy source requires the installation of biodigesters. Biogas is produced by the fermentation of human, animal or plant organic matter in the absence of oxygen. In addition to the biogas generated, the digestate can then also be reused as an organic fertiliser.

In Ouagadougou, the company FasoBiogaz operates a large-scale biodigester that co-digests wastewater sludge with organic waste to increase gas production. The system has a processing capacity of 400 m³ of mixed sludge per day, and includes a combined heat and power (CHP) engine to convert biogas to electricity. However, the plant has operated at less than half of its potential since inauguration (Ouedraogo et al. 2023).

The digestate from FasoBiogaz plant is further used by 3T Services to produce compost as highlighted in the interview with the 3T Services manager below:

Mr. BADO André, Manager of 3T Services (Transport, Technology and Trade)

“The 3T company produces and market compost (solid and liquid organic) based on animal rumen contents collected at the Ouagadougou refrigerated slaughterhouse (Figure 16). The company collaborates with the Faso Biogaz company, which uses the same feedstock for biogas generation. The biogas is converted into electricity and fed into the SONABEL national grid, while the digestate is used by 3T to produce compost.

3T produces approximately 1,500 tons of compost annually, enriched with Burkina phosphate, dolomite, ash, crushed bone meal, etc., depending on the objectives of organic or organo-mineral amendments. The main clients include the Ministry of Agriculture and Fisheries, Non-Governmental Organizations (NGOs), and individuals (market gardeners, cereal growers, and horticulturalists). The main difficulties we encounter are:

- *Ensuring consistent production and market promotion of our composts.*
- *The limited technical supervision from agricultural and research authorities in the manufacturing process and evaluation of the physicochemical characteristics of composts and their impacts on the soil and agricultural production.*
- *The lack of support for the development of compost production sheets and technical extension sheets.*
- *The reluctance of financial structures (banks etc.) to support the financing of our activities.*

Looking ahead, we plan to increase our production capacity by acquiring mechanical mixers and expanding our composting areas. This expansion will support the government's agro-sylvo-pastoral offensive programme, which prioritizes the provision of organic fertilisers to rural communities in order to boost agricultural production.”



Figure 16: Dolomite-enriched compost pile (left) and a compost drying bed (right)

The **National Biogas Programme of Burkina Faso (PNB-BF)** was launched to promote renewable energy derived from organic waste, particularly animal manure and agri-food residues. The biogas is used for cooking and lighting in the households and institutions that operate the systems, and the digestate can be reused for agricultural production. The programme aims to contribute to the creation of a permanent, viable, and market-oriented multi-stakeholder sector for the construction and operation of biodigesters.

The programme was implemented in two phases — from 2010 to 2013 and from 2014 to 2018 — under the leadership of the Government of Burkina Faso with support from various partners. To gain a better understanding of the reuse component of the national biogas programme, Mr Somda at PNB-BF was interviewed:

Mr. SOMDA W. Serge, Agricultural Extension Officer at PNB-BF.

“The households use the digestate at the end of the biogas production cycle in agricultural production or sell it. This is because of the excellent quality of the digestate obtained, which is an organic fertiliser that can:

- *restore degraded soils;*
- *increase yields;*
- *produce animal feed;*
- *produce an organic pesticide.*

When households sell the surplus digestate, this improves their income and strengthen their autonomy to reinvest in their farm.

In Burkina Faso, the number of biogas devices installed in households by the PNB-BF is estimated at 16,476 biodigesters.

The challenges related to the promotion of these systems in Burkina Faso are twofold. At the household level, they include a permanent supply of animal waste and achieving behavioural change so that families fully integrate the biodigester into their daily routines. At the sector level, the lack of a financing mechanism for biogas production remains a major constraint for the upscaling of this programme.”

2.5.5. Biochar

Biochar is carbon-rich material produced by pyrolysis, heating biomass such as crop residues (rice husks, maize cobs etc.) while limiting air-inflow. Biochar can then complement composting, because it uses lignified waste that is not used in composting.

Because of its stable aromatic structure, biochar is resistant to microbial degradation and can improve soil fertility, water retention and carbon sequestration (Baldock and Smernik, 2002).

In Burkina Faso, the production and use of biochar currently remains limited and at the experimental stage. The production of biochar from human excreta, although possible, has not yet been explored.

2. 8. Conclusion of chapter 2

Burkina Faso has established legal and policy frameworks governing the management of excreta, wastewater and organic waste. While these frameworks encourage reuse of by-products, they lack detailed regulatory guidance on how such recovery and reuse should be conducted. Similarly, agricultural policies remain largely focused on mineral fertilisers, leaving organic sources less recognized and standardized. As a result, reuse of key waste flows is still not mainstreamed in Burkina Faso, despite the significant potential to improve soil fertility and agricultural production.

Field experiments in Burkina Faso on the reuse of hygienised urine and faeces in agriculture have also shown equal or better agronomic performances compared to mineral fertilisers. Estimates indicate that the quantity of N, P and K available in human excreta surpasses the current national application of chemical fertilisers in Burkina Faso and represents a value of 100 to 221 billion CFA francs per year depending on fertiliser prices.

Thirty-three (33) Ecosan projects could be identified in Burkina Faso in the period 2002–2024, providing valuable experiences and recommendations for future implementation and scaling up. The Clean and Green framework connects Burkina Faso’s unique Ecosan experience with the current national rural sanitation focus on ending open defecation (ODF). In this framework, once ODF-status is achieved, rural communities address wider risks (clean) and also recover and reuse resources in local waste flows (green) in a structured way.

However, Clean and Green would likely need further refinement and piloting, including impact assessment, to become part of any national policy or program.

Beyond its agricultural value, excreta and organic waste can also serve as a source of renewable energy through biogas production, as demonstrated by the national biodigester programme and other initiatives in Burkina Faso.

CHAPTER 3: PATHWAYS TO MAINSTREAMING RESOURCE REUSE

3.1 Introduction

Building on the analyses in Chapters 1 and 2, this chapter presents reuse perspectives from the WaSH and agriculture sectors (3.2), examines the specific challenges and opportunities in rural and urban contexts (3.3), summarizes insights from stakeholder consultations (3.4) and outlines recommendations for moving from pilots to mainstreaming resource reuse (3.5).

3.2. WaSH and agricultural sector perspectives on resource reuse

From the WaSH sector perspective, the priority is to ensure that sanitation by-products are managed in ways that protect health and the environment while also providing usable resources. Burkina Faso has developed policy frameworks such as the decree on autonomous sanitation and the National Programme for Wastewater and Excreta Management (PN-AEUE). Notably, the PN-AEUE emphasises reuse in its third objective: “to optimise the management and valorization of wastewater and faecal sludge in a perspective of environmental and social protection.” The decree on autonomous sanitation is also a significant step as it regulates the entire chain from containment to treatment and reuse for on-site sanitation solutions. However, its real impact will depend on the ministerial orders (arrêtés) still to be developed by different ministries. These will define treatment standards, certification systems for reuse products, licensing rules for operators, and health and environmental safeguards. Until these instruments are in place, both WaSH and agricultural actors face uncertainty, and the scaling up of safe reuse will remain constrained.

From the agricultural sector perspective, sanitation by-products offer a valuable but underused resource for restoring Burkina Faso’s soils. Beyond nutrients such as nitrogen, phosphorus, and potassium, they can also provide organic matter that improves soil structure and water-holding capacity, as well as the water itself present in wastewater. Agronomic trials and pilot initiatives have shown that hygienised urine and faeces can equal or outperform mineral fertilisers. Yet, agricultural policies and programmes in Burkina Faso remain mainly oriented toward mineral fertilisers, with subsidies and development plans reinforcing this bias. Sanitation by-products are not formally acknowledged as legitimate inputs, nor are they integrated into extension services, subsidy schemes, or input markets. As a result, farmers receive little guidance or institutional support to adopt reuse practices.

In summary, the WaSH sector is responsible for safely recovering and supplying usable sanitation by-products, while the agricultural sector is needed to create demand and integrate these inputs into farming systems. Unlocking this potential depends on stronger alignment of policies, programmes and extension services across the two sectors, so that safe reuse becomes a normal part of soil fertility management rather than a series of isolated pilot projects..

3.3 Rural and urban resource recovery and reuse loops

Strategies for resource recovery and reuse must also reflect the different realities of rural and urban areas. Burkina Faso remains predominantly rural, with 67% of the population living in rural communities³. This means that rural solutions will remain critical for decades to come, even as urbanization and the associated urban sanitation challenges grow.

Rural short and local loops: In rural Burkina Faso, some reuse of waste resources already takes place, particularly animal manure, crop residues, some wood ash and in some instances human excreta. However, much potential remains untapped, and existing practices are not always safe or optimized. Strengthening these short recycling loops requires community-based approaches—such as the Clean and Green framework—that help households and villages manage all household waste flows safely and encourage reuse of the nutrient, organic matter and water resources present.

Urban longer and more complex loops: In towns and cities, sanitation by-products are generated in greater volumes and often involve different actors that manage collection, transport, treatment, and reuse. Here, effective recovery depends on infrastructure, regulations, and functioning markets. Investments in treatment plants, regulations and certification systems, and viable business models are important to ensure that products flow safely from the point of waste generation to the agricultural and energy end-users.

Rural and urban areas therefore require different but complementary approaches to resource recovery and reuse: strengthening local recycling loops in rural communities and building regulated, large scale reuse systems in urban centers. Together these should be guided by a shared national vision for safe resource recovery.

3.4 Insights from stakeholder consultation

A stakeholder consultation carried out by the expert group in November 2024 with representatives from government, civil society, academia, and farmer organisations confirmed many of the challenges identified in earlier chapters:

- **Infrastructure and financing:** Limited coverage of sludge and wastewater treatment facilities, high construction costs for latrines, and difficulties in mobilizing sustainable funding.

³ World Bank data: <https://data.worldbank.org/indicator/SP.RUR.TOTL?locations=BF>

- **Community adoption:** Low uptake of organic fertilisers due to limited availability of raw materials, lack of awareness of benefits, and absence of standardized, trusted products.

At the same time, participants identified several priority actions: accelerating implementation of the PN-AEUE, subsidising appropriate sanitation facilities for households, promoting awareness of reuse benefits, expanding funding for sanitation projects, and strengthening community education on safe practices. These perspectives provide important input for shaping the recommendations in the final section.

3.5 Recommendations

Based on findings in Chapters 1 and 2 and the perspectives of key stakeholders, five strategic areas of action emerge:

1. Policy, regulations and guidance

- Strengthen the implementation of the PN-AEUE, especially its objective on optimising valorisation.
- Accelerate the development of ministerial orders (*arrêtés*) to operationalize the decree on autonomous sanitation, including treatment standards, certification systems, and safety guidelines.
- Update agricultural policies and fertiliser programmes to recognise sanitation by-products as legitimate inputs, and integrate them into extension services and eventually also subsidy schemes.
- Develop joint technical guidelines for safe and effective agronomic use of sanitation by-products.
- Define a national vision and roadmap for safe reuse of sanitation by-products and other organic wastes
- Differentiate strategies for rural and urban areas: support short local loops in rural settings; build regulated reuse value chains in urban contexts.

2. Awareness and capacity building

- Train WaSH actors, extension agents, and agricultural professionals in safe management of sanitation by-products along the sanitation chain, including field application.
- Use farmer field schools, demonstration plots, and practical guides to build farmers' skills and confidence in safe reuse.
- Conduct community campaigns to raise awareness of the agronomic, environmental and health benefits of safe reuse.

3. Research and innovation

- Support further applied reuse-related research on the agronomic performance, environmental impacts, and health risks of reuse under Burkina Faso's soils and farming conditions.
- Encourage innovation in context-adapted infrastructure and treatment options that reduce reuse costs.

4. Finance and incentives

- Mobilise dedicated financing for sanitation infrastructure that enables safe resource recovery.
- Provide targeted incentives for farmers and entrepreneurs adopting reuse practices.
- Explore the possibility to align resource recovery initiatives with climate, land restoration, and food security funding streams.

5. Partnerships and coordination

- Strengthen coordination between WaSH and agricultural institutions at national and local levels.
- Foster partnerships among government, civil society, research institutions, and the private sector to scale up successful pilots.
- Further explore integrated community approaches, such as *Clean and Green*, that can be used for upscaling productive sanitation in rural areas.

In Burkina Faso's Sahelian context — marked by variable rainfall, widespread soil degradation, and dependence on rain-fed agriculture— the reuse of sanitation by-products offers an important lever for enhancing agricultural productivity and make better use of scarce local resources.

To unlock this potential, stronger coordination between the WaSH and agricultural sectors is essential, aligning the "resource supply" role of sanitation with the "resource demand" of farming systems. By further developing policies, regulations and implementation approaches suited to both rural and urban contexts, Burkina Faso can make productive sanitation a driver of soil restoration, food security, public health and environmental protection.

BIBLIOGRAPHIC REFERENCES

- ACTEA (2018). L'assainissement écologique au Burkina Faso: quelles expériences, quelles conditions de réussite et quelles pistes d'amélioration? www.actea.org/wp-content/uploads/2018/04/cr_atelier-Ecosan_VF.pdf
- Alley, M.M., Vanlauwe, B. (2009). The Role of Fertilisers in Integrated Plant Nutrient Management. (TSBF-CIAT (ed.); First edit). IFA.
- Baldock, J., Smernik, J.R. (2002). Chemical composition and bioavailability of thermally altered *Pinus resinosa* (Red pine) wood. *Organic Geochemistry*, Vol. 33 (2002), p.1093–1109, [https://doi.org/10.1016/S0146-6380\(02\)00062-1](https://doi.org/10.1016/S0146-6380(02)00062-1)
- Bationo, A., Lompo, F., Koala S. (1998). Research on nutrient flows and balances in West Africa: State-of-the-art. In: Smaling EMA (ed) Nutrient Balances as Indicators of Production and Sustainability in Sub-Saharan African Agricultural. *Agric Eco Environ* 71:19–36
- Bond, T., Templeton, M. R. (2011). History and future of domestic biogas plants in the developing world. *Energy for Sustainable development*, 15(4), 347–354.
- Bonzi, M., Lompo, F., Kiba, I. D., Kone, A., Ouandaogo, N., Sédого, P. M. (2011). A Study of the Agronomic Efficiency of human Stool and urine on Production of Maize and Egg Plant in Burkina Faso. In Innovations as Key to the Green Revolution in Africa: Exploring the Scientific Facts (pp. 641–649). Dordrecht: Springer Netherlands.
- Carrasco, M., Dubé, A., Bassono, R. (2014). Efficacité des interventions en matière d'hygiène et d'assainissement: Etude de cas des latrines EcoSan dans le cadre du projet d'appui à l'assainissement familial dans 12 communes rurales des régions du Plateau Central et du Centre-Ouest au Burkina Faso de 2011 à 2014, IRC www.ircwash.org/sites/default/files/2014_10_29_irc_lvia_rapport_ecosan.pdf
- Cobo, G.J., Dercon, G., Cadisch, G. (2010). Nutrient balances in African land use systems across different spatial scales: A review of approaches, challenges and progress. *Agriculture, Ecosystems and Environment*, Vol. 136 (2010) p. 1–15 doi:10.1016/j.agee.2009.11.006
- Crétenet M., Gourlot J.-P. (2016). The cotton plant. CTA, Tropical Agriculture in your pocket, Wageningen, Netherlands. ISSN: 1778-6568. 216p
- Dagerskog, L., Dickin, S. and Savadogo, K. (2020). Return to learn: Recommendations from revisited rural ecosan projects in Burkina Faso. *Waterlines*, 39(1). 61–72. <https://doi.org/10.3362/1756-3488.19-00008>
- Dagerskog, L., Dickin, S., Savadogo, S., Sebgo, D., Yameogo, M. (2023). *Avancement du Cadre d'Assainissement « Village Propre et Productif » (VPP) pour Améliorer la Santé et la Production Agricole : Perspectives du Burkina Faso*. SEI Report. Stockholm Environment Institute. <https://doi.org/10.51414/sei2023.054>
- Dagerskog, L., Liera, C. (2023). *Village Propre et Productif – Suivi des progrès réalisés au niveau des ménages, Version 1*. SEI Report. Stockholm Environment Institute. <https://doi.org/10.51414/sei2023.055>
- Dagerskog, L. (2023). *Flux des Ressources (FdR): Guide de mise en œuvre*. SEI Report. Stockholm Environment Institute. <https://doi.org/10.51414/sei2023.056>
- Dakouré, M., Traoré, M.B., Sossou, S.K., Maïga, A.H. (2017). 'Development of

sanitation technologies in african context: how could we make it more sustainable?'
IOP Conference Series: Earth and Environmental Science 60(1): 012032
<https://doi.org/10.1088/1755-1315/60/1/012032>

Dao, J., Lompo, D.J., Stenchly, K., Haering, V., Marschner, B., Buerkert, A. (2019). Gypsum Amendment to Soil and Plants Affected by Sodic Alkaline Industrial Wastewater Irrigation in Urban Agriculture of Ouagadougou, Burkina Faso. *Water Air Soil Pollut* , 230–282.
<https://doi.org/https://doi.org/10.1007/s11270-019-4311-x>

Dickin, S., Dagerskog, L., Jiménez, A., Andersson, K., Savadogo, K. (2018). Understanding sustained use of ecological sanitation in rural Burkina Faso. *Science of the Total Environment*, 613. 140–48. DOI: 10.1016/j.scitotenv.2017.08.251

Gomgnimbou, A. P. K., Coulibaly, K., Sanon, A., Bacyé, B., Nacro, B. H., Sédogo, P. M. (2016). Study of the nutrient composition of organic fertilizers in the zone of Bobo-Dioulasso (Burkina Faso). *Int. Jour. Sci. Res. Sci. Eng. Tech*, 2(4), 617–622.

Hema, S.A. (2024). Effects of amendments based on dry sewage sludge associated with natural phosphates and montmorillonitic clay on agro-pedological parameters under maize (*Zea mays* L.) and cotton (*Gossypium hirsutum* L.) in two agro-ecological zones of Burkina Faso. Single Doctoral Thesis in Rural Development, Specializing in Soil Science. NAZI Boni University. 174 p.

Jonsson, A, Land, A. (2017). An Evaluation of the Long-Term Functionality of Ecological Sanitation (EcoSan) Projects in Rural Burkina Faso: Reuse of Sanitized Human Excreta as Fertilizer in Local Agriculture, Msc thesis, royal institute of technology, stockholm, sweden
www.diva-portal.org/smash/get/diva2:1128388/FULLTEXT01.pdf

Karg, H., Akoto-Danso, K.E., Drechsel, P., Abubakari, A.H., Buerkert, A. (2019). Food- and feed-based nutrient flows in two West African cities. *Nutr . Cycle . Agroecosyst .*, Vol.115, p. 173–188.
<https://doi.org/10.1007/s10705-018-9944-4>

Karg, H., Drechsel, P., Akoto-Danso, K., Edmund, G., Nyarko, G., Buerkert, A. (2016). Foodsheds and City Region Food Systems in Two West African Cities. *Sustainability*, Vol. 8, 1175.

Kvarnström , E., Dagerskog, L., Norström , A., Johansson, M. (2012). Nutrient reuse as a solution multiplier (SIANI policy brief 1.1), A policy brief by the SIANI Agriculture–Sanitation Expert Group, Sweden https://www.siani.se/wp-content/uploads/2017/10/siani_policy_brief_-_nutrient_reuse_130204_web.pdf

Lompo, F. (1993). Contribution to the valorization of natural phosphates in Burkina Faso. Study of the effects of the phosphate–organic matter interaction. Thesis Doctorate . Ing . National University of Côte d'Ivoire 249 p.

MAAH (2019). National Strategy for Soil Restoration, Conservation and Recovery in Burkina Faso 2020–2024. Final version. 59p.

MARAH (2022). Statistical dashboard of agriculture, animal resources and fisheries 2021. Report. 83 p.

Maatman A., Sawadogo H., Schweigman C. and Ouedraogo A. (1998). Application of zaï and rock bunds in the north west region of Burkina Faso. Study of its impact on household level by using a stochastic linear programming model. *Netherlands journal of Agriculture science*, 46: 123–136.

MEEA (2022) Document Cadre de Gestion de la Filière Assainissement des Eaux Usées et Excréta au Burkina Faso 2022–2026

https://www.pseau.org/outils/ouvrages/dga_document_cadre_de_gestion_de_la_filiere_assainissement_des_eaux_usees_et_excreta_au_burkina_faso_2022_2026_2022.pdf

Ouedraogo, N. I. G., Konaté, Y., Sawadogo, B., Beré, E., Sodré, S., & Karambiri, H. (2023). Characterization and Methanogenic Potential Evaluation of Faecal Sludge: Case of the Kossodo Biogas Plant in Ouagadougou. *Sustainability*, 15(23), 16401.

Richert, A., R. Gensch, H. Jönsson, T.-A. Stenström, L. Dagerskog, with contributions from: M. Kjellén et al. (2010). Practical Guidance on the Use of Urine in Crop Production. SEI, EcoSanRes series: 2010-1. ISBN 9789186125219.

Rose, C., Parker, A., Jefferson, B., & Cartmell, E. (2015). The characterization of feces and urine: a review of the literature to inform advanced treatment technology. *Critical reviews in environmental science and technology*, 45(17), 1827–1879.

Roose, E. (1981). Current dynamics of tropical ferrallitic and ferruginous soils in West Africa. Experimental study of technological and sociological transfers of materials under natural or cultivated vegetation. Works and documents of ORSTOM, n°130, 569 p.

Roose, E. (1985). Land degradation and development in West Africa. *Bull. research . Agron . Gembloux* , Vol. 20 (3/4), 505–537

Roose, E., Sabir, M. (2015). Restoration of low terraces devastated by torrents in the High Atlas (Morocco). Restoration of the productivity of tropical and Mediterranean soils. Contribution to agroecology. Preliminary version, Editions IRD. pp. 441–448

Sanchez, PA, Shepherd, KD, Soule, MJ, Place, FM, Buresh, RJ, Izaac, AMN, Mokwunye , AZ, Kwesiga, FR, Ndiritu, CG Woome, PL. (1997). Soil fertility replenishment in Africa: An investment in natural resource capital. In: Buresh, et al. Replenishing Soil Fertility in Africa. SSSA Special Publication Number 51:1–46.

Sedogo, M. (1993). Evolution of tropical ferruginous soils leached under cultivation: impact of management methods on fertility. Doctoral thesis in science, National University of Côte d'Ivoire, 333 p.

Sou, Y.M. (2009). Recycling wastewater in irrigation: fertiliser potential, health risks and impacts on soil quality. Swiss Federal Institute of Technology of Lausanne. Doctoral thesis in science. 162p.

Stoorvogel, J.J., Smaling, E.M.A. (1990). Assessment of soil nutrient depletion in sub-Saharan Africa: 1983–2000. Flight. III. Literature review and description of Land Use Systems. Wageningen (The Netherlands) The Winand Staring Centre, Report 28, 4 Vol. 1

Traoré, M.B., Dakouré, M.S., Maïga, A.H. (2017) Ameli-EaUr project: which lessons for the promotion of agricultural value chains? IOP Conference Series: Earth and Environmental Science 60(1): 012033 <https://doi.org/10.1088/1755-1315/60/1/012033>

Vanlauwe , B., Dobermann, A. (2020). Sustainable intensification of agriculture in sub-Saharan Africa: first things first! *Forehead. Agr . Sci . Eng.*, 7. <https://doi.org/https://doi.org/10.15302/J-FASE-2020351>

World Health Organization (2006). Guidelines for the safe use of wastewater, excreta and greywater (Vol. 4). World Health Organization <https://iris.who.int/handle/10665/78280>

Zoungana, M. (2021). Study of the optimization of fecal sludge management by the implementation of a GIS: case of the city of Ouagadougou, Burkina Faso. Master II thesis in Water, Sanitation and Hydro-agricultural Engineering (GEAAH), 2ie, 63 p.