SalvaTerra

NATURE-BASED SOLUTIONS

Key results and lessons learned from IFAD Adaptation for Smallholder Agriculture Program (ASAP)

TECHNICAL PAPER

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Acronyms and abbreviations

AFOLU	Agriculture, forestry and other land use
ASAP	Adaptation for Smallholder Agriculture Program
CCA	Climate Change Adaptation
BIRDP	Butana Integrated Rural Development Project
EbA	Ecosystem-based Adaptation
EC	European Commission
EX-ACT	EX-Ante Carbon-balance Tool
FNML	Southern Laos Food and Nutrition Security and Market Linkages Programme
GGWSSI	Great Green Wall for the Sahara and Sahel Initiative
GHG	Greenhouse gas
GIS	Geographical information system
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IFAD	International Fund for Agriculture Development
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem
IUCN	International Union for Conservation of Nature
LPDP	Livestock and Pasture Development Project
NbS	Nature-based Solutions
NEMA-CHOSSO	National Agricultural Land and Water Management Development Project
NICADAPTA	Adapting to Markets and Climate Change Project
NRM	Natural resources management
PASIDP	Participatory Small-Scale Irrigation Development Programme
ProDAF	Family Farming Development in Maradi, Tahoua and Zinder Regions
SNNPR	Southern Nations Nationalities and Peoples Region
ToR	Terms of Reference
UNFCCC	United Nations Framework Convention on Climate Change

Nature-based Solutions – ASAP IFAD – Technical paper

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Executive summary

The Nature-based Solution (NbS) concept emerged during the United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP 15) in 2009. It was developed from the Ecosystem-based Adaptation (EbA) concept that integrates biodiversity and ecosystem services as part of an overall adaptation strategy, but makes a paradigm shift from focusing solely on nature (EbA), to focus on people and nature (NbS)[1]. NbS put in perspective the fact that people can proactively protect, manage or restore natural ecosystems, as a significant contribution to addressing six major societal challenges: climate change, food security, water security, human health, disaster risk, social and economic development. The NbS concept is increasingly being applied.

Several NbS definitions still exist. IUCN one is '*actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits*'[2]. Some specific tools to operationalize the concept have been developed, among others by IUCN, the World Bank[3], IPBES[4], the EU-funded ThinkNature[5], the University of Oxford[6], GRISCOM[7] (the latest providing an exhaustive list of NbS in the Agriculture, Forestry and Other Land Use – AFOLU – sector).

This technical paper seeks to present key results and lessons learned on NbS from IFAD ASAP portfolio. NbS have been analysed based on five criteria: climate change adaptation and disaster risk reduction; climate change mitigation potential; provision of non-carbon ecosystem services; food security and income generation; social benefits. Each criteria is divided into sub-criteria, with a definition and example of evidence that specifically applies to ASAP. Seven case studies have been developed in seven countries, illustrating the diversity of NbS implemented under ASAP:

- In Tajikistan, pasture rotation was developed for the Livestock and Pasture Development Project, second phase (LPDP-II). This NbS considers changing the way animals are grazed, exercising control over where and when livestock can occupy portions of the rangeland, thereby allowing natural ecological processes to favour rainfall use efficiency, plant growth and biodiversity.
- In Sudan, the Natural Resources Governance Framework was implemented through the Butana Integrated Rural Development Project (BIRDP). This NbS is geared towards a better management and shared use of natural resources in the target areas, including farmlands, rangelands and water.
- In Gambia, mangrove restoration was developed for the National Agricultural Land and Water Management Development Project (NEMA-CHOSSO). This NbS aims at making both environmental and socioeconomic conditions more sustainable for communities, while strengthening an ecosystem that plays a key role in terms of climate adaptation and mitigation, and biodiversity enhancement.
- In Nicaragua, the NbS 'Shade trees in diversified croplands' was implemented through the Adapting to Markets and Climate Change Project (NICADAPTA). It integrates a combination of

[1] Mace, G., 2014. Who's Conservation? Science 345 (6204).

[2] Cohen-Shacham, E., Walters, G., Janzen, C., Maginnis, S., 2016. Nature-Based Solutions to Address Societal Challenges. Gland, Switzerland: International Union for Conservation of Nature.

[3] Van Wesenbeeck, B. K., et al., 2017. Implementing nature-based flood protection: principles and implementation guidance. Working Paper n°120735. World Bank.

[4] Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

[5] Recorded at the Horizon 2020 Clustering Action "Transforming Cities, Enhancing Well-being: innovating with nature-based solutions" which took place at the University of A Coruna in 2018.

[6] https://www.naturebasedsolutionsinitiative.org

[7] Griscom, B. W., et al., 2017. Nature climate solutions. PNAS Vol 114 N°44 11645-11650.

Diversified Agricultural Systems and Agroforestry Systems approaches, that tends to benefit both environment conservation/restoration and enhancing food security as well as wood availability.

- In Laos, the NbS 'Effective Microorganisms' was set up through the Southern Laos Food and Nutrition Security and Market Linkages Programme (FNML). It contributes to improve soil fertility in vegetable gardens (and croplands) and reduce pest/insect invasion. It is composed of various blends of predominantly anaerobic microorganisms that positively influence the growth of plants.
- In Ethiopia, watershed management was implemented under the Participatory Small-Scale Irrigation Development Programme phase II (PASIDP II). This NbS contributes to sustainably increase soil fertility and productivity through activities such as: trainings, micro watershed management plans, biophysical soil and water conservation technics and trees nurseries.
- In Niger, land restoration through the ProDAF has enabled the conservation and restoration of natural resources, such as soil and water; the adaptation to climate change; the enhancement of productive capacities on agricultural and pastoral lands, thus improving the resilience of small-scale producers.

The main lessons learnt from ASAP case studies are as follows:

- NbS often simultaneously meet several of the five above-mentioned criteria.
- NbS are particularly relevant to ASAP objectives and vice-versa ASAP is an interesting portfolio to test and promote NbS.
- NbS may contribute to wider environmental projects, such as the Great Green Wall for the Sahara and Sahel Initiative (GGWSSI), on which IFAD is also currently engaged.
- The active involvement of local communities and authorities is critical for the success of the NbS, and must be promoted through intensive mobilization and trainings.
- For greater chance of success, NbS can be combined with other activities that more directly support livelihood assets at individual, households and/or community levels. Related inputs and skills training need to be available and accessible at local level to smallholder farmers.
- Labour-intensive NbS (e.g. digging trenches) often require significant external financial resources and specific approaches (e.g. cash for work schemes).
- NbS often promote a wide diversity of local plants/trees, which are grown in nurseries, thus creating job opportunities mostly targeting vulnerable women and young people. Such diversity of plants ensures that various households needs are met (timber, firewood, food, incomes, pesticide, etc.).
- NbS may in some cases require long time to develop as they can include multiple and complex activities, such as mobilizing communities or strengthening farmers knowledge.
- Stronger evidence of NbS results and impacts are required based on qualitative and quantitative data, to know which benefits can specifically be attributed to NbS. Wider geographical coverage would also allow NbS to be tested in different contexts and facilitate subsequent scaling up.

As a way ahead towards a stronger operationalization of NbS, more evidence is needed for NbS to be deployed at scale, to ensure the maximum benefits for society and nature. To do so, there is still a need for a Global Standard, on which IUCN members have started working. Related tools and guidance will instruct how to use this standard.

The recommendations suggest that IFAD should:

1. Give wider emphasis to NbS at IFAD strategic and operational levels;
2. Ensure sufficient expertise is available to design, implement and monitor NbS;
3. Implement NbS in different contexts and expand their geographical coverage;
4. Ensure NbS are systematically set up in collaboration with communities and authorities;
5. Produce NbS-specific data.

Introduction

The overarching development goal of the International Fund for Agricultural Development (IFAD) is to invest in rural people to enable them to overcome poverty and achieve food security through remunerative, sustainable and resilient livelihoods. The IFAD Adaptation for Smallholder Agriculture Program (ASAP) aims at mainstreaming climate change in IFAD operations. ASAP is composed of a portfolio of 42 projects active in 41 countries.

Nature-based Solutions (NbS) have the potential to contribute to both climate change adaptation and mitigation, while also enhancing biodiversity. This technical paper aims at presenting the theory and background of the NbS concept, and at showcasing a variety of NbS operational applications within ASAP portfolio. It also seeks to draw lessons from NbS implemented so far and to provide recommendations to inform the ongoing process of drafting a new phase for ASAP. The objectives are to increase the focus on NbS, to better promote them among policymakers and donors, and to support their operationalization and scaling up by IFAD practitioners.

1. The Nature-based Solutions (NbS) concept

1.1. State of the art of the literature

1.1.1. Origin and definitions of NbS

In the 1970's the scientific literature began to integrate the idea of environmental and ecosystem services. At the turn of the 21st century, an understanding emerged that ecosystems need to be managed for adaptation to climate change (HANSEN et al., 2003, cited by COHEN-SHASHAM & al., 2016[8]). The 2005 Millennium Ecosystem Assessment[9] provided a strong evidence linking global ecosystem degradation to a decline in human well-being. This assessment thus promoted the conservation, restoration and sustainable management of ecosystems. Since 2008 the term Ecosystem-based Adaptation (EbA) has been used to define an approach that integrates biodiversity and ecosystem services as part of an overall adaptation strategy to help increase the resilience of people and ecosystems to climate change. EbA served as the foundation for the development of the Nature-based Solutions (NbS) concept and framework, which emerged during the United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP 15) in 2009, making a paradigm shift from focusing solely on nature, to focus on people and nature (MACE, 2014[10]).

NbS put in perspective the fact that people are not only the passive beneficiaries of nature's benefits, but they can also proactively protect, manage or restore natural ecosystems and the services they provide, as a significant contribution to addressing climate change and other major societal challenges. As a recent illustration, as the coronavirus pandemic rattled people's life all over the world, it appeared even more clearly that agriculture needed to be better aligned with ecosystems to strengthen poor farmers' resilience to outbreaks (such as the COVID) as well as longer-term disruption (such as climate change and biodiversity loss)[11].

The NbS concept is increasingly being developed and applied by International Union for Conservation of Nature (IUCN) and other organisations, such as the European Commission (EC). The EC has made NbS part of its Horizon 2020 Research and Innovation Programme and invests in a series of projects to strengthen the evidence base on NbS (MAES & JACOBS, 2015[12]). However, IUCN and the EC have developed their own definitions of NbS, which while broadly similar have a few significant differences.

[8] Cohen-Shacham, E., Walters, G., Janzen, C., Maginnis, S., 2016. Nature-Based Solutions to Address Societal Challenges. Gland, Switzerland: International Union for Conservation of Nature. https://doi.org/10.2305/IUCN.CH.2016.13.en.

[9] Millennium Ecosystem Assessment, 2005. Ecosystems and human well-being. Synthesis.

[10] Mace, G., 2014. Who's Conservation? Science 345 (6204).

[11] Source: https://www.ifad.org/en/web/latest/blog/asset/41952700?inheritRedirect=true

[12] Maes, J., Jacobs, S., 2015. Nature-based solutions for Europe's sustainable development. Conserv. Lett. https://doi.org/10.1111/conl.12216 [online journal].

The framing of the EC has a larger focus on urban ecosystems due to the high proportion of Europeans who live in cities.

The IUCN Programme 2013-2016 has defined NbS as one of its three Programme Areas. It was formalized as such: *'Deploying Nature-based Solutions to Global Challenges in Climate, Food and Development',* thus expanding IUCN's work on nature's contribution to tackling sustainable development issues, particularly as regards climate change, food security, and social and economic development. This NbS Programme Area sought to offer standards and methodologies for nature-based approaches in many sectors.

Through a consultative process IUCN and its membership defined NbS as ***'actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits'*** (COHEN-SHASHAM & al., 2016). Hence, the IUCN definition is action-oriented and refers to three broad types of options: (i) protection, (ii) management and (iii) restoration of ecosystems. IUCN identified six major societal challenges that NbS can address: **climate change, food security, water security, human health, disaster risk, social and economic development**.

NbS can be considered as an umbrella concept covering a range of EbA addressing societal challenges and simultaneously providing human well-being and biodiversity benefits, which in turn can improve the functioning of NbS and have impacts on human well-being (NAEEM et al., 2016[13]). Five categories of EbA can be categorised under NbS:

- Restorative (Ecological restoration, Forest Landscape restoration, Ecological engineering);
- Issue-specific (Ecosystem-based adaptation, Ecosystem-based mitigation, Ecosystem-based disaster risk reduction, Climate adaptation services);
- Infrastructures (Natural infrastructures, Green infrastructures);
- Management (Integrated coastal zone management, Integrated water resources management);
- Protection (Area-based conservation approach including protected area management and other effective area-based conservation measures).

They are summarized in the **conceptual framework** below:

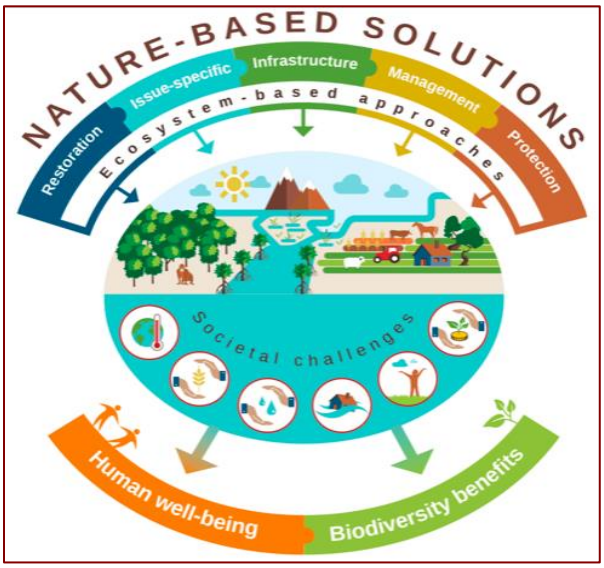

Figure 1. NbS as an umbrella term for ecosystem-related approaches (COHEN-SHACHAM & al., 2016)

[13] Naeem S., Chazdon R., Duffy J. E., Prager C., Worm B. 2016. Biodiversity and human well-being: an essential link for sustainable development. Proc. R. Soc. B.28320162091. http://doi.org/10.1098/rspb.2016.2091

1.1.2.Current principles and framework defined by IUCN

In an attempt to align the multiple definitions of NbS and move towards the operationalization of the concept, IUCN proposed **eight NbS core principles** based on several existing frameworks and consultative processes. According to IUCN, NbS:

1. Embrace nature conservation norms (and principles);
2. Can be implemented alone or in an integrated manner with other solutions to societal challenges (e.g. technological and engineering solutions);
3. Are determined by site-specific natural and cultural contexts that include traditional, local and scientific knowledge;
4. Produce societal benefits in a fair and equitable way, in a manner that promotes transparency and broad participation;
5. Maintain biological and cultural diversity and the ability of ecosystems to evolve over time;
6. Are applied at a landscape scale;
7. Recognise and address the trade-offs between the production of a few immediate economic benefits for development, and future options for the production of the full range of ecosystems services; and
8. Are an integral part of the overall design of policies, and measures or actions, to address a specific challenge.

However, comparative analysis between these principles identified areas of agreement and gaps that need to be addressed to improve impacts; as well as the need to assess how the NbS principles are implemented (COHEN-SHACHAM et al., 2019[14]).

1.1.3.Works carried out to operationalize the concept

IUCN works

Some specific tools have already been defined such as: “Implementing nature-based flood protection. Principles and implementation guidance” (WORLD BANK, 2017[15]) or “Ecological restoration for protected areas: principles, guidelines and best practices” (IUCN WCPA Ecological Restoration Taskforce, 2012[16]). The IUCN has also developed case studies to demonstrate the range of application of NbS in different types of ecosystems and in different regions.

IPBES works

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) recently released a global assessment of biodiversity and ecosystem services (IPBES, 2019a[17] and 2019b[18]). Within its chapters 5 and 6, the document outlines the links between biodiversity and climate change (with a discussion on how to meet climate goals while maintaining nature and nature’s contributions to people) and provides references to pathways and options which help reduce greenhouse gas (GHG) emissions (i.e. options on dietary transitions, local food systems, etc.). Chapter 6 briefly mentions NbS as an approach for sustainable cities (promoting green infrastructure such as green spaces, vegetation and tree cover into existing urban areas) as well as for sustainable freshwater management. The IPBES has not yet conducted a detailed and systematic assessment of

[14] Cohen-Shacham, E., et al., 2019. Core principles for successfully implementing and upscaling Nature-based Solutions. Environmental Science and Policy 98 (2019) 20-29. Elsevier.

[15] Van Wesenbeeck, B. K., et al., 2017. Implementing nature-based flood protection: principles and implementation guidance. Working Paper n°120735. World Bank.

[16] Keenleyside, K., et al., 2012. Ecological Restoration for Protected Areas: Principles, Guidelines and Best Practices. IUCN WCPA Ecological Restoration Taskforce. Developing capacity for a protected planet. Best Practice Protected Area Guidelines Series No.18.

[17] IPBES, 2019a. Global Assessment of Biodiversity – Draft Chapter 5: Pathways towards a Sustainable Future.

[18] IPBES, 2019b. Global Assessment of Biodiversity – Draft Chapter 6: Options for Policy-Makers.

the synergies between climate change and biodiversity and has therefore, a fortiori, not compared/prioritized different NbS according to their estimated co-benefits.

A meta-analysis on the climate mitigation potential of 20 NbS

GRISCOM & al. (2017)[19] conducted a comprehensive meta-analysis of the climate mitigation potential of 'nature climate solutions' or 'natural pathways' in the Agriculture, Forestry and Other Land Use (AFOLU) (sector. The authors identified and quantified 20 conservation, restoration and improved land management actions across global forests, wetlands, grasslands, and agricultural lands, which practitioners may take to avoid GHG emissions and/or increase carbon storage. These NbS are clustered in three groups: Forests, Agriculture & Grasslands, and Wetlands. This is so far one of the only attempts to provide an exhaustive list of NbS in the AFOLU sector. Example activities are proposed for each NbS in the article appendix, as reproduced in the Annex 1.

The article shows that NbS can provide over one-third of the cost-effective climate mitigation needed between now and 2030 to stabilize global warming to below 2°C. It also provides a rough identification of NbS co-benefits, with a focus on four types of non-carbon ecosystems services: biodiversity, water (both filtration and flood buffering), soil health/enrichment, and air filtration. However, the article does not provide in-depth analysis and evidence of the corresponding impacts of each NbS.

ThinkNature project and handbook

The EC-funded ThinkNature project has organized / developed / capitalized on a series of interventions: interviews[20], summer school[21], forum[22] and scenario game[23], providing a range of perspectives of the future of NbS. In 2019 ThinkNature has developed a NbS handbook providing general background knowledge; addressing issues relevant to different NbS stakeholder groups (research and innovation / business sector / policy sector) and formulating key recommendations. ThinkNature handbook more specifically targets urban areas and development.

Nature-based Solutions Initiative (University of Oxford)

The University of Oxford conducts an interdisciplinary programme of research, policy and education on NbS called Nature-based Solutions Initiative[24]. It brings together natural, physical and social scientists with economists, governance and finance experts. The mission of this programme is to enhance understanding of the potential of NbS to address global challenges and increase their sustainable implementation worldwide. It has developed an "evidence platform[25]" and a "policy platform" linking NbS to climate change adaptation. The evidence platform centralizes a total of 303 case studies easily accessible by each of these filters:

- Habitat type (referencing 26 of them, e.g. temperate forests, montane/alpine, created grassland, tropical and subtropical forests, coral reefs, tropical oceans);
- Climate change impact (referencing 22 of them, e.g. water availability, soil erosion, agricultural production, timber production, biomass cover, desertification, coastal inundation, wind damage, pest);
- Intervention type (created habitats, restoration, management, combination, protection, mixed created/non created habitats);

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[19] Griscom, B. W., et al., 2017. Nature climate solutions. PNAS Vol 114 N°44 11645-11650.

[20] Recorded at the Horizon 2020 Clustering Action "Transforming Cities, Enhancing Well-being: innovating with nature-based solutions" which took place at the University of A Coruna in 2018.

[21] Organized by the ThinkNature project in September 2019 in Chania, Greece, and untitled "NbS from theory to practice".

[22] October 2019 in Bucharest, Romania focusing on "Cities and policies" and "Business models and technical aspects".

[23] "Greentown" developed by the ThinkNature partners to demonstrate the impact of choice and thereby the advantages of using NbS.

[24] https://www.naturebasedsolutionsinitiative.org

[25] https://www.naturebasedsolutionsevidence.info

- Effects of NbS on climate change impact (positive, unclear results, negative, mixed results, no effects, not addressed);
- Social outcomes (not reported, positive, mixed, unclear, no-effect);
- Ecosystem outcomes (not reported, positive, mixed, unclear, no-effect).

This platform makes it possible to share research publications about each practical case study that is referenced, and to have access to it in a clear and structured manner. It analyses impacts with regard to climate change, social issues and ecosystems outcomes, with the possibility to cross-analyse them.

Attempts to learn from NbS implementation

The PANORAMA and OPPLA platforms were respectively developed through the IUCN/GIZ partnership and by the EC. The objective of these platforms is to enable a wide variety of institutions and individuals to share their experiences, challenges, lessons learned and success factors following the use of NbS. Together, these platforms contain nearly 850 case studies on NbS across a wide range of issues and geographical areas. OPPLA presents mostly urban challenges, while PANORAMA deals with all environments and a diversity of issues. Each platform groups the case studies by theme. For example, PANORAMA comprises five themes: protected areas, business engagement, agriculture and biodiversity, ecosystem-based adaptation, and marine and coastal, with the possibility to select a region (5 continents), an ecosystem (7 ecosystems proposed), a theme (17 themes, e.g. human development, gender mainstreaming, ecosystem conservation), and a challenge (4 challenges: climate change, ecological, economic and social challenges).

Conclusion

There are still several definitions of NbS, with different points of view on what is a NbS. Although the IUCN definition of NbS is geared towards action, the overall approach and framework still requires a Global Standard and related operationalization tools to support the deployment and upscaling of NbS among the community of actors.

Even though the concept of NbS is particularly relevant for rural poor households to strengthen their resilience and improve their livelihoods, there are still no clear guidelines on how to plan and implement NbS for the rural development sector. For the purpose of this technical paper, we have therefore developed our own grid of analysis, which is broad enough to cover the different themes that NbS encompass, but remains sufficiently simple and user-friendly for practitioners involved in ASAP and other rural development programmes. The case studies that are presented in this paper draw from ASAP experience and will contribute to the development of NbS at the IFAD institutional level.

1.2. ASAP projects analysis framework

1.2.1. Rationale

The Terms of Reference (ToR) of this study proposed 5 criteria of analysis for ASAP projects:

- building climate resilience (to shocks such as extreme weather and pests);
- improved social benefits (including food production, nutrition and water access);
- increased carbon sequestration and increase in biomass level;
- enhancement of biodiversity (both agrobiodiversity and habitat for wild species);
- improved participation of vulnerable groups.

This technical paper seeks to draw lessons from ASAP, whose projects target smallholder farmers and communities, and primarily address the impacts of climate change and biodiversity loss. We therefore look at NbS from the point of view of the benefits and advantages they can provide to smallholders and their communities, with a specific focus on climate change adaptation, resilience to climate shocks and other challenges smallholders may face.

Based on the ToR, we decided to analyse NbS by type of benefit or impact, taking into account three broad categories of impacts: climate-related impacts, impacts on biodiversity and ecosystems, and

socio-economic impacts. We also made sure that there is coherence between the selected criteria and relevant SDG, so that our framework can easily be understood by practitioners.

The 20 NbS listed in GRISCOM's article also helped identifying and screening NbS activities within the sampled ASAP projects.

1.2.2. Proposed framework

The analysis framework consists of 5 criteria, each of them being divided into sub-criteria, with a definition that specifically applies to ASAP and several examples of evidence. In the second part of the report, case studies drawn from ASAP projects illustrate in concrete terms different types of NbS and the criteria or sub-criteria they address, in connection with the typology proposed by GRISCOM.

Criteria	Sub-criteria	Criteria application to ASAP NbS activities	Examples of evidence
1. Climate change adaptation and disaster risk reduction	**1a. Adaptation to the long-term trends and effects of climate change** (e.g. higher average temperature, concentration of rainfall over a shorter period of time, changes in seasonal patterns)	NbS activities help smallholder farmer and communities cope with the long-term effects of climate change	Crops and varieties are climate tolerant Irrigation water is available during dry spells Forage is available when needed
	1b. Resilience to climate-related shocks i.e. extreme weather events (floods, drought, cyclones, etc.) and disease/pest proliferation	NbS activities increase the capacities of smallholder farmers and communities to withstand and recover from shocks linked to climate change	Risk of large crop failure is reduced Livelihoods are diversified Floods are better controlled Pest attacks are reduced Households can meet their livelihood needs after climate disasters
2. Climate change mitigation potential	**2a. Reduction of GHG emissions** including reduction in energy use and resource efficiency	NbS activities have the potential to avoid or reduce CO2 or other GHG emissions	Forest fires are avoided or better managed Farmers turn away from slash-and-burn Rice-cropping practices reduce methane emissions Livestock feeding reduce methane emissions Farmers have access to renewable energy, including for irrigation Firewood is used more efficiently
	2b. Improvement of carbon and other GHG pools	NbS activities contribute to increase in biomass level and have the potential to store carbon or other GHG	Forests are conserved or restored Wetland drainage is avoided Pulse production is increased
3. Provision of non-carbon ecosystem services	**3a. Enhancement of biodiversity** including agrobiodiversity and wild species	NbS activities contribute to the enhancement of biodiversity at the ecosystem, interspecific and intraspecific levels	Farmers have access to a diversity of crops/varieties Local varieties/breeds are maintained Local seeds systems are enhanced Agroecosystems remain a habitat for wild species
	3b. Preservation of freshwater resources including irrigation potential	NbS activities ensure the availability of freshwater for human consumption, livestock and irrigation purposes	Water is used optimally for agricultural production Communities have access to safe drinking water Water pollution by agrochemicals is avoided Catchment are conserved through community or natural resources management (NRM) institutions backed by local governments

Criteria	Sub-criteria	Criteria application to ASAP NbS activities	Examples of evidence
	3c. Soil conservation and improvement	NbS activities preserve the health and productive potential of soils	Soil erosion is reduced Soil fertility renewal is ensured Soil water absorption and storage capacity is preserved Degraded lands are restored
	3d. Reduction of air pollution	NbS activities have positive effects on outdoor and indoor air quality	Spraying of chemicals is reduced Domestic smoke is reduced
4. Food security and income generation	**4a. Improvement of food production** including agricultural, livestock and fisheries production	NbS activities contribute to the food and nutrition security of smallholder farmers and communities	Agricultural yields are increased Food gaps are reduced Diet diversity is improved
	4b. Improvement of incomes including farm and non-farm incomes	NbS activities provide sustainable incomes for smallholder farmers and communities, and in particular for youth and landless vulnerable groups	Cash crops are sustainably developed Access to stable markets for cash crops and surplus production is secured Incomes from forest products are increased Households diversify their income sources
	4c. Local job creation including for unemployed people	NbS activities create better/secure job opportunities for smallholder farmers and communities	Decent jobs in local value chains are enhanced Out-migration is reduced
5. Social benefits	**5a. Improvement of land access**	NbS activities contribute to secure land rights and access of smallholder farmers and communities	Rural poor local communities secure their access to their lands and natural resources Land conflicts are reduced
	5b. Capacity building	NbS activities contribute to build local capacities and knowledge	Local knowledge and know-how are preserved Communities increase their knowledge on the use and management of natural resources Communities engage in co-creation and experimental learning
	5c. Social cohesion and inclusion of marginalized groups	The benefits of NbS activities are shared among the whole community, ensuring participation of and added-value for every households and individuals according to their needs and capacities	Vulnerable groups such as youth, landless rural poor and persons with disabilities take part in the identification and implementation of NbS Conflict drivers are reduced
	5d. Gender equality and women's empowerment	NbS activities contribute to gender balance and the empowerment of women	Women leadership is enhanced Women are aware of their rights and duties Women gain financial autonomy

2. Key results from the implementation of NbS in ASAP projects

2.1. Overview of the types of NbS implemented in ASAP projects

Even though they were not defined as such in project documents, several NbS have been implemented within ASAP portfolio. The table below shows the projects and NbS we have screened for the purpose of this technical paper, as well as sub-criteria they relate to. This list of NbS is not exhaustive, but rather seeks to reflect a diversity of NbS implemented in various contexts; sample projects are representative of the different types of ASAP-funded interventions. The selection of NbS and projects was done under the supervision of IFAD ECG team members, taking into account the availability of data on NbS implementation methods and results.

Each NbS is described in more detail in section 2.2 in the form of case studies in order to inspire further projects.

ASAP project / Country	NbS	NbS category	Main sub-criteria addressed (and secondary ones[26])
Livestock and Pasture Development Project (LPDP) / TADJIKISTAN	Pasture rotation (or rotational grazing)	Grassland management / optimal grazing intensity	3a / 3b / 3c (2b / 4a / 4b)
Butana Integrated Rural Development Project (BIRDP) / SUDAN	Natural Resource Governance Framework	Grassland and natural forest management	5a / 5b / 5c / 5d (2b / 3c / 4a)
National Agricultural Land and Water Management Development Project (NEMA-CHOSSO) / GAMBIA	Mangroves restoration	Coastal wetland restoration	4a / 4b (1b / 2b / 3a)
Adapting to Markets and Climate Change Project (NICADAPTA) / Nicaragua	Shade trees in diversified croplands	Trees in cropland	1a / 2b / 3a (3c / 4a / 5b)
Southern Laos Food and Nutrition Security and Market Linkages Programme (FNML) / LAOS	Effective Micro-organisms	Soil fertility and pest management	3c / 4a / 5b (4b)
Participatory Small-Scale Irrigation Development Programme phase II (PASIDP II) / ETHIOPIA	Watershed management	Watershed management	1a / 1b / 3b / 3c / 4a / 5b (2b / 3a / 4b / 5d)
Family Farming Development in Maradi, Tahoua and Zinder Regions (ProDAF) / NIGER	Land restoration	Cropland and grassland restoration	1a / 1b / 2b / 3b / 3c / 4a / 5b (3a / 4b / 4c / 5d)

[26] Secondary sub-criteria are the ones that are addressed by the NbS but to a lesser extent than the main ones.

2.2. NbS case studies

2.2.1. Tajikistan LPDP-II case study: restoring pasture ecosystems through rotational grazing

Pasture rotation (or **rotational grazing**)[27] was developed for the Livestock and Pasture Development Project (LPDP) in Tajikistan.[28] This NbS is about changing the way animals are grazed, exercising control over where and when livestock can occupy portions of the rangeland landscape, thereby allowing natural ecological processes to favour higher rainfall use efficiency, more plant growth and greater diversity of species in the vegetation.

NbS type: Grassland management / optimal grazing intensity

Highlighted sub-criteria:

This NbS provides a range of ecosystem services and specifically meets sub-criteria 3a – Enhancement of biodiversity, 3b – Preservation of freshwater resources and 3c – Soil conservation & improvement.

Other sub-criteria covered include: 2b - Improvement of carbon and other GHG pools, 4a - Improvement of food production and 4b – Improvement of incomes.

Key facts

Project name	Livestock and Pasture Development Project, second phase (LPDP-II)
Duration	2016-2021
Target groups	38,000 smallholder livestock households in 180 communities of 5 Districts in Khatlon Region
Financing	Government of Tajikistan, IFAD, ASAP Trust Fund, Debt Sustainability Framework, beneficiaries

Background and development challenge

In Tajikistan, pastures underpin the resilience of communities. In most villages in the LPDP area, more than 80% of households own livestock. The average size of a household herd comprises 4-5 sheep and goats, often a cow, and maybe a donkey. Communal herds of livestock owned by many households are managed as one herd. Poor households usually have additional income from remittances from men working in Russia, or from small village enterprises.

Overgrazing and pasture degradation is a major problem throughout Central Asia, especially near villages.[29] Lower livestock production on degraded pastures affects the livelihood of many thousands of livestock-dependent households. In Tajikistan, overgrazing is linked to a growing population of livestock and a history of unregulated pasture use since 1991. Often, it is more a problem of livestock carrying distribution than of overloading, hence the interest of better planning the management of pasture.

The extent of landscape and gully erosion is immense in Tajikistan, occurring on at least 80% of the pasturelands and particularly intense near villages at lower elevations. The silt soils prevalent in Khatlon region have very poor physical structure and are particularly susceptible to erosion and landslides. Poorly managed livestock grazing is the principal driver of erosion. The greatest climate-change threat to Tajik pastures is the occurrence of severe storms causing accelerated soil erosion.

[27] This case study mostly builds on a lesson learning note prepared by Dr. Ben NORTON, 21 May 2020, as well as other material he provided. Dr. NORTON served as an international advisor on the LPDP-I, 2014-15, then carried out several supervision missions for LPDP-I and LPDP-II.

[28] LPDP-I was completed in 2018 after 7 years of implementation. LPDP-II is a time extension and geographical expansion of LPDP-I.

[29] On the other hand, some areas are also under-grazed, particularly at high altitude, because the access infrastructures to the summer pastures set up by the Soviets have disappeared due to lack of maintenance.

NbS description

Pasture rotation is a management method that maximizes pasture growth without reducing the number of animals. On the contrary, carrying capacity is likely to increase. Within LPDP-II, pasture rotation is part of the Community Resilient Pasture Management and Investments sub-component, which objective is to reverse the trend of destructive grazing, use pastures more efficiently and raise the efficiency of livestock production.

The rationale for rotational grazing is simple: more forage growth; more root growth with roots extending deeper into the soil; higher infiltration of rainwater where it falls; less erosion; and more diverse vegetation that includes a variety of desirable perennial forage species.

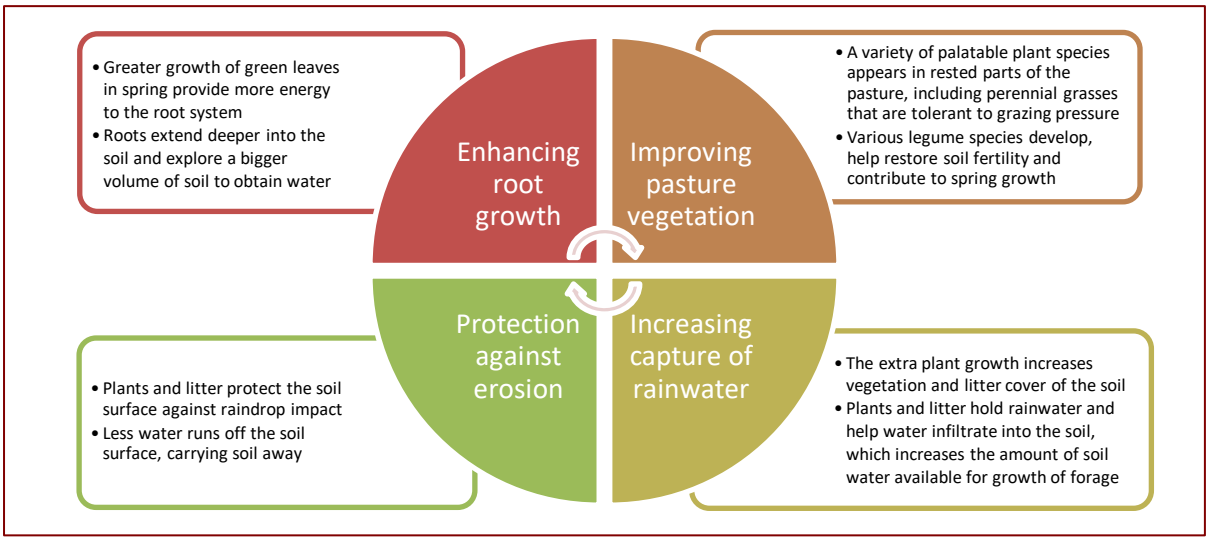

Figure 2. Rationale for rotational grazing

Pasture rotation takes the current pasture area and the livestock that use that area and simply changes the way in which livestock harvest the pasture forage. Instead of the entire pasture being exposed to grazing animals all the time, livestock access to pasture is restricted to small portions grazed by the herd for short periods. After a short grazing period, the herd moves to another small grazing unit. The first grazing unit is allowed to recover and grow freely for the remainder of the season. There is no requirement to introduce plant species or irrigation water. This lap of time gives the chance to a diversity of plants in the bank of seeds in the soil to grow, hence a more diverse vegetation; it could also reduce the presence or emergence of invasive plant species (e.g. Caragana) and protect endemic species.

In Tajikistan, the principal management unit is the Pasture Users Union (PUU), one per village, to which all households in the village belong. They have an elected Board of 9-10 members (at least three of whom must be women) and executive officers. They can collect fees, receive support from donors and the government, purchase equipment, manage infrastructure and supervise pasture management. 180 PUUs were established under LPDP-II. Grazing rotations on rangeland – locations and sizes of grazing units, composition of communal herds and timing of grazing periods – are determined each year by the PUU Board and presented to PUU members for discussion and ultimate approval. The Board appoints a Grazing Supervisor to oversee the implementation of the grazing plan. The Supervisor directs herders on where to go on the communal rangeland, when to go and how long they can stay in a grazing unit. Most PUUs have a chart showing a graphical representation of their grazing schedule.

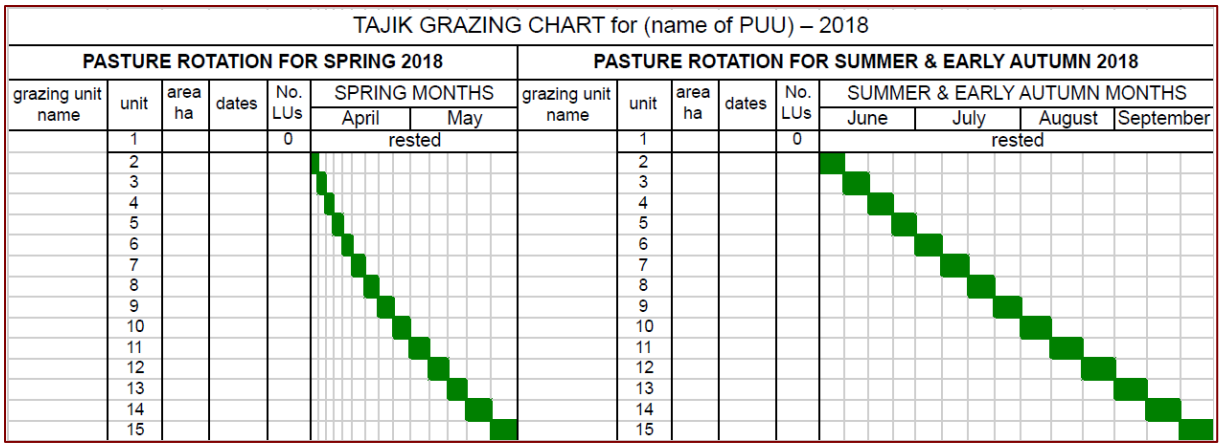

Figure 3. Example of an initial grazing plan for 15 grazing units

The LPDP rangeland specialist trained PUU leaders in the principles and practice of rotational grazing. Within each District, a Community Facilitator (generally an NGO hired by the project) provided direct liaison between PUUs and the central Project Management Unit (PMU) and guided the local grazing plan management. Part of the training was to conduct internal study tours involving high-performing PUUs who share experiences with PUUs that are struggling. In addition, a Pasture Rotation Bulletin was designed to explain the principles involved to project staff and communities. Pasture rotation performance is monitored by the PMU using indicators such as pasture production in demonstration plots[30], condition of grazed pastures, and livestock milk yield and liveweight.

Key results & impacts

Rotational grazing with each unit grazed only once per year has been almost universally adopted by LPDP beneficiaries. As of September 2019, 179 PUUs (out of the 180 targeted under LPDP-II) had pasture rotation plans with satellite maps and detailed grazing schedule. Pasture rotations are a relatively low-cost change to pasture use and give a substantial return on investment. PUUs have reported benefits of the rotation in terms of: (i) more forage on the pastures, with better quality (more diversity, more legumes, less unpalatable species); (ii) bigger, heavier, fatter livestock; (iii) higher milk yield, often enough for a surplus to household consumption which can be processed into milk products for sale; and (iv) more livestock in village herds.

Under LPDP-I, more than 80,000 ha of pastureland (accounting for about 60% of the total area of pastures available in the target districts, and 86% of the total area covered by pasture in the 203 target villages) were improved in productivity as a result of implementing rotational grazing. Under LPDP-II, an additional 32,000 ha had been improved by the end of 2019. A survey conducted in 36 PUUs concluded that the pasture productivity had increased by 8% for the total biomass and by 19% for the eatable biomass. This indicates a qualitative improvement of pasture, which is a logic effect of introduction of rotation but could also be attributed to the better rainfall in 2019. This change should be confirmed on the longer term.

The increase in available forage led to higher levels of livestock production and health. These benefits helped particularly women from poor households, who could sell or barter milk produced beyond the household's immediate needs. Numbers of livestock in household herds increased, allowing higher income from market sales. The overall nutritional status of targeted communities is also likely to have improved.

In ecological terms, more cover of vegetation and litter reduced the threat of soil erosion. Where rotational grazing has been adopted, erosion has been controlled. Pasture rotation is the primary mechanism for combatting the adverse effects of climate change, and it has broad application over entire landscapes.

[30] Each village community is required to establish a 1-ha fenced demonstration plot, which serves to estimate plant production on a site protected from livestock and to track change in vegetation composition. They can be used to test broadcast seeding of palatable forage species, and trials of tree planting to provide shade in grazed rangelands.

According to an EX-ACT analysis[31] conducted on 10 IFAD investments supported by ASAP, a very similar project in Kyrgyzstan induces the second highest overall project mitigation benefits (more than 2 million tons of CO_2 equivalent), most of which is attributed to controlled grazing and winter and spring pasture improvement.

Constraints and limits

There is evidence from LPDP that pasture rotation is yielding benefits. The LPDP-I impact assessment carried out in 2018 highlights a number of positive impacts, which are, however, difficult to attribute to any single activity.[32] With regard to environmental impacts, the effects of pasture rotation require a long time to be seen. Future projects should include a more focused assessment of its benefits (e.g. assessment of the nutritive value of pasture, remote sensing analysis of pasture of all PUUs, repeated botanical surveys to assess the impact on the floristic composition of pasture). Monitoring pasture production in demo plots presents a number of biases, in particular due to the specific conditions of these demo plots (fencing, fertilizer use, full deferred grazing), which are unlikely to be scaled-up. Botanical monitoring may either be conducted directly in the pastures or through indirect methods (e.g. analysis of pollen of colonies of honeybees placed at several locations within the project area).

The rest period in a pasture rotation is likely to heal erosion gullies. However, data are not available to demonstrate it. Although rangeland conservation methods such as gully protection and reclamation, windbreaks, etc. have been envisaged in project design there is little evidence of these being recognised as a priority during implementation. There needs to be greater emphasis on these aspects by the PUUs and their supporting Community Facilitators and the PMU.

Winter fodder remains a major limitation to livestock production in Khatlon region, a situation exacerbated when the winter season extends longer than usual.

An additional constraint might be the complexity of the rotation system and the expertise required to manage, with varying degrees of success in the implementation of PUUs and pasture management plans depending on the country and local context.

Lessons learnt

Technically speaking, there are 5 key components to achieve the best results from pasture rotation in agro-ecological contexts such as the Tajik one: (i) delay spring grazing until the environmental temperature gets higher, so that grazed plants can quickly recover their leaf canopy, thereby decreasing the risk of erosion[33]; (ii) graze each portion of the pasture for no more than 1 week and (iii) only once per year;[34] (iv) from year to year, change the calendar date at which a portion of pasture is subjected to grazing, so that an individual part of the pasture is never grazed at the same calendar time in consecutive years; (v) completely rest the worst degraded areas for an entire year.

In terms of management structure and training, external expertise was instrumental to guide the implementation of rotational grazing and pasture management activities, considering that IFAD's country presence is limited[35]. Rotational grazing for LPDP was designed by an international pasture management advisor working with a local rangeland specialist.

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[31] The EX-Ante Carbon-balance Tool (EX-ACT) is an appraisal system that provides ex-ante estimates of the impact of agriculture and forestry development projects, programmes and policies on the carbon balance. The carbon balance is defined as the net balance from all GHGs that were emitted or sequestered due to project implementation, expressed in tons of carbon dioxide equivalent (CO_2e). In other words, it refers to the difference that a project makes as compared with a 'business as usual' scenario, with 'project' referring to an IFAD investment that includes ASAP and other financing sources.

[32] Significant positive impacts were reflected on livestock income, herd size and animal weight as well as stronger household resilience to the most frequently occurring shocks.

[33] In a continental climate with winter-spring rains, pastures are vulnerable to trampling damage during early spring grazing when temperatures are still low, plant recovery from grazing is slow and the ground is wet.

[34] To achieve both objectives in components (ii) and (iii), it may be necessary to adjust the size of grazed portions to prevent the need to re-graze them. That will likely result in a concentration of livestock in small areas of the pasture. But if the grazing period is short and the area will not be grazed again that year, ecological damage from short-term heavy grazing is unlikely to occur.

[35] The FAO Investment Centre has had the lead in design and subsequent supervision of LPDP (I and II).

Unless rotational grazing is implemented faithfully and completely, as it is in Tajikistan, it will not work, not yield the benefits that are supposed to occur. The role of herder often changes from household to household and from week to week, and therefore a Grazing Supervisor is critical to a rigorous organization of the rotation. This person should be very familiar with both the community pasture and the grazing plan.

In the Tajik context, the success and long-term sustainability of a rotational grazing regime on extensive communal rangeland depends on a legal framework that grants authority to villages to manage the land, land tenure arrangements that provide security of communal ownership of rangeland, and an effective management structure with accountability to the village households. The increased livestock herd and size may also raise some issues of concerns with regard to the carrying capacity and to the environmental benefits obtained through establishment of rotational plans on pastureland.

Lack of water available in grazed pastures in Khatlon region has caused herders to return to the village with their livestock in the middle of the day to drink at the village well.[36] The grazing area may be 4-5 km or more from the village, which entails a round trip of 8-10 km to obtain water. The livestock maintenance cost of these long-distance walks is at the expense of weight gain and milk production, and may negate any production benefits created by pasture rotation. The project has introduced access bridges and drinking troughs to shorten these trips. When viewed in the context of reducing livestock productivity loss and household poverty, waterpoint development in grazed summer pastures that lack available drinking water, is important.

A sound rotational grazing plan can be disrupted if livestock move onto spring pastures too early in the season. Yet the pressure to take animals out of the barn at the end of winter and put them on rangeland is strong. This problem can be addressed by ensuring that there is an abundance of stored hay and fodder to last through winter into the early spring. A key feature of LPDP was to supply PUUs with agricultural equipment, seed and fertilizer to facilitate the production of fodder crops.

2.2.2. Sudan BIRDP case study: linking a rights-based approach with sustainable management of natural resources

The **Natural Resource Governance Framework (NRGF)**[37] is a NbS implemented through the Butana Integrated Rural Development Project (BIRDP) in Sudan.[38] It is mainly geared towards a better management and shared use of natural resources in the target areas, including farmlands, rangelands and water.

NbS type: Grassland and natural forest management

Highlighted sub-criteria:

This NbS meets all four sub-criteria under criteria 5 (social benefits), namely: 5a – Improvement of land access, 5b – Capacity building, 5c – Social cohesion and inclusion of marginalized groups and 5d – Gender equality and women's empowerment.

Other sub-criteria include: 2b – Improvement of carbon and other GHG pools, 3c – Soil conservation & improvement and 4a – Improvement of food production.

Key facts

Project name	Butana Integrated Rural Development Project (BIRDP)
Duration	2008-2019 (BIRDP)
Target groups	90,000 households in 540 communities of ten localities in the five states of Khartoum, Gedaref, River Nile, Gezira and Kassala
Financing	Government of Sudan, IFAD (incl. ASAP), Italy, beneficiaries

[36] Animal scientists are not certain that a mid-day drink is necessary, but nevertheless that is the custom in Tajikistan, especially during summer months.

[37] This case study builds on a working note shared by David RADCLIFFE, Consultant, 12 May 2020.

[38] BIRDP was completed in September 2019 after 10 years of implementation. An ASAP grant of $3 million was provided as part of an additional funding package for the final three years of the project.

Background and development challenge

Located in the central eastern part of Sudan, Butana is a Sahelian environment where rainfall amount is low, erratic and spatially variable. Periodic droughts lasting 2-3 years are not uncommon. Livelihood systems combine crop farming and livestock raising. Butana has a population of about 800,000 people, most of whom live in settled communities. Butana is also used for wet season grazing by semi-nomads and transhumant herders. Agriculture depends essentially on harvesting of rainwater and wadi cultivation. Poor communities have the following characteristics: reliance on agro-pastoral and pastoral modes of production, with limited access to irrigated scheme or mechanized farms; lack of permanent water source; absence of social services; average to severe deterioration of the vegetation; and distance from dry season markets. Before the project starts, the quality of social capital was also described as very low and women were particularly disadvantaged, excluded and marginalized.

In terms of natural resources management (NRM), local communities have low awareness of their rights and how to exercise these rights in developing more sustainable models of production. Natural resources in Butana are under pressure from outside interests such as large-scale commercial farming, uncontrolled grazing and artisanal gold mining. Apart from "grabbing" land and water resources on which communities depend such activities are often environmentally damaging. Climate change, in the form of increasing temperatures and less predictable rainfall, imposes additional pressure on an already fragile agro-ecosystems.

Key NRM needs include: (i) the ability to handle land dispute peacefully, which supposes that communal rights to land are recognized and enforced, especially vis-à-vis outside interests; (ii) the ability to regulate the access to and use of land and water resources through, for example, payment for water or guarding community range or forest land; (iii) the development of organizational experience in managing community initiatives and NRM.

NbS description

The NRGF objectives are: (i) to establish a coherent and cost-effective governance framework that ensures a regulated access to land and water resources of the Butana, and (ii) to help communities sustainably manage natural resources and reduce conflicts among end users (settled farmers and transhumant pastoralists) in Butana.

The approach adopts a model of a 'Butana ecosystem' whose natural resources are overexploited and threatened. Communities thus need to be made aware of their rights and responsibilities with respect to accessing their natural resources and to managing them sustainably. The NRGF provides a framework for identifying priorities and constraints through dialogue and negotiation with government agencies. It involved a heavy consultative process around NRM, with many workshops and stakeholder forums conducted at four levels: communities' clusters (24 forums), Localities (9), States (5) and inter-states (1). This process was interactive and aimed at (i) discussing issues of land tenure and governance of natural resources; (ii) developing a common understanding of the root causes of range/forest degradation; (iii) assuring grassroot stakeholders voice being heard at higher levels; and (iv) reaching agreed actions for addressing legislation issues and enhancing the enforcement mechanisms for better NRM.

Forums are required to have 50% women participants. Discussions are structured around sub-sector themes of water, forest land, rangeland and cropland, animal resources and gold mining. Problems, resulting plans and priorities, and required legislation or regulations, are identified in matrices for each theme. Problems identified at community level are cascaded upwards for action at the appropriate level of government. The inter-state forum identified policies and the required legislation and instruments for their enactment and implementation.

Key results & impacts

NRGF implementation has resulted in outcomes at different levels. Following its bottom-up methodology most tangible outcomes are at the community cluster or locality level. Some examples are: (i) adoption of protection of communal as well as government forests collectively by a community (Abu 'Ushar women's group); (ii) provision of incentives or salary payments for forest guards (Shorfa village); (iii) practical steps by communities to register their communal forests (Balaa' Al Haiya village community); (iv) documentation and activation of customary regulations related to natural resource management in 10 communities; (v) community lobbying in taking collective action in resisting the establishment of new

ceramic factory inside 'Andalha forest. In addition, over 2000 km of fire lines have been demarcated in community forest, and local orders have been issued by New Halfa Locality to prevent encroachment of other activities on dryland fodder, and to prevent land transactions for investment in land in the vicinity of villages. East Gezira Locality issued a local order to regulate and resolve conflicts on land use between agro-pastoral and farming communities.

The establishment and functioning of community networks managing their landscapes together under a joint vision and land-use and development plans, has for now been the outcome that has given more benefits to the communities. It is under these plans in most cases that conflicts over resources have been solved and the communities are seeking the legal recognition of their communal rangeland or forestland. It is also in the networks (with the establishment of women committees and the women village saving and credit clubs) that women have been empowered.

The consultative process led to an improved awareness of natural resource issues, which in turn – together with other project activities such as water infrastructures and harvesting, capacity building in crop and animal production – had positive impact on resilience to drought and climate change.[39]

This NbS also contributed to gender transformation in a conservative society: unlike in the past, women actively participate in community meetings, and assume leadership positions in community development committees (CDC) and community networks. BIRDP had a major impact on women's empowerment, in terms of improving status, respect and self-confidence.

Village networks with organized committees are now acting individually and collectively to improve social relationships, and manage the natural resources at their disposal, reduce conflict over them, mobilise support for common initiatives to protect rangelands, build *hafirs* (artificially constructed water catchment basins), and venture into youth led social enterprises. The NRGF thus clearly provided a range of social benefits and contributed to build local capacities, including for women.

Improved forest and rangeland management is also a main factor increasing CO_2 storage performance, with an estimated balance of -46.5 tons per hectare of CO_2 equivalent for BIRDP project as per EX-ACT analysis, which ranked ASAP investments in Sudan first among 10 projects in terms of mitigation benefits (with a total of 4 million tons of CO_2 equivalent mainly stored thanks to improved management of forests).

Constraints and limits

The NRGF has been a projected outcome of BIRDP from the outset, but has taken a long time to develop, the entire process of arriving at a NRGF being very demanding as it mobilizes many stakeholders at different levels. A further issue is a sector-focused government structure that impedes an integrated approach to problem solving.

Sustainability of the NRGF approach in the absence of BIRDP is a key issue. The inter-state forum decided that the Federal Ministry of Agriculture and Forest has taken on the responsibility to supervise and lead the process of implementing the NRGF's proposed policies, institutional and legislative arrangements in collaboration with relevant stakeholders at federal, state, locality and community levels. However, the civic-government engagement established through the NRGF needs to be strengthened and institutionalised and the Butana Development Fund (BDF)[40] needs to become effective.

Lessons learnt

The NRGF has provided a structure that empowered people to discuss their interests and rights with respect to natural resources through local networks, and to pursue their priorities with authorities at various levels of government. Considerable time and investment have gone into its development. An argument could be made that it is too ambitious and resource intensive, but it deals with complex and often contentious issues including those of a political nature. Timelines are long in the development of new policies, institutions and regulations.

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[39] An impact assessment carried out in 2019 showed that 83% of respondent households perceived enhanced resilience as one of the project's positive impacts.

[40] The BDF was established during the project course as a legal entity to sustain BIRDP achievements as well as to oversee and coordinate other development interventions in Butana. It replaced the Butana Development Corporation (BDA), which remained dormant in spite of project efforts to revitalize it.

The NRGF aims to resolve some of the contradictions between customary rights and statutory laws. The former are eroding due to increased pressure on natural resources. A finding is that there is more enforcement of laws and regulations at local level than at higher levels of government

For this type of NbS to be successful and to get full community engagement, it needs to be combined with tangible activities that support livelihood assets. In the BIRDP example, the combination of a community empowerment process with other interventions including improved access to resources/services and multi-faceted capacity building has led to improved wellbeing, including better food and nutrition security and strengthened resilience and adaptation to climate change.

Despite positive achievements there are some significant threats to sustainability of project achievements. The NRGF has yet to realise its full potential. It is important that it continues to be tested, further refined and scaled up, which is the idea of the IFAD follow-up Sustainable Natural Resources and Livelihood Programme (SNRLP) approved in September 2019.

2.2.3. Gambia NEMA-CHOSSO case study: strengthening coastal communities' livelihoods through mangrove restoration

Mangrove restoration was implemented as part of the watershed planning component of the National Agricultural Land and Water Management Development Project in Gambia.[41] This NbS aims at making both environmental and socioeconomic conditions more sustainable for local communities, while strengthening an ecosystem that plays a key role in terms of climate adaptation and mitigation, and biodiversity enhancement.

NbS type: Coastal wetland restoration

Highlighted sub-criteria:

This NbS specifically addresses sub-criteria 4a – Improvement of food production (including fisheries production) and 4b – Improvement of incomes.

Other sub-criteria covered include: 1b – Resilience to climate-related shocks / extreme weather events, 2b – Improvement of carbon and other GHG pools and 3a – Enhancement of biodiversity.

Key facts

Project name	National Agricultural Land and Water Management Development Project (NEMA-CHOSSO)
Duration	2012-2019
Target groups	23,560 smallholder households in all six Agricultural Regional Directorates along the River Gambia
Financing	Government of The Gambia, domestic financing institutions, IFAD, ASAP Trust Fund, Debt Sustainability Framework, African Development Fund, Islamic Development Fund, beneficiaries

Background and development challenge

The Gambia is a small but densely populated country of West Africa. The accelerated growth of its population[42] is leading to increasing pressure on lands and other natural resources. The wetlands and mangrove degradation has been a major issue in past decades, partly due to unsustainable woodcutting.[43] In addition, the construction of anti-salt dams and dykes led to salinization, acidification

[41] The NEMA project was completed in December 2019 after 7 years of implementation. An ASAP grant (CHOSSO) was approved by IFAD in December 2015 to enhance NEMA activities in expanding smallholder farmers coping options with climate change within the framework of the National Adaptation Plan of Actions.

[42] According to the 2013 population census, the population density was 174 persons per km² (up from 127 per km² in 2003). The population growth rate increased from 2.7% per year between 1993 and 2003, to 3.1% per year between 2003 and 2013.

[43] As the terrestrial land cover is disappearing at a much quicker scale, there seems to be a total switch to the use of mangrove as a source of fuelwood, construction poles, fish smoking, etc.

and mangrove dieback. Wetlands have long been a victim of non-consideration by the general public. They are often described as wastelands, and therefore used for dumping of garbage or often reclaimed for housing. For communities along the river Gambia, mangroves however represent a major source of revenue and livelihood. This ecosystem plays a vital role in the sustainability of the fisheries sub-sector.

The Gambia is considered highly vulnerable to climate change: in the short-term, extreme climate events including windstorms, rainstorms, droughts and dust storms will become more frequent with increased severity. Land use and land cover change, sea level rise, and coastal erosion present significant long-term challenges. Mangroves are particularly vulnerable to climate change. As temperatures and precipitation patterns change, broader tidal ranges are affecting mangroves throughout Gambia and neighbouring countries. Larger tide volumes combined with higher soil salinity have deteriorated swamps across the region.

Mangroves form an important element of Gambia's biological diversity and play pivotal role in the maintenance of functions and process of the estuary system. Mangroves provide habitat for fish, oysters, mud crabs and clams, promoting food sources, fishers' incomes and biodiversity. They also serve as fish nurseries, allowing water life reproduction and sustainability, and provide wood for small community practices, such as fish curing. Their vegetation retains sediments and filter run-off water, preventing coastal erosion and siltation. Moreover, mangroves moderate the climate. They can store carbon dioxide; their destruction may therefore disastrously release great amounts of greenhouse gases into the atmosphere.

NbS description

With the launching of the climate change sub-component of the NEMA-CHOSSO project in 2016, the project has made significant investment in mangrove and forest restoration as key elements of the overall strategy to promote adaptation and resilience. This initiative was part of a watershed development component, which focuses on investments in public and communal economic assets, and also included the establishment of woodlots and agroforestry sites, the development of lowlands and the control of runoff on uplands.

The project partnered with government as well as non-government institutions[44] to launch mangrove restoration through the regeneration of local mangrove species and the establishment of tree nurseries. Like other project interventions, mangrove restoration follows a community-based approach as the community groups identify the activities and project sites before submitting a proposal to the regional agriculture departments. Once approved by the regional directorates, proposals are sent to the project coordination for approval. During the implementation, populations from villages close to mangroves participate in an extensive training and mangrove regeneration exercise to restore degraded mangroves in their communities.

Restoration efforts have been combined with intensive mobilization, sensitization and capacity building to ensure ownership and sustainability of both the initiative and its targeted results. Management committees have been formed and trained at each beneficiary site to manage the investment and ensure community participation. They are also provided with relevant equipment and material support such as motorized boats which they use to collect propagules for mangrove regeneration as well as river transport.

Key results & impacts

Between 2016 and 2019, the project achieved the restoration of 1,458 hectares of mangrove area spread across 43 communities in the West Coast, Lower River, Central River and North Bank regions of the country. For example, the mangrove planting initiative contributed to restore the strategically important Bintang Bolong estuary. The areas of the estuary that suffered from long-term wetland degradation with visible signs of mangrove dieback as well as dwindling fisheries stock and increased salinization were specifically targeted in 2017.

[44] The key partners of the initiative include the Department of Parks and Wildlife Management (DPWM), Department of Forestry (DoF), All Gambia Forestry Platform (AGFP), Makasutu Wildlife Trust (MWT), West Africa Birds Study Association (WABSA) and the Sahel Wetlands Concern (SWC).

Since results quickly exceeded initial targets, a new MoU has been signed with the traditional partners of the NEMA-CHOSSO project for a greater coverage of mangrove restoration, with an additional 630 ha of mangroves being restored.

This NbS shows a high level of satisfaction and ownership by the beneficiaries, who appreciate the investments made so far and are already seeing the benefits. It has been observed by the local people that mangroves as well as fish and oyster stocks are regenerating fast in targeted areas, as illustrated by the example of Bondali Tenda in West Coast Region.

Constraints and limits

There is so far no quantitative assessment of the socio-economic benefits of the mangrove restoration implemented through the NEMA-CHOSSO project. Tracking indicators such as fishing incomes or household diet diversity would probably help providing more evidence of the impacts of mangrove restoration on coastal communities' livelihoods and food security.

Mangrove restoration is likely to contribute to cooling micro-climatic conditions in areas of often high temperatures. Such environmental benefits are however difficult to measure.

The NEMA-CHOSSO project included lowland development activities such as tidal irrigation schemes. Adopting a watershed development approach and prioritizing interventions based on watershed hydrological plans would reinforce the mutual benefits of the different activities (e.g. mangrove restoration nearby tidal irrigation scheme). This however proved to be difficult to implement due to a mismatch in geographic targeting: mangrove restoration rightly focused on densely populated protected areas with high degradation rates, which are far away from the tidal belt.

Lessons learnt

The active participation of local populations was critical for the success of this NbS. It has been promoted through intensive mobilization and training. Over a short period of a week or so, community members came out in large numbers to participate in the tree planting exercise. Decentralized government agencies, such as the Department of Parks and Wildlife Management (DPWM), were also fully involved in the project, which is a promising sign for the sustainability of the project.

Under NEMA-CHOSSO, mangroves located within protected areas (PA) have regenerated fast thanks to the participation of the same communities that were previously contributing to its overexploitation. This tends to show that applying community-based sustainable land and natural resource management in communities adjacent to protected areas (PA) can contribute to reduce the pressures on these PA. This argues in favour of approaches that combine conservation measures with initiatives that ensure local communities can access to and benefit from PA resources for their livelihoods.

2.2.4. Nicaragua NICADAPTA case study: shade trees in croplands, a cross-cutting nature-based solution

The implementation of **shade trees in diversified croplands** is a NbS implemented through the NICADAPTA project in Nicaragua. Through a combination of Diversified Agricultural Systems (*Sistemas Agrícolas Diversificados* – SAD) and Agroforestry Systems (*Sistemas Agro Forestales* – SAF) approaches[45], it tends to benefit both environment conservation/restoration and enhancing food security, as well as wood availability.

NbS type: Trees in cropland

Highlighted sub-criteria:

This NbS meets sub-criteria 1a – Adaptation to the long-term trends and effects of climate change, 2b – Improvement of carbon and other GHG pools and 3a – Enhancement of biodiversity.

[45] SAD and SAF are Spanish acronyms.

It also complies with sub-criteria 3c – Soil conservation/improvement as well as 4a – Improvement of food security. As numerous training sessions were provided on this NbS, it also covers sub-criteria 5b – Capacity building.

Key facts

Project name	Adapting to Markets and Climate Change Project – NICADAPTA
Duration	2014-2020
Target groups	120 coffee and cocoa producer organisations (around 20,000 households) in Jinotega, Matagalpa, Boaco, Madriz, Nueva Segovia, Estelí, Rio San Juan and the Autonomous Regions of the Northern and Southern Caribbean Coast of Nicaragua
Financing	IFAD, Central-American Bank for Economic Integration (BCIE), Government of Nicaragua and beneficiaries

Background and development challenge

The areas targeted by the NICADAPTA project are among those most affected by climate change: Nicaragua is among the ten most impacted nations worldwide by extreme hydrometeorological events during the last twenty years[46], and temperature is expected to rise by 2 to 2.5°C by 2050. Coffee and cocoa are pillar crops for Nicaragua's economy, and account for a large part of employment in rural areas.

This predicted rise in temperature threatens coffee and cocoa production systems, impacting producers' income and food security. Higher ambient temperatures accelerate the ripening of coffee cherries, which decreases the quality of the product. In addition, high-value arabica coffee, especially the type that meets the requirements of the more lucrative specialty markets, requires lower temperatures. Cocoa plants will also be negatively affected, variability in rainfall patterns potentially affecting the sustainability of the crop by accelerating the evolution and reducing the incubation periods of harmful organisms, and modifying the geographical distribution of pathogens and pests.

The NbS presented here is perfectly in line with national climate plans, in the sense that it combines both SAD and SAF approaches, proposing adaptation and mitigation practices to climate change, while reinforcing food security and ensuring land conservation. It was one of the main objectives of the project when using ASAP funds.

NbS description

This NbS is based on crop combination within cocoa and coffee plantations, by associating trees (fruit, timber, musaceous[47]) and/or annual crops (leguminous species).

The introduction of trees in coffee/cocoa plantations, based on agroforestry system models (SAF), accounts for several cross-cutting benefits:

- It provides temporary shade (musaceous) and/or permanent shade (fruit and timber) for coffee and cocoa trees, thus maintaining temperature at decent levels in the plantations;
- Crop diversification is allowed by the introduction of fruit or timber varieties, either enforcing household food security or/and contributing to fuel needs;
- Trees significantly contribute to carbon capture;
- They also provide ecosystem services such as soil conservation or organic matter renewal;
- Plantation of native species allows to promote and conserve local biodiversity.

[46] Global Climate Risk Index.

[47] Musaceae includes bananas and plantains.

Several models have been tested in the NICADAPTA project. Amongst them:

1) Plantain banana trees – cocoa (cf. adjacent picture) or coffee
2) Leguminous tree species (guaba[48]) – coffee
3) Timber species (e.g. granadillo, mahogany and cedar) – cocoa/coffee
4) Fruit species (e.g. lemon tree, orange tree, avocado tree) – cocoa/coffee.

Figure 4. Plantain-cocoa mixed cropping in Nicaragua

In order to enhance soil conservation, leguminous cover crops have also been introduced in cropping systems: cowpea, Canavalia and Mucuna in between coffee/cocoa plants maximize nitrogen fixation and can be used as green manure. These varieties are characterized by a high germination rate and good soil coverage.

This NbS has been the subject of numerous training sessions with producers, which covered 10 topics, including crop diversification and tree pruning for shade management.

Key results & impacts

As a result, 2,717 mz[49] (around 1,900 ha) of cocoa was established in combination with shade species, and 6,205 mz (around 4,344 ha) of coffee was established with the same combination of shade species.

Around 80,000 plants of Musaceae were planted in cocoa and coffee plantations (data from 2018). Leaves are cut to provide organic matter to the soil when the shade is no longer necessary, enhancing soil structure. Musaceae are also natural hosts of the cocoa pollinating fly. In 2018, some of the Musaceae established in the cocoa plantations were already producing bananas.

Over 30,000 plants of fruit varieties were planted (2018) and around 20,000 plants of timber species. Leguminous trees also provide a rich organic matter that enhances soil quality and nutrient availability for crops. Cover crops have been used by 4 producer organisations, over 4 000 kg of seeds were distributed.

The implementation of trees in the coffee and cocoa plots contributes to the reduction of risks related to water deficit, landslides, damages due to extreme meteorological events. This NbS helps recovering degraded areas, caused in most cases by poor agronomic management of plantations and the harmful effects of the last 30 years generated by climate change.

In addition to contributing to household food security, this NbS allows income diversification, strengthening household's resilience.

As per EX-ACT data, NICADAPTA project accounts for an estimated -188,341 tons of CO_2 equivalent sequestrated for the entire duration of the project implementation and capitalization phase[50]. Those figures are mainly attributed to the integration of shade trees in cocoa and coffee plantations. When comparing projects' carbon balance in terms of impact per hectare per year, Nicaragua's agroforestry and cropland restoration activities generate the highest-density impact potential of 2.7 tons of CO_2 equivalent sequestered per hectare per year.

[48] Inga tree (common name shimbillo, subfamily Mimosoideae), a genus of small tropical, nitrogen-fixing trees and shrubs.

[49] Manzana is a local unit. 1 manzana (mz) is equivalent to 0,7 hectares (ha).

[50] Based on results achieved as per March 2020.

As a result of the training and technical assistance developed in the project, 66% of the producers have taken up and implemented actions attributable to NICADAPTA, in order to establish the basic conditions for coffee and cocoa crops to adapt to the new climatic conditions in the project area.[51]

Constraints and limits

Regarding this NbS, two limits were identified. First, no strong evidence has been found that the areas where SAD are implemented are increasing resilience and reducing climate risk yet. The approach used corresponded to diversification of shade types for multiple purposes, but it was not made explicit or documented how such diversification increases resilience and reduces climate risks of coffee and cocoa crops on the organizations' family farms. Measurements will be carried out after the end of the implementation phase.

Second, a lack of definitions, methodology and measurement has been noted as a limit of the project: (i) no definition of what is considered to be climate resilience and risk; (ii) no methodology to determine whether the selected farms are being affected or could be impacted by a climate threat; and (iii) no methodology to measure climate resilience and risk; and, therefore, to determine whether the expected result is being achieved.

Lessons learnt

Prior to the implementation of the project, some tree species had already been introduced into cocoa and coffee plantations. However, these trees were prone to coffee/cocoa diseases, thus limiting their effectiveness in maintaining adequate shade. The project has resulted in the introduction of resistant species that therefore fully fulfil their role as shade providers.

The project, as initially conceived, was to focus on a transition from coffee to cocoa, a more suitable crop given the effects of climate change at work in the target areas. However, this ambition does not translate into the implementation of the project: the accent is set upon adaptation and mitigation practices to be applied in the coffee system instead of advocating a shift from one cropping system to the other. SAF and SAD implementation, combined with the dissemination of cocoa/coffee varieties that are climate change resistant[52] are at the core of the project. The combination of these two practices has made it possible to extend coffee/cocoa plantations where it was not possible to cultivate due to weather conditions, while also increasing crop productivity.

2.2.5. Laos FNML case study: enhancing soil fertility and pest management with Effective Microorganisms

In Laos, **Effective Microorganisms (EM)** is an NbS set up through the Southern Laos Food and Nutrition Security and Market Linkages Programme (FNML), that contributes to improve soil fertility in vegetable gardens (and crop lands) and reduce pest/insect invasion. EM is composed of various blends of common predominantly anaerobic micro-organisms that positively influence the growth of plants[53].

NbS type: Soil fertility and pest management

This NbS meets sub-criteria: 3c – Soil conservation; 4a – Improvement of food production; and 5b – capacity building.

[51] Some more precise results regarding training sessions in 14 organisations show that 76% of coffee producers and 55% of cocoa producers attended the 'culture diversification' training programme, whereas the 'pruning of shade trees' programme was followed by 76% of coffee producers and 71% of cocoa producers. These results tend to indicate a strong interest for these two techniques.

[52] This genetic material was developed by the Government of Nicaragua. Genetic gardens and nurseries were established to expand the scale and increase the provision of these climate resistant varieties to producers.

[53] According to a review article published in 2013, in 70% of published studies, it was concluded that EM had a positive effect on growth of vegetable, while, in the other 30% they had no significant influence. Source: Olle, C.; Williams, Y. (2013). *Effective microorganisms and their influence on vegetable production – a review*. Journal of Horticultural Science & Biotechnology. **88** (4): 380–386

It also complies with sub-criteria: 4b – Improvement of incomes.

Key facts

Project name	Southern Laos Food and Nutrition Security and Market Linkages Programme (FNML)
Duration	2013 - 2019
Target groups	11,485 households
Financing	National Government, IFAD (incl. ASAP), Asian Development Bank, Private sector, beneficiaries

Background and development challenge

Agriculture remains the primary source of subsistence and employment in the rural areas of Lao PDR. This sector has a number of weaknesses: low access to inputs, finances, markets, support services, and technologies; low productivity; income per capita of less than half the national average. The country is one of the most vulnerable to climate change in South East Asia, mainly due to its high dependence on climate-sensitive natural resources and its low adaptive capacity, which further undermines farmers' food and nutrition security as well as potential to produce marketable surpluses. Ethnic minorities are among the most food-insecure, and undernutrition is alarming with 44% of children under five stunted[54].

The FNML programme's goal is to contribute to reducing extreme poverty and hunger. It is implemented in three southern Provinces (and five Districts among the poorest and most remote of the country) : Attapeu (Sanxay and Phouvong Districts), Salavan (Ta Oi and Samuoi Districts), and Xekong (Dakcheung District). It targets a total of 175 villages that combine conditions of poverty with production and market potential. Women constitute a key target group to ensure their equal or priority access to programme benefits.

Smallholder farmers usually practice household gardening to increase food security and nutrition and generate an income. In vegetable gardens and crop lands, many have experienced low soil nutrient content, outbreaks of pests and diseases, that considerably reduce yields. In order to increase production, farmers often apply chemical fertilizer in combination with animal compost. However, the production outputs were not up to expectations and it has been noted that the use of chemical fertilizers has short-term effects on the soil fertility. To address these challenges, IFAD FNML Programme introduced the EM solution technique that improves soil production capacities and thereby enhances yields of home garden vegetables (as well as any other potential crops).

NbS description

EM is a bio-extracting technique based on vegetable waste materials to produce a microbial solution activating plant production. It is created by combining specific microorganisms which work together synergistically such as lactic acid bacteria, yeast and phototrophism bacteria. It activates local and native microorganisms that live in soil (and water) and maximizes their natural power, by restoring a healthy balance of microorganisms in the ecosystem (soil, water), thereby increasing its self-purification ability[55]. EM ferments organic matter within the soil to help activate other beneficial microorganisms. And when desirable microorganisms increase in number, other living things such as worms increase along with them.

Farmers use vegetable waste such as cabbage, pineapple, spinach, mustard, etc. (should be available at an agricultural produce outlet) together with sugar and molasses in the following proportions: 3 kg of

[54] Baseline of the FNML project. See FNML Supervision report, April 2019.

[55] The Professor Teruo Higa, from the University of the Ryukyus in Okinawa, Japan, claimed that three groups of micro-organisms exist: « positive micro-organisms » (regeneration), « negative micro-organisms » (decomposition, degeneration), « opportunistic micro-organisms » (regeneration or degeneration). He stated that in every medium (soil, water, air, the human intestine), the ratio of "positive" and "negative" microorganisms was critical, since the opportunistic microorganisms followed the trend to regeneration or degeneration. Then he claimed it is possible to positively influence the given media by supplementing with « positive » micro-organisms through EM.

vegetables, 1 kg of sugar, 0,5 litter of molasses[56]. Vegetables are initially chopped thoroughly then mixed with sugar and molasses in a 20 litter tank. The mixture is then sealed properly and stored in the shade for one week. It is then opened, mixed again, then stored again in the shade for up to one month. Thereafter, EM mixture is ready for use: one table spoon is to be added to 10 litres of water (the compost is soup-like), and once this has been well mixed, it can be applied to the vegetables in the home garden (or in crop land) by using watering cans.

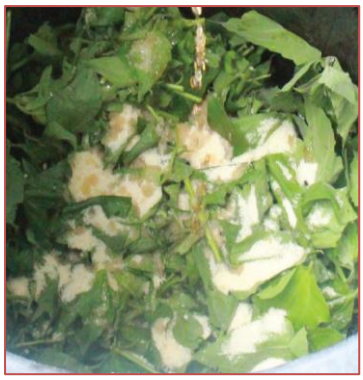

Figure 5. Waste from vegetables, sugar and molasses

Key results and impacts

According to the Collection of Sustainable Land Management Technologies – Practices by smallholder farmers in Lao PDR[57], the EM mixture is easy to produce as it can be based on any types of vegetables wastes, using a simple process. It is also environmentally friendly and does not harm farmer's health.

It is noted that after the application of the EM solution, there are more earthworms around the vegetable plots, while plant pathogens and pests/insects (such as red ants and leaf worms) are significantly reduced[58]. Furthermore, marked increases have been noted in both soil moisture and nutrients: the soil, relatively white and compacted before EM application, becomes black and porous, allowing good water seepage and avoiding water run-off over the surface.

As a result, the vegetables grow well to a good average weight: there is an increase in terms of quality (plants are strong and healthy), diversity (EM application boosts production of all varieties of vegetables) and yield. As a comparison, before using EM, farmers used to harvest 5-6 kg of vegetables per plot; using EM, they are now able to harvest 12 – 15 kg per plot.

Moreover, it reduces household expenses, by eliminating spending required for chemical fertilizers (which are expensive than buying sugar and molasses and need to be applied more and more every year).

EM use has resulted in increased household incomes and improved food security and nutrition, as production is consumed by those who produce them or from local markets.

Limits and constraints

EM use was not implemented from the beginning of the programme, its implementation only started in 2015 and it was deployed on a single site, which makes it difficult to analyse the true impacts and limitations of EM use.

It was noted that EM may favour grass/weeds growth, (such as *Eleusine indica* in the targeted areas), that are not easy to control, thus requiring more input of working hours for weeding.

Another constraint is that, in some contexts, it may be difficult to find molasses in general groceries.

[56] Molasses is a brownish, syrupy by-product which is produced during the sugar refining procedure, i.e., crystallization of sucrose from sugar-cane or sugar beet (Biology online).

[57] Collection of Sustainable Land Management Technologies – Practices by smallholder farmers in Lao PDR. NAFRI, IFAD, WOCAT, Universitat Bern. Vientiane, August 2019.

[58] EM restores a healthy balance of microorganisms in the ecosystem, thereby increasing its self-purification ability.

Lessons learnt

The FNML programme has provided local farmers with experience in the preparation and application of the EM solution, thus building their capacity to improve soil health and produce greater yields in their vegetable gardens. The method is efficient and easily repeatable and the role of preparing the solution could be undertaken by men or women in the communities. Further activities could be conducted to improve farmer incomes, nutrition and women empowerment based on EM results from the pilot. EM has only been used on a small scale and is not mentioned in the supervision reports, so the results of EM use has not yet been reliably reported. More emphasis on the uptake of EM use is required and more time is required to properly analyse the impacts and implications for other ASAP programmes.

2.2.6. Ethiopia PASIDP II case study: watershed management, a broad-based approach to sustainably rehabilitate and conserve soil and water resources

In Ethiopia, **watershed management** is an NbS set up through the Participatory Small-Scale Irrigation Development Programme phase II (PASIDP II). It contributes to sustainably increase soil fertility and productivity and protect irrigation schemes from sedimentation.

NbS type: Watershed management

This NbS meets sub-criteria: 1a – Adaptation to the long-term trends and effects of climate change, 1b – Resilience to climate-related shocks, 3b – Preservation of freshwater resources, 3c – Soil conservation, 4a – Improvement of food production, and 5b – Capacity building.

It also complies with sub-criteria: 2b – Improvement of carbon and other GHG pool, 3a – Enhancement of biodiversity, 4b – Improvement of incomes, and 5d – Gender equality and women's empowerment

Key facts

Project name	Participatory Small-Scale Irrigation Development Programme phase II (PASIDP II)
Duration	2017-2024
Target groups	480,000 men and women (targeted respectively at 49 and 51%) from poor smallholder households
Financing	Government of Ethiopia, IFAD (incl. ASAP), Alliance for a Green Revolution in Africa, beneficiaries

Background and development challenge

PASIDP II cover four regions (Amhara, Oromia, Southern Nations Nationalities and Peoples Region SNNPR and Tigray) out of 9 in total (of which 2 are town-regions), localised from north to south of the country, and targeting 68 food insecure woreda[59]. Key challenges in Ethiopia include soil degradation, deforestation and loss of biodiversity, besides weak environmental management and enforcement capacity. Moreover, climate change projections for the country indicate a significant increase in temperature, limited water availability and a likely increase in drought occurrences, heavy rains and floods. Smallholder farmers are especially exposed to these challenges as they directly rely on climate-affected natural resources for their livelihoods and inhabit vulnerable and marginal landscapes such as hillsides and deserts.

Watershed management interventions include different activities providing support to adjacent micro-watersheds on environment and natural resources managements, soil and water conservation measures. And these activities implemented in various agro-climatic contexts have been contextualized based on local gap and capacity assessments. Promotion of gender equality has been a constant effort including within watershed management interventions, to increase women's active membership in committees; to share responsibilities; and to promote technologies that reduce their drudgery.

[59] 19 woredas in Amhara, 25 in Oromia, 25 in SNNPR and 9 in Tigray.

NbS description

Watershed management practices implemented under the PASIDP II includes various activities: training on watershed management; development of micro watershed management plans; biophysical soil and water conservation measures; establishment and strength of trees' nurseries.

Trainings on watershed management have targeted famers, trainers[60], federal and regional experts on various theme related to biophysical soil and water conservation techniques, community-based participation, Geographical Information Systems (GIS) and Earth observation for agriculture and rural development.

Micro watershed management plans have been developed for 5 years by communities, using the National Community Based Participatory Watershed Development Planning Guide Line. They are based on identification and prioritization of biophysical and socio-economic issues as well as propositions of alternative technologies for communities, that improve land production and productivity at a micro watershed level. At mid-term review, about half of micro watershed management plans developed have been formalized with maps of location, land use land cover, soil type, slope, and development plan map prepared by using GIS tools, which represents about 49,990 ha of land under different climate resilience practices.

Biophysical soil and water conservation techniques include bund construction, trenches, gully rehabilitation, grass strips and tree planting are based on conservation agriculture and agro-forestry approaches. They have been implemented freely by beneficiaries based on micro watershed management plans and on watershed management guidelines. They have been implemented on private and communal lands. They have allowed the restoration of the watershed and contributed to ecosystem services such as provisioning, regulating and supporting services (soil structure formation, nutrient cycling and primary production of crops and fodders). Species planted come from nurseries supported by the programme.

Nurseries have promoted various tree species to ensure simultaneously, the sustainability of watershed by enhancing soil fertility and biodiversity; the diversification of farmers' income (ensuring income-generating activities mostly handled by women); and the improvement in nutritional status of local communities (e.g. *Cordia africana, Sesbania sesban, Lecunea lucociphala, Acacia politanka Croton macrostachyas).*

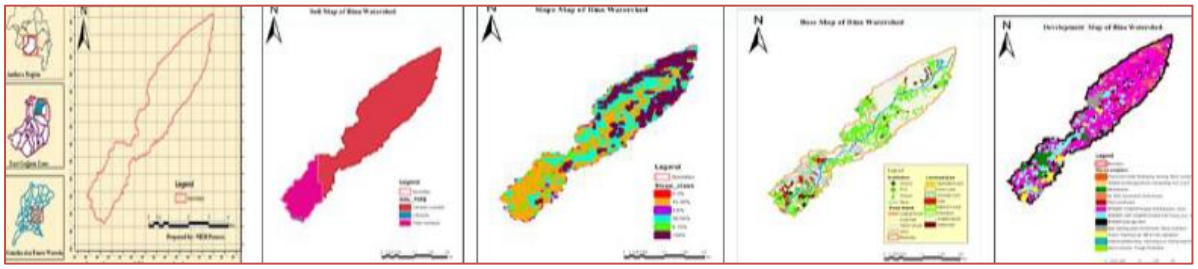

Figure 6. Watershed maps (from left to right: location, soil, slope, base and development maps[61])

Key results and impacts

According to the IFAD supervision report (June 2019), watershed management and the way in which it was implemented were highly relevant and have strong potential for scaling-up. The results of activities set-up showed that: community members appreciated training provided by the PASIDP II team, which effectively supplemented their traditional knowledge; the plans developed are comprehensive; the watershed management committees were functional (in the sites visited during the supervision mission) and contributed to raise awareness and to sensitise other community members on the benefits of watershed management; more than 80% of trees planted have survived. All these activities have ensured the development and the implementation of the management plans.

According to the same document, there is some scope to further improve sustainable watershed management by: strengthening promotion of sustainable biological erosion control measures such as

[60] Through trainings of trainers.

[61] PASIDP II. ASAP to date report. February 2017 – February 2020.

grass strips; engaging the community further during the selection of the appropriate measures; and promoting soil fertility improvement measures and water use efficiency. Impacts have not directly been assessed by the programme.

Finally, in some areas, GIS was not integrated for the development of micro-watershed management plan, due to lack of working materials (laptop), internet connectivity problems, workload of focal person with regular government duties, limited technical support from regional and federal technical staff.

Limits and constraints

More could be done to make use of the mapping capacity to further the implementation of watershed management plans and to illustrate the interdependency of communities.

There is limited skills training provided to analyze details on land use, land cover and biomass productivity. Thus, there should be additional practical field training for technical staff to work from the initial stage to be able to evaluate the impact of the programme.

Lessons learnt

The trenches are labour intensive, less sustainable than other methods and require resources (currently provided through the social safety net programme). Grass strips on the other hand are more sustainable as they need less maintenance, can contribute to terracing, are a source of feed for livestock and can also be done by women. Consequently, more focus should be placed on the biological solutions such as grass strips including vetiver species that can be used on steep slopes.

Moreover, other trees species should be promoted such as Neem (Azadirachta indica) and Faidherbia albida along with fruit trees, and benefits of these tree species should be further explained to communities to incentivize adoption.

2.2.7. Niger ProDAF case study: land management to enhance productive capacities and improve resilience of smallholder farmers

In Niger, **land restoration** set up through the ProDAF has enabled the conservation and restoration of natural resources, such as soil and water; the adaptation to climate change; the enhancement of productive capacities on agricultural and pastoral lands,thus improving the resilience of small-scale producers.

NbS type: Land management

This NbS meets sub-criteria: 1a – Adaptation to the long-term trends and effects of climate change, 1b – Resilience to climate-related shocks, 2b – Improvement of carbon and other GHG pool, 3b – Preservation of freshwater resources, 3c – Soil conservation, 4a – Improvement of food production, and 5b – Capacity building.

It also complies with sub-criteria: 3a – Enhancement of biodiversity, 4b – Improvement of incomes, 4c – Local job creation, and 5d – Gender equality and women's empowerment.

Key facts

Project name	ProDAF – Family Farming Development in Maradi, Tahoua and Zinder Regions / *Programme de développement de l'agriculture familiale*
Duration	2015-2023
Target groups	240,000 households involved in agro-sylvo-pastoral activities, targeting 30% of women and 30% young people
Financing	Government of Niger, IFAD (incl. ASAP), Italian cooperation, OPEC Fund for International Development, GEF, beneficiaries

Background and development challenge

ProDAF target areas are characterized by land degradation and high vulnerability to food insecurity, malnutrition, and climate change. These areas include severely degraded arable land caused by water

and wind erosion[62]. The dominant farming systems are extensive agro-pastoral rainfed production systems based on cereal crops, gardening, and rangeland grazing.

The overall objective of the ProDAF is to contribute to sustainable food and nutrition security, and improved resilience of rural households in the Regions of Maradi, Tahoua, and Zinder. In order to increase farmers' incomes on a sustainable basis, as well as their resilience to shocks particularly climate-related shocks, the project has notably supported the rehabilitation of 22 watersheds through the implementation of various NbS, all contributing to soil and water conservation.

NbS description

Under ProDAF, land restoration is implemented through several NbS, aimed at improving agricultural and livestock production systems. It combines mechanical treatments (water and soil conservation techniques and removal of invasive plants such as *Sida Cordifolia*) with biological treatments (by planting grasses and trees). Apart from the technical aspects presented in the table below, the development of social and organisational skills of village committees is an integral part of the project to ensure the sustainability of these activities.

NBS name	NBS description	NBS mid-term achievements / end of project target[63] Illustration
Dunes fixation by planting trees	Plantation of local tree species (e.g. *Euphorbia sp*) in successive lines, perpendicular to dominant winds, in order to protect cropland; Creation of kitchen gardens, reservoirs, and ponds.	1 525 ha / 1 950 ha 
Assisted Natural Regeneration (ARN)	Protection of trees growing naturally in cropland. Based mainly on the protection of fertilizer trees such as Acacia albida or trees protecting against insects such as *Piliostigma reticulatum* in millet fields. Acating also as windbreaks and limiting extreme temperatures.	118 630 ha / 193 425 ha 
Soil and water conservation measures	Measures to conserve and restore soil and water: - zaï: farming technique consisting of digging pits (10,000 per hectare) in degraded land in order to concentrate organic matter and capture water - stone lines: anti-erosion devices consisting of blocks of stone arranged in rows in the fields - filter diguettes: stone structure of 0,5 to 2 m high and 1 to 4 m thick, built across a high runoff area - living fences: hedgerows of tree or herbaceous species able to propagate easily and grow quickly	 Zaï  Stone lines  Filter diguettes
Restoration of pastoral rangelands and corridors	Clean land off invasive species (*Sida cordifolia)* through cash for assets[64], and planting grasses of	Development of transhumance corridors and sylvo-pastoral areas: 1 735 ha / 2 500 ha

[62] Niger losses 100,000 ha of arable land every year due to erosion. Moreover, forest areas have reduced from 16 million ha (1982) to 5 million ha (2006). Climate change and human activities are the main causes of land degradation. Source: Niger Republic. 2018. Final report of the Target Setting Programme on Land Degradation Neutrality.

[63] ProDAF mid-term internal report, IFAD, may 2019.

[64] Cash for assets systems address food and livelihoods needs through cash transfers, while creating long-term healthier natural environment, reducing risks and impacts of climate-related shocks, increasing food productivity, and strengthening resilience to natural disasters through building or rehabilitating natural assets.

	forage interest[65] and sometimes trees[66]. The use of fodder plants is discussed and encouraged in the livestock innovation schemes[67]	
Pastoral half-moons	Digging water harvesting semi-circular holes (2-3m wide) to help biomass regeneration Around 300 half-moons per ha acting as a water reservoir for planted trees (local species such Acacia sp and Balanites) and enabling grass regeneration.	
Multi-local-species tree nursery run by women	Vulnerable women are selected and trained to create and run tree nurseries based on local species. Trees are sold and used for various purposes (e.g. pastoral half-moons or associated through agroforestry practices)	

Key results & impacts

At its mid-point ProDAF rehabilitated 101,000 ha of degraded land through these land restoration measures, adopted by 50 to 85% of the targeted communities. The immediate effect is the reduction of erosion, enabling the recovery of degraded land and the increase of arable lands (irrigated, flood recession, and rainfed cultivation). Assisted natural regeneration and hedgerows also help to reduce evapotranspiration and act as windbreaks.

As a consequence, the average yields have significantly increased; around 40% for irrigated crops (e.g. onion, cabbage, and tomato) and above 30% for all rainfed crops, with particularly impressive increases for millet (+78%), sorghum (+63%) and cow pea (+53%). The increase in yields improves food security and nutritional status of households in a sustainable manner, generates significant and diversified incomes, mitigates the impacts of climate change at the watershed level. All these effects contribute to the resilience of small-scale farmers. In addition, these measures have co-benefits in terms of mitigation (increasing carbon sequestration in the vegetation and the soils) as well as in terms of biodiversity (creation of new and diverse habitats).

In the livestock sector, the rehabilitation of pastoral areas and transhumance corridors reduces the risks of conflicts between farmers and herders by reducing grazing competition due to earlier migrations in case of shorter rainy seasons. When selecting areas to be rehabilitated, it is important to maintain the continuity of the transhumance corridors to ensure positive results all along. Moreover, dried *Sida cordifolia* can be used as cattle feed, in the form of nutritional block (grinding of millet stalks and *Sida cordifolia*, the latter not exceeding 20%). Finally, by developing nurseries and selling tree seedlings,women integrate jobs and generate incomes, mainly used to purchase small livestock, which has positive impact on the nutrition status of their children (through milk consumption) and is a traditional form of savings. This also contributes to strengthen women's participation in decision making.

According to IFAD's mid-term supervision report, the different learning mechanisms, Farmer Field Schools (FFS) and Farm Advisory Services for Farmers (FASF)[68] have been assessed as positive tools. They rely on: i) Regional Directorate of Agriculture (one agricultural technician per commune) for supervision and facilitation, ii) specialized NGOs for facilitation, iii) Groups of farmers providing agricultural advisory support. They have presented land restoration techniques together with other techniques, such as other NbS adapted to climate change: composts; bio-pesticide production (based on Neem leaves); promotion of local diversified seeds. Adoption rates of these climate change

[65] *Eragrostistremula sp.,Cenchrusbiflorus sp.), Cassia tora , Zornia glochidiata, Cenchrus biflorus, Eragrostis tremula, Alysicarpus ovalifolius, Panicum leatum, Tephrosia linearis.*

[66] *Moringa oleifeira, Adansonia digitata, Balanites aegyptiaca, Acacia senegal, Acacia nilotica, Ziziphus mauritiana.*

[67] DIPE: *Dispositifs d'innovations paysanne en élevage*.

[68] *Champs Ecole Paysans* (CEP) / *Appuis Conseils Agricoles Paysans* (ACAP).

adaptation techniques are significant: 87% for the use of short-cycle seeds, 60% for compost, 47% for ANR[69].

Another result of this NbS concerns the organization of site management committees (e.g. guards watching over the NbS) also contributing to these good results according to the mid-term report. Moreover, in the Tahoua Region, the agricultural areas increased by 10,000 ha increasing the average field size from 0,6 to 2,2 ha per smallholder farm[70]. In land restoration areas in the Maradi Region, the biomass increased by 76% compared to the control in 2017[71], thus increasing carbon storage[72].

After 4 years the project has enabled mitigating - 474 908 tCO2e, and the total estimation for the whole project (including revision of objectives at mid-term review) is – 5 263 773 tCO2 on a period of 20 years (8 years of project implementation and 12 years of capitalisation) on a total surface of 225 530 ha, thus an average of 1,2 tCO2e per ha and per year[73].

Constraints and limits

The production of an extensive database would allow analysing the impact regarding the evolution of water resources and soil fertility, as well as the people's resilience to climate change.

The tree survival rate is about 50%, with 3 years of full guarding (including dry season). Guarding is a strong constraint, however, absolutely necessary to ensure tree growth.

The sustainability of the new extension system created is also a key challenge. They must be properly embedded in the national extension framework and seek for long-term funding.

[69] ProDAF plans to amplify the ANR practice on all the areas concerned by the FFS/ FAFS extension system, i.e. 190,000 ha at the level of rainfed farm.

[70] Revue à mi-parcours du ProDAF. Rapport interne à mi-parcours de l'URGP de Tahoua au 15 mai 2019.

[71] Rapport étude sur la situation de référence des indicateurs biophysiques. CNSEE 2017.

[72] Note d'information à l'attention de la mission de revue à mi-parcours, Maradi du 10 au 15 juin 2019.

[73] EX-Ante Carbon-balance Tool (EX-ACT).

3. Conclusions and recommendations

3.1. Main lessons learnt from ASAP case studies

Above case studies provide a sample which illustrates the diversity of the NbS that can be implemented in rural areas with smallholder farmers. The NbS presented in this paper concern different types of contexts (cropland, grassland, forest, wetland) and have various goals (conservation, restoration and/or management). Moreover, each of them **simultaneously meets several of the five criteria** and related sub-criteria described in part one of this paper.[74]

Several NbS have already been integrated into ASAP projects, without explicitly mentioning them as NbS. On the one hand, it is necessary to integrate them further into ASAP programming since **NbS can contribute to ASAP core objective** (climate change adaptation) while also supporting agro- and biodiversity, providing carbon sinks as well as a range of socio-economic benefits for smallholder farmers and communities. On the other hand, ASAP is an interesting portfolio to experiment and promote NbS as two of its pillars are the testing of innovative solutions (on the technical and institutional side) and the scaling up of these solutions.

NbS enable the preservation of ecosystems through various types of interventions that may contribute to **wider environmental projects**, such as the Great Green Wall for the Sahara and Sahel Initiative (GGWSSI), on which IFAD is also currently engaged. NbS implemented in Niger (land management), Ethiopia (watershed management) and Sudan (natural resources governance framework) all contribute to combat climate change effects and desertification as well as address food insecurity and poverty issues in targeted areas, as endorsed by the GGWSSI.

NbS implemented through ASAP projects most often **involve communities as well as authorities** (at local, regional and/or national levels) from the design to the implementation phases. Their active involvement is critical for the success of the NbS, and must be promoted through intensive mobilization and trainings. When implemented adequately, this participative approach directly tackles the need to consider site-specific natural and cultural contexts that include traditional, local and scientific knowledge. This ensures proper ownership of the NbS and also builds the capacities and awareness of stakeholders by bridging the gap between modern scientific and traditional knowledge. Across the 7 case studies, the strong involvement of communities and/or authorities is a promising sign for the sustainability of the NbS.

NbS provide structure, methodology, process and/or a plan that respect and preserve natural resources and empower people. For greater chance of success, NbS may be **combined with other activities** that more directly **support livelihood assets** at individual, household and/or community levels (e.g. in Sudan the community empowerment process was combined with improved water infrastructures; in Gambia the mangrove restoration was combined with the provision of boats facilitating river transport). To ensure the sustainability and replication of NbS, **inputs and skills training** (e.g. trees, construction materials, seedling management skills, etc.) need to be available and accessible at local level to smallholder farmers.

As shown in the mangrove restoration example, applying community-based approaches, and combining conservation measures with initiatives that ensure local communities can **access to and benefits from NbS for their livelihoods**, can contribute to increase acceptation, replication and sustainability of NbS.

NbS activities that are labour intensive for their implementation or maintenance (e.g. digging trenches) often require **significant external financial resources**. This involves specific approaches that need to be well thought from project design (e.g. cash for work schemes) as well as long-term financial planning to ensure NbS sustainability (e.g. through social safety net programme).

When planting trees and grass as part of NbS, a **wide diversity of local species** is commonly proposed. In order to meet the different needs of the population (timber, firewood, food, incomes, etc.), it is indeed interesting to provide rural households with plants that have different purposes (e.g. forest trees together with fruit trees and trees with medicinal properties) and that also preserve soil and groundwater resources. These plants/trees are usually cultivated in **nurseries** that are specifically implemented for the project and ensure the availability of seedlings. Nurseries also provide job opportunities which often

[74] 1. Climate change adaptation and disaster risk reduction / 2. Climate change mitigation potential / 3. Provision of non-carbon ecosystem services / 4. Food security and income generation / 5. Social benefits.

benefit to vulnerable women and young people. After planting trees, taking care of the young plants is a strong constraint for the first three years; it is however absolutely necessary for ensuring sustainable tree growth.

As shown in the Sudan example, NbS may in some cases **require time** to be fully deployed as they include multiple and complex activities. A long timeline is necessary in the development of solutions such as designing new regulations and policies, mobilizing communities or strengthening farmer knowledge.

Reliable data on NbS specific results was not always available when analysing ASAP reports; it was often difficult to know which project benefits and impacts were specifically attributable to NbS. In order to provide stronger evidence of NbS results and impacts, **monitoring and assessments** are required from the initial stage to the final one, based on both quantitative and qualitative indicators that are **specifically related to NbS**.

Among the case studies some NbS were implemented with a relatively narrow **geographical focus** (e.g. effective micro-organisms solution has only been implemented in one site in Laos). Wider geographical coverage would allow NbS to be tested in different contexts and facilitate subsequent scaling up.

3.2. Way ahead: towards a stronger operationalization of NbS

While these case studies provide useful lessons, more evidence is needed for decision makers and donors to ensure NbS move beyond site-based examples and pilot projects, and instead are deployed at scale to ensure the maximum benefits for society and nature.

To enable effective transfer of NbS approaches from pilots to larger scales and to make the concept useful in planning and implementing societal responses to important challenges, a standard has to be defined at international level. This will help generate a common understanding and consensus on what is a 'good' NbS.

IUCN members have started working on a **Global Standard for NbS** (AFD-IUCN-CEM, 2019[75]) and developing associated tools. The Global Standard was due to be launched in June 2020 during the IUCN World Conservation Congress, but it has been postponed due to the Covid-19 pandemic.

Drawing from the core principles of NbS, the draft Global Standard for NbS currently includes eight criteria, each consisting of several indicators. Guidance will instruct how to use the standard to: (i) design new NbS; (ii) upscale pilots by identifying gaps and; (iii) verify past projects and future proposals[76]. The objective is to facilitate the operationalization of NbS, and ensure the quality and credibility of the solutions.

The IUCN French Committee has also started to work on a stakeholder guide, translating this Global Standard into seven questions that a project manager will have to answer so that a project or activity can be considered a NbS.

One of the outcomes of the co-sponsored IPCC/IPBES workshop on biodiversity and climate change (planned to be held in May 2020 but postponed) will be a technical paper on potential synergies such as NbS and trade-offs between efforts that aim to conserve, restore and sustainably use biodiversity and efforts that support climate change adaptation and mitigation.

A number of other initiatives, platforms and handbooks are also being developed to gather and share lessons on NbS implementation. They can be of good support to help practitioners build upon previous experiences.

3.3. Recommendations

1. **Give wider emphasis to NbS at IFAD strategic and operational levels** – NbS should be integrated within strategies at national, regional, institutional levels to expand their reach, which of course requires larger institutional discussions and dedicated resources and expertise. It should also be promoted on both theoretical and operational aspects among IFAD field staff, implementing

[75] AFD, IUCN, CEM. 2019. Draft 2: Global Standard for Nature-based Solutions.

[76] Source: www.iucn.org/theme/ecosystem-management/our-work/a-global-standard-nature-based-solutions

partners and targeted communities. This technical note is a first step in this direction. The release of the IUCN Global Standard is however very necessary to design a NbS strategy and develop specific training sessions.

2. **Ensure sufficient expertise is available to design, implement and monitor NbS** – External support is particularly relevant when IFAD's country presence or competences on a specific issue or solution is limited. It is important to have the proper technical expertise to ensure NbS are correctly settled and to avoid improper application.
3. **Implement NbS in different contexts and expand their geographical coverage** – This will ensure NbS are experimented with different stakeholders and under various conditions, and then can more easily be scaled up.
4. **Ensure NbS are systematically set up in collaboration with communities and authorities** – NbS should be implemented through a community-based and participative approach, and authorities (at local, regional, national levels) should be key partners of their implementation. This will contribute to stronger ownership and faster replication.
5. **Produce NbS-specific data** – During the whole project course, production of data is essential in order to provide stronger evidence of NbS specific results and impacts, and notably how their implementation can strengthen resilience to climate change.

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Annexes

Annexe 1. Activities associated with 20 nature climate solutions

Source: GRISCOM & al., 2017.

NbS	Example activities
FORESTS	
Avoided forest conversion	Protected areas establishment and improved enforcement; improved citing of non-forest land use; forest certification; improved land tenure; zero deforestation commitments; sustainable intensification of subsistence agriculture; avoided loss of high carbon forests; reduced consumption of land-extensive food types (e.g. beef).
Reforestation	Conversion from non-forest to forest in areas ecologically appropriate for tree growth through agricultural certification programs and impact mitigation frameworks that prioritize restoration; regulations that advance minimum forest cover requirements; integration of trees into grazing lands (i.e. sylvo-pastoral systems).
Natural forest management	Extension of logging rotations; reduced-impact logging practices that avoid damage to non-commercial trees; voluntary certification programs; regulatory requirements that limit impacts from logging; improved land tenure; stop-logging.
Improved plantations	Extension of logging rotation lengths to achieve maximum yield while increasing average landscape carbon stocks; certification systems; multi-species plantation systems.
Fire management	Advance prescribed fires to reduce the likelihood of more intense wildfires in fire-adapted forests; advance fire control practices in tropical moist forests such as fire breaks between pasture and forest edges; regulations and certification programs that promote improved fires management; improved forest management practices that reduce slash and improve resiliency to natural disturbance.
Avoided woodfuel harvest	Reduce woodfuel harvest levels by adoption of improved efficiency cook stoves or stoves using alternative fuel (e.g. solar, methane from agricultural waste).
AGRICULTURE & GRASSLANDS	
Avoided grassland conversion	Protected areas establishment and improved enforcement to prevent conversion of grasslands to tilled croplands; improved land tenure; intensification of existing croplands.
Biochar	Extension programs to build capacity on biochar management; improved land tenure; certification systems; incentives programs.
Cropland nutrient management	Certification programs that seek to maintain water quality by reducing excessive fertilizer; water quality/pollution mitigation; credit trading programs; removal of regulations creating perverse incentives to apply excessive fertilizer; improved manure management.
Conservation agriculture	Cultivation of additional cover crops in fallow periods; shift to reduced-tillage or zero-tillage systems and other conservation agriculture practices may enhance soil carbon benefits of cover crops.
Trees in cropland	Regulations and certification programs that promote integration of trees into agricultural lands; agroforestry certification systems; increasing the quantity of trees in croplands by introducing windbreaks (also called shelterbelts), alley cropping, and farmer managed natural regeneration (FMNR).
Grazing – Animal management	Animal management practices such as improved health; reduced mortality; improved genetics; live weight gain.
Grazing – Optimal intensity	Maintaining forage consumption rates that enable maximum forage production; certification programs.

Grazing – Legumes in pastures	Sowing legumes in existing planted pastures.
Grazing – Improved feed	Inclusion of cereal grains in feed to improve feed quality and reduce methane emissions.
Improved rice cultivation	Adopting water management techniques such as alternate wetting and drying (AWD) and midseason drainage (MSD); residue incorporation; fertilizer management.
WETLANDS	
Avoided coastal wetland impacts	Protected areas establishment and improved enforcement; improved land tenure; no-net-loss mitigation regulations; avoided harvest of mangroves for charcoal; avoided consumption of food products with acute impacts on coastal wetlands (e.g. mangrove replacing shrimp farms).
Avoided peatland impacts	Protected areas establishment and improved enforcement; improved land tenure; no-net-loss mitigation regulations; re-siting of oil palm plantation permits to non-peat locations.
Coastal wetland restoration	Re-wetting and re-planting with native salt-water wetlands; wetland mitigation programs.
Peatland restoration	Re-wetting and re-planting with native freshwater wetlands species; wetland mitigation programs.

Annexe 2. Linking problems, NbS evidences and benefits

Main issues	NbS examples	Returns and benefits
1a- Long-term effects of climate change	– Promotion of local climate resistant seeds and of farming practices adapted to climate change	– Increased in agricultural / livestock production systems, even when changes of seasonal patterns
1b- Extreme weather events linked to climate change (floods, drought, cyclones, etc.)	– Land management technics: trees planted in pastoral half moons; living fences; assisted natural regeneration	– Floods controls – Reduction of forage failure
2a- Reduction of GHG emissions	– Rice-cropping practices reducing methane emissions – Protection, restoration, management of wetlands	– Avoid GHG emissions from agricultural practices or from ecosystems degradation
2b- Improvement of carbon and other GHG pools	– Participatory forest management plans	– Increase carbone storage capacities from forests
3a- Enhancement of biodiversity	– Seeds multiplication of local and diverse seeds promoted through agroforestry practices	– Communities' capacities are strengthened on seeds multiplication and on agroforestry practices
3b- Preservation of freshwater resources	– Reforestation of degraded areas – Protection of water recharge areas	– Recharged watertable and increased water resources available for human consumption, livestock and irrigation purposes
3c- Soil conservation/ improvement	– Development of watershed management plans – Biophysical soil and water conservation techniques (e.g. conservation agriculture, agroforestry technics, gully rehabilitation, trees planting)	– Increase land production and productivity – Increase community cohesion at watershed scale
3d- Reduction of air pollution	– Using natural or biological pest control	– Avoid the use of pesticides
4a- Improvement of food production	– Pest management using agroforestry and biopesticides	– Reduce lost of agricultural production due to pests attacks
4b- Improvement of incomes	– Support trees crops plantation for sailing trees production (e.g. fruits, flowers, branches)	– Increase incomes generated from trees plantation
4c- Local job creation	– Develop viable entreprises of nurseries (targeting women, landless rural households, young people)	– Development of nurseries ensure jobs creation and sustainable availability of trees and seedlings
5a- Improvement of land access	– Restoration of meadows in transhumant passageways	– Access to transhumant areas is improved and facilitated
5b- Capacity building	– Climate change adaptation (CCA) mainstreamed in all trainings and demonstrations plots of agricultural production	– Increase farmers, communities, authorities competences on CCA practices

	models (e.g. farmers fields schools)	
5c- Social cohesion and inclusion of marginalized groups	– Natural Resource Governance Framework (NRGF)	– All groups are included through a participatory approach to design the NRGF
5d- Gender equality and women's empowerment	– Integrate women at leaders positions (e.g. nurseries, demonstration plots)	– Women increasingly become references for their community

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