Environmental Assessment of PRISMA

Final report

Prepared by Oxford Consulting Partners

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Introduction

The AIP-PRISMA environmental strategy seeks to assess the environmental context of the sub-sectors in which the program works to ensure it does no harm through its interventions and, where possible, invests in activities that promote environmental conservation, mitigate adverse effects of environmental changes and improve poor peoples' resilience to environmental shocks and other effects of climate change. This report seeks to provide the following:

- A brief on the environmental situation in Eastern Indonesia and largest environmental risks, and what that potentially means for livelihoods which are dependent on that environment.
- An update and elaboration to the current environmental program strategy including: providing key principles for operationalizing a do-no-harm environmental approach and identifying opportunities to mainstream environmental management into PRISMA's intervention processes.
- A report summarizing the environmental context of the 7 sub-sectors selected by the project and the potential effects (either positive, negative or neutral) of the interventions in these sectors.

Environmental issues in Eastern Indonesia

This section sets out the key environmental challenges faced in Eastern Indonesia. These challenges are a combination of natural systems effects from current climate variability, together with poor environmental management practices and governance. These are set out in more detail below:

Poor natural resource management and governance

A significant set of environmental issues in Eastern Indonesia derive from poor environmental management and governance practices. These include the following:

Deforestation

Eastern Indonesia has suffered high levels of deforestation. From 2000-05, the FAO estimates that overall, Indonesia lost an area of forest equivalent to the side of Portugal (over 91,000 km^2) every year. Among the primary drivers were the global demand for pulp and palm oil which has resulted in the clearance of forests for plantations. Other drivers included the global demand for timber, which resulted in high levels of illegal logging. Both resulted in the loss of high value conservation forests, which have in turn led to the loss of forest ecological functions (habitat, biodiversity), and the socio-economic benefits enjoyed by forest dependent communities.

Over-exploitation of marine resources and destructive fishing

Most, if not all, of Indonesia's capture fisheries are fully or overexploited. Bad fisheries practices further increase the problem. For example, in the Arafura Sea, eastern Indonesia, bottom trawling for shrimp is strip-mining the ocean floor. The ratio of other species to shrimp caught in tropical waters is roughly estimated at about 10:1. Destructive fishing such as cyanide and blast fishing on coral reefs has degraded not only the ecosystems, but also affected the vast number of marine species that depend on them.

Pollution

About 96% of Indonesians live within 100 km of the coast. This places large demands on the country's coastal environment. Rapid economic development, particularly around major population centres results in large amounts of sewage and industrial pollution, causing the decline of many reef areas. There are also environmental problems linked to rapid urbanization and economic development, such as air pollution, traffic congestion, garbage management, and reliable water and waste water services.

Current climate variability and future climate change

Poor environmental governance is compounded by climate impacts, both in terms of current climate variability and future climate change.

Current climate variability

Eastern Indonesia already suffers from climate variability and extreme events (including floods, droughts, storms, landslides and fires). The influence of the El Nino-Southern Oscillation (ENSO), resulting from changes in ocean currents, can result in more droughts, where La Nina results in more floods. The ENSO is also one of the main factors in the frequency of major forest fires and associated air pollution.

Climate impacts are also related to the location and movement of tropical cyclones in the Indian (January to April) and Pacific Oceans (May to December). These can result in strong winds and heavy rainfall. Strong winds also occur during the transition between the Northeast and Southwest monsoons.

Trends and Projections.

The observational data for the Indonesian archipelago is relatively weak, but records indicate an overall warming trend over the last 50 years. Expected warming trends are in the region are in the range of 2-3 C under the SRES A1B emissions scenario by 2100[1]. Precipitation trends are more complex.

Extreme events have become more severe and frequent over recent years. Drought intervals have shortened from one in four to one in three years. Floods are occurring more frequently in almost all provinces and flooding is projected to increase. Projected changes to the frequency cyclone activity remain uncertain, but the severity of storm events is likely to increase. Sea level rise, together with storm surge activity puts coastal communities and infrastructure under threat.

Impact on livelihoods

Environmental pressures impact particularly hard on those dependent on natural resources in Eastern Indonesia. These are often the poorest communities who are least able to cope. Subsistence and small holder farmers and fishing communities often live in the most marginal areas that are vulnerable to environmental impacts such as droughts, floods or landslides. Such communities lack resources to survive environmental shocks, and may be forced to sell land or other productive assets (e.g. livestock or farming equipment) in the event of environmentally induced stress, making it even more difficult to sustain livelihoods over time.

Environmental stresses can impact communities in a broad range of ways, undermining livelihoods. Potential impacts include:

- Degrading forests, fish, pastures, crop land and other natural sources of livelihoods;
- Exacerbating rural community food security and poverty issues;
- Damaging homes and other social infrastructure;
- Impacting on health and welfare (e.g. heat, extreme events, vector borne diseases);
- Increasing conflict for land and natural resources, leading to tension and/or migration;
- Reducing biodiversity and damaging eco-systems;
- Creating disproportionate impacts for women, the elderly and young.

Farming communities are likely to be particularly badly hit, although these is some uncertainty associated with the complexity of the ENSO pattern. However, agricultural seasons are already changing with shortened growing seasons. Temperatures will increase and changes in rainfall patterns will differ according to location. A number of regional scale studies indicate that yields of crops, such as soybean and maize may fall significantly (20-40%), however rice yields may increase from 2050 onwards. Upland farmers may experience increased erosion as a result of run off. Availability of water for irrigation may become more scare.

Coastal fishing communities are also being impacted. Changes in climate can result in small eco-system changes which can have large knock-on effects on marine ecosystems. For example, changes in water temperature and acidification can damage coral reef systems and exacerbate man-made stresses such as over fishing and pollution. It is projected that the 10 year averaged maximum catch potential could decrease by 23% from 2005-2055 under SRES A1B scenario. Coastal communities are

[1] The Special Report on Emissions Scenario (SRES) A1B emissions scenario is one of a number of emission scenarios used by the IPCC. Each scenario reflects emissions associated with different pathways of future technological and political change. The A1B scenario which assumes progress towards a balanced use of fossil and non-fossil fuels and a level of political cooperation and integration is often used as a central scenario for policy making purposes.

also exposed to more severe weather events (which can destroy weather infrastructure) as well as high waves. The entire coastline is exposed to sea level rise (which in turn exacerbates high tide and storm surges). Many of the islands in Eastern Indonesia are susceptible to sea level rise. These impacts are exacerbated by environmental governance issues (uncontrolled development, river damming, sand and coral mining and the destruction of mangrove forests). Rising sea levels may also inundate coastal fish and shrimp ponds in Eastern Indonesia.

PRISMA Environmental Management System (EMS)

This section sets out the Environmental Management Strategy (EMS) for the AIP-PRISMA programme. It is based on the provisional environmental strategy set out in the early design phase.

Context

AIP-PRISMA is a market development programme that follows the "Making Market Work for the Poor (M4P)" approach to bring sustainable long-term growth in the economy. AIP-PRISMA aims to alleviate poverty and stimulate pro-poor growth in eastern Indonesia, by improving the competitiveness of key agricultural sectors where the poor participate as producers, employees and consumers. The program responds to the opportunities present in sub-sectors and works with multitude of private and public sector partners to bring about systemic change. It takes on a facilitative role to bring about changes in sub-sectors and achieve its goals.

Environment is not a core part of the programmes mandate. However, the rural poor are heavily dependent on environmentally sensitive natural resources for their livelihoods. These resources can potentially be negatively impacted by programmatic activities, as well as by wider environmental change (e.g. climate change or extreme events). The programme may also provide the opportunity for the improvement of environmental conditions, or for the strengthening of community resilience to environmental change. Although AIP PRISMA does not focus directly on environmental markets, it is nonetheless important that the programme understands the environmental context to maximise positive environmental outcomes and minimise risks. The EMS is a critical element for planning how the program can and should operate.

Principles

AIP-PRISMA's EMS has been designed to reflect AusAID Environmental Management Guide Objectives[2]. The environment is defined in the following ways

- ecosystems and their constituent parts, including people and communities
- natural and physical resources
- qualities and characteristics of locations, places and areas
- heritage values of places
- social, economic and cultural aspects

The EMS seeks to ensure that negative environmental impacts are identified and mitigation strategies adopted. It also seeks to take advantage of positive environmental opportunities where these are feasible, and where there are incentives for stakeholders in a sub-sector to do so. Negative and positive environmental impacts are defined below:

[2] See http://aid.dfat.gov.au/Publications/Pages/2297_1393_1917_9648_6600.aspx

- 'negative' environment issues (e.g. threats to the environment, such as resource degradation and pollution, exposure to climate change and extreme events, or other impacts that affect poor people and undermine sustainable economic growth);
- 'positive' environment issues (e.g. opportunities for increased biodiversity, opportunities for the sustainable use of environment resources to reduce poverty and support economic development).

The EMS also recognises that environmental impacts may be either *direct* (those directly caused by programme investments such as introduction of new infrastructure or species), or *indirect* (those downstream effects arising from investments such as impacts of increased transportation, or improved environmental awareness).

The EMS recognises that AIP-PRISMA must comply with national legislation and conform to any relevant multi-lateral environmental agreements (MEAs).

The EMS integrates environment, climate change and disaster risk reduction considerations under one framework. Climate change has the potential to interact with, and potentially magnify, other environment phenomena such as desertification, biodiversity loss, air pollution or the increasing scarcity of fresh water.

EMS Objective

1.

These are set out in more detail below.

Implementation Steps

1. Environmental Assessment and Planning

Environmental assessment of the proposed sub-sectors will be a critical element of the scoping and selection process and a threshold criterion for proceeding to implement an intervention. The program will follow the DFAT guideline to assess how planned interventions can potentially impact the environment and take those in consideration while designing the interventions. In particular, the following aspects will be reviewed:

- Q1. Will the intervention take place in a vulnerable place or risky sector?
- Q2. Could climate change or natural disasters impact on the intervention?
- Q3. Could the intervention impact on ecosystems that sustain livelihoods?
- Q4. Could opportunities to build resilience into people's livelihoods be incorporated?
- Q5. Could the intervention have a significant impact on the environment, including increasing greenhouse gas emissions?

As part of the design phase, each intervention in a given sub-sector will be assessed against the above questions. A subsector consists of a combination of an industry sector and a geographical location. Each sub-sector may have a number of different interventions. The design stage will be the first evaluation point to ensure that the program promotes minimises environmental risk. This also presents an opportunity to assess the possibility of including interventions that can promote better management of the environment, including improving the resilience of the targeted groups of stakeholders (i.e. poor farm households in eastern Indonesia) and interventions to the impacts of current climate variability and future climate change.

The responsibility for undertaking the environmental assessment is the responsibility of the Results Measurement and Learning (RM/L) team. To conduct the environmental assessment, the program will draw support from experienced environment specialists to review its strategies, look for potential environmental effects and identify areas to improve, in line with program's approach and goals. The initial outputs will be a high level Environmental Analysis for the AIP-PRISMA programme as well as for each proposed sub-sector intervention. The scope and use of these documents are set out below in Table 1:

Table 1. Environment analysis and Environmental Impact Assessment

TYPE	CHARACTERISTICS	PURPOSE/BENEFITS	REQUIREMENTS
Environment analysis (both in the situation analysis of a sub-sector strategies and delivery strategies as well as in the design of interventions)	• high-level; broad • not as in-depth or detailed as other levels of analysis • vary in size and scope, but are usually quick to complete (can, for example, be a brief desk study or involve an external expert conducting targeted field studies)	• used for both strategic planning processes and the design of sub-sector strategies • conducted to confirm the findings of the environment screening and determine if a more comprehensive assessment is needed • most often appropriate if there is potential for a negative or positive environment impact which is of a size and type that can be readily identified and is unlikely to be significant	• A high level analysis will be undertaken for each subsector (combination of province and industry sector). This will be prepared as a separate report.

Where the impact of the intervention on the environment or the exposure of the intervention to the environment are considered to be moderate or low, it will be the responsibility of the team leader of the intervention to decide what further action is undertaken. Where either impact is considered to be high, then the RM/L will be responsible for undertaking a more formal risk appraisal - an Environmental Impact Assessment (EIA) - and for actively considering mitigation strategies (see Table 2).

Table 2. Environmental Impact Assessment

TYPE	CHARACTERISTICS	PURPOSE/BENEFITS	REQUIREMENTS
Environment Impact Assessment (EIA) (design of interventions)	1. only used for interventions, either: a. after environment assessment requires it b. if it is immediately known that an activity may have a significant negative environment impact	1. used for interventions, but only if required by a high risk rating 2. identifies and evaluates foreseeable environment impacts for high risk interventions 3. undertaken in-country by the feasibility team or the design team (at the site where the activity will take place)—team must include at least one member with environment expertise	1. results and appropriate mitigation strategies should be incorporated into the intervention design

On the basis of initial environmental screening and expert review, AIP-PRISMA will then ensure that environmental safeguards and other suitable risk management actions are integrated into the intervention design, and that opportunities to increase environmental sustainability and resilience are incorporated where feasible and aligned with the intervention. Specific actions or concerns will be set out in a short Environmental Management Plan (EMP) for each intervention where specific risks or opportunities have been identified. The EMP is set out as part of the Intervention Steering Document (ISD). The EMP sets out the environmental risks of/to the intervention, together with plans to address these risks where appropriate. The profile of the EMP is set out in table 3.

Table 3. Environmental Management Plan

TYPE	CHARACTERISTICS	PURPOSE/BENEFITS	REQUIREMENTS
Environment Management Plan (EMP) (design of interventions)	• used to outline how environment issues identified in the Environmental Assessment or EIA will be managed • Is integrated into the project management system	• key vehicle for ensuring that environment impacts are managed during implementation • specifies how the environment impacts identified during the Environmental Assessment or EIA will be addressed • identifies who is responsible for implementation	• Every intervention has an Intervention Steering Document. It is mandatory for the team to mention in that document what environmental effects their intervention is likely to have or what environmental threats the intervention faces, together with any mitigation activities

2. Implementation

During implementation, any environment assessment and management requirements determined during the assessment and incorporated into the EMP section of the ISD will be delivered alongside the main investment and project activities.

All decisions and activities undertaken during implementation relating to the environment are recorded in the EMP section of the ISD. Where environmental aspects are identified during the Environmental Assessment monitoring for expected environment impacts will form part of the regular monitoring and evaluation plan.

If new environment impacts arise during implementation, which were not identified during the design phase, AIP-PRISMA will undertake appropriate assessment and planning so the new environment impact can be appropriately managed.

3. Monitoring and Evaluation

During implementation, environment performance will be monitored and evaluated where appropriate. Each subsector and the associated interventions will be reviewed semi-annually, and where appropriate this review will include a discussion about the environment. This is to determine whether environmental outcomes have been achieved.

Where new environment issues arise during implementation of the activity then these need to be assessed and managed with additional indicators adopted.

The programme will report semi-annually to the donor, and the semi-annual reports will include a section on the environmental impact, and any issues and risk mitigation activities arising during implementation.

4. Build Capacity

The program will initiate activities to build and improve capacity and awareness of environmental contexts and impacts amongst the program's technical team and its external implementation personnel. This is to ensure that there is a common understanding regarding the program environmental strategy across the implementers and partners of AIP-PRISMA, and all relevant staff are able to assess the contexts in which they are working and collect appropriate (and critical) information to feedback into the decision making process.

AIP-PRISMA will to transfer knowledge and skills to allow beneficiary communities to continue to apply environmental best practice following programme implementation.

Sector Assessment

The following section sets out the environmental assessment for the initial group of sub-sectors and interventions reviewed. Each intervention is assessed on two criteria:

1. The risk of negative impacts of the intervention on the environment
2. The exposure of the intervention to environmental and climatic risk

These criteria are assessed on a three point scale:

- *Low:* There is limited environmental risk or exposure associated with the subsector interventions, and/or interventions incorporate sufficient mitigation or resilience measures. There is very limited need for additional risk mitigation measures and/or monitoring;

- *Moderate.* There is a moderate level of environmental risk or exposure associated with the sub-sector interventions, and opportunities exist to further reduce risk and build resilience. The team should monitor environmental risk and exposure and mitigate risk where possible;
- *High:* There is a high level of environmental risk or exposure associated with the interventions, and further review and integration of mitigation/resilience measures are required. The Portfolio team should look at ways to carry out a more detailed assessment and identify potential mitigation strategies to adopt.

Table 4 sets out the summary of those sectors reviewed as part of the initial assessment. Further details setting out the justification can be found in the following sections.

Table 4: Summary of risk rating for interventions reviewed

	Risk of negative impacts of intervention on the environment (no-risk mitigation)	Exposure of sub-sector intervention to environmental and climatic risk (no risk mitigation)
Cashew	Low	Moderate
Cassava	Low	Low
Coconut	Low	Moderate
Coffee	Moderate	Moderate
Fish farming	Moderate	Moderate
Pig farming	Moderate	Moderate
Seaweed	Moderate	Moderate

Cashew Sector

Sector summary

Cashew production is found across many areas of Indonesia. The main cashew producing provinces in the country are East and West Java, South Sulawesi, Nusa Tenggara Timur, and Nusa Tenggara Barat. In general, cashews are an excellent crop for deforested and degraded coastal areas. They grow between sea level and approximately 760 meters. Currently Indonesia accounts for only 4% of the global raw cashew nut market, yet it is an increasingly important export commodity for Indonesia. Indonesia has a comparative advantage over other cashew producing countries as it is the only country to have raw cashew nut available from Sept – Nov. However, most product is exported raw, and there is a limited domestic processing industry, with India and Vietnam dominating the value added processing sector.

Intervention summary

One intervention is currently proposed to support Cashew farmers in NTB (Bima and Dompu districts). NTB experiences lower cashew yields than other regions, mainly due to farmers not applying good farming practices. This in turn leads to tree vulnerability to attacks by diseases and pests, including gummosis, helopeltis, and white moth cicada. This can decrease productivity by up to 30%. In addition, many plantations are more than 20 years old and beyond their peak productivity. Farmers are not investing in replanting. Planting distance between trees, for example, varies between 6 and 12 m as farmers receive a variety of information on standards. The intervention seeks to help Cashew farmers raise productivity by establishing partnerships with Service Providers to supply pest control and good agricultural practice (GAP) services. These will include effective pest control products, tools and technology; pest control services; knowledge and skills on good agriculture practices, including trimming, effective planting distance, and fertilization.

Impact of intervention on environment

The following are the issues relating to the potential environmental impacts:

- *Agricultural inputs:* Cashews are often grown with minimal inputs and as a consequence are relatively benign to the environment in terms of pesticides, herbicide and fertiliser use. Little weed control is needed, other than allowing livestock to graze beneath mature trees. Good yields can be achieved without the addition of fertilizers or manures and cashew is often grown on relatively infertile soils. In addition, small holder farmers are often not wealthy enough to purchase agricultural inputs from commercial suppliers. Although trees will produce cashew without added nutrients, fertilizers (such as urea, rock phosphate, and potash) are sometimes used (albeit sparingly due to their cost). Where pests are an issue (e.g. Helopeltis) these can be controlled by chemical pesticides (such as dieldrin sprays or dusting with BHC or DDT). Sulphur and organic fungicides are used to fight powdery mildew disease. However, application is often poorly undertaken in terms of timing and quantity, creating impacts for both farmers and the environment. The use of chemical pesticides is both expensive and can create the potential for soil toxicity and pest immunity. This project seeks to promote the increased use of organic agricultural inputs and pest control products to improve yields. As such, the risk of negative environmental impact is low and the likely outcome an improvement over current practice.

- *Deforestation and land use change:* Cashew nut production is typically undertaken on a smaller scale than many other agricultural commodities. Given the harsh conditions that the tree is able to withstand, many of the affected areas have vegetation that would never otherwise be cleared for agriculture, thereby lowering the potential impact on deforestation

and land use change. However, while individually the scale of cashew farms is small, collectively they may have a large cumulative impact on the natural habitat. In particular, a shift towards larger scale plantation farming could increase environmental impacts, especially in drier and more marginal areas. From a positive perspective, cashews have proven useful as a species of choice for reforestation in degraded areas. They are one of the few trees that do well under such conditions and that generate both food and income. The project is targeted at supporting small holders, so the risk of large-scale negative environmental impact is low, but the project should ensure that the project does not encourage expansion of cashew cultivation into existing forested areas;

- *Biodiversity:* The leaf of the cashew tree contains compounds that may be toxic to other plants and animals. Leaf fall discourages the growth of other vegetation under the cashew tree. Also, the seed is surrounded by a concentrated caustic solution that can burn the skin and can prevent wild animals from eating the seeds. Large plantations of cashew trees may dominate the landscape and discourage biodiversity in the same area. However it should be noted that Cashew trees are often the most nutritional source of food for wildlife in many more marginal areas of degraded land. Typically, they can be planted in clumps and as border vegetation, as part of a mixed agro-forestry strategy. The project seeks to support small-scale farming, so the danger of large scale mono-cultures is likely to be low. Nonetheless, the project should be aware of the potential downsides and seek to ensure that cashews farming is promoted as part of a diversified agricultural strategy;

- *Land stabilisation:* Cashew trees are very effective at retaining soil and stopping erosion, especially in coastal and mountainous areas. They are long lived deep rooted trees that can have a stabilizing impact on the soil and a relatively sustainable farming system in a monsoonal wet dry environment such as the eastern provinces of Indonesia. They are used globally as shelterbelts and windbreaks, stabilising soils and protecting fertile agricultural land. This is likely to generate a positive environmental impact, particularly where Cashew are grown on degraded land;

- *Downstream processing:* Most of the money from cashews is made not from producing them but from shelling them before selling them into the market. For this reason, investments are unlikely to be made as a result of the intervention in downstream processing. Chemicals may be used to fumigate raw cashew nuts and kernels in warehouses and storage spaces. If not properly applied residues may remain that can have hazardous effect on consumers. There are potential environmental impacts from agro-processing activities. Large quantities of potable water are required. In particular, roasting and cooking can result in environmental discharge of toxic smoke and water pollutants which need to be addressed through the use of environmental technologies. Given that these are not being directly promoted by the intervention, the environmental risk is considered low.

- *Waste disposal:* Cashew by-products, if not properly disposed of, can cause environmental problems. The pace of decomposition is relatively slow, and cashew shell nut liquid can reduce the level of microbes in the soil, which can reduce agricultural fertility.

Assuming that the intervention only promotes organic based pest control and other agricultural inputs, the overall environmental risk is considered to be low, with some implicit benefits in terms of improving the productive use of marginal and degraded lands.

Risks of environment to success of the intervention

There are a number of environmental factors that may impact upon the long term viability of Cashew production in NTB. Like other agricultural groups, cashew farmers are to a great extent dependent on climate and environmental factors for their livelihoods. Climate variability and extreme climatic events such as floods and droughts have a significant impact on agricultural production and food security. Climate variability in NTB, like other Indonesian regions with monsoon rainfall, is influenced to a significant degree by the El Niño and Southern Oscillation. El Niño conditions correspond result in a delayed onset of the rainy season, longer dry spells and less rainfall, while La Niña conditions correspond to excessive rainfall[3]. There are a number of potential environmental risks to the viability of cashew production. These are set out below:

- *Pest and disease constraints:* Cashew production is subject to a number of pests and diseases, including gummosis, helopeltis, and white moth cicada. These can impact upon agricultural productivity by up to 30%. The prevalence of existing and new pests may change under climate change scenarios as temperatures rise and precipitation becomes more variable. The quality of the current research base on the likely impacts of climate change in this regard is currently weak;

- *Change in suitable land:* Changes in climate can significantly impact upon the location and availability of land suitable for the cultivation of cashew. Although no data is available for Eastern Indonesia, a similar study was undertaken for Ghana and Ivory Coast which found that the location of suitable growing land for Cashew was likely to shift significantly over the period to 2050, with a clear reduction in growing area altitude as average temperatures increased;[4]

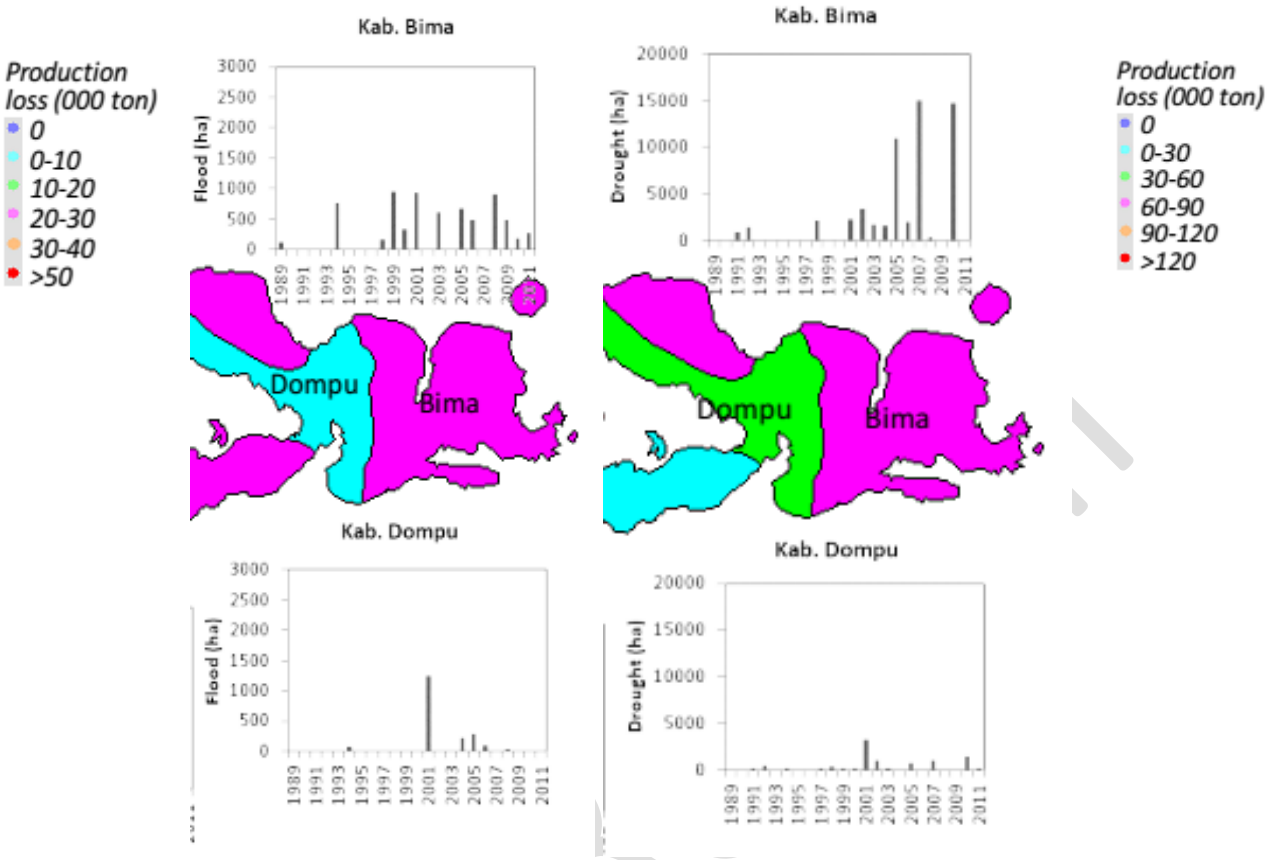
- *Fire hazards:* Increasing temperatures and later onset monsoon can create conditions for increased occurrence of fire risk. While there is no evidence of large scale burning of cashew regions in NTB, fire risk has been a major risk in other Cashew growing regions.[5] Fires not only reduce yields during the year of the fire, but can reduce yields over subsequent years and potentially kill trees outright. While annual crop farmers have little interest in fire control, cashew production tends to provide a longer term community incentive to manage fire risk.

- *Drought effects:* Crop failure due to extreme climate events may become more frequent. The frequency of massive drought in the country increased over the last 40 years compared to the previous decade - from once in three to four years to once in two to three years.[6] Long dry seasons during El Niño years significantly affect not only annual crops, but also perennial crops. Based on field observations, a long dry season generally destroys young plants. During the 1994 El Niño for example, the percentage of young plants (age of less than 2 years) die back due to the long dry season was 11% for cashew;[7]

- *Flood effects:* The region suffers from serious flooding which can have an impact on agricultural productivity. For example, historical data from 1989-2008 shows that significant flood events have occurred in both Bima and Dompu districts. It is not clear to what extent these impacted upon cashew growing regions;

[3] Boer and Subbiah, 2005; ADB and Bappenas, 1999
[4] CCAFS (2011)
[5] See ITE (2002)
[6] Boer and Subbiah, 2005
[7] Indonesia Second National Communication to the UNFCCC

Figure 1. Flood and drought events in NTB (1989-2011)



Environmental risk mitigation strategies and opportunities for improved resilience

There are a number of environmental risk mitigation and resilience strategies that might be considered either within or alongside the proposed intervention:

Issue	Resilience/Risk mitigation strategy
Use of damaging agricultural inputs	The promotion of good agricultural management practices can often be a more effective and environmentally beneficial route to addressing productivity issues than the intensive use of potentially damaging agricultural inputs. Cashew tree pruning, replanting or topping existing trees with new grafts can substantially increase yield and help control pests. Extension services can promote the efficient management of soils, water and fertilizer application. For example, the application of agricultural inputs can be avoided during monsoon seasons where nutrients are washed away, and where soil moisture is low (as absorption is an issue). Care should be taken to ensure that implementing partners promote no-cost behavioural change as well as building supply chains for the sale of agricultural inputs and other products;
Climate impacts on farmers	Although the service providers are primarily oriented towards improving cashew productivity, consideration may also be given to expanding the role of these structures to promote climate resilient approaches to agriculture, particularly where farmers are engaged in multiple crops. The service could act as a channel for early warning information on weather and climate risk, and farmer education services relation to climate adaptation;

Environmental impacts	Organic and/or fair trade cashew production can capture a significant price premium. The promotion of organic farming methods (herbicides, pesticides and fertilisers) would align strongly with the programme's environmental remit. It would also ensure that potential negative impacts of non-organic inputs, such as groundwater contamination, and greenhouse gas emissions, would be managed in a sustainable way;
Non-resilient strains	Although Cashew is generally considered a drought resistant crop, it is not clear to what extent farmers in NTB are growing the most resilient or high yielding varieties of Cashew. The programme may be an opportunity to promote higher yielding and more drought and pest resilient strains. Further research would be required in this regard;
Lack of rural economic resilience	Unlike many agricultural products, cashew production can provide simple and environmentally friendly on-farm shelling or local processing (e.g. grading) and employment opportunities. This can help increase farm level income through the capture of economic value which currently flows to regional buyers, and help small holder farmers better withstand environmental or economic shocks. Processing the cashew apple into juice, dried fruit, and other products is also possible. Support for improving storage capacity and conditions can ensure the product is well conditioned until local communities are able to process the entire crop. There may be an opportunity to influence the downstream environmental management of downstream storage and processing facilities;
Lack of rural economic resilience	Cashews are themselves a form of economic resilience strategy for smallholder farmers and the rural poor. Cashew is an attractive crop because it provides income with relatively low labour inputs. They can be produced on a wide range of soil types and produce both fruit and nuts. Either or both can be sold for income or consumed on the farm depending on the needs of the producer. This makes them a very versatile source of income in relation to dealing with climate related shocks. The ability to use marginal, abandoned and degraded lands means they need not compete with existing agricultural outputs;
Lack of knowledge on climate impacts for cashew	The programme could support or align with research into the impact of climate change on the shift in agro-ecological zones for cashew production. Such research might assess the implications on cashew quality and quantity, and identify alternative crops where cashew production becomes unsuitable. This would require partnering with national level research institutions or relevant government programmes;

Cassava Sector

Sector summary

Global demand for cassava is growing. The plant is used for food, biofuel, bio-plastics and other industrial uses. Indonesia is the third largest producer of cassava and the fourth largest exporter. Domestic demand is also strong and growing. East Java is a major centre for Cassava production in Indonesia, but productivity is low (c. 16 MT per ha vs. 19.5 nationally). A lack of domestic supply means that starch producers import outside the peak production period of May to September. Cassava farmers are considered to be among the poorer income groups.

Intervention summary

Three interventions are planned, mostly focussed around improving agricultural practices, promoting higher yielding more resilient varieties and providing access to agricultural inputs (fertiliser and credit facilities) with a view to increasing supply. Agricultural best practices will be promoted (stagger planting, harvesting, demonstration plots).

- *Developing a consistent supply of cassava chip:* The proposed intervention in West Timor seeks to increase the year round supply of dried cassava chips from farmers to locally-based trader to support income diversification.
- *Increasing the Quantity and Regularity of Fresh Cassava Supply for Starch Processing:* The intervention in the East Java districts of Sampang, Mojokerto, Bangkalan, Pamekasan and Sumenep will increase the year round supply of cassava fresh root to a private company starch processor.
- *Increasing access to good agriculture practice and fertilizer provision*: This intervention will target the East Java districts of Trenggalek and Kediri by promoting good agricultural practices via the local processor.

Impact of intervention on environment

Cassava production and processing is associated with a number of potential environmental impacts. These are set out below:

- *Soil quality:* There is evidence that high yielding cassava production can result in nutrient removal from the soil (nitrogen, phosphorus). Potential best practices include the return of leaves and stems to the soil. However where leaves and stems are also utilised, nutrient removal can increase. The use of fertilisers, animal manure, wood ash and rotation can also help maintain soil productivity and sustained high yields. However Cassava is a relatively robust and resilient crop that can adapt to less productive and more acidic soils (albeit with reduced yield).
- *Soil erosion:* Cassava has the reputation of causing serious erosion when grown on slopes. This may be due to the fact that Cassava is grown on already-eroded soils where few other crops can survive. A review of the literature indicates that production of cassava on slopes generally causes more erosion on an annual basis than other crops grown under the same circumstances. This is mainly due to the fact that cassava needs to be planted at a relatively wide spacing. Initial growth and canopy formation are slow, leaving soil exposed to the direct impact of rainfall during 3-4 months after planting. On the other hand, once the crop canopy is closed, erosion is usually minimal during the remainder of the crop cycle. Once the topsoil is eroded away, it is very difficult to restore the soil's productivity.

- *Biodiversity:* There is no documented evidence that cassava production has had a significant effect on the biodiversity of other species. However, cassava production has sometimes led to deforestation which can in turn contribute to a loss of biodiversity. The continuous cropping of cassava, accompanied by burning of vegetation may be an issue.

- *Downstream cassava processing:* Although the project is focussing on upstream support to farmers to increase the supply of cassava product, the environmental effects of downstream processing of cassava can be significant. The processing of cassava into food and industrial products requires large amounts of water (which can deplete local water resources). It also produces large amounts of waste water. This water may be high in organic constituents and cyanide (particularly where processes create large amounts of 'squeezed juice). This can pollute the ground water or the lakes, streams or rivers into which it is released. Eutrophication of slow moving water systems (ditches, lakes) may occur in the dry season. Other waste products (peels or fibrous by-products) resulting from cassava processing are often inadequately disposed of, causing a foul smell and unattractive sight, and giving the cassava processing industry a reputation of polluting the environment. While large processors may be regulated and be able to afford environmental technologies, smaller processors may be clustered, resulting in localised impacts.

- *Cassava as a source of bio-ethanol:* Bioethanol is a substitute for liquid fossil fuels. It can be produced from cassava. However, cassava only contributes marginally to the production of global bioethanol at present, although its use in South East Asia is increasing rapidly. The use of Cassava in this way could have positive environmental benefits, with the proviso that trade-offs between fuel and food production should be carefully managed.

The risk of the intervention on the upstream work with farmers is considered low given that sustainable agricultural practices will be promoted. However, the downstream risks are considered medium but it is not clear whether the programme can influence processing by project partners.

Risks of environment to success of the intervention

There are a number of environmental factors that relate to the long-term viability of cassava production in Eastern Indonesia.

- *Impacts of long term climate change:* There is some evidence that increased temperatures are likely to negatively impact upon the productivity of cassava production (reducing yields by up to 30% over this century). However, these impacts are likely to be mostly (but not entirely) offset by the benefits of increased CO_2 fertilisation. Reductions in productivity are also likely to be offset by improvements in agricultural technology in Eastern Indonesia. Cassava therefore is potentially more robust than other crops to the effects of climate change.

- *Impacts of extreme events.* Because Cassava is a resilient crop, it is often grown on more marginal lands. These lands may be more exposed to extreme events (e.g. floods, landslides). Consideration should be given to the suitability of land where Cassava production is expanded to ensure it is not over-exposed to such impacts.

- *Cassava as an environmental climate resilience strategy:* Cassava has the potential to maintain rural incomes during periods of natural resource stress. Cassava is often a food of last resort, as the crop is very tolerant of poor soils and drought. Cassava is often grown in fragile environments, such as on slopes and in the forest margins. It has been identified in some studies as the most resilient staple crop to climate change (Jarvis et al. 2012). It has

characteristics that make it attractive to small holder farmers in marginal areas with poor soils and low or unpredictable rainfall. It is propagated from stem cuttings so plant material is low cost. It is tolerant to acidic soils and is regarded as one of the highest food security crops, with a high energy yield and starch content. It is therefore a useful crop to support farmers or rural communities that may otherwise be dependent on more environmentally sensitive crops.

Environmental risk mitigation strategies and opportunities for improved resilience

There are a number of environmental risk mitigation and resilience strategies that might be considered either within or alongside the proposed intervention:

Issue	**Resilience/Risk mitigation strategy**
Removal of soil nutrients	The project should promote the use of soil management practices, including the use of organic fertilisers, animal manure, and wood ash. Rotation practices can also help maintain soil productivity and sustained high yields. However Cassava is a relatively robust and resilient crop that can adapt to less productive and more acidic soils (albeit with reduced yield).
Increased soil erosion	Erosion can be addressed through improved yields (reducing planted area), closer plant spacing and planting on contour ridges. Other good practices include intercropping, reduced tillage and planting contour hedgerows of grasses. Together, these can reduce erosion by 50-90%. Most practices to control erosion require some additional inputs (fertiliser, seed, labour) or may reduce yields through land competition. Approaches should be site specific based on trade-offs identified.
Loss of biodiversity	Where possible, the project should ensure that expansion of cassava production should only occur on already degraded lands, rather than on land which may result in deforestation or change in existing land use.
Environmental impacts of processing	The project should seek to promote best practice environmental management practices to downstream processors. The type of best practice will depend on the scale and type of processing operation. Water depletion can be minimized by the adoption of processing technologies suitable for the water resources available. Care should be exercised that cyanide-containing waste is either diluted or stored in such a manner that the cyanide concentration is reduced. This is usually the case, even if the waste is stored for a short time.
Bioethanol opportunities	The project may consider reviewing the supply chains in Indonesia for bio-ethanol production, and whether it is feasible to link production without damaging food supply chains.
Climate change impacts	Further work may be warranted in understanding the longer term sustainability of Cassava as a crop under climate change scenarios. This could be done by linking with local research institutions and the FAO.
Economic resilience	Cassava can be promoted as a rural livelihoods resilience strategy. Its robustness can help communities diversify incomes, and withstand environmental shocks that may negatively impact upon other crops.

Coconut Sector

Sector summary

In recent years there has been a marked increase in global demand for coconut products. Although Indonesia is the world's largest producer, the country lags in terms of exports. Although significant numbers of coconut sugar producers along the south coast of West and Central Java already sell coconut sugar for export, producers in East Java are very poorly linked to export markets, which provide premium prices for quality sugar. The fact that coconut production in the mountainous target districts is naturally organic represents a significant opportunity, since organic certification has become a pre-requisite for export as it is seen as a guarantee of quality.

Intervention summary

The proposed interventions seek to promote the sustainable development of coconut production, whist increasing both the output and value added of production, whilst scaling up collection and processing. There are two specific interventions

1. *Promotion of Organic Certification in Coconut Sugar in Trenggalek and Pacitan:* This comprises three subcomponents: (1) the development of organic certification amongst producer groups by private companies; (2) the development of sugar collection points by private companies to improve the supply of processed sugar; and, (3) the provision of credit for processing equipment by equipment suppliers to exporters and producers.

2. *Establishment of Coconut Aggregation Points in East Java and Lombok (West Nusa Tenggara):* This comprises two subcomponents: (1) The commercial operation of Coconut Aggregation Points (CAPs) – small business operations run by e.g. local collectors, producers, traders or other local business persons – to organise aggregation of supplies from farmers or local collectors for transport to private companies; and, (2) provision of extension services to include GAP training and knowledge dissemination.

Impact of interventions on environment

The following are the potential impacts on the environment from the intervention:

- *Potential impacts of coconut sugar production:* Coconut sugar offers a more environmentally friendly alternative to large scale cane sugar production, which can result in land clearance, mono-cropping, water consumption and soil degradation. Coconut is generally grown in more diverse ecosystems, with positive environmental impacts, and produce higher sugar volumes per hectare. They require little fertiliser, with only one application per year necessary. There is some trade-off between coconut sugar and coconut product production, in that when trees are tapped for sugar, coconut yields may fall (Dalibard). However, research indicates that coconut sugar farming generally provides environmental benefits in terms of carbon sequestration[8] with minimal resource use (Magat 2009).

- *Improvement in cook stove technology:* The project seeks to disseminate improved cook stove technology for processing of coconut sugar. These new fuel stoves will promote fuel efficiency, and improve product quality through better hygiene and reduced smoke. They will also promote improved health of producers, including women and children through reduced pollution and improved air quality.

[8] This refers to the process of capturing CO2 from the atmosphere and storing in terrestrial systems (e.g. through growing new trees, or capturing organic matter in the soil.

- *Promotion of environmentally sustainable practices:* The project will support the implementation of organic standards around coconut product production and promote best practices in terms of agricultural processing. This includes minimal fertiliser application, weeding practices to control pests and improve nutrient management, soil coverage with husks or fronds to conserve water and intercropping.

- *Promotion of coconut syrup:* The production of coconut syrup also reduces the time and fuel inputs associated with downstream processing, thereby reducing fossil fuel consumption and associated negative environmental impacts in the supply chain process.

In summary, there are no obvious negative environmental impacts associated with the intervention and the risks are considered to be low. The intervention proposes a number of potentially beneficial environmental aspects.

Risks of environment to success of the intervention

- *Impacts of climate change on coconut yield:* Coconut trees are naturally occurring vegetation in Eastern Indonesia. Like other types of plantation vegetation, they are potential vulnerable to climate change impacts. Research on the impacts of climate change on coconut production in Eastern Indonesia is, however, weak. Research elsewhere has found that changes in temperature and water availability (e.g. monsoon patterns) can adversely impact upon coconut production. The reproductive development is more sensitive to temperature and water stress than vegetative development. Reduced nut setting can occur under long hot and dry spells. This may occur due to unfavourable environmental conditions during fertilisation or poor pollen quality (Ranasinghe 2012). Further research is required in this regard.

- *Impacts of climate change on pests and diseases:* Like other crops, coconuts may be affected by a wide range of pests and diseases. The most common pests are boring insects rhinoceros beetles palm weevil, red palm mite, coconut leaf caterpillars, moth borers and ants. These affect the productivity of the palm and an integrated approach to pest management is usually effective in achieving some measure of control. With respect to diseases, the palm is susceptible to a range of fungal and bacterial diseases which cause a range of rots, spots and blights to leaves. Pest and diseases may become more prevalent under future climate scenarios, challenging the organic production mode and requiring the use of chemical pesticides.

- *Impacts of extreme events:* Coconut farms and infrastructure may be exposed to extreme climatic events (e.g. floods, cyclones, coastal surges), but there are no specific threats related to coconut cultivation. Care should be taken to ensure that risks are mitigated through the siting of coconut plantations in areas unlikely to be impacted by extreme events.

Environmental risk mitigation strategies and opportunities for improved resilience

There are a number of environmental risk mitigation and resilience strategies that can be considered either within or alongside the proposed intervention:

Issue	**Resilience/Risk mitigation strategy**
Air pollution associated with processing	The programme will promote the use of clean cook stoves associated with coconut product processing. These will in turn mitigate health and air pollution impacts.

Climate resilience of agricultural communities	The programme will increase the added value to farming communities, allowing them to increase and diversity their income. This is an economic resilience strategy allowing communities to withstand climate induced shocks

Coffee Sector

Sector summary

Coffee is a high value added product, and Indonesia is a significant global exporter, ranked third behind Brazil and Vietnam. It produces a number of single-origin speciality coffees, of which approximately two thirds are exported to the US and Europe. There is increasing global demand for sustainably produced coffees. A number of certification schemes exist. These systems generally promote sustainable agriculture practices, such as Good Agriculture Practices (GAP), Good Post-harvest Practices (GPP) and Good Manufacture Practices (GMP). Financial added value is potentially large. However, farmers currently do not provide product that can meet export demand (quantity) and or conform to standards (quality). Productivity and value generation levels are approximately 50% of estimated potential. Farmer knowledge is low, and willingness and ability to pay for extension services is constrained. Processing systems, certification and traceability are weak.

Intervention summary

Two interventions are planned. Both work through an ICCRI franchise model based on the cooperative structure. The cooperative ICCRI Franchises receive capacity building from ICCRI which is then directed towards individual small holders.

- Firstly, it is proposed to promote the strengthening the agronomic information and technology transfer service, particularly related to Good Agricultural Practices. The GAP will address issues of rejuvenation of old trees; introduction of superior clones; soil and water conservation; pruning both coffee and its shading trees; and pest and disease control using sustainable methods.
- Secondly, it is proposed to strengthen Good Post Harvest Practices (GPP). This will be done through the establishment of decentralised progressing facilities for speciality coffee in Ngada, Manggarai and Lumajang. This addresses issues related to quality, including harvesting, grading, sorting, fermenting, drying and quality control methodologies.

Impact of intervention on environment

The following are the issues relating to the potential environmental impacts of coffee production.

- While the project intends to promote good practice in both coffee growing and processing, some issues might arise from the expansion or intensification of coffee production:
    - *Deforestation:* Traditionally, coffee has been cultivated under a shaded tree canopy in Indonesia. Sun-cultivation can result in the canopy being cleared for more intensive forms of cultivation (both for Arabica and Robusta varieties).
    - *Biodiversity:* The loss of forest resulting from a shift from shade to sun-grown coffee can have a knock on effect on bio-diversity. The canopy provides valuable habitat for animals and insects, and the loss of canopy can harm eco-systems.
    - *Soil erosion:* The loss of deep rooted tropical forest and shift to mono-culture can result in higher levels of soil erosion, leaving coffee cultivating areas more susceptible to the impacts of climate change (e.g. flash flooding).
    - *Chemical inputs.* The loss of foliage and natural litter means that soil quality and productivity needs to be maintained with natural chemical inputs. Their use over time can result in lower levels of soil productivity, as well as the potential harmful effects of pesticides on human health. There is a strong correlation between the

removal of shade cover in coffee plantations, and the increased use of fertilizer inputs. These can contribute to the contamination of waterways and aquifers.

- *Loss of environmental services:* Where deforestation occurs, farming communities can become dependent on a single crop, with the loss of other forest based environmental services (firewood, fruit). Large trees provide a habitat for native wildlife, support soil health, fight erosion and provide side benefits (fruit, firewood).

- There are in addition a number of potential impacts from downstream coffee processing:
  - *Water contamination:* Contamination of waterways also pose serious environmental threats from the processing of coffee beans. Largely irrespective of how coffee is grown, discharges from coffee processing plants represent a major source of river pollution. Ecological impacts result from the discharge of organic pollutants from the processing plants to rivers and waterways, triggering eutrophication of water systems and depriving aquatic plants and wildlife of oxygen.
  - *Waste management:* Coffee manufacture can result in a large amount of waste. The process of separating the commercial product (the beans) from the coffee cherries generates large volumes of waste material in the form of pulp, residual matter and parchment, as well as polluted water. This waste can impact both soil and water systems, degrading eco-systems. It is possible to use waste material (e.g. husks), mixed with animal manure to use as organic fertiliser. The project should seek to promote sustainable waste management practices at the processing level.

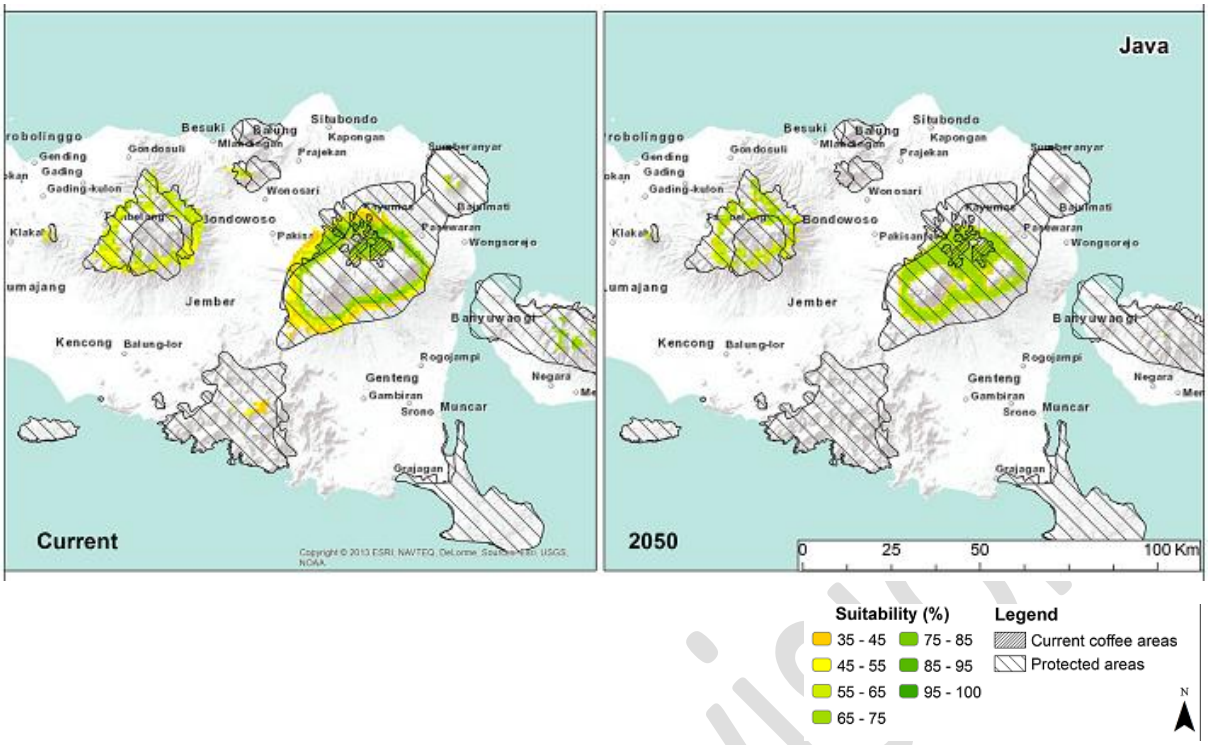
The project intends to promote sustainable approaches (GAP, GPP) to both coffee cultivation and processing. The overall environmental risk is therefore considered to be low.

Risks of environment to success of the intervention

There are a number of environmental factors that may impact upon the long term viability of coffee cultivation and production in East Java and NTT. These are set out below:

- *Climate change impacts – long term sustainability:* There is a growing body of evidence that climate change is likely to present a significant threat to coffee production. The IPCC 5th assessment report indicated a reduction in the area suitable for coffee production by 2050 in all countries. Higher temperatures increase plant metabolism and lead to lower quality and yields. Coffee growing zones can shift in terms of altitude, potentially resulting in land use conflicts. Rising temperatures and rainfall patterns may also lead to new pests, such as the coffee berry borer (Hypothenemus hampei) which is migrating to higher altitudes in Indonesia. A recent study looked at land suitability for Arabica coffee production by 2050 in Indonesia (Schroth et al 2014). It concluded that the total amount of suitable land would be reduced dramatically. However, the volume of land would still be sufficient, with currently unused lands and a shift in suitable locations offsetting declines in current growing regions. Some regions, such as Flores, may cease to produce coffee. It points out that such shifts could become a significant driver of highland deforestation. Coffee plantations may also be exposed to extreme events associated with climate change (storms, floods).

Figure 2. Suitability of Coffee Growing Areas in Java



Environmental risk mitigation strategies and opportunities for improved resilience

There are a number of environmental risk mitigation and resilience strategies that might be considered either within or alongside the proposed intervention:

Risk	Resilience/risk mitigation strategy
Environmental impacts of coffee production	The project will mainstream good environmental practices into coffee cultivation through certification and good agricultural practices (supporting land protection (e.g. forest cover), erosion protection (steep areas), reducing the use of pesticides, water source protection, soil nutrition, biodiversity promotion and waste management. Agro-forestry can also be promoted helping to avoid deforestation.
Environmental impacts of downstream coffee processing	The project is proposing to implement Good Post-harvest and Good Manufacture Practices. This will involve ensuring that water discharges from coffee processing facilities do not pollute waterways with organic pollutants, and that waste is properly managed, and where possible used as a fertiliser input.
Poor resilience of coffee varieties	The programme proposes investigating the use of resilient varieties as part of the GAP programme. These are varieties that may be more robust against changes in temperature or water availability. Where higher value but more climate sensitive coffees (e.g. Arabica) become more difficult to cultivate, consideration may be given to diversifying to Robusta varieties which are better adapted to lowland conditions (although this is considered a lower value added product).
Climate change and shift in suitable agro-ecological zones	The project should ensure that coffee production is promoted in regions that are likely to be suitable for production in the medium to long term. The life cycle for establishing mature coffee plantations can be 20-30 years. Plantations should be encouraged on already degraded lands, and avoid areas under legal protection to avoid deforestation. Intercropping should be promoted to support landscape restoration. Increasing intensification may also help avoid the need for new planting in potentially unsuitable areas.

Fish Farming Sector

Sector summary

As the largest archipelagic country in the world, fisheries is an important sector in the Indonesian economy, making up some 19.2% of the country's GDP. As a sector, it provides employment and livelihoods to more than 3.5M people. More than 60% of Indonesians live at or near the coastline. Over fishing and exploitation of marine resources has put tremendous pressure on fish stocks. East Java is the largest fish producing province in Indonesia accounting for 8% of total marine fish production. The Situbondo area already has a closed season for marine fishing, impacting on coastal community incomes.

Intervention summary

Two linked interventions are planned

- Firstly, the programme will promote fish cage farming in Situbondo to provide a year-round source of food and income for fishermen particularly during the closed season.
- Secondly, the program will provide credit facilities to allow fishing communities to invest in fish farming equipment.

Impact of intervention on environment

The following are the issues relating to the potential environmental impacts:

- *Water quality impacts*: Practiced unsustainably, fish farms can result in significant environmental impacts. Nutrification of the waters can occur through food and fish waste. In Indonesia fish are often fed small trash fish which are cut up and hand fed to the cages, rather than feed pellets which have lower local environmental impacts. Sea bed sediment can suffer from organic loading as a result, creating localised environmental impacts.
- *Escape of captive fish:* Where farms are used to cultivate non-native captive species, these may escape where nets or cages are damaged. Under such circumstances, escaped fish may interbreed with or displace native varieties, resulting in negative biodiversity effects. The project should seek only to use local species where possible, unless cage systems can be guaranteed as secure.
- *Disease and parasites:* There is some evidence that intensively farmed fish may be more susceptible to disease and parasites than natural populations. Where in close contact, these diseases can spread to local wild populations living near the farming sites. Separation of farmed and native wild species is therefore important.
- *Toxic chemicals:* Chemicals may be used to control disease and promote animal health. These chemicals can accumulate in the fish farm site in sea bed sediments. Care should be taken to use minimal chemical inputs.
- *Feed:* Where fish farms use wild-caught fish as a feedstock, this can have a wider environmental impact if these fish are caught unsustainably, particularly where a larger supply chain develops around fish farming feed inputs. Currently in Indonesia, farming uses fish waste or smaller fish that otherwise do not have economic value so the impact is likely to be minimal.
- *Poor site location:* Improperly sited, fish farms can damage coral and mangrove systems which act as fish nurseries and constitute natural coastal defences. Site selection is

important to ensure that yields are commercially viable, as once established, a cluster may soon develop in the same area leading localised environmental impacts. Where clusters developed, less sustainable farming locations may be abandoned, with equipment left in coastal waters;

- *Reduction in overfishing:* The promotion of cage based fish farming may encourage coastal communities to pursue it as a viable alternative to marine fishing, and therefore have a positive indirect impact on current levels of over fishing where it can be shown to be economically productive.

Assuming that some of the above risks are addressed, the overall environmental risk is considered to be low, with some potential benefits in terms of reducing overfishing.

Risks of environment to success of the intervention

There are a number of environmental factors that may impact upon the long term viability of marine fish farming in East Java. These are set out below:

- *Localised environmental effects*: Successful fish farming depends on water quality, water temperature, and oxygen, light and nutrient levels. Site selection is therefore important to ensure that fish farms are placed in sustainable locations, and that the volume of fish farming accurately reflects the carrying capacity of the selected sites.
- *Climate change impacts – marine ecosystems:* The impact of climate change may negatively impact upon habitats and affect fish populations. Coral reefs will likely degrade with increasing water temperatures and acidification of the oceans and be more sensitive to poor marine governance (overfishing, pollution, and invasive species). This may impact upon the source of fish stock for farming. Likewise fish feed (small wild fish such as anchovies and sardines) that are processed or used to feed other fish directly may be sensitive to changes in ocean conditions.
- *Climate change impacts – extreme events:* Coastal communities are exposed to the impact of extreme events, particularly storms which can damage fish farming infrastructure, as well as impact negatively on the economic well-being of coastal fishing communities.

Environmental risk mitigation strategies and opportunities for improved resilience

There are a number of environmental risk mitigation and resilience strategies that might be considered either within or alongside the proposed intervention:

Issue	**Resilience/risk mitigation strategy**
Poor environmental management practices	The promotion of good fisheries management practices can minimise environmental impacts. This can include the use of floating cages which do not damage coral reefs and other ecosystems, clearance of abandoned equipment from shallow coastal waters, the use of sustainably sourced feedstock, minimal use of chemical inputs and good separation between native wild and captive species where appropriate;
Unsuitable environmental conditions	Fish farm sites should be sited in those locations with suitable water and nutrient levels, and excessive clustering should be discouraged. The expansion of fish farms to neighbouring sites where conditions may not be optimal should be managed to ensure that over-intensification does not occur;

Climate change impacts	The programme could support or align with research into the impact of climate change on the impacts on marine aquaculture (e.g. ocean acidity). This would require partnering with national level research institutions or relevant government programmes;
Marine overfishing	The promotion of fish farming in marine and inland waters may in itself encourage local communities to stop overfishing in inshore waters. The programme might consider educating local communities on the impacts of marine overfishing as part of the fish farming dissemination activities;
Poor economic resilience of coastal communities	Fish farming can help diversify income streams for coastal communities, particularly those involved in sea fishing or other forms of agriculture. Increased and more diversified incomes can help improve community level resilience to environmental shocks. Added value can be further developed through certification, with evidence that international consumers are willing to pay a price premium for fish that is sustainably sourced and eco-labelled (e.g. Tuna);

Pig Farming Sector

Sector summary

The global pork market is dominated by established exporters in the developed world. Indonesia is a small player in the global pork market with an under-developed industry. Domestic demand for higher quality pork is increasing in certain regions where religious affiliations allow. Pigs are often imported between islands, especially from the district Manggarai in Flores, which has the largest pig population in Indonesia. East Nusa Tenngara (NTT) Province is the largest pork consuming area in Indonesia. Demand for pig meat is growing in NTT.

Intervention summary

The intervention seeks to improve and upscale pig breeding. At the service level, this involves the development of slaughtering, wholesale and retail export services. Farmers will be improved with better inputs (better piglets and affordable fodder). Envisaged interventions are set out below:

1. Introduction of improved pig breeds and promotion of commercial pig rearing in Ngada and SBD
2. Establish processing facilities in SBD (slaughterhouse, cool storage).
3. Develop trade between existing processing operations and higher value markets.
4. Establish commercial aggregation services and link to processing facilities.

Impact of intervention on environment

In the context of the intensification of pig production and consequent higher animal densities, there are a number of potential environmental impacts, of which the pig farm itself is the greatest area of focus. Issues are set out below.

- *Soil and Water Degradation:* There are a number of potential localised environmental impacts from pig production. These include the leaking of nutrients into the ecosystem, and acidification resulting from acidic gasses such as ammonia reacting with water in the atmosphere. The use of manure determines the level of environmental impacts. Used properly, pig manure can contribute to soil fertility, particularly alongside agro-silvo-pastoral or organic farming systems. However, the uncontrolled use of manure can lead to soil and water degradation due to an overload of nutrients and other substances – a process known as eutrophication. High density pig production can release high levels of nitrogen and phosphorus. Where copper and zinc are used as feed supplements, these can also accumulated in soil and water sources.

- *Greenhouse gas emissions:* Intensification of pig production can contribute to the release of greenhouse gases (in particular ammonia, nitrous oxide and methane). While the amounts associated with the intervention are likely to be limited due to the focus on small holders, it is possible to manage the release of GHGs through appropriate storage, and their use in community level bio-digesters (which can produce gas for cooking or electricity production). The production of artificial fertiliser and pig feed outside the pig farm also have potential global warming impacts in the pork supply chain. The primary source of GHG emissions associated with pig production are associated with manure management and feed production. Emissions from slaughterhouse and transport are relatively low.

- *Disease risks:* Pig farming has the potential to impact upon human health. Pathogens can cross from pigs to humans and vice versa (e.g. Influenza). Diseases such as trichinellosis and cysticercosis are identified as “poverty-related” because they are predominant in extensive and low-input pig production systems with poor sanitation and hygiene. The use of

antibiotics in pig production can more widely contribute to antibiotic resistance. Oversight is challenging in the context of subsistence driven pig production.

Given the small scale of the intervention, and assuming that the intervention will promote environmentally sensitive approaches to pig production, the overall environmental risk is considered to be low.

Risks of environment to success of the intervention

There are a number of environmental factors that may impact upon the success of expanded pig production in NTT. Farmers are to some extent dependent on environmental conditions for successful pig rearing. Climate variability and extreme climatic events can impact upon pig production:

- *Impact on higher temperatures on pig health:* Pigs are susceptible to increased temperatures due to the poor functioning of sweat glands. Increases in the ambient temperature may result in lower feed consumption which can in turn lead to weight loss and reduced reproductive performance. Respiration rates also increase under thermal stress, and blood oxygen levels can also be affected. Reproduction can also be affected, with female swine exposed to thermal stress may have lower conception rates, and lower viability during early and late pregnancy. Birth weights can be reduced. In extreme heat conditions, mortality rates increase, and bacteria such as Escherichia Coli can become more drug resistant. Mycotxicosis may also increase due to the growth of fungi.

- *Exposure of communities to climate change impacts*. Climate impacts in NTT can include droughts (experienced during El-Nino periods), while rainstorms liked to typhoons can undermine agricultural production where direct impacts are felt. This can result in food security problems. Future climate change may undermine the agricultural supply chain for feedstock where locally sourced.

Environmental risk mitigation strategies and opportunities for improved resilience

There are a number of environmental risk mitigation and resilience strategies that might be considered either within or alongside the proposed intervention:

Issue	**Resilience/risk mitigation strategy**
Impacts of waste	The project proposes to use composting as a waste management strategy, educating the local community and using the raw material for plant fertilisation. The reduction of over-supply of nutrients in the diet will also reduce the environmental impacts of manure.
GHG emissions	Consideration may be considered to using waste for bio-gas applications if volumes and technology access allow. Low emission feedstock (e.g. soy or vegetable based) and effective manure management will also contribute.
Health impacts	Food-safety should be implemented along the supply chain to ensure protection. These include regulated slaughter processes, mandatory meat inspection, and public education. The programme should ensure that service providers operate to high environmental and hygiene standards.
Understanding climate impacts	The programme may undertake further research or engage with national authorities to understand the potential impacts of climate change on pig rearing, including identifying resilient breeds.

Seaweed Sector

Sector summary

The majority of global seaweed production is located in East and South East Asia. Indonesia is a highly suitable location for tropical seaweed production and is the world's second largest seaweed producer with 85% serving the export market. Both global and domestic demand is growing. The area around NTT allows year-round cultivation (as opposed to seasonal cultivation in other regions), and provides approximately 19% of national production. Of this, Eastern Flores represents half. Although national production has been increasing, production in NTT has declined over recent years

Intervention summary

The intervention seeks to expand the area under cultivation in Eastern Flores (the current area represents only two thirds of potential areas for cultivation) and by improving smallholder cultivation and post harvesting capacity. This will be done through a seaweed support centre, which will be established with a private sector partner and a series of agents (farmers).

Impact of intervention on environment

The following are the issues relating to the potential environmental impacts:

- *Agricultural inputs:* Seaweed in Eastern Flores is sometimes grown with the use of chemical pest control products (green tonic). The use of chemical fertilisers is widespread due to lack of awareness by farmers of the damaging effects of these practices. The project supports the transitioning of farming practices away from chemical inputs to preventative and curative action to overcome disease issues. Farmers currently have limited knowledge of such approaches, which will be promoted through training and extension services.
- *Impacts of intensification:* Rich farming locations tend to be under more pressure because of the increase in new plots and farms that are built in these locations. The project should ensure that intensification is managed in a sustainable way to prevent over-farming.
- *Abandoned equipment:* Seaweed farmers may abandon farming equipment in the shallow coastal areas, particularly where expansion and intensification takes place in areas that are not sufficiently fertile. The programme must ensure coastal areas are well managed.
- *Environmental benefits:* Seaweed production may have a number of environmental benefits. These include improved biodiversity, where seaweed crops may provide shelter and habitat for spawning fish or other small organisms, thereby helping fish stocks. Water quality can be improved through higher oxygen levels and the absorption of nutrients associated with eutrophication. Integrated multi-trophic aquaculture (where seaweed and fish farming are practiced together) can help manage excess nutrients.

The programme is promoting a reduction in the use of chemicals and a move towards non-input based management practices. Assuming that the intervention manages the allocation of sites as part of the expansion process the overall environmental risk is considered to be low, with the possibility that the project will improve environmental management practices among local communities.

Risks of environment to success of the intervention

There are a number of environmental factors that may impact upon the long term viability of seaweed production in NTT. Like other agricultural groups, seaweed farmers are to a great extent dependent on climate and environmental factors for their livelihoods. Further details are set out below:

- *Pest and disease constraints:* It is not clear which seaweeds will be farmed. However, the production of certain seaweeds (e.g. K. alvarezii) can be susceptible to diseases such as ice-ice disease. Farmers may choose to turn to more disease resistant strains although these may fetch lower market prices. These may change under future climate change scenarios.
- *Environmental conditions:* The productivity of seaweed can be determined by salinity and wave conditions (lower levels of both are generally preferred). Productivity in the area will be impacted by the choice of local growing conditions (weather patterns, currents).
- *Climate change and marine environment:* In the longer term, seaweed production may be impacted by two of the main effects of climate change on the marine environment - increased sea surface temperatures and ocean acidification. Both of these trends are likely to have significant impacts on marine species, in that species are unable to adapt to historically rapid changes in the external environment. The impact of ongoing climate change on seaweed ecosystems is poorly understood, and further research is required.
- *Climate change and extreme events.* Coastal communities are exposed to extreme events, such as increasing frequency and severity of coastal storms. These can impact upon coastal communities, particularly when equipment or infrastructure is damaged.

Environmental risk mitigation strategies and opportunities for improved resilience

There are a number of environmental risk mitigation and resilience strategies that might be considered either within or alongside the proposed intervention:

Risk	**Resilience/risk mitigation strategy**
Use of chemical fertilisers	The programme is promoting a reduction in the use of chemicals and a move towards non-input based management practices. The project should promote such approaches where possible, and avoid the use of chemical inputs. This approach would support the programme's environmental remit and would help manage any potential localised environmental impacts;
Over intensification of farming	There are techniques to optimize the carrying capacity of seaweed farming. Among these techniques are setting enough buffer space between farms, reducing the number of farms in dense cultivation areas, and using the right cultivation method that is suitable to the environmental conditions of a given area. Good agricultural management practices should be promoted to ensure that farming methods do not create environmental impacts in coastal areas
Climate change impacts	The programme could support or align with research into the impact of climate change on the productivity of seaweed cultivation. Such research might assess the implications on seaweed productivity of increased acidification, and increasing temperatures. This would require partnering with national level research institutions or relevant government programmes;
Social impacts of climate change	A number of studies have linked the positive impact of seaweed farming to coastal villages. The seaweed production model favours small-scale, family operations over corporate, plantation-style farms. The drying and local processing of seaweed products can help local communities capture a higher proportion of the value added associated with their product. It also allows diversification from fishing and other activities that may also be influenced by environmental change.

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