Adaptation of agricultural production systems in Coastal Areas of Northwest Guinea-Bissau

COST-EFFECTIVENESS ANALYSIS

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CONTENTS

ABBREVIATIONS

CRRP	Climate Resilient Rice Production
GDP	Gross Domestic Product
GHG	Greenhouse gas
IRR	International Rice Research
MPI	Multidimensional Poverty Index
NDC	Nationally Determined Contribution
NPV	Net Present Value
OSS	Observatory of the Sahara and Sahel
PANA	Programa de Ação Nacional de Adaptação
PRRCASAHMC-GB	Projeto de Reforço da Resiliência e da Capacidade de Adaptação dos Sectores Agrário e Hídrico às Mudanças Climáticas na Guiné-Bissau
SAP-GNB	Adaptation of agricultural production systems in the coastal areas of Northwest Guinea-Bissau
SRI	System of Rice Intensification
SRI-WAAPP	Rice Intensification System in West Africa – Project
SRI-CRRP	System of Rice Intensification -Climate Resilient Rice Production
SWI	Saline Water Intrusion
WAAPP	West African Agricultural Productivity Programme

EXECUTIVE SUMMARY (Summary Document to be included in the Project Proposal)

INTRODUCTION

In 2020, the Country witnessed a deterioration of the food security situation caused by: movement limitations during the state of public health emergency declared on 27 March following the increase in COVID-19 cases, the unsuccessful annual cashew nut marketing campaign and above average rainfall resulting in flooding[1]. The latter negatively affected agricultural production and caused widespread damage to homes and community infrastructure, particularly in the regions of Cacheu, Oio, Bafatá, Tombali and Quinara[2].

Despite Guinea-Bissau's agro-forestry-pastoral potential and fisheries resources, many studies have shown that, the current food situation in the country is very precarious, with poverty identified as the underlying cause. Greenhouse gas (GHG) emissions from the agricultural sector were identified as very high, with the country indicating reforestation as the main action to mitigate GHG emissions in its nationally determined contribution (NDC)[3].

The agricultural sector is the main pillar of Guinea-Bissau's economy. In the absence of other resources, the sector, although underdeveloped, plays a leading role in supporting food security and job creation. Agriculture currently contributes about 46% of the national GDP, with 84% of the population actively employed in primary production agriculture largely dominated by women[4].

Vulnerable households, especially farming households, are highly exposed to unpredictable fluctuations in the international market price of cashew nuts, climate change risks and recurrent environmental degradation caused by land misuse and flooding[5]. Most of these farmers are smallholder farmers cultivating on less than two hectares (2 ha).

More than 45% of the country's domestic cereal use is covered by imports. Rice accounts for about 80% of import requirements, followed by wheat, which accounts for about 15%[6]. More than half (58%) of the total land in Guinea-Bissau is used for agriculture with an area under forest heavily degraded by rapid exploitation. Rice is a staple crop in West Africa and largely produced by low-income smallholders throughout the region.

In Guinea-Bissau, therefore, rice represents, along with cashew, a key element for food security for the populations, both those living in rural and urban areas. It is estimated that this staple crop accounts for 75% of cereals consumed, and more than 60% of the surface area devoted to cereal crops[7].

With increasing temperatures and decreasing precipitation, groundwater, which is the main source of drinking water for the population, could be strongly affected. In addition, irregular precipitation and rising temperatures would lead to a decrease in the base flow of rivers and a significant drop in the water table. An increase in groundwater salinity is also expected, amplified by rising sea levels.

The main impacts of climate change on the agriculture and livestock sector relate to irregular rainfall in terms of intensity and onset/end of season, increase in temperature and submergence of agricultural land due to rise in mean sea level. Rice crops are vulnerable to both irregular rainfall and sea level rise affecting production due to excessive saline water intrusion (SWI), especially in mangrove rice fields due to high tides and the consequent destruction of anti-salt dikes [8].

The livestock sector is also strongly affected by the increase in temperature and the decrease in precipitation, which inevitably translates into a general lack of water for grazing, a decrease in grazing areas, a severe reduction in the production of pasture, milk and meat. This encourages transhumance in search of better pastures, creating conflicts between pastoralists and farmers[9].

In response to these challenges, the *Adaptation of agricultural production systems in the coastal areas of Northwest Guinea Bissau* project will be implementing a smart approach to improve agricultural production (mainly rice, vegetables and legumes) and therefore the livelihoods and income of coastal communities in relation to climate change.

As such, the project not only provides for the introduction of land management techniques for climate adaptation, but also for an increase in crop productivity, more sustainable management of water resources,

[1] https://docs.wfp.org/api/documents/WFP-0000125391/download/
[2] Ibidem
[3] https://www.fao.org/publications/card/en/c/CA5406EN/
[4] https://www.fao.org/publications/card/en/c/CA5406EN/
[5] https://docs.wfp.org/api/documents/WFP-0000125391/download/
[6] https://www.fao.org/giews/countrybrief/country.jsp?code=GNB
[7] https://www.cambridge.org/core/journals/experimental-agriculture/article/mangrove-rice-biodiversity-valorization-in-guinea-bissau-a-bottomup-approach/584BD76069CB66571CDA2A13276E037A
[8] Ibidem
[9] Ibidem

land and an introduction and increase of income generating initiatives in communities in the regions of Cacheu and Oio.
These rural and farming communities see their climate-related livelihoods heavily affected by climate change, with the future scenario likely to worsen if no appropriate intervention is made. The SWI, derived from rising sea levels, together with rainfall variability are threatening the livelihoods and lives of these rural communities, affecting rice production and agricultural production in general. The direct consequences are decreases in income, food insecurity and loss of livelihoods. The indirect socio-economic consequences are malnutrition, migration, increased domestic violence and maternal and child deaths.
The project intends at local level to create local observatories that will monitor climate impacts and coordinate adaptation interventions in communities, which, accompanied by concrete adaptation plans and interventions for climate resilient water and coastal zone management and the introduction of smart techniques to increase climate resilient agriculture and climate resilient livelihoods, will allow for an improvement of the lives and socio-economic activities of communities in the regions of Cacheu and Oio.
The *Adaptation of agricultural production systems in the coastal areas of Northwest Guinea-Bissau* (also named in this text SAP-GNB) project will be implemented in the regions of Oio and Cacheu by the Observatory of the Sahara and Sahel (OSS), as Regional Implementing Entity; the institution with the most relevant technical experience (IBAP); and the relevant line ministries MoEB and MoA) and ADPP-GNB, the largest NGO in Guinea-Bissau that will lead the activities in the field and with the communities.
The overall objective of the *Adaptation of agricultural production systems in the coastal areas of Northwest Guinea Bissau* project is to **enhance the climate-resilience of livelihoods and food security of the most vulnerable populations in Oio's and Cacheu's coastal areas**.
The project Components are:

- C1. "Development of technical and institutional capacity of government and civil society"; Outcome 1. Strengthened capacity and knowledge management to monitor and address climate risks in Oio and Cacheu Regions.
- C2. "Adaptation of water management towards climate risks in coastal zones", Outcome 2. Improved Water Availability and quality for production and consumption in coastal communities in Oio and Cacheu, despite climate risks.
- C3. "Building climate-resilient farming communities"; Outcome 3. Enhanced climate-resilience of smallholder farmers, in coastal communities in Oio and Cacheu Region.

The project also has three main results, one for each component:

- Outcome 1. Strengthened capacity and knowledge management to monitor and address water and agriculture-related climate risks in Oio and Cacheu Regions.
- Outcome 2. Improved water availability and quality for production and consumption, in coastal communities in Oio and Cacheu, despite climate risks.
- Outcome 3 Enhanced climate-resilience of smallholder farmers, in coastal communities in Oio and Cacheu Region.

1. ALTERNATIVES CONSIDERED FOR THE COST-EFFECTIVENESS STUDY

The Adaptation of agricultural production systems in the coastal areas of Northwest Guinea Bissau project will create significant economic, social and environmental benefits and impact at household, community, national and regional levels. This cost-effectiveness analysis will evaluate two alternatives:

- Alternative 1: The alternative to the project *Adaptation of agricultural production systems in the coastal areas of Northwest Guinea Bissau of* no project intervention, or the continuation of sectoral approaches in agricultural production and diversification in income sources, as currently underway in Guinea-Bissau.
- Alternative 2: The economic, environmental and social benefits that the proposed *Adaptation of agricultural production systems* interventions *in the coastal areas of Northwest Guinea-Bissau are* expected to create in relation to increased agricultural productivity and improved livelihoods, environmental protection, mitigation benefits and climate change *adaptation.*

Table 1: Comparison of yield, water use and net return for four alternative rice systems with the conventional flooded paddy system (at 100%)

	Cost of the project (USD)	Number of beneficiaries	Average expenditure per beneficiary (over 5 years of project) USD	Year 1 USD	Year 2 USD	Year 3 USD	Year 4 USD	Year 5 USD	Total USD
SAP-GNB	9.990.985,00	170 Clubs 8500 agriculture family 82.450 Beneficiary	121,18	1.998.197,00	1.998.197,00	1.998.197,00	1.998.197,00	1.998.197,00	9.990.985,00
NO-Project	70.082.500,00	170 Clubs 8500 agriculture family 82.450 Beneficiary	850,00	14.016.500,00	14.016.500,00	14.016.500,00	14.016.500,00	14.016.500,00	70.082.500,00
	170 USD/year (Humanitarian AID/Beneficiary/Year)	Difference with the project		**12.018.303,00**	**12.018.303,00**	**12.018.303,00**	**12.018.303,00**	**12.018.303,00**	**60.091.515,00**

This cost-effectiveness analysis compares all the climate-adapted agricultural production and livelihood and income strengthening interventions defined in the proposal with the conventional system, considering the project investment and its return to the beneficiaries.

Furthermore, the cost-effectiveness analysis makes a comparison between the implementation of different systems of income generating activities and in water management.
As shown in the study in Table 1, the SAP-GNP project with a budget of 9,990,850.00 USD supports 82,450 direct beneficiaries, with an average expenditure of about 120 USD per beneficiary. If the project were not implemented, to provide emergency assistance to the communities covered by the project, consisting of one meal a day, it would take more than six times the total value of the project, that is, about 60 million USD.
Furthermore, the results of the project are long-lasting, incorporating the benefits of the investments made into the communities.

1.1 Alternative 1: The project Adaptation of agricultural production systems in the coastal areas of Northwest Guinea Bissau is not implemented

Without adaptation measures, agriculture in Guinea-Bissau is likely to be exposed and targeted for the worse because of climate change effects.
Climate scenarios for Guinea-Bissau systematically project increases in mean daily temperature up to + 1.4 °C for the period 2016-2045, with the potential to reach up to + 2.2 °C between 2046 and 2075 per low emissions scenario[10].
Considering instead the worst-case scenario, with high emissions, the projected changes are even higher with temperature increases of + 1.6 °C to + 3.1 °C for the periods 2046 and 2075, respectively (Image 1). Altogether, the models point to significant increases in daily maximum and minimum temperatures in the order of +3.0 °C and +3.2 °C, respectively, particularly in the eastern part of the country[11].
Regarding precipitation (Figure 2), the average of fourteen models used in the simulation’s points to a slight increase in average daily precipitation of + 3% [2 to + 5%] for almost the entire national territory, under the low emissions scenario for the period 2016-2045. For the high emissions scenario, no significant changes are expected compared to the reference period: 1961-1990. Except for the southwestern part of the Bijagós Archipelago and part of the southern region of Tombali, where an increase of + 5 percent is expected, the projections in this scenario are generally characterized by significant variability [12].
The projected changes in temperature and precipitation are likely to have a substantial impact on water resources that are already limited in their ability to provide sufficient and especially adequate water for the agricultural sector. Without adequate and intelligent climate solutions, with rain-fed or rainfed agricultural production systems predominating, yields of the main food crops and livestock production are also expected to decrease[13].

1.2 Alternative 2: The Adaptation of agricultural production systems in the coastal areas of Northwest Guinea Bissau project is implemented: The CRRP is expanded throughout West Africa

The proposed alternative to the current situation focuses on the use of an approach already tested in other climate change adaptation and mitigation projects that allows leading communities towards more economically, socially (gender) and environmentally sustainable production.
For rice production, the main one in the project area, the project plans to boost the Climate Resilient Rice Production (CRRP) methodology. CRRP is based on the Rice Intensification System (SRI) rice productivity enhancement methodology and is complemented with locally adapted and improved soil and water management practices, as well as integrated pest and disease management methods that are critical for climate change adaptation.
To produce alternative crops, such as maize, cassava (no irrigated) and vegetables (irrigated) the project will also compare traditional cultivation methods with improved cultivation methods adapted to climate change (more intensive productions, better water management - drip irrigation and ecologically sustainable systems - solar probes). In parallel, the production of plants of interest (fruit trees, medicinal plants, among others.) is compared in the following sections.

Table 2: Comparison between the benefits created by the project (Alternative 2) and the no-intervention of the project (Alternative 1)

[10] https://www.fao.org/publications/card/en/c/CA5406EN/
[11] Ibidem
[12] Ibidem
[13] Ibidem

Component	Result	Budget	Output	Exit	With Project	no project
Component 1 - Development of technical and institutional capacity of government and civil society	**Outcome 1** Strengthened capacity and knowledge management to monitor and address water and agriculture-related climate risks in Oio and Cacheu Regions	760.475,00	Output 1.1. Improved local observation and management systems for monitoring water and agriculture-related climate risks in Oio and Cacheu Region	458.150,00	The project aims to create an enabling environment for the sustainability and success of the initiative, nationally and centrally, with and within central government structures. The project will promote dialogue and create synergies with other initiatives (UNDP/EU) through direct communication between common implementing partners. The solutions created jointly will be piloted in the two target regions of the project; it can then be replicated at national level. In the consultations carried out with the Executing Partners, as well as in the PFS consultation seminar, the need and importance of such an initiative was confirmed and supported.	Without the project there will be no increase in the capacity of the local population and government to deal with natural disasters remains very weak and extreme weather events, which are increasing in frequency and impact in the context of global CC, and pose direct threats food and nutrition security of target populations. Without the project the rural population will not have adequate knowledge of CC or the ability to prepare for extreme weather events, as there is a lack of climate information and early warning. Therefore, around 202,450 people (direct + indirect beneficiaries) will have the risk of seeing their own resilience reduced with respect to CC
			Output 1.2. Strengthened technical capacities of decision-makers and field staff in Oio and Cacheu Region for addressing water and agriculture related climate risks	85.925,00	The development of an Operation and Maintenance (O&M) Manual for observatory tasks will entail the creation of guidelines for O&M. This will include observatory tasks and equipment, including: monitoring the correct functioning of each piece of equipment to promote preventive and corrective maintenance; repairs; inspections; and cleaning, among others. This activity will include the training of OG teams in O&M. It also includes the printing and distribution of manuals to target stakeholders, including project implementing partners and target beneficiaries. The training of key stakeholders involved in the operation and maintenance of the OG will use a community-based approach and will be carried out with the Proximity Monitoring Stations (hosted by the CCCs (A3.1.1)). Training sessions will be given to: EE field project team, CO members, and CCC management teams; representatives of the MoEB, MoA Regional Office, and MI will be invited to participate in the trainings. Special attention will be paid to the development of gender-sensitive materials, and the promotion of gender-balanced working groups.	Without the project, technicians and decision makers at central and peripheral levels will not increase their knowledge about the risks linked to climate change and adaptation and mitigation measures can be implemented. Without the project all knowledge will not be capitalized through the development of an Operation and Maintenance (O&M) Manual for observatory tasks will imply the creation of guidelines for O&M.
			Output 1.3. Improved availability and accessibility to knowledge on water and agriculture-related climate risks and adaptation options	216.400,00	Synthesize existing knowledge about CC and make it available to active stakeholders in the country. The project identified a significant number of CC-related initiatives underway and in preparation in the country, thus confirming the need to create platforms and forums where these initiatives can be consulted, lessons learned can be shared and synergies created to improve solutions success and increase the impact of such initiatives. There is a lack of opportunities for dialogue to strengthen the capacity of active stakeholders and to coordinate individual efforts to address the impacts of CC.	Without the project, it will not be possible to know the real and detailed situation in which the communities in the region of Oio and Cacheu live and are preparing for the CC. As a result, it will not be possible to publicize them in local forums in order to keep people aware of their future.
Component 2 - Adaptation of water management towards climate risks in coastal zones	**Outcome 2** Improved water availability and quality for production and consumption, in coastal communities in Oio and Cacheu, despite climate risks	1.887.280,00	Output 2.1. Community-based water management is improved and adapted towards climate risks, including salt-water intrusion and extreme weather events	1.544.250,00	Installation of "bolonhas": The "bolanhas" targeted by this activity belong to the 8,500 families (170 Farmers' Clubs) and to the 34 communities targeted by the project. Part of the pre-selection criteria for target communities was the existence of available fields and their need for intervention. From previous interventions and according to the field pre-assessment done, most target households have 0.2ha to 2ha of available field, with some exceptions having up to 3ha and more. It is estimated that this activity could reach 7,000ha by the end of the project. The exact numbers must be confirmed in the baseline study. 17 rainwater retention systems per target region, for a total of 34 - one per target community; and 20 individual home roof retention systems, including locally manufactured tank/tank, one for each CCC. Access to fresh water will thus be improved in all 34 target communities.	Without the project, the recovery of soils lost to agriculture will not begin. 40. Nationally, of the 50,000 ha of rice fields farmed by farmers, it is estimated that around 20,000 ha have been successively abandoned or never fully utilized, due to broken dikes or inadequate land preparation. WITHOUT THE PROJECT, THE 7,000 ha intended to be rehabilitated will still be unused (7,000 ha - more than 1/3 of the total lost ha). Without the project 8500 farming families will recover their own fields, will not start adopting the SRI rice production system and will continue to be food insecure.
			Output 2.2. Mangrove ecosystems are better managed , as an ecosystem-based adaptation measure towards salt-water intrusion	343.030,00	The project will establish 4 mangrove and coastal tree nurseries (2 per target region). The activity will be implemented by the EE project team with the support of IBAP as Executing Partner and will include communities in a participatory manner, particularly young people and the elderly. The project will protect/restore 250ha of mangrove forest as follows: Each Farmers Club (A3.2.3.) of approximately 50 members will assume responsibility for overseeing approximately 1.5ha of mangrove forest	Without the project, the reforestation of the mangroves will not start, which allows for the maintenance of an environmental balance and thus production in the areas adjacent to them. Without the project, 250 ha of mangroves will not be rehabilitated, to be rehabilitated by the beneficiary communities after the awareness work
Component 3 - Building resilience of farming communities towards climate change	**Outcome 3** Enhanced climate-resilience of smallholder farmers, in coastal communities in Oio and Cacheu Region	6.824.880,00	Output 3.1. Vulnerable populations have gained access to community-based structures for climate change adaptation	1.424.030,00	20 CCCs will be established and equipped in strategic geographic locations to cover the needs of all 34 target communities. They will cover the needs of a frontline observation center and Proximity Monitoring Stations, and will accommodate the CO teams. The CCCs will be especially relevant so that farmers and community members have access to locally generated climate information (mainly by the project itself, but also including information from other local initiatives taking place in the target area - to be collected by the EE project team and by the GC) and also received from the national systems upon completion of the project. 82450 direct beneficiaries and 120,000 indirect beneficiaries	Without the project, and without the installation of the CCCs, there will be no real coordination between communities, local authorities and central bodies. Without the CCCs, the 34 beneficiary communities will not receive the proper training (theoretical and practical) on climate change and will not increase their own resilience.
			Output 3.2. Increased and diversified food production of smallholder farmers	4.654.770,00	Establishment, organization and regular training in CRA practices in Model Lots of 170 Farmers' Clubs - 8,500 farmers (70% women) - 82,450 people. Farmers will receive the ok production KIT depending on the baseline study findings. The Farmers Club system comprises approximately 50 members per Club, subdivided into 5 core groups of 10 members with 1 leader and 5 frontline farmers. This division and distribution takes place naturally in a participatory way with the beneficiaries; is done on a voluntary basis or based on suggestion or through election by the group.	Without the project, the Farmers' Clubs (170) will not be installed and the resilience of communities will not be increased through diversification of production and sources of income. Thus keeping 8500 families in food insecurity. Without the project, the rice production methodology will not be installed: Sustainable Rice Intensification (SRI) and Climate Resilient Rice Production (CRRP
			Output 3.3. Increased income options in climate-resilient economic activitie along agricultural value chains	746.080,00	The project envisages providing target groups with a funding opportunity through a call for proposals - for small amounts - and a grant award to selected candidate rural small businesses, in response to the lack of available and affordable financial support from the banking system and the private sector. 20 new microenterprises and enterprises (IGAs) will be established by project beneficiaries, at least 50% led by women. In addition, 20 existing micro-enterprises will be formed and equipped with the initial equipment and investments necessary to develop their commercial activities.	Without the project, 20 existing microenterprises and 20 microenterprises to be installed during the project will not receive the support and technical assistance necessary to maintain their own sustainable production and contribute to strengthening the value chains of the productions chosen by them.

2. COST-EFFECTIVENESS STUDY FOR THE ALTERNATIVES

The cost-effectiveness analysis will compare the alternatives:

i) Rice, with and without project
ii) Agricultural productions, with and without project
iii) Alternatives for diversification of income sources

The production costs, return and benefit of improved yields compared to the conventional method at plot level of the different crop productions are based on detailed input and labour costs per hectare, expected yield (kg/ha), plot income (yield x price) and plot benefit (yield - costs).

2.1 Cost-Effectiveness Analysis on Rice production

Rice farming without Project with traditional practices with Project implementation represented by the currently implemented conventional rice production practices (called Conventional or CONV in this analysis), and the SRI-CRRP methodology in West Africa with the SAP-GNB project (called SRI-CRRP), it is another crucial point of SAP-GNB.

In this analysis (table 3), the production of conventional rice was compared with the SRI rice and the analysis identified an increase of more than 250%, going from 1500 kg/ha to 3500Kg/ha, and the production costs had an increase much lower than the benefits. In this analysis, the gains went from 483 USD to 1899 USD with a percentage increment of gains that was almost 300% (293%), equivalent to 1,416 USD (Table 2).

Considering the environmental benefits of the installation of the SRI-CRRP ploughs, the analysis can only confirm the importance of the installation of this methodology for immediate, medium- and long-term results.

2.2 Cost-Effectiveness Analysis on Agriculture production

The traditional agricultural production without the SAP-GNB Project with adapted agricultural production and introduction of irrigation techniques with the SAP-GNB Project, is analyzed in this section using table 3.

At the level of agricultural production, traditional production (rain-fed Mays, Cassava, etc.) and horticulture with a motor pump and furrow irrigation were compared with the sustainable production systems promoted by the project: drip irrigation and motor pump, drip irrigation and solar system, drip irrigation, solar system and greenhouse (for nursery).

Again, all improved systems show greater gains, with a strong increase in production and family income. The solar systems, due to the reduced management costs linked to the use of solar energy, compared to petrol, show a greater increase in benefits, compared to the fuel system, and the use of drop by drop already allows a strong reduction in the management costs of mining.

In this analysis (table 3), the production of rainfed food crops and vegetable crops, using motor pumps and furrows, was compared with the production of vegetables with drip irrigation systems (fed with a motor pump or solar system) and the installation of a nursery, fed with a solar and drip system.

The production with a motor pump and drip irrigation system allows an increase in inputs of 207 and 432% with respect to rainfed production and the production of vegetables with a motor pump, while the production with an electric pump and irrigation system allows an increase of 310 and 645%, and finally the installation of a nursery can increase inputs by 376 and 781%, thus producing an increase in inputs of about 5000 USD (6000 USD - 1000 USD).

We must point out that these large amounts of incremental income are due to an extremely low production condition at this time. Therefore, the improvements made will have a preponderant weight with respect to the current production.

To produce vegetables, considering the great demand in the local market, it is estimated that the increment of supply will be relatively low in relation to demand, so it is estimated that the increment of production will not provoke significant variations on the price of the final product.

To produce the nurseries, market evaluations will have to be done on an annual basis, in order to guarantee that the investments are dimensioned with the production demand, avoiding the installation of too high a number of nurseries and thus saturate the market, causing the price of the production to fall.

Also in this case, the choices selected by the project, besides having a better financial result have important environmental benefits; solar systems, as compared to motor pumps, do not produce pollution, and have a much longer life span as compared to fuel systems.

Drip irrigation systems allow the use less quantity of water, significantly increasing the efficiency of use. At the same time, causing a reduced leaching of the soil, they allow reducing the pollution linked to infiltration of fertilizers and nutrients, typical of furrow irrigation and relative pollution of groundwater.

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Table 3: Additional benefits (USD) produced with the adaptation farming method compared to the conventional method (SRI and conventional rice and improved and conventional crop production, including irrigation systems) over the project period.

			traditional rice			SRI Rice			No irrigation (More, Cassava,....)			Motor pump + furrow irrigation Horticulture			Motor pump + drop by drop Horticulture			Solar system + Electropump + drop by drop Horticulture			Solar system + Electropump + drop by drop Nursery		
Input cost / ha for production	Unit (eg kg)	Money	Quantity / ha	cost / ha	USD	Quantity / ha	cost / ha	USD	Quantity / ha	cost / ha	USD	Quantity / ha	cost / ha	USD	Quantity / ha	cost / ha	USD	Quantity / ha	cost / ha	USD	Quantity / ha	cost / ha	USD
seeds	kg	F CFA	40	24 000	44	20	12 000	22	25	15 000	27								-	-		-	-
100 g cans	cans	F CFA			-			-			-	10	-	-	10	-	-	10	-	-			-
organic fertilizer	kg	F CFA		-	-	5000	50 000	91	5000	50 000	91	5000	50 000	91	5000	50 000	91	5000	50 000	91	5000	50 000	91
Urea	kg	F CFA	200	-	-	100	-	-	100	-	-	200	-	-	100	-	-	100	-	-	150	-	-
NPK (DAP)	kg	F CFA	100	-	-	50	-	-	200	-	-	400	-	-	200	-	-	200	-	-	75	-	-
Other fertilizers		F CFA			-			-			-			-			-			-		-	-
Fungicide	Liter	F CFA	1	-	-	1	-	-	0	-	-	2	-	-	2	-	-	2	-	-	2	-	-
Insecticide	Liter	F CFA	1	-	-	1	-	-	0	-	-	2	-	-	2	-	-	2	-	-	2	-	-
Irrigation	Hydro cost	F CFA	0		-	1	70 000	127	0		-	1	1 200 000	2 182	1	1 000 000	1 818	1	300 000	545		300 000	545
Plastic bags	1000 Kit	F CFA			-			-			-			-			-			-	100	1 000 000	1 818
					-			-			-						-			-			-
workers	Unit (eg kg)	Money	Quantity / ha	cost / ha		Quantity / ha	cost / ha		Quantity / ha	cost / ha		Quantity / ha	cost / ha		Quantity / ha	cost / ha		Quantity / ha	cost / ha		Quantity / ha	cost / ha	
soil preparation	There is	F CFA	1	37 500	68	1	37 500	68	1	37 500	68	1	37 500	68	1	37 500	68	1	37 500	68			-
Transplant	h / d	F CFA	3	9 000	16	5	15 000	27	5	15 000	27	20	60 000	109	20	60 000	109	20	60 000	109	60	180 000	327
Weeding	h / d	F CFA	4	12 000	22	2	6 000	11	15	45 000	82	15	45 000	82	15	45 000	82	15	45 000	82	16	48 000	87
Irrigation	h / d	F CFA	9	27 000	49	5	15 000	27			-	25	75 000	136	10	30 000	55	10	30 000	55	60	180 000	327
Harvest	h / d	F CFA	15	45 000	82	15	45 000	82	15	45 000	82	20	60 000	109	20	60 000	109	20	60 000	109	30	90 000	164
Threshing	h / d	F CFA																					
			31			27			35			80			65			65			166		
Total cost				cost / ha			cost / ha			cost / ha			cost / ha			cost / ha			cost / ha			cost / ha	
				154 500	281		250 500	455		207 500	377		1 527 500	2 777		1 282 500	2 332		582 500	1 059		1 848 000	3 360
								-			-			-			-			-			-
Yield (Kg)			Unit (eg kg)	yield / ha		Unit (eg kg)	yield / ha		Unit (eg kg)	yield / ha		Unit (eg kg)	yield / ha		Unit (eg kg)	yield / ha		Unit (eg kg)	yield / ha		Unit (eg kg)	yield / ha	
			H	1 500		H	3 500		H	1 500		H	5 000		H	6 000		H	6 000		H	10 000	
Price for 1 kg of product			kg	400	0,7	kg	400	0,7	kg	450	0,8	kg	500	0,9	kg	550	1,0	kg	600	1,1	Unit	550	1,0
Total income (yield x price)			Money	income / ha		Money	income / ha		Money	income / ha		Money	income / ha		Money	income / ha		Money	income / ha		Money	income / ha	
			F CFA	600 000	1 091	F CFA	1 400 000	2 545	F CFA	675 000	1 227	F CFA	2 500 000	4 545	F CFA	3 300 000	6 000	F CFA	3 600 000	6 545	F CFA	5 500 000	10 000
Profit (revenue - costs)			Money	profit / ha		Money	profit / ha		Money	profit / ha		Money	profit / ha		Money	profit / ha		Money	profit / ha		Money	profit / ha	
				445 500	810		1 149 500	2 090		467 500	850		972 500	1 768		2 017 500	3 668		3 017 500	5 486		3 652 000	6 640
			Difference:				704 000	1 280	Difference Respect -No irrigation							1 550 000	2 818		2 550 000	4 636		3 184 500	5 790
			Increment Percentage				158%	158%	Difference Respect Motor Pump + furrow irrigation							1 045 000	1 900		2 045 000	3 718		2 679 500	4 872
									Percentage Respect No irrigation							432%	432%		645%	645%		781%	781%
									Percentage increase with respect Motor Pump + furrow irrigation							207%	207%		310%	310%		376%	376%

2.3 Cost-Effectiveness Analysis on Agriculture Small-Business and Income projects implementation

Other activities with high potential and adequate adaptation to climate change as considered in this analysis for the creation of small-business and income for cooperatives and households.

In this case, considering that they are considered new activities, the benefits of the activities and the efficiency of the different investments were studied, calculating the necessary initial expenses, the operating costs and the profits, thus calculating the IRT of the different investments.
The activities linked to the diversification of income sources (8: fishing, Aquaculture, Beekeeping and honey production, Goat farming, sheep Farming, cattle breeding, pig farming, Poultry farming), were compared with the others linked to agriculture and previously studied (Conventional Rice, Climate-Resilient Rice Production (CRRP), Tubers (Mays, Mandioc, Sweet potatoes, and other non-irrigated crops), Horticulture and fruit growing - Motor pump + furrow irrigation, Horticulture and fruit growing - Motor pump + drop by drop, Horticulture and fruit growing - Solar system + Electropump + drop by drop, nursery fruit and medicinal plants - Solar system + Electropump + drop by drop), thus totaling the analysis of 15 income generating activities.
The analysis was based on the analysis of the initial investment necessary to carry out the activity, the management costs (including the calculation of depreciation), the annual earnings and thus the profits. Finally, the IRR was calculated at 5 years (end of the project) and at 10 years (after 5 years of the end of the project).
As can be seen from the table 4 traditional rice is the worst investment, with an IRR of 10%, followed by pig and cow production and horticulture with motor pumps and furrow irrigation systems.
Poultry production, beekeeping, goat production and aquaculture, present the highest IRR values, being 69%, 61%, 48%, 47% respectively. Finally, the SRI-CRRP rice and solar powered drip irrigation systems show excellent results, with values of 30%, 30 and 35% respectively.
For that which refers to the exploitation of ruminants, analyzing also the environmental and social aspect, it is advisable to privilege the production of goats and ovine in a combined way, being that they present a very strong alimentary synergy (goats prefer arboreal and bush pasture, being that the ovine prefer grass), it is not advisable the bovines because, besides having a much longer productive cycle and besides needing a bigger initial investment, it has greater demands in terms of pasture and a lesser index of conversion.
Among the monogastric animals, pig production should be avoided because, besides having lower economic yields than the others, they are subject to the African swine fever, which in many contexts has decimated family productions, even when these have increased the bovine population and thus increased the population density and the risk of diffusion. Also in this case, the market analysis guarantees a high demand for the product, since no depreciations linked to an increase in supply are foreseen. Furthermore, the exploitation of chickens is traditionally carried out by women, so that by increasing this activity the role of women within the community will be directly reinforced.
Fishing and aquaculture both present great potentialities. Also in this case, the high demand for the product does not show problems related to increasing the supply. For fishing, the current stock must be analyzed to estimate the volume of fishing possible in line with the environmental regeneration capacities, maybe during the Baseline Study.
For aquaculture, it is necessary to study the areas that guarantee the safe digging of the tank and with clay soils that allow a more economical production of the paving.
The production can be carried out in an intensive way (with certified alevins and industrial feed) or traditional (with alevins captured in the rivers and local feed).
In short, beekeeping has a very high potential. By providing a protection kit and an extraction and bottling kit, experiments carried out in other countries show great productive increases (besides an increase in the bee population). Also in this case, the whole extraction, filtering and bottling phase is traditionally carried out by women, and they themselves manage the inputs of the activity.

Table 4: Comparative Cost-Effectiveness Analysis of the Investment Projects proposed by the intervention in agricultural production and diversification of income sources.

		Area/quantity	initial investment	annual profit	annual expenditure (including running and maintenance costs)	annual gain (stabilised at 3 years)	Abortion 10% (10 years)	current gain	Internal rate of return (IRR) - 5 Years	Internal rate of return (IRR) - 10 Years
1	Conventional Rice	1 ha	1.141,81	1.090,91	608,18	482,73	114,18	**368,55**	**10%**	**22%**
2	Climate-Resilient Rice Production (CRRP)	1 ha	3.087,27	2.545,45	646,36	1.899,10	308,73	**1.590,37**	**29%**	**38%**
3	Tubers (Mays, Mandioc, Swet potatoes, and other non-irrigated crops)	1 ha	1.087,27	1.227,27	650,00	577,27	108,73	**468,55**	**21%**	**31%**
4	Horticulture and fruit growing - Motor pump + furrow irrigation	1 ha	2.087,27	4.545,45	3.586,33	959,12	208,73	**750,39**	**14%**	**26%**
5	Horticulture and fruit growing - Motor pump + drop by drop	1 ha	5.587,27	6.000,00	2.949,97	3.050,03	558,73	**2.491,30**	**23%**	**32%**
6	Horticulture and fruit growing - Solar system + Electropump + drop by drop	1 ha	8.087,27	6.545,45	1.495,44	5.050,01	808,73	**4.241,28**	**30%**	**38%**
7	Nursery fruit and medicinal plants - Solar system + Electropump + drop by drop	1 ha	9.240,62	10.000,00	3.673,63	6.326,37	924,06	**5.402,31**	**35%**	**43%**
8	Fishing	1 fishing equipment	800,00	1.920,00	1.308,00	612,00	80,00	**532,00**	**42%**	**48%**
9	Aquaculture	1 tank (with fingerlings and feed for 1st production)	3.888,00	6.000,00	2.739,27	3.260,73	388,80	**2.871,93**	**47%**	**53%**
10	Beekeeping and honey production	1 KIT (2 protective suits 1 press, 1 filter 1 decanter)	2.160,00	3.000,00	777,00	2.223,00	216,00	**2.007,00**	**61%**	**66%**
11	Goat farming	1 KIT (1 male - 4 females + local sheepfold)	863,64	900,00	163,64	736,36	86,36	**650,00**	**48%**	**54%**
12	Shep Farming	2 KIT (1 male - 4 females + local sheepfold)	954,55	800,00	163,64	636,36	95,45	**540,91**	**34%**	**41%**
13	Cattle breeding	1 KIT (1 male - 3 females + local sheepfold)	1.690,91	1.112,73	327,27	785,45	169,09	**616,36**	**15%**	**26%**
14	Pig farming	1 KIT (1 male - 4 females + local sheepfold)	927,27	749,09	327,27	421,82	92,73	**329,09**	**14%**	**25%**
15	Poultry farming	1 KIT (1 Rooster - 10 chickens + local sheepfold)	1.273,35	1.948,18	490,91	1.457,27	127,34	**1.329,94**	**69%**	**73%**

3. FINANCIAL ANALYSIS

The financial analysis for the cost effectiveness of the project is presented in Table 5. The financial profitability of the project investment is determined by the project cost components and the estimated financial benefits obtained through the project interventions based on the following financial appraisal techniques: i) cash flow ii) benefit cost ratio, iii) net present value (NPV), and iv) internal rate of return (IRR).

For the calculation of the benefits, only the benefits related to the increase of the beneficiaries' income were calculated, since the social and environmental benefits have already been calculated in another part of this analysis, not monetizing them, since they are not monetary goods.
Every analysis was carried out in a precautionary way, calculating that at the end of the project only 50% of the beneficiaries will have reached economic and financial sustainability, whether for the SRI rice production activity or for the diversified income generating activities directed to women.

Table 5: Financial analysis for project cost-effectiveness

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
A. Cost Components						
Component 1	287 990,00	124 652,50	104 740,00	135 952,50	107 140,00	760 475,00
Component 2	804 183,67	810 013,67	102 738,67	85 172,00	85 172,00	1 887 280,00
Component 3	3 112 753,00	1 933 666,33	785 123,00	566 948,00	426 389,67	6 824 880,00
Execution costs (management units)	144 070,00	90 570,00	96 570,00	90 570,00	96 570,00	518 350,00
Implementation costs (management unit)						-
Total costs (A)	4 348 996,67	2 958 902,50	1 089 171,67	878 642,50	715 271,67	9 990 985,00
B. Financial benefits						
Study/Consultancy Benefits						
Benefits for trainers and extension services						
Benefits for rice farmers	1 088 000	1 360 000	1 700 000	2 125 000	2 656 250	8 929 250
Benefits for diversified producer farmers	2 741 791	3 427 239	4 284 048	5 355 060	6 693 825	22 501 964
Benefits for producer associations/groups						
Total financial benefits (B)	3 829 791	4 787 239	5 984 048	7 480 060	9 350 075	31 431 214
Cash flow (BA)	-519 206	1 828 336	4 894 877	6 601 418	8 634 804	21 440 229
Benefit Cost Ratio (B/A)	0,88	1,62	5,49	8,51	13,07	3,15
Net Present Value (NPV)						18 366 652
Internal Rate of Return (IRR)						44%

The financial analysis indicates a positive cost-benefit ratio of 3.15. The NPV is positive with $18.36 million, and the internal rate of return is also positive with 44%. An important aspect to consider is that the additional benefits from the implementation of the project will continue in the future to occur on an annual basis. The proposed project is therefore very cost effective and worth the investment.

CONCLUSIONS

Considering this situation, cost-effectiveness analysis has shown that investments in planned interventions will be effective in building community resilience to climate change, creating local conditions to strengthen livelihoods and access to water and agriculture production, improve knowledge and awareness of environmental protection and preservation, and improve community collaboration of public, private and network institutions.
The SAP-GNB project is very important for the creation of household and business performance at the local level because it could stimulate the market and influence other actors not directly involved in the project. At the same time, the SAP-GNB project is an important contribution to these regions and to the country for some "novelties": climate change centers, which will help communities to have more knowledge about environmental issues related to agricultural production activity, networking through cooperatives, improvement of water quality both for irrigation and consumption, introduction of agricultural practices adapted to climate, support in the creation of small local businesses and especially women empowerment, which will be the focus of all activities.
Considering that populations live cyclically and periodically affected by disasters, the investments made on the territory by the interventions of the SAP-GNB Project represent a concrete possibility to change the condition of vulnerability in which they find themselves, improving their livelihoods, income, relationship, and interaction with the environment and therefore the future itself.

INTRODUCTION

Guinea-Bissau is a low-income, food-deficit country in West Africa with a population of 2 million and ranked 175th out of 189 countries in 2020 on the Human Development Index[14]. Forty-seven years of political instability have profoundly limited socio-economic and human development. Poverty, which affects 70% of the population, impacts women more than men, reflecting gender inequalities in access to education, land and credit. Data from 2014 indicates that in Guinea-Bissau, 67.3% of the population (1,261,000 people) are multidimensionally poor, while an additional 19.2% are classified as vulnerable to multidimensional poverty (359,000 people). The breadth of deprivation (intensity) in Guinea-Bissau, which is the average deprivation score experienced by people in multidimensional poverty, is 55.3%. The Multidimensional Poverty Index (MPI), which is the percentage of the population that is multidimensionally poor, adjusted by the intensity of deprivations, is 0.372[15].

Since 2020, vulnerabilities have been further exacerbated by the compounded impacts of COVID-19, increasing institutional weaknesses, inadequate public services, lack of a social protection system and over-reliance on cashew nut exports[16] . Growth is expected to recover to 2.9% in 2021 and 3.9% in 2022, a prospect based on large-scale vaccination against COVID-19 and a resumption of trade activities. Political stability will be crucial to attract investment and stimulate private sector engagement. Inflation is expected to remain stable - at 2% in 2021 and 1.9% in 2022. A slight improvement will be seen in both the budget deficit - at 5.3% of Gross Domestic Product (GDP) in 2021 and 4.6% in 2022 - and the current account balance, which will be at a deficit of 4.4% in both years[17].

Among the social issues, malnutrition and poor feeding practices also remain a concern, affecting 27.7% of children aged 6-59 months and peaking at over 30% in the regions of Oio, Bafatá and Gabu, while wasting affects 5% of children aged 6-59 months[18]. Only 8% of children aged 6-23 months receive a minimum acceptable diet and 29% of women and girls aged 15-49 years achieve minimum dietary diversity[19]. Anemia is a major public health issue, affecting 44% of women and girls aged 15-49 years and 68% of children aged 6-59 months[20].

In 2020, the Country witnessed a deterioration of the food security situation caused by: movement limitations during the state of public health emergency declared on 27 March following the increase in COVID-19 cases, the unsuccessful annual cashew nut marketing campaign and above average rainfall resulting in flooding[21]. The latter negatively affected agricultural production and caused widespread damage to homes and community infrastructure, particularly in the regions of Cacheu, Oio, Bafatá, Tombali and Quinara[22].

According to the November 2020 “Cadre Harmonisé” analysis, an estimated 96.000 people (7% of the analyzed population) required food assistance by August 2021, with a substantial increase of 68.000 food insecure people during the period June to August 2020. The main drivers of food insecurity are the

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[14] http://hdr.undp.org/en/countries/profiles/GNB
[15] http://hdr.undp.org/sites/default/files/Country-Profiles/GNB.pdf
[16] https://www.ifad.org/es/web/operations/w/country/guinea-bissau
[17] https://www.afdb.org/en/countries/west-africa/guinea-bissau/guinea-bissau-economic-outlook
[18] Inquérito aos Indicadores Múltiplos (MICS6) 2018-2019, Relatório Final. Ministério da Economia e Finanças, Direcção Geral do Plano/Instituto Nacional de Estatística (INE)
[19] Ibidem
[20] Ibidem
[21] https://docs.wfp.org/api/documents/WFP-0000125391/download/
[22] Ibidem

effects of adverse weather events (floods), Autumn Army attacks on maize, millet and sorghum crops across the country and the impacts of the COVID-19 pandemic on the value chain[23].

Despite Guinea-Bissau's agro-forestry-pastoral potential and fisheries resources, many studies have shown that, the current food situation in the country is very precarious, with poverty identified as the underlying cause. Greenhouse gas (GHG) emissions from the agricultural sector were identified as very high, with the country indicating reforestation as the main action to mitigate GHG emissions in its nationally determined contribution (NDC)[24].

Malnutrition and food insecurity derive from critical issues related to the agricultural sector and the impact of climate change on the territory and communities.

In Guinea-Bissau, the impact of climate change had already been felt on the economy for some time, especially due to a decrease in rainfall and a gradual increase in temperature. In terms of water resources, this can be seen in aquifers that have decreasing amounts of water and are more easily flooded by salt water, increasingly deeper groundwater and dry lakes; with regard to the agrarian sector, the production of Guinean staple foods (rice), has decreased sharply, also due to the salinity and acidity of hydromorphic soils and the flooding of rice fields[25].

Climate change will have a negative influence on the quality and quality of water resources through a reduction in precipitation, as well as on the agricultural sector, which already exhibits critical deficiency elements.

The agricultural sector is the main pillar of Guinea-Bissau's economy. In the absence of other resources, the sector, although underdeveloped, plays a leading role in supporting food security and job creation. Agriculture currently contributes about 46% of the national GDP, with 84% of the population actively employed in primary production agriculture largely dominated by women[26].

Vulnerable households, especially farming households, are highly exposed to unpredictable fluctuations in the international market price of cashew nuts, climate change risks and recurrent environmental degradation caused by land misuse and flooding[27]. Most of these farmers are smallholder farmers cultivating on less than two hectares (2 ha).

More than 45% of the country's domestic cereal use is covered by imports. Rice accounts for about 80% of import requirements, followed by wheat, which accounts for about 15%[28]. More than half (58%) of the total land in Guinea-Bissau is used for agriculture with an area under forest heavily degraded by rapid exploitation. Rice is a staple crop in West Africa and largely produced by low-income smallholders throughout the region.

In Guinea-Bissau, therefore, rice represents, along with cashew, a key element for food security for the populations, both those living in rural and urban areas. It is estimated that this staple crop accounts for 75% of cereals consumed, and more than 60% of the surface area devoted to cereal crops[29].

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[23] Ibidem
[24] https://www.fao.org/publications/card/en/c/CA5406EN/
[25] https://www.adaptation-undp.org/explore/western-africa/guinea-bissau
[26] https://www.fao.org/publications/card/en/c/CA5406EN/
[27] https://docs.wfp.org/api/documents/WFP-0000125391/download/
[28] https://www.fao.org/giews/countrybrief/country.jsp?code=GNB
[29] https://www.cambridge.org/core/journals/experimental-agriculture/article/mangrove-rice-biodiversity-valorization-in-guinea-bissau-a-bottomup-approach/584BD76069CB66571CDA2A13276E037A

However, there are huge potentials for agricultural and forestry land, including arable land estimated at about 1.5 million hectares. Farmers are engaged in the production of various crops and livestock such as cashew, rice (the country's staple food), sorghum, maize, etc., largely grown by subsistence farmers. Women are generally engaged in horticulture in urban areas. Livestock production concentrated mainly in the north and east of the country is one of the main economic activities supporting food security and thousands of livelihoods[30].

The country is divided into three agro-ecological zones based on ecological, climatic and demographic characteristics. Agriculture is mainly rain-fed, with very limited irrigated agriculture practiced[31]. About 82% of water withdrawals are used for agricultural purposes, driving the need for huge investments in irrigation to support agricultural production.

Agriculture, therefore, and the livelihoods related to it are exposed to the effects of climate change, and the country is vulnerable to droughts, floods and sea level rise.

From the point of view of the effects and impacts of climate change in Guinea-Bissau, the country can be divided into two major regions: the coastal zone and the interior.

In the interior, the climate is drier and more susceptible to temperature and precipitation anomalies resulting from the effects of climate change. These include a shortening of the rainy season and lower temperatures in the so-called "cold season" from three months (December to February) to just two months (December and January). Dusty winds are also expected to become more frequent in rural areas and affect agricultural production. Although climate change scenarios point to a general trend of increased average rainfall, phenomena such as longer droughts and higher incidence of forest fires are also expected anomalies. Flooding may also occur as an effect of climate change in the hinterland. Under these conditions, water availability for human consumption will be negatively affected.

The coastal zone occupies two thirds of the country's territory. It is of significant economic importance and is home to about 70% of the population. The only major urban centre of the country is located on the coast: the capital Bissau, with 300,000 inhabitants (up to 500,000 if the peri-urban area is also considered)[32]. The maritime influence is felt in Guinea-Bissau's hydrographic basins in places as far from the sea as Farim or Bafata. Maritime influence mainly includes not only tides, but also saline intrusion will be exacerbated in coastal agricultural fields. The surface of the nominal coastal zone, as represented on the map in Figure 1, is quite extensive and will be affected mainly by sea level rise, tropical storms, coastal erosion, and flooding in low-lying areas. There may be water scarcity, noting that much of the coast already suffers from aridity. The oceans will become more acidic as a global effect of climate change. In Guinea-Bissau, this will at some point impact marine productivity, the marine food chain, and consequently also affect the availability of fish[33].

With increasing temperatures and decreasing precipitation, groundwater, which is the main source of drinking water for the population, could be strongly affected. In addition, irregular precipitation and rising temperatures would lead to a decrease in the base flow of rivers and a significant drop in the water table. An increase in groundwater salinity is also expected, amplified by rising sea levels.

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[30] https://www.fao.org/publications/card/en/c/CA5406EN/

[31] Ibidem

[32] https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Guinea-Bissau%20First/NDC-Guinea%20Bissau-12102021.Final.pdf

[33] Ibidem

The main impacts of climate change on the agriculture and livestock sector relate to irregular rainfall in terms of intensity and onset/end of season, increase in temperature and submergence of agricultural land due to rise in mean sea level. Rice crops are vulnerable to both irregular rainfall and sea level rise affecting production due to excessive saline water intrusion (SWI), especially in mangrove rice fields due to high tides and the consequent destruction of anti-salt dikes [34].

The livestock sector is also strongly affected by the increase in temperature and the decrease in precipitation, which inevitably translates into a general lack of water for grazing, a decrease in grazing areas, a severe reduction in the production of pasture, milk and meat. This encourages transhumance in search of better pastures, creating conflicts between pastoralists and farmers[35].

In response to these challenges, the *Adaptation of agricultural production systems in the coastal areas of Northwest Guinea Bissau* project will be implementing a smart approach to improve agricultural production (mainly rice, vegetables and legumes) and therefore the livelihoods and income of coastal communities in relation to climate change.

As such, the project not only provides for the introduction of land management techniques for climate adaptation, but also for an increase in crop productivity, more sustainable management of water resources, land and an introduction and increase of income generating initiatives in communities in the regions of Cacheu and Oio.

These rural and farming communities see their climate-related livelihoods heavily affected by climate change, with the future scenario likely to worsen if no appropriate intervention is made. The SWI, derived from rising sea levels, together with rainfall variability are threatening the livelihoods and lives of these rural communities, affecting rice production and agricultural production in general. The direct consequences are decreases in income, food insecurity and loss of livelihoods. The indirect socio-economic consequences are malnutrition, migration, increased domestic violence and maternal and child deaths.

The project intends at local level to create local observatories that will monitor climate impacts and coordinate adaptation interventions in communities, which, accompanied by concrete adaptation plans and interventions for climate resilient water and coastal zone management and the introduction of smart techniques to increase climate resilient agriculture and climate resilient livelihoods, will allow for an improvement of the lives and socio-economic activities of communities in the regions of Cacheu and Oio.

The *Adaptation of agricultural production systems in the coastal areas of Northwest Guinea-Bissau* (also named in this text SAP-GNB) project will be implemented in the regions of Oio and Cacheu by the Observatory of the Sahara and Sahel (OSS), as Regional Implementing Entity; the institution with the most relevant technical experience (IBAP); and the relevant line ministries MoEB and MoA) and ADPP-GNB, the largest NGO in Guinea-Bissau that will lead the activities in the field and with the communities.

The overall objective of the *Adaptation of agricultural production systems in the coastal areas of Northwest Guinea Bissau* project is to **enhance the climate-resilience of livelihoods and food security of the most vulnerable populations in Oio's and Cacheu's coastal areas**.

The project Components are:

[34] Ibidem

[35] Ibidem

- C1. “Development of technical and institutional capacity of government and civil society”; Outcome 1. Strengthened capacity and knowledge management to monitor and address climate risks in Oio and Cacheu Regions.
- C2. “Adaptation of water management towards climate risks in coastal zones”, Outcome 2. Improved Water Availability and quality for production and consumption in coastal communities in Oio and Cacheu, despite climate risks.
- C3. “Building climate-resilient farming communities”; Outcome 3. Enhanced climate-resilience of smallholder farmers, in coastal communities in Oio and Cacheu Region.

The project also has three main results, one for each component:

- Outcome 1. Strengthened capacity and knowledge management to monitor and address water and agriculture-related climate risks in Oio and Cacheu Regions.
- Outcome 2. Improved water availability and quality for production and consumption, in coastal communities in Oio and Cacheu, despite climate risks.
- Outcome 3 Enhanced climate-resilience of smallholder farmers, in coastal communities in Oio and Cacheu Region.

1 ALTERNATIVES CONSIDERED FOR THE COST-EFFECTIVENESS STUDY

The Adaptation of agricultural production systems in the coastal areas of Northwest Guinea Bissau project will create significant economic, social and environmental benefits and impact at household, community, national and regional levels.

This cost-effectiveness analysis will evaluate two alternatives:

- <u>Alternative 1</u>: The alternative to the project *Adaptation of agricultural production systems in the coastal areas of Northwest Guinea Bissau of* no project intervention, or the continuation of sectoral approaches in agricultural production and diversification in income sources, as currently underway in Guinea-Bissau.
- <u>Alternative 2</u>: The economic, environmental and social benefits that the proposed *Adaptation of agricultural production systems* interventions *in the coastal areas of Northwest Guinea-Bissau are* expected to create in relation to increased agricultural productivity and improved livelihoods, environmental protection, mitigation benefits and climate change *adaptation.*

Table 1: Comparison of yield, water use and net return for four alternative rice systems with the conventional flooded paddy system (at 100%)

	Cost of the project (USD)	Number of beneficiaries	Average expenditure per beneficiary (over 5 years of project) USD	Year 1 USD	Year 2 USD	Year 3 USD	Year 4 USD	Year 5 USD	Total USD
SAP-GNB	9.990.985,00	170 Clubs 8500 agriculture family 82.450 Beneficiary	121,18	1.998.197,00	1.998.197,00	1.998.197,00	1.998.197,00	1.998.197,00	9.990.985,00
NO-Project	70.082.500,00	170 Clubs 8500 agriculture family 82.450 Beneficiary	850,00	14.016.500,00	14.016.500,00	14.016.500,00	14.016.500,00	14.016.500,00	70.082.500,00
	170 USD/year (Humanitarian AID/Beneficiary/Year)	Difference with the project		**12.018.303,00**	**12.018.303,00**	**12.018.303,00**	**12.018.303,00**	**12.018.303,00**	**60.091.515,00**

This cost-effectiveness analysis compares all the climate-adapted agricultural production and livelihood and income strengthening interventions defined in the proposal with the conventional system, considering the project investment and its return to the beneficiaries.

Furthermore, the cost-effectiveness analysis makes a comparison between the implementation of different systems of income generating activities and in water management.

As shown in the study in Table 1, the SAP-GNP project with a budget of 9,990,850.00 USD supports 82,450 direct beneficiaries, with an average expenditure of about 120 USD per beneficiary. If the project were not implemented, to provide emergency assistance to the communities covered by the project, consisting of one meal a day, it would take more than six times the total value of the project, that is, about 60 million USD.

Furthermore, the results of the project are long-lasting, incorporating the benefits of the investments made into the communities.

1.1 Alternative 1: The project *Adaptation of agricultural production systems in the coastal areas of Northwest Guinea Bissau* is not implemented

If the project *Adaptation of agricultural production systems in the coastal areas of Northwest Guinea Bissau* is not implemented, the current situation for communities remains the same, therefore agricultural production is not improved and adaptation measures are not implemented, leaving agricultural production (mainly rice, vegetables and legumes) insufficient to meet the demand of the population.

1.1.1 Impact of climate change on no-adapted agricultural production

Without adaptation measures, agriculture in Guinea-Bissau is likely to be exposed and targeted for the worse because of climate change effects.

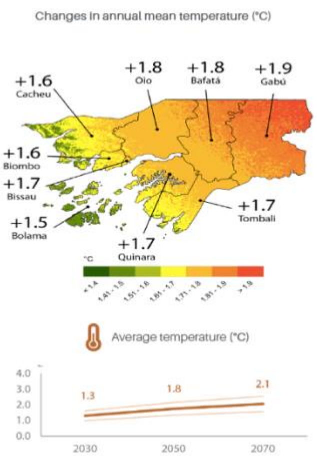

Image 1Source: https://www.fao.org/3/ca5406en/CA5406EN.pdf

Climate scenarios for Guinea-Bissau systematically project increases in mean daily temperature up to + 1.4 °C for the period 2016-2045, with the potential to reach up to + 2.2 °C between 2046 and 2075 per low emissions scenario[36].

Considering instead the worst-case scenario, with high emissions, the projected changes are even higher with temperature increases of + 1.6 °C to + 3.1 °C for the periods 2046 and 2075, respectively (Image 1). Altogether, the models point to significant increases in daily maximum and minimum temperatures in the order of +3.0 °C and +3.2 °C, respectively, particularly in the eastern part of the country[37].

Regarding precipitation (Figure 2), the average of fourteen models used in the simulation's points to a slight increase in average daily precipitation of + 3% [2 to + 5%] for almost the entire national territory, under the low emissions scenario for the period 2016-2045. For the high emissions scenario, no significant changes are expected compared to the reference period: 1961-1990. Except for the southwestern part of the Bijagós Archipelago and part of the southern region of Tombali, where an increase of + 5 percent is expected, the projections in this scenario are generally characterized by significant variability[38].

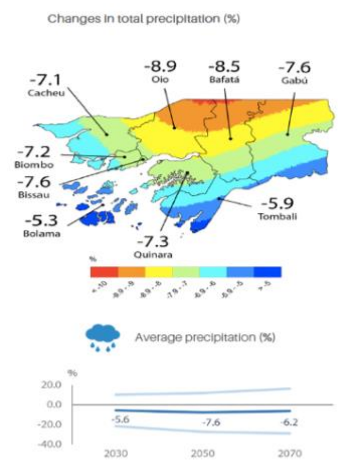

Image 2Source: https://www.fao.org/3/ca5406en/CA5406EN.pdf

The projected changes in temperature and precipitation are likely to have a substantial impact on water resources that are already limited in their ability to provide sufficient and especially adequate water for the agricultural sector. Without adequate and intelligent climate solutions, with rain-fed or rainfed agricultural production systems predominating, yields of the main food crops and livestock production are also expected to decrease [39].

1.1.2 Vulnerability of current practices and approaches to agricultural production, income generation and water resource management

The widespread and common agricultural production practices in Guinea-Bissau are prevalent traditional (using rudimentary cropping, harvesting and seed conservation systems), marked by low yields as well as being dependent on rainwater. Traditional practices are also not environmentally sustainable.

The vulnerability of current agricultural production systems is characterized by:

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36 https://www.fao.org/publications/card/en/c/CA5406EN/
37 Ibidem
38 Ibidem
39 Ibidem

- High dependence on rainwater and poor capacity and efficiency in the management of water resources or in the use of water for irrigation.
- Seasonal agricultural cycles with few crop alternatives in the dry season
- High dependence on rice and cashew nuts for agricultural production
- Use of rudimentary and unproductive farming techniques by farmers
- Difficulties in keeping quality, climate-resilient seeds for farmers
- Little capacity of farmers to introduce agricultural technologies and innovations adapted to climate change; little support provided to strengthen locally adapted and efficient solutions, e.g. traditional soil and water management practices, locally adapted crop varieties and cultivation practices
- Minimal attention and support to good agro-environmental practices, soil fertility management and agro-ecological approaches in agricultural production.
- Agricultural sector and production very much based on subsistence, with few opportunities, stimuli and interests of farmers in marketing opportunities for agricultural products, Unsustainable agricultural livelihoods.
- Weak capacity of rural communities to understand the value chain as a business and understand how to minimize costs, improve efficiency, differentiate products, and overcome challenges to achieve profitability.

With this type of situation and weaknesses in the agricultural sector, the pressure on natural resources is expected to increase, whether on vegetation, soils or water, leading to overuse, degradation, potential conflicts, rural exodus and inter-regional and international emigration. To mitigate these effects, it is necessary to introduce adaptation measures and strengthen resilience.

a) Environmental impact:

- Overexploitation and indiscriminate use of water resources
- Soil and land degradation, decreased land productivity
    - Loss of soil organic matter, deterioration of soil structure, loss of water and soil-yielding capacity
- Loss of biodiversity in the environment and in production
- Increased vulnerability to drought and extreme weather events as resilience to overcome and adapt to negative impacts weakens.

b) Social impact:

- Fluctuation and uncertainty in total crop production increase the vulnerability of farming communities.
- Progressive increase in food demand because of high and rapid population growth.
- Increased food insecurity, hunger and malnutrition in rural, poor and marginalized communities
- Risks of farmers abandoning rural areas and cultivation and increasing rural exodus and migration
- Increase in family and social conflicts, gender inequality and social injustice, as well as early marriages and pregnancies (e.g. teenagers), school drop-outs, etc.
- Political instability may also arise from the food crisis.

c) Economic impact:

- High input and material costs for farmers, increased financial debts, reduced ability to invest in new economic opportunities, reduced wealth of farming communities.
- Decrease in crop yields and fluctuation in crop yields from year to year depending on rainfall.
- Crop failure.
- Loss of income, loss of food security.
- The increase in the price of staple crops has a negative impact on the urban population.

- Imports of agricultural products need to increase and drive-up costs.

1.1.3 Poor or ineffective agricultural sector policies and strategies in addressing climate adaptation in an integrated manner

Although climate change is a major concern in the current thinking and narrative of agricultural development in Guinea-Bissau, adaptation measures have not been systematically addressed and integrated into agricultural and environmental policies and strategies at national and local levels.

The weak capacity for sectoral integration and implementation of climate change adaptation policies and local adaptation strategies represents a major gap in building climate resilience and smart agricultural production.

Without the implementation of the SAP-GNB Project, which will also strengthen institutional capacity and knowledge on climate resilient issues and methods related to agriculture, it will be difficult to change the scenario of little achievement of political and strategic promises. An example is the *National Action Plan for Adaptation to Climate Change* (PANA), approved in 2006 by the Government of Guinea-Bissau, which, although active for over fifteen years, has not had an effective implementation and integration with other sectors[40]. Another example is the document *Strengthening the Resilience and Adaptation Capacity of the Agrarian and Water Sectors to Climate Change in* Guinea-Bissau (PRRCASAHMC-GB), which, although presenting very interesting elements of analysis and attention to the consequences of climate change in the country, was not in fact used to define concrete intervention actions[41].

Thus, state actions may only be directed at responding, as best they can, to the negative effects of climate change and the needs of the populations, thus investing large sums of resources that will have to be spent, among others:

- Emergency food aid (rural and potentially urban population)
- Subsidies to the agricultural sector to maintain a certain level of agricultural production
- Subsidies to keep staple food prices affordable
- Increase in food imports
- Disaster relief and climate change disaster response efforts: among others:
    - Damage from floods, storms, forest fires, heat
    - Damage to natural resources, various economic sectors, infrastructure, personal property
- Restoration of land and water resources.

1.2 Alternative 2: The *Adaptation of agricultural production systems in the coastal areas of Northwest Guinea Bissau* project is implemented: The CRRP is expanded throughout West Africa

The proposed alternative to the current situation focuses on the use of an approach already tested in other climate change adaptation and mitigation projects that allows leading communities towards more economically, socially (gender) and environmentally sustainable production.

[40] Republic of Guinea-Bissau. Ministry of Natural Resources and Environment, *National Action Plan for Adaptation to Climate Change in Guinea-Bissau (PANA)*, Bissau: UNDP, 2006.

[41] Ibidem

For rice production, the main one in the project area, the project plans to boost the Climate Resilient Rice Production (CRRP) methodology. CRRP is based on the Rice Intensification System (SRI) rice productivity enhancement methodology and is complemented with locally adapted and improved soil and water management practices, as well as integrated pest and disease management methods that are critical for climate change adaptation.

To produce alternative crops, such as maize, cassava (no irrigated) and vegetables (irrigated) the project will also compare traditional cultivation methods with improved cultivation methods adapted to climate change (more intensive productions, better water management - drip irrigation and ecologically sustainable systems - solar probes). In parallel, the production of plants of interest (fruit trees, medicinal plants, among others.) is compared in the following sections.

1.2.1 Rice

1.2.1.1 The System of Rice Intensification (SRI)

In a low production system, such as that of Guinea, where traditional rice production hardly exceeds 1,500 kg per hectare, it is possible, with small improvements, to significantly increase production. The System of Rice Intensification (SRI), an agro-geological and low consumption methodology to increase rice productivity. It enables yields to be increased by more than 200% (up to 3500 kg per hectare) with small increases in operating costs. Based on the principles of early plant establishment, reduced plant competition, soil enrichment with organic matter, and reduced water use, rice plants grow more vigorously and can better express their genetic potential compared to conventional approaches. Healthier and stronger plants with deeper roots can better withstand climatic calamities such as drought, floods and high winds and ensure (at least some) production, whereas conventional crops succumb more easily to these forces, leaving farmers with reduced or no crops. The introduction of SRI in West Africa began in 2000 and confirmed these advantages. With growing interest in SRI across the region, a regional project “Improvement and Extension of the Rice Intensification System in West Africa” (SRI-WAAPP) was commissioned and supervised by CORAF/WECARD as part of the West African Agricultural Productivity Programme (WAAPP), supported by the World Bank under the institutional aegis of ECOWAS. The SRI-WAAPP project ran from 2014 to 2016 in 13 ECOWAS countries: Benin, Burkina Faso, Côte d’Ivoire, Gambia, Ghana, Guinea, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. The project benefited more than 50,000 farmers, of whom 31% were women. Yields increased on lowland and rainfed irrigated land by more than 50%.

1.2.1.2 Benefits of SRI

During the past 20 years, SRI has been introduced and validated in over 60 countries in Africa, Asia, Latin America and the Caribbean. The benefits of SRI have been widely researched and reported (SRI-Rice, 2021a). They obviously vary by location, but can be summarized as follows:

- Higher crop yields: Combined changes in crop management result in plant phenotypes that give higher crop yields and have more resistance to stress. Rice yields are improved by 20-50%, and often more. Better grain quality often earns a higher market price; and when rice is grown organically, its price can be even higher[42].

- Increased yields: Whether production costs and labour requirements for SRI methods are higher, equal, or lower than for conventional rice production will depend on the comparison with current practice, the degree of intensification, and the types of changes required to move to SRI practices. But significantly higher yield increases with SRI translate into higher labour and input productivity, and thus increase farmers' income in most cases by 50% or more with SRI adoption[43].
- Reduced water requirements and improved drought resistance: SRI plants thrive with 30-50% less irrigation water compared to continuously flooded rice. Reduced competition between plants in combination with aerated and organic matter-enriched soils creates stronger above- and below-ground plants with larger, deeper and less centigrade root systems that can better withstand drought and temperature extremes. In addition, soils enriched in organic matter are able to store more water as well as nutrients[44]. How many kilograms of rice can be produced for each cubic meter of water used (or water productivity) becomes a very important parameter. Several research studies have shown that with regard to water productivity, SRI is the most efficient agronomic method with 0.43-1.02 kg of rice produced/m3, compared only to the alternative wet and dry irrigation method resulting in 0.39 - 0.54 kg/m3, and compared to flooded rice with 0.25-0.44 kg/m3[45].
- Greater resistance to pests and diseases: Stronger and healthier rice plants are less susceptible to pest and disease attacks. Given the much lower plant density with SRI, less moisture accumulates within the plant canopy as air can circulate more easily between plants. This provides pests and diseases with a less favourable environment compared to conventional densely planted and continuously flooded rice paddies.
- Improved resistance to rain and wind damage from storms. SRI plants have thicker tillers and deeper roots, and in combination with greater plant spacing, the rice plants have been shown to resist heavy rain and high winds better than conventional paddy rice. A study in Japan reported that during a storm event, 10% of the SRI field lodged compared to 55% of an adjacent conventionally managed field.
- Improved soils: With the SRI method, soils are improved by regular additions of organic matter, such as compost, animal manure, green manure or crop residues. Soils enriched with organic matter contain more carbon, nutrients and water. They can nurture greater soil biodiversity, which supports the uptake of nutrients and water by plants and can protect plants from certain diseases. Fertiliser use efficiency is improved when fertilisers are applied to soils rich in organic

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[42] Styger and Uphoff, 2016. The System of Rice Intensification (SRI): Revisiting Agronomy for a Changing Climate. Climate-Smart Agriculture Practice Brief. CCAFS, Copenhagen, Denmark.
Styger and Traoré, 2018. 50,000 Farmers in 13 countries; Results from Scaling-up SRI in West Africa. CORAF/WECARD, Dakar, Senegal.

[43] Thakur AK, Rath S, Mandal KG. 2013. Differential responses of system of rice intensification (SRI) and flooded-rice management methods to applications of nitrogen fertilizer. Plant & Soil 370: 59-71.

[44] Jagannath P, Pullabhotla H, Uphoff N. 2013. Meta-analysis evaluating water use, water saving and water productivity in irrigated production of rice with SRI vs. standard management methods. Taiwan Water Conservancy 61: 14-49.

[45] Styger and Uphoff, 2016. The System of Rice Intensification (SRI): Revisiting Agronomy for a Changing Climate. Climate-Smart Agriculture Practice Brief. CCAFS, Copenhagen, Denmark.

matter compared to degraded soils. Farmers can thus achieve the same fertilisation benefits with 30-50% less fertiliser and save on input costs.

- Mitigation of greenhouse gas emissions: SRI management contributes to mitigation objectives by decreasing greenhouse gas (GHG) emissions when continuous flooding of paddy soils is stopped, and other rice cultivation practices are changed.
    - Methane (CH4) is reduced by between 22% and 64% as intermittent irrigation (or alternate wetting and drying, AWD) means soils have more time in aerobic conditions.
    - Nitrous oxide (N2O) emissions increase only slightly with SRI or sometimes decrease as N fertilizer use is reduced. No study to date has demonstrated N2O increases that offset the gains from CH4 reduction.
    - The total global warming potential (GWP) of rice paddies was reduced with SRI methods in the above studies by 20-30%, and up to 73% in one of the studies.
    - The carbon footprint of rice production is reduced as fewer fertilizers and fewer agrochemicals are used. GHG emissions from the production, distribution and use of these inputs amount to about 5-10% of the global warming potential (GWP) of all direct emissions from food production.
    - Soil carbon sequestration contributes to reducing atmospheric CO2, while restoring degraded soils, increasing biomass production, and filtering and purifying surface and groundwater.

1.2.1.3 Benefits of CRRP methodology

As mentioned above, CRRP is based on the System of Rice Intensification (SRI) methodology and is complemented with locally adapted and sustainable land and water management (SLWM) practices and integrated pest and disease management (IPM) methods, which can play a critical role in adapting rice systems to climate change. Implementing CRRP will not only increase overall rice productivity, but also reduce the irregularity in rice production influenced by year-to-year climate variability and better withstand devastating weather events that could otherwise lead to crop failure. The environmental, economic and social benefits resulting from the resilience of CRRP systems and their adaptive response to climate change in West Africa have yet to be quantified. However, it is clear that the benefits accruing from the association of SLWM and IPM practices with IRS will lead to additional benefits to the already occurring IRS benefits, thus enhancing the capacity of the IRS methodology to address climate change threats. These benefits can be cumulated and added to the SRI benefits but will most likely create synergistic effects.

When and how severe abiotic and biotic stresses - such as droughts, floods, storm damage, stressful temperatures, and pests and diseases - will occur is difficult to predict and forecast.

1.2.2 Other agricultural production

For other agricultural crops, the analysis compares traditional production (without the project) with adapted production.

Specifically, the analysis will compare the production of cereals and tubers, normally produced by self-consumption (not irrigated) and the production of vegetables, irrigated by furrowrow and fed with a motor pump (diesel or petrol), with vegetables, irrigated with a drip system and fed with motor pumps or solar systems. Finally, also compare the installation of 1 nursery, always fed with a solar and drip system.

The analysis made shows that the traditional models have a totally inferior income than the others, and with the implementation of the project it will be possible to significantly increase the income of the communities.

Finally, to guarantee real resilience, diversify income sources and valorize the different possibilities offered by the territory, the previous agricultural activities were compared with other possible income sources in the territory and for each one, within the scope of the initial investment, the economic and financial sustainability of the action was calculated, as well as the IRR.

1.2.3 Other income activity (Gender Focus)

Another strong component of the project, both as a budget and as a focus of action, combined with the interventions to improve agricultural production and sustainability described above, are the activities of yield creation and small business.

The project proposes to encourage community collaboration through small agricultural cooperatives that aim to implement small agricultural businesses.

Beyond the growth of family and community performance, these activities will be mainly aimed at strengthening the role and involvement of women, acting on both social and economic empowerment. To this end, possible business creation activities have been analyzed.

The analysis compares eight main activities, based on the environmental potential of the area, considering the social situation and the potential market of the productions. For these activities the installation cost of the investment, the current costs, and the inputs and thus the sustainability of the investment were calculated. The same results have been compared in a single table with the investments linked to the agricultural activities, to have an overview or a complete picture of the possibilities of development of the object areas.

The analysis shows that from a small initial investment and local accompaniment of cooperatives, by ADPP-GNB, the benefits and profits for the communities will be evident.

In a context like Guinea-Bissau where the gender gap is very high and where women live in a condition of high inequality and exclusion (e.g. exclusion of human rights, exclusion from the possession of land and property, child marriage and early pregnancies, difficulty of access to maternal and child care, basic and social services, as well as the official justice system, domestic and gender-based violence, human trafficking and sexual exploitation etc.), the SAP-GNB project, which aims to strengthen the participation and the role of women at the socio-economic level, has great potential for success.

1.3 Considerations about the comparison of Alternative 1 and Alternative 2

As indicated in the initial phase of this chapter, the SAP-GNB project has clear benefits in the results to be achieved for each component of the project.

In the following table 2, the considerations made in the analyze are presented in a more schematic way, in order to facilitate the reading. In any case, the comparative analysis shows that the benefits and effectiveness of the implementation of the SAP-GNB Project are very evident, especially in the following points:

- Improvement of household and regional agricultural production
- Mitigation and improvement of soil salinity for growing crops
- Improved sustainability of agricultural practices
- Improvement of regional climate
- Improvement in water quality and community life
- Improvement of the family and local economy as a result of yield-generating economic activities and small businesses
- Improved local and regional markets
- Improvement of gender inclusion and participation in socio-economic activities
- Improvement of female empowerment
- Decreased social conflict
- Improved support to communities by public institutions for agricultural and climate issues.

Table 2: Comparison between the benefits created by the project (Alternative 2) and the no-intervention of the project (Alternative 1)

Component	Result	Budget	Output	Exit	With Project	no project
Component 1 - Development of technical and institutional capacity of government and civil society	**Outcome 1** Strengthened capacity and knowledge management to monitor and address water and agriculture-related climate risks in Oio and Cacheu Regions	760.475,00	Output 1.1. Improved local observation and management systems for monitoring water and agriculture-related climate risks in Oio and Cacheu Region	458.150,00	The project aims to create an enabling environment for the sustainability and success of the initiative, nationally and centrally, with and within central government structures. The project will promote dialogue and create synergies with other initiatives (UNDP/EU) through direct communication between common implementing partners. The solutions created jointly will be piloted in the two target regions of the project; it can then be replicated at national level. In the consultations carried out with the Executing Partners, as well as in the PFS consultation seminar, the need and importance of such an initiative was confirmed and supported.	Without the project there will be no increase in the capacity of the local population and government to deal with natural disasters remains very weak and extreme weather events, which are increasing in frequency and impact in the context of global CC, and pose direct threats food and nutrition security of target populations. Without the project the rural population will not have adequate knowledge of CC or the ability to prepare for extreme weather events, as there is a lack of climate information and early warning. Therefore, around 202,450 people (direct + indirect beneficiaries) will have the risk of seeing their own resilience reduced with respect to CC
			Output 1.2. Strengthened technical capacities of decision-makers and field staff in Oio and Cacheu Region for addressing water and agriculture related climate risks	85.925,00	The development of an Operation and Maintenance (O&M) Manual for observatory tasks will entail the creation of guidelines for O&M. This will include observatory tasks and equipment, including: monitoring the correct functioning of each piece of equipment to promote preventive and corrective maintenance; repairs; inspections; and cleaning, among others. This activity will include the training of OG teams in O&M. It also includes the printing and distribution of manuals to target stakeholders, including project implementing partners and target beneficiaries. The training of key stakeholders involved in the operation and maintenance of the OG will use a community-based approach and will be carried out with the Proximity Monitoring Stations (hosted by the CCCs (A3.1.1)). Training sessions will be given to: EE field project team, CO members, and CCC management teams; representatives of the MoEB, MoA Regional Office, and MI will be invited to participate in the trainings. Special attention will be paid to the development of gender-sensitive materials, and the promotion of gender-balanced working groups.	Without the project, technicians and decision makers at central and peripheral levels will not increase their knowledge about the risks linked to climate change and adaptation and mitigation measures can be implemented. Without the project all knowledge will not be capitalized through the development of an Operation and Maintenance (O&M) Manual for observatory tasks will imply the creation of guidelines for O&M.
			Output 1.3. Improved availability and accessibility to knowledge on water and agriculture-related climate risks and adaptation options	216.400,00	Synthesize existing knowledge about CC and make it available to active stakeholders in the country. The project identified a significant number of CC-related initiatives underway and in preparation in the country, thus confirming the need to create platforms and forums where these initiatives can be consulted, lessons learned can be shared and synergies created to improve solutions success and increase the impact of such initiatives. There is a lack of opportunities for dialogue to strengthen the capacity of active stakeholders and to coordinate individual efforts to address the impacts of CC.	Without the project, it will not be possible to know the real and detailed situation in which the communities in the region of Oio and Cacheu live and are preparing for the CC. As a result, it will not be possible to publicize them in local forums in order to keep people aware of their future.
Component 2 - Adaptation of water management towards climate risks in coastal zones	**Outcome 2** Improved water availability and quality for production and consumption, in coastal communities in Oio and Cacheu, despite climate risks	1.887.280,00	Output 2.1. Community-based water management is improved and adapted towards climate risks, including salt-water intrusion and extreme weather events	1.544.250,00	Installation of "bolonhas": The "bolanhas" targeted by this activity belong to the 8,500 families (170 Farmers' Clubs) and to the 34 communities targeted by the project. Part of the pre-selection criteria for target communities was the existence of available fields and their need for intervention. From previous interventions and according to the field pre-assessment done, most target households have 0.2ha to 2ha of available field, with some exceptions having up to 3ha and more. It is estimated that this activity could reach 7,000ha by the end of the project. The exact numbers must be confirmed in the baseline study. 17 rainwater retention systems per target region, for a total of 34 - one per target community; and 20 individual home roof retention systems, including locally manufactured tank/tank, one for each CCC. Access to fresh water will thus be improved in all 34 target communities.	Without the project, the recovery of soils lost to agriculture will not begin. 40. Nationally, of the 50,000 ha of rice fields farmed by farmers, it is estimated that around 20,000 ha have been successively abandoned or never fully utilized, due to broken dikes or inadequate land preparation. WITHOUT THE PROJECT, THE 7,000 ha intended to be rehabilitated will still be unused (7,000 ha - more than 1/3 of the total lost ha). Without the project 8500 farming families will recover their own fields, will not start adopting the SRI rice production system and will continue to be food insecure.
			Output 2.2. Mangrove ecosystems are better managed , as an ecosystem-based adaptation measure towards salt-water intrusion	343.030,00	The project will establish 4 mangrove and coastal tree nurseries (2 per target region). The activity will be implemented by the EE project team with the support of IBAP as Executing Partner and will include communities in a participatory manner, particularly young people and the elderly. The project will protect/restore 250ha of mangrove forest as follows: Each Farmers Club (A3.2.3.) of approximately 50 members will assume responsibility for overseeing approximately 1.5ha of mangrove forest	Without the project, the reforestation of the mangroves will not start, which allows for the maintenance of an environmental balance and thus production in the areas adjacent to them. Without the project, 250 ha of mangroves will not be rehabilitated, to be rehabilitated by the beneficiary communities after the awareness work
Component 3 - Building resilience of farming communities towards climate change	**Outcome 3** Enhanced climate-resilience of smallholder farmers, in coastal communities in Oio and Cacheu Region	6.824.880,00	Output 3.1. Vulnerable populations have gained access to community-based structures for climate change adaptation	1.424.030,00	20 CCCs will be established and equipped in strategic geographic locations to cover the needs of all 34 target communities. They will cover the needs of a frontline observation center and Proximity Monitoring Stations, and will accommodate the CO teams. The CCCs will be especially relevant so that farmers and community members have access to locally generated climate information (mainly by the project itself, but also including information from other local initiatives taking place in the target area - to be collected by the EE project team and by the GC) and also received from the national systems upon completion of the project. 82450 direct beneficiaries and 120,000 indirect beneficiaries	Without the project, and without the installation of the CCCs, there will be no real coordination between communities, local authorities and central bodies. Without the CCCs, the 34 beneficiary communities will not receive the proper training (theoretical and practical) on climate change and will not increase their own resilience.
			Output 3.2. Increased and diversified food production of smallholder farmers	4.654.770,00	Establishment, organization and regular training in CRA practices in Model Lots of 170 Farmers' Clubs - 8,500 farmers (70% women) - 82,450 people. Farmers will receive the ok production KIT depending on the baseline study findings. The Farmers Club system comprises approximately 50 members per Club, subdivided into 5 core groups of 10 members with 1 leader and 5 frontline farmers. This division and distribution takes place naturally in a participatory way with the beneficiaries; is done on a voluntary basis or based on suggestion or through election by the group.	Without the project, the Farmers' Clubs (170) will not be installed and the resilience of communities will not be increased through diversification of production and sources of income. Thus keeping 8500 families in food insecurity. Without the project, the rice production methodology will not be installed: Sustainable Rice Intensification (SRI) and Climate Resilient Rice Production (CRRP
			Output 3.3. Increased income options in climate-resilient economic activitie along agricultural value chains	746.080,00	The project envisages providing target groups with a funding opportunity through a call for proposals - for small amounts - and a grant award to selected candidate rural small businesses, in response to the lack of available and affordable financial support from the banking system and the private sector. 20 new microenterprises and enterprises (IGAs) will be established by project beneficiaries, at least 50% led by women. In addition, 20 existing micro-enterprises will be formed and equipped with the initial equipment and investments necessary to develop their commercial activities.	Without the project, 20 existing microenterprises and 20 microenterprises to be installed during the project will not receive the support and technical assistance necessary to maintain their own sustainable production and contribute to strengthening the value chains of the productions chosen by them.

2 COST-EFFECTIVENESS STUDY FOR THE ALTERNATIVES

The cost-effectiveness analysis will compare the alternatives:

iv) Rice, with and without project
v) Agricultural productions, with and without project
vi) Alternatives for diversification of income sources

The production costs, return and benefit of improved yields compared to the conventional method at plot level of the different crop productions are based on detailed input and labour costs per hectare, expected yield (kg/ha), plot income (yield x price) and plot benefit (yield - costs).

2.1 Cost-Effectiveness Analysis on Rice production

Rice farming without Project with traditional practices with Project implementation represented by the currently implemented conventional rice production practices (called Conventional or CONV in this analysis), and the SRI-CRRP methodology in West Africa with the SAP-GNB project (called SRI-CRRP), it is another crucial point of SAP-GNB.

In this analysis (table 3), the production of conventional rice was compared with the SRI rice and the analysis identified an increase of more than 250%, going from 1500 kg/ha to 3500Kg/ha, and the production costs had an increase much lower than the benefits. In this analysis, the gains went from 483 USD to 1899 USD with a percentage increment of gains that was almost 300% (293%), equivalent to 1,416 USD (Table 2).

Considering the environmental benefits of the installation of the SRI-CRRP ploughs, the analysis can only confirm the importance of the installation of this methodology for immediate, medium- and long-term results.

2.2 Cost-Effectiveness Analysis on Agriculture production

The traditional agricultural production without the SAP-GNB Project with adapted agricultural production and introduction of irrigation techniques with the SAP-GNB Project, is analyzed in this section using table 3.

At the level of agricultural production, traditional production (rain-fed Mays, Cassava, etc.) and horticulture with a motor pump and furrow irrigation were compared with the sustainable production systems promoted by the project: drip irrigation and motor pump, drip irrigation and solar system, drip irrigation, solar system and greenhouse (for nursery).

Again, all improved systems show greater gains, with a strong increase in production and family income. The solar systems, due to the reduced management costs linked to the use of solar energy, compared to petrol, show a greater increase in benefits, compared to the fuel system, and the use of drop by drop already allows a strong reduction in the management costs of mining.

In this analysis (table 3), the production of rainfed food crops and vegetable crops, using motor pumps and furrows, was compared with the production of vegetables with drip irrigation systems (fed with a motor pump or solar system) and the installation of a nursery, fed with a solar and drip system.

The production with a motor pump and drip irrigation system allows an increase in inputs of 207 and 432% with respect to rainfed production and the production of vegetables with a motor pump, while the production with an electric pump and irrigation system allows an increase of 310 and 645%, and finally the installation of a nursery can increase inputs by 376 and 781%, thus producing an increase in inputs of about 5000 USD (6000 USD - 1000 USD).

We must point out that these large amounts of incremental income are due to an extremely low production condition at this time. Therefore, the improvements made will have a preponderant weight with respect to the current production.

To produce vegetables, considering the great demand in the local market, it is estimated that the increment of supply will be relatively low in relation to demand, so it is estimated that the increment of production will not provoke significant variations on the price of the final product.

To produce the nurseries, market evaluations will have to be done on an annual basis, in order to guarantee that the investments are dimensioned with the production demand, avoiding the installation of too high a number of nurseries and thus saturate the market, causing the price of the production to fall.

Also in this case, the choices selected by the project, besides having a better financial result have important environmental benefits; solar systems, as compared to motor pumps, do not produce pollution, and have a much longer life span as compared to fuel systems.

Drip irrigation systems allow the use less quantity of water, significantly increasing the efficiency of use. At the same time, causing a reduced leaching of the soil, they allow reducing the pollution linked to infiltration of fertilizers and nutrients, typical of furrow irrigation and relative pollution of groundwater.

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We must point out that these large amounts of incremental income are due to an extremely low production condition at this time. Therefore, the improvements made will have a preponderant weight with respect to the current production.

To produce vegetables, considering the great demand in the local market, it is estimated that the increment of supply will be relatively low in relation to demand, so it is estimated that the increment of production will not provoke significant variations on the price of the final product.

At the same, to produce the nurseries, market evaluations will have to be done on an annual basis, in order to guarantee that the investments are dimensioned with the production demand, avoiding the installation of too high a number of nurseries and thus saturate the market, causing the price of the production to fall.

Also in this case, the choices selected by the project, besides having a better financial result have important environmental benefits; solar systems, as compared to motor pumps, do not produce pollution and have a much longer life span as compared to fuel systems.

Drip irrigation systems allow the use less water, significantly increasing the efficiency of use. At the same time, causing a reduced leaching of the soil, they allow reducing the pollution linked to infiltration of fertilizers and nutrients, typical of furrow irrigation and relative pollution of groundwater.

Table 3: Additional benefits (USD) produced with the adaptation farming method compared to the conventional method (SRI and conventional rice and improved and conventional crop production, including irrigation systems) over the project period.

			traditional rice			SRI Rice			No irrigation (More, Cassava,....)			Motor pump + furrow irrigation Horticulture			Motor pump + drop by drop Horticulture			Solar system + Electropump + drop by drop Horticulture			Solar system + Electropump + drop by drop Nursery		
Input cost / ha for production	Unit (eg kg)	Money	Quantity / ha	cost / ha	USD	Quantity / ha	cost / ha	USD	Quantity / ha	cost / ha	USD	Quantity / ha	cost / ha	USD	Quantity / ha	cost / ha	USD	Quantity / ha	cost / ha	USD	Quantity / ha	cost / ha	USD
seeds	kg	F CFA	40	24 000	44	20	12 000	22	25	15 000	27								-	-		-	-
100 g cans	cans	F CFA			-			-			-	10	-	-	10	-	-	10	-	-			-
organic fertilizer	kg	F CFA		-	-	5000	50 000	91	5000	50 000	91	5000	50 000	91	5000	50 000	91	5000	50 000	91	5000	50 000	91
Urea	kg	F CFA	200	-	-	100	-	-	100	-	-	200	-	-	100	-	-	100	-	-	150	-	-
NPK (DAP)	kg	F CFA	100	-	-	50	-	-	200	-	-	400	-	-	200	-	-	200	-	-	75	-	-
Other fertilizers		F CFA			-			-			-			-			-			-		-	-
Fungicide	Liter	F CFA	1	-	-	1	-	-	0	-	-	2	-	-	2	-	-	2	-	-	2	-	-
Insecticide	Liter	F CFA	1	-	-	1	-	-	0	-	-	2	-	-	2	-	-	2	-	-	2	-	-
Irrigation	Hydro cost	F CFA	0		-	1	70 000	127	0		-	1	1 200 000	2 182	1	1 000 000	1 818	1	300 000	545		300 000	545
Plastic bags	1000 Kit	F CFA			-			-			-			-						-	100	1 000 000	1 818
					-			-			-			-			-			-			-
workers	Unit (eg kg)	Money	Quantity / ha	cost / ha		Quantity / ha	cost / ha		Quantity / ha	cost / ha		Quantity / ha	cost / ha		Quantity / ha	cost / ha		Quantity / ha	cost / ha		Quantity / ha	cost / ha	
soil preparation	There is	F CFA	1	37 500	68	1	37 500	68	1	37 500	68	1	37 500	68	1	37 500	68	1	37 500	68			-
Transplant	h / d	F CFA	3	9 000	16	5	15 000	27	5	15 000	27	20	60 000	109	20	60 000	109	20	60 000	109	60	180 000	327
Weeding	h / d	F CFA	4	12 000	22	2	6 000	11	15	45 000	82	15	45 000	82	15	45 000	82	15	45 000	82	16	48 000	87
Irrigation	h / d	F CFA	9	27 000	49	5	15 000	27			-	25	75 000	136	10	30 000	55	10	30 000	55	60	180 000	327
Harvest	h / d	F CFA	15	45 000	82	15	45 000	82	15	45 000	82	20	60 000	109	20	60 000	109	20	60 000	109	30	90 000	164
Threshing	h / d	F CFA																					
			31			27			35			80			65			65			166		
Total cost				cost / ha			cost / ha			cost / ha			cost / ha			cost / ha			cost / ha			cost / ha	
				154 500	281		250 500	455		207 500	377		1 527 500	2 777		1 282 500	2 332		582 500	1 059		1 848 000	3 360
								-			-			-			-			-			-
Yield (Kg)			Unit (eg kg)	yield / ha		Unit (eg kg)	yield / ha		Unit (eg kg)	yield / ha		Unit (eg kg)	yield / ha		Unit (eg kg)	yield / ha		Unit (eg kg)	yield / ha		Unit (eg kg)	yield / ha	
			H	1 500		H	3 500		H	1 500		H	5 000		H	6 000		H	6 000		H	10 000	
Price for 1 kg of product			kg	400	0,7	kg	400	0,7	kg	450	0,8	kg	500	0,9	kg	550	1,0	kg	600	1,1	Unit	550	1,0
Total income (yield x price)			Money	income / ha		Money	income / ha		Money	income / ha		Money	income / ha		Money	income / ha		Money	income / ha		Money	income / ha	
			F CFA	600 000	1 091	F CFA	1 400 000	2 545	F CFA	675 000	1 227	F CFA	2 500 000	4 545	F CFA	3 300 000	6 000	F CFA	3 600 000	6 545	F CFA	5 500 000	10 000
Profit (revenue - costs)			Money	profit / ha		Money	profit / ha		Money	profit / ha		Money	profit / ha		Money	profit / ha		Money	profit / ha		Money	profit / ha	
				445 500	810		1 149 500	2 090		467 500	850		972 500	1 768		2 017 500	3 668		3 017 500	5 486		3 652 000	6 640
			Difference:				704 000	1 280	Difference Respect -No irrigation							1 550 000	2 818		2 550 000	4 636		3 184 500	5 790
			Increment Percentage				158%	158%	Difference Respect Motor Pump + furrow irrigation							1 045 000	1 900		2 045 000	3 718		2 679 500	4 872
									Percentage Respect No irrigation							432%	432%		645%	645%		781%	781%
									Percentage increase with respect Motor Pump + furrow irrigation							207%	207%		310%	310%		376%	376%

2.3 Cost-Effectiveness Analysis on Agriculture Small-Business and Income projects implementation

Other activities with high potential and adequate adaptation to climate change as considered in this analysis for the creation of small-business and income for cooperatives and households.

In this case, considering that they are considered new activities, the benefits of the activities and the efficiency of the different investments were studied, calculating the necessary initial expenses, the operating costs and the profits, thus calculating the IRT of the different investments.

The activities linked to the diversification of income sources (8: fishing, Aquaculture, Beekeeping and honey production, Goat farming, sheep Farming, cattle breeding, pig farming, Poultry farming), were compared with the others linked to agriculture and previously studied (Conventional Rice, Climate-Resilient Rice Production (CRRP), Tubers (Mays, Mandioc, Sweet potatoes, and other non-irrigated crops), Horticulture and fruit growing - Motor pump + furrow irrigation, Horticulture and fruit growing - Motor pump + drop by drop, Horticulture and fruit growing - Solar system + Electropump + drop by drop, nursery fruit and medicinal plants - Solar system + Electropump + drop by drop), thus totaling the analysis of 15 income generating activities.

The analysis was based on the analysis of the initial investment necessary to carry out the activity, the management costs (including the calculation of depreciation), the annual earnings and thus the profits. Finally, the IRR was calculated at 5 years (end of the project) and at 10 years (after 5 years of the end of the project).

As can be seen from the table 4 traditional rice is the worst investment, with an IRR of 10%, followed by pig and cow production and horticulture with motor pumps and furrow irrigation systems.

Poultry production, beekeeping, goat production and aquaculture, present the highest IRR values, being 69%, 61%, 48%, 47% respectively.

Finally, the SRI-CRRP rice and solar powered drip irrigation systems show excellent results, with values of 30%, 30 and 35% respectively.

For that which refers to the exploitation of ruminants, analyzing also the environmental and social aspect, it is advisable to privilege the production of goats and ovine in a combined way, being that they present a very strong alimentary synergy (goats prefer arboreal and bush pasture, being that the ovine prefer grass), it is not advisable the bovines because, besides having a much longer productive cycle and besides needing a bigger initial investment, it has greater demands in terms of pasture and a lesser index of conversion.

Among the monogastric animals, pig production should be avoided because, besides having lower economic yields than the others, they are subject to the African swine fever, which in many contexts has decimated family productions, even when these have increased the bovine population and thus increased the population density and the risk of diffusion. Also in this case, the market analysis guarantees a high demand for the product, since no depreciations linked to an increase in supply are foreseen. Furthermore, the exploitation of chickens is traditionally carried out by women, so that by increasing this activity the role of women within the community will be directly reinforced.

Fishing and aquaculture both present great potentialities. Also in this case, the high demand for the product does not show problems related to increasing the supply. For fishing, the current stock must be analyzed to estimate the volume of fishing possible in line with the environmental regeneration capacities, maybe during the Baseline Study.

For aquaculture, it is necessary to study the areas that guarantee the safe digging of the tank and with clay soils that allow a more economical production of the paving.

The production can be carried out in an intensive way (with certified alevins and industrial feed) or traditional (with alevins captured in the rivers and local feed).

In short, beekeeping has a very high potential. By providing a protection kit and an extraction and bottling kit, experiments carried out in other countries show great productive increases (besides an increase in the bee population). Also in this case, the whole extraction, filtering and bottling phase is traditionally carried out by women, and they themselves manage the inputs of the activity.

Table 4: Comparative Cost-Effectiveness Analysis of the Investment Projects proposed by the intervention in agricultural production and diversification of income sources.

		Area/quantity	initial investment	annual profit	annual expenditure (including running and maintenance costs)	annual gain (stabilised at 3 years)	Abortion 10% (10 years)	current gain	Internal rate of return (IRR) - 5 Years	Internal rate of return (IRR) - 10 Years
1	**Conventional Rice**	1 ha	1.141,81	1.090,91	608,18	482,73	114,18	**368,55**	**10%**	**22%**
2	**Climate-Resilient Rice Production (CRRP)**	1 ha	3.087,27	2.545,45	646,36	1.899,10	308,73	**1.590,37**	**29%**	**38%**
3	**Tubers (Mays, Mandioc, Swet potatoes, and other non-irrigated crops)**	1 ha	1.087,27	1.227,27	650,00	577,27	108,73	**468,55**	**21%**	**31%**
4	**Horticulture and fruit growing - Motor pump + furrow irrigation**	1 ha	2.087,27	4.545,45	3.586,33	959,12	208,73	**750,39**	**14%**	**26%**
5	**Horticulture and fruit growing - Motor pump + drop by drop**	1 ha	5.587,27	6.000,00	2.949,97	3.050,03	558,73	**2.491,30**	**23%**	**32%**
6	**Horticulture and fruit growing - Solar system + Electropump + drop by drop**	1 ha	8.087,27	6.545,45	1.495,44	5.050,01	808,73	**4.241,28**	**30%**	**38%**
7	**Nursery fruit and medicinal plants - Solar system + Electropump + drop by drop**	1 ha	9.240,62	10.000,00	3.673,63	6.326,37	924,06	**5.402,31**	**35%**	**43%**
8	**Fishing**	1 fishing equipment	800,00	1.920,00	1.308,00	612,00	80,00	**532,00**	**42%**	**48%**
9	**Aquaculture**	1 tank (with fingerlings and feed for 1st production)	3.888,00	6.000,00	2.739,27	3.260,73	388,80	**2.871,93**	**47%**	**53%**
10	**Beekeeping and honey production**	1 KIT (2 protective suits 1 press, 1 filter 1 decanter)	2.160,00	3.000,00	777,00	2.223,00	216,00	**2.007,00**	**61%**	**66%**
11	**Goat farming**	1 KIT (1 male - 4 females + local sheepfold)	863,64	900,00	163,64	736,36	86,36	**650,00**	**48%**	**54%**
12	**Shep Farming**	2 KIT (1 male - 4 females + local sheepfold)	954,55	800,00	163,64	636,36	95,45	**540,91**	**34%**	**41%**
13	**Cattle breeding**	1 KIT (1 male - 3 females + local sheepfold)	1.690,91	1.112,73	327,27	785,45	169,09	**616,36**	**15%**	**26%**
14	**Pig farming**	1 KIT (1 male - 4 females + local sheepfold)	927,27	749,09	327,27	421,82	92,73	**329,09**	**14%**	**25%**
15	**Poultry farming**	1 KIT (1 Rooster - 10 chickens + local sheepfold)	1.273,35	1.948,18	490,91	1.457,27	127,34	**1.329,94**	**69%**	**73%**

3 FINANCIAL ANALYSIS

The financial analysis for the cost effectiveness of the project is presented in Table 5. The financial profitability of the project investment is determined by the project cost components and the estimated financial benefits obtained through the project interventions based on the following financial appraisal techniques: i) cash flow ii) benefit cost ratio, iii) net present value (NPV), and iv) internal rate of return (IRR).

For the calculation of the benefits, only the benefits related to the increase of the beneficiaries' income were calculated, since the social and environmental benefits have already been calculated in another part of this analysis, not monetizing them, since they are not monetary goods.

Every analysis was carried out in a precautionary way, calculating that at the end of the project only 50% of the beneficiaries will have reached economic and financial sustainability, whether for the SRI rice production activity or for the diversified income generating activities directed to women.

Table 5: Financial analysis for project cost-effectiveness

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
A. Cost Components						
Component 1	287 990,00	124 652,50	104 740,00	135 952,50	107 140,00	760 475,00
Component 2	804 183,67	810 013,67	102 738,67	85 172,00	85 172,00	1 887 280,00
Component 3	3 112 753,00	1 933 666,33	785 123,00	566 948,00	426 389,67	6 824 880,00
Execution costs (management units)	144 070,00	90 570,00	96 570,00	90 570,00	96 570,00	518 350,00
Implementation costs (management unit)						-
Total costs (A)	4 348 996,67	2 958 902,50	1 089 171,67	878 642,50	715 271,67	9 990 985,00
B. Financial benefits						
Study/Consultancy Benefits						
Benefits for trainers and extension services						
Benefits for rice farmers	1 088 000	1 360 000	1 700 000	2 125 000	2 656 250	8 929 250
Benefits for diversified producer farmers	2 741 791	3 427 239	4 284 048	5 355 060	6 693 825	22 501 964
Benefits for producer associations/groups						
Total financial benefits (B)	3 829 791	4 787 239	5 984 048	7 480 060	9 350 075	31 431 214
Cash flow (BA)	-519 206	1 828 336	4 894 877	6 601 418	8 634 804	21 440 229
Benefit Cost Ratio (B/A)	0,88	1,62	5,49	8,51	13,07	3,15
Net Present Value (NPV)						18 366 652
Internal Rate of Return (IRR)						44%

The financial analysis indicates a positive cost-benefit ratio of 3.15. The NPV is positive with $18.36 million, and the internal rate of return is also positive with 44%. An important aspect to consider is that the additional benefits from the implementation of the project will continue in the future to occur on an annual basis. The proposed project is therefore very cost effective and worth the investment.

4 CONCLUSIONS

The SAP-GNB project is well structured and meets the needs of the environment, agriculture and communities.

Due to the complex climate change impact and rudimental agriculture practices Cacheu and Oio Regions' populations have seen their production and household output deteriorate.

In addition, the socio-economic condition of the communities, related to low production, increasing water salinity and weak involvement of women in the productive and social sectors, has largely affected the poverty level of these regions.

This situation has led the communities to decrease the activity of cultivo, migrate and find other solutions to survive (sale of coal for example). The uncontrolled production of charcoal and wood that cause greater fragility of the environment in front of a lower quantity of water and less coverage of vegetation against erosion phenomena. This factor not only affects the direct loss of food, as the cows feed on mutate leaves (the charcoal tree) during dry periods, but also affects the local climate and endangers biodiversity by encouraging desertification.

Often these alternatives or the way of agricultural production, create a vicious circle of negative environmental impact, thus worsening local conditions. With the perpetuation of these practices and macro practices at the national and international level, in addition to the growing climate change effects, the fate of these communities is very difficult.

Community vulnerability and exposure to disaster risks and climate change is putting traditional practices and community knowledge into crisis and causing a breakdown in habits, as well as degrading the environment without a recovery process.

Considering this situation, cost-effectiveness analysis has shown that investments in planned interventions will be effective in building community resilience to climate change, creating local conditions to strengthen livelihoods and access to water and agriculture production, improve knowledge and awareness of environmental protection and preservation, and improve community collaboration of public, private and network institutions.

The SAP-GNB project is very important for the creation of household and business performance at the local level because it could stimulate the market and influence other actors not directly involved in the project. At the same time, the SAP-GNB project is an important contribution to these regions and to the country for some "novelties": climate change centers, which will help communities to have more knowledge about environmental issues related to agricultural production activity, networking through cooperatives, improvement of water quality both for irrigation and consumption, introduction of agricultural practices adapted to climate, support in the creation of small local businesses and especially women empowerment, which will be the focus of all activities.

Considering that populations live cyclically and periodically affected by disasters, the investments made on the territory by the interventions of the SAP-GNB Project represent a concrete possibility to change the condition of vulnerability in which they find themselves, improving their livelihoods, income, relationship, and interaction with the environment and therefore the future itself.

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