ECONOMIC STRESS

For economic growth to continue in countries worst affected by climate change, it is crucial that they be able adapt to the most serious economic stresses. The poorest communities will rely on external assistance. Several major concerns, such as mass global shifting of fish stocks and coral destruction, are unlikely to be preventable to any meaningful degree by the types of local actions that are currently available. There will be further limits to adaptation on the frontlines of scorched dryland regions that receive less and less rain.[267] However, a number of effective responses could have extended benefits for socio-economic development that might far outweigh the negative effects of climate change in the near future. Adaptation to climate stresses should be seen as an opportunity to sustain the fight against the worst forms of rural poverty and hunger.

HIGH
Overall Effectiveness Rating

19 #Actions Assessed

FINDINGS

The economic cost of climate change is perhaps the least understood aspect of the climate challenge and the most difficult to gauge. Significant changes in air temperature, water temperature, rainfall, river flows, and ocean acidity will have wide-reaching effects on the environment and the economy but have not been documented in a way that enables us to fully quantify those effects.[268] It is difficult to forecast outputs and prices in agricultural markets even without factoring in climate change. Many other considerations, such as population growth, general economic activity, and resource inputs, also play into the equation.

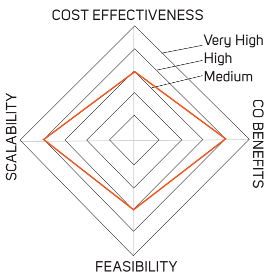
In some cases, climate change is projected to lead to net benefits in the near term.

But most often it implies net costs. Many industries are already adapting to the changes regardless of whether they are of a beneficial or a negative nature.[269]

While all sectors of the economy will feel the changes, agriculture, forestry, fishery and other primary sectors will be most affected. These sectors will reap most of the benefits but will also be hit with most of the negative effects of climate change. The effects on these sectors will also be passed on to other parts of the economy and to society as a whole.

In some cases, climate change is projected to lead to net benefits in the near term
The focus of this report is on helping areas that

REVIEW FINDINGS



THE ECONOMIC COST OF CLIMATE CHANGE IS PERHAPS THE LEAST UNDERSTOOD ASPECT OF THE CLIMATE CHALLENGE will face the negative impacts of climate change to minimize those risks, not to advise economies profiting from climate change (those in the far north or south) on how to better reap the benefits. It is not within the scope of this report, however, to document all possible responses to all possible negative impacts. When assessing the economic stresses caused by climate change, the serious effects being felt by high-altitude or high-latitude communities due to thawing permafrost, for example, have not been taken into account. As once permanently frozen land thaws, all manner of infrastructure, from roads and bridges to homes and electricity grids, become destabilized and unsafe. The associated adaptation costs are overwhelming on a local basis. The cost of moving just one small village in Alaska, for example, has been estimated at over USD 50 million.[270]

The number of people suffering permafrost-type impacts is dwarfed by the number who, in the next 20 years, will be affected by severe productivity drops in crop production, livestock rearing, forestry and the fishing industries in warmer parts of the world. This report assesses some of the more effective responses available to these communities.

IN SOME CASES, CLIMATE CHANGE IS PROJECTED TO LEAD TO NET BENEFITS IN THE NEAR TERM

THE SUMMARY

The measures assessed in this report that relate specifically to reducing economic stress received generally high ratings for effectiveness and testify to a range of promising options already available to seriously reduce some of the main economic impacts of climate change.

Measures taken to help communities adapt to economic stress can be very costly and must be justified in the local economic context. Programmes generally range from around USD 100,000, such as for a groundwater prospecting and extraction project, to over USD 5 million for an integrated pest management scheme.[271] Governments will often have to provide significant support to help farmers and fisher folk adapt to these stresses.

The most options available relate to crop and livestock based agriculture and water stress situations. Fewer options were found for limiting impacts to the forestry and fishery sectors, based on the research behind this report. Even fewer options are available to combat major threats to land-based biodiversity, such as in rapidly warming mountainous or Polar regions.

Changes in crop management are among the simplest measures for fighting off heat, drought, water scarcity or salt intrusion in soils due to climate change. The use of newly available drought-resistant plants or simple changes in planting dates can improve yields in certain circumstances.[272] Coastal communities can also plant crops that can be irrigated with seawater alone for the price of a pump (or around USD 600 per acre). But salt-resistant crops are generally only suitable for livestock feed and yield lower returns than other cash crops.[273]

The world's poorest farmers struggle to obtain access to high-quality fertilizers and seeds, with many surviving on the least productive varieties available. These plant types will make less and less commercial sense in the world's most marginal regions as a result of climate change, forcing a switch to higher quality seeds and plant varietals. This could ultimately bring about a surge in agricultural productivity that well outweighs the negative impacts of climate change.[274] Many low-income farmers will not have resources to make the switch for the same reasons they have been unable to gain access to better supplies in the past.

Another cost-effective alternative for irrigated crops is switching to drip irrigation. This entails feeding small drops of water through tubing directly onto plants, minimizing wastage and evaporation, but again requiring installations over and above the means of most worst-affected farmers, with projects assessed here ranging from USD 100,000 to 400,000.[275]

In many cases, simply upgrading services available to farmers could help to minimize many negative impacts of climate change. In parts of Africa and Asia, for example, the most basic weather-monitoring networks are often inadequate. Additional automatic weather stations on the ground are cheap and effective and can help farmers make crucial decisions while also enabling disaster forecasting and delivering other commercial benefits.[276]

In many areas, pests and fires will increasingly threaten forests, and coastal erosion will threaten mangroves.[277] Pest management is assessed as a highly effective response here, but it also carries a high cost.[278] Other forest or mangrove plantation conservation programmes are highly effective and much less costly to implement. Sustainably managed forests and mangrove plantations also result in significant benefits to biodiversity.[279]

Proactively collecting and storing rainwater can compensate for shrinking water availability even in areas where rain will continue to decline. But collected water has to be carefully managed in order to last through extended periods of drought.[280] In the driest regions, the annual rainfall may no longer suffice for larger communities, in which case, prospecting for new sources of groundwater, sometimes far away, may be the only alternative to relocation.

Conservation-type programmes are among the best-documented measures to reduce the economic impact of climate change on fisheries. Projects include the creation of marine sanctuaries to allow aquatic life to regenerate, and monitoring and re-propagating threatened coral or shellfish. It's unclear how well such initiatives would function on a large scale.[281]

The feasibility of implementing any of the measures assessed here to counter economic stresses is a major concern. Above all, the costs are over and above the means of worst-affected communities, which makes implementation unlikely without deliberate external funding. And while a quarter-of-a-million dollar shellfish programme may prove fruitful for a three-year duration to a local island community of a few thousand people in the South Pacific, extending that programme to millions of stressed marine environments and coastal communities around the world would be a massive undertaking.[282]

A number of the actions assessed in this report will also require legislative changes, for example through establishing conservation areas, or involving local government services, such as with the improvement of weather monitoring networks. In areas where the institutional frameworks of government are already stressed, this will make implementation very difficult.[283]

Forest, mangrove, and marine conservation or enforced sustainable practices, may also run into competing commercial interests within communities, which might cause short-term risks to food security, if, for example, local fishermen are suddenly prohibited from wetland or coastal fishing.[284]

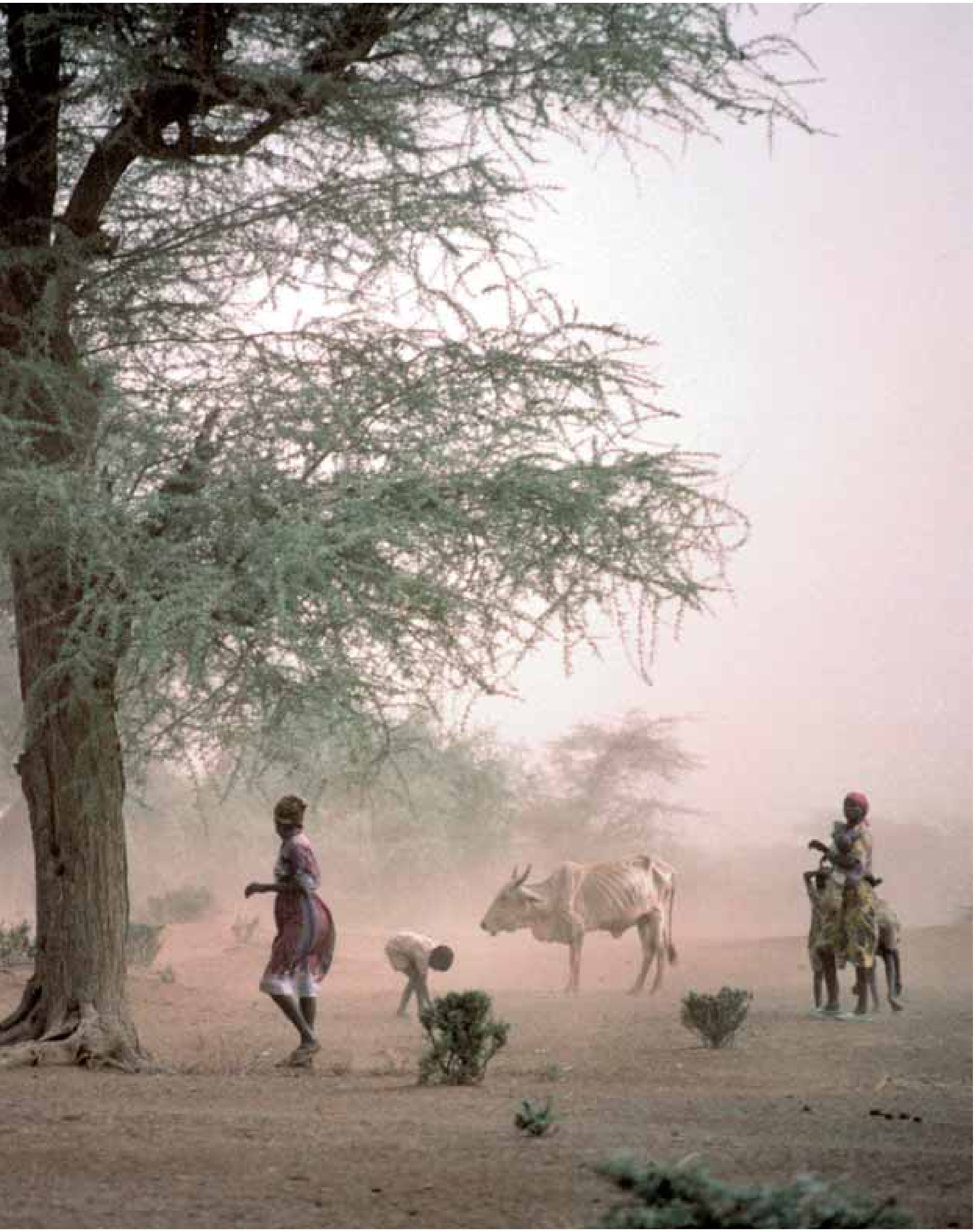
However, a number of the measures assessed here could unlock new potential across value chains if properly implemented, particularly for poor rural communities. Proper weather monitoring, for example, is a prerequisite for insurance plans based on indexes of meteorological information that are affordable even to the poor, since they pay out when rainfall drops below a certain level and do not require costly assessment procedures. Insurance can in turn facilitate access to microfinance, and microfinance can lead to the procurement of better seeds, fertilizers and other supplies. In successful cases, therefore, benefits of some of the responses assessed here could be wide-reaching.

Some of the actions assessed here are long familiar to agricultural or development communities. It has been well documented, for example, that improved roads and seeds result in higher rural output levels. These initiatives are easily replicated anywhere and will widely benefit communities in most cases. However, a number of measures, such as introducing salt-water crops, are pioneering responses to emerging concerns, and we are only beginning to see case examples that would serve as a foundation for widespread implementation.[285]

TIMEFRAME CONCERNS

A number of the measures here can be implemented almost immediately, such as installation of weather monitoring networks or even the launch of a coral or mangrove conservation programme. Such actions, however, may take much longer, often years, to achieve a positive impact.[286] Marine life may bounce back fast (as with some examples of coral reef damage) or take decades to properly regenerate even if left completely undisturbed by commercial operations. Desalination plants or micro-irrigation systems are quick fixes by comparison that will continue to reap benefits for years, although maintenance and running costs will need to be met.

Concrete water storage facilities on the other hand, may require more than a year to construct and link to local water systems. But the lifetime benefits of such systems could continue to be enjoyed by communities for much more than 10 years with only minimal maintenance



A sandstorm on the western shore of Lke Baringo, Kenya. Source: UN Photo/Ray Witlin.

ECONOMIC STRESS **ADAPTATION ACTIONS**

	ACTION SET	VULNERABILITIES	MOST VULNERABLE POPULATIONS	EFFECTIVENESS RATING	EVIDENCE RATING
1	DRIP IRRIGATION	• Agriculture • Water scarcity	Farmers	Very High	High
2	SOIL CONSERVATION	• Drought, Water Scarcity	Farmers	Very High	Medium
3	CROP ENGINEERING FOR DROUGHT RESISTANCE	• Agriculture • Water stress	Food-stressed populations, Subsistence farmers	Very High	High
4	DRAINAGE SYSTEMS	• Agriculture • Water stress	Farmers, Food-stressed populations	Very High	High
5	RAINWATER HARVESTING	• Water scarcity	Subsistence farmers, Food-stressed populations	Very High	High
6	WATER STORAGE FACILITIES	• Water scarcity	Subsistence farmers, Food-stressed populations	High	High
7	CANAL LINING	• Water scarcity	Farmers, Food-stressed populations	Medium	Medium
8	INTEGRATED PEST MANAGEMENT (IPM)	• Agriculture • Declines in projected yields • Length of growing season	Subsistence farmers, Food-stressed populations	High	High
9	GROUNDWATER MANAGEMENT	• Water scarcity	Rural populations	Very High	High
10	MANGROVE RESTORATION AND PROTECTION	• Forestry • Erosion, wetland loss	Food-stressed populations	Medium	High

Farmers · Subsistence farmers · Food-stressed populations · Rural populations · Indigenous populations · Rural population with poor energy access

	ACTION SET	VULNERABILITIES	MOST VULNERABLE POPULATIONS	EFFECTIVENESS RATING	EVIDENCE RATING
11	COMMUNITY FORESTRY	• Forestry • Deforestation		High	Medium
12	IMPROVED CROP MANAGEMENT	• Agriculture • Declines in projected yields • Length of growing season		High	Medium
13	DESALINATION	• Salination • Water scarcity		Medium	Very High
14	SALT-TOLERANT CROPS	• Agriculture • Salination		Medium	Very High
15	ENERGY-EFFICIENT BIOMASS STOVES	• Forestry • Deforestation • Cardiovascular, Respiratory diseases		High	High
16	WEATHER STATIONS	• Agriculture • Less predictable weather patterns		High	Medium
17	AQUACULTURE DIVERSIFICATION	• Fisheries		Medium	Medium
18	SHELLFISH BREEDING PROGRAMMES	• Fisheries		Medium	Medium
19	CORAL RESTORATION	• Damage to marine ecosystems • Tourism income • Fisheries		Medium	Medium

Very low | Low | Medium | High | Very high

DRIP IRRIGATION

1

To reduce pressure on fresh water resources by dripping water slowly to the roots of plants through a network of valves, pipes, tubing and emitters.

ASSESSMENT Very High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✓	Implementation Lapse	Typically within 1 year
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $100,000-$500,000

Impacts Addressed: **Agriculture, water scarcity**

Drip irrigation programmes rate highly on cost-effectiveness, co-benefits, and scalability.

With a cost-benefit ratio of zero, and implementation achievable within one year, the programme is cost-effective. The primary co-benefit of the programme is food security. In Senegal, the programme is also expected to increase rural inhabitants' quality of living and reduce energy consumption.

Implementation concerns for a programme in Mauritania include maintenance and a potential lack of water to feed the system. Coordination among multiple players and sectors was also noted as vital to the programme's success.

Peer-reviewed studies are currently available through the World Bank, UNFCCC and UNEP. Recognition of the programme by policy makers is already relatively high.

MDG BOOST ↑1, ↑7

Sources: ECA WORKING GROUP (2009), NAPA, Mauritania (2008), NAPA, Senegal (2008), NAPA, Cape Verde (2008)

Very low | Low | Medium | High | Very high

SOIL CONSERVATION

2

Reduce soil erosion by identifying and implementing soil conservation techniques, such as reduced tillage and mulching.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 1 year
SCALABILITY	Medium				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 3 years

Expense: $2 million +

Impacts Addressed: **Drought, water scarcity**

Soil conservation programmes rate highly on cost-effectiveness and co-benefits. In Maharashtra, India, the programme was found to have a cost-benefit ratio of -0.2. Because soil conservation techniques involve less use of fertilizer and tillers, it can yield large cost savings. Implementation can occur within three years. Co-benefits include increased food security and improved water quality from a reduced sediment load in coastal waters.

Barriers to implementation include a possible lack of participation and interest from farmers and a lack of consistent implementation, since all farms in each programme area must participate to ensure its success.

The programme is relevant in all areas subject to loss of forest cover and inappropriate land use. Presently, technical guidelines and training programmes are limited.

MDG BOOST ↑1, ↑7

Sources: ECA WORKING GROUP (2009), NAPA, Cambodia (2008)

Very low | Low | Medium | High | Very high

CROP ENGINEERING FOR DROUGHT RESISTANCE

3

Seed-engineering measures to make plants more drought-tolerant through conventional breeding.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✓	Implementation Lapse	Typically within 1 year
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $5 million – $100 million +

Impacts Addressed: **Agriculture, water scarcity**

Programmes that promote crop engineering for drought resistance rate highly on cost-effectiveness, co-benefits and scalability. The cost-benefit ratio of the programme is 0.1 for irrigated agriculture and 0.7 for rain-fed agriculture. Implementation is possible within one year, although the full effects are more long-term.

The programme targets all groups, regardless of income. The main co-benefit is improved food security. In Burundi, varieties of sweet potato, sorghum, and corn are being developed to resist drought and adapt to the weak soil fertility in affected regions.

The programme is relevant to countries with a high reliance on food production from natural resources. Specifications and guidelines are available through local NGOs working in connection with the programme. Training of farmers occurs as a component of NAPA implementation.

The World Bank, UNFCCC, and UNEP have conducted peer-reviewed studies on this programme, but it could benefit from further quantitative analysis and more case examples.

MDG BOOST ↑1, ↑7

Sources: NAPA, Bangladesh (2005), NAPA, Burundi (2007), NAPA, Cape Verde (2007), UNDP/NAPA, Bangladesh (2005), ECA Working Group (2009)

Very low | Low | Medium | High | Very high

DRAINAGE SYSTEMS

4

Development of irrigation and drainage systems for agricultural production.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 1 year
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 5-10 years

Expense: $74 (Irrigated) - $80 million (Rain-fed)

Impacts Addressed: **Agriculture, water scarcity**

Drainage system upgrade programmes rate highly on cost-effectiveness, co-benefits, and scalability. Although initial costs are high, the programme has a cost-benefit ratio of -2.1 (rain-fed) to -0.2 (irrigated). Implementation is possible within a year.

Co-benefits include improved food security and water conservation. In Sierra Leone, the long-term results of such a programme include increased income among farmers, poverty alleviation, and improved food storage, processing, and marketing.

The programme's feasibility is dependent on the availability of well-trained technicians and farmers; monitoring and supervision; and the availability of essential equipment and tools. Risks and barriers include the availability of funding, a potential increase in waterborne diseases, and poor production infrastructure.

The World Bank, UNFCCC, and UNEP have carried out peer-reviewed studies on this programme.

MDG BOOST ↑1, ↑7

Sources: Sources: NAPA, Sierra Leone (2008), ECA Working Group (2009), IFPRI (2009)

Very low | Low | Medium | High | Very high

RAIN WATER HARVESTING

5

Supplementing domestic/household water requirements by collecting, treating, and storing rainwater as part of a wider drinking water supply programme.

ASSESSMENT Very High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✗	Quick Start	✓
CO-BENEFITS	Very High				
FEASIBILITY	Medium	Short-Term	✓	Implementation Lapse	Typically within 1 year
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 4 years

Expense: $500,000 +

Impacts Addressed: **Agriculture, water scarcity**

Rainwater harvesting programmes rate highly on cost-effectiveness, co-benefits, and scalability. The programme has a cost-benefit ratio of 0.1. A simple and affordable rainwater harvesting system combined with an integrated approach to agricultural production significantly improves the lives of local farmers. A rainwater harvesting programme in Burundi reported such benefits as an increase in farmer income, and improved food security and health due to safe drinking water. Rainwater harvesting may also help control erosion and flooding during periods of excessive rainfall.

The programme is highly relevant in low-income countries. Various rainwater harvesting technologies have been adopted successfully in many parts of the world. Programme guidelines are available through local and global NGOs, and training programmes are included as part of the implementation process.

Implementation risks include labour shortage and a lack of farmer participation. In extreme dry seasons, rainwater harvesting may fail.

Peer-reviewed studies are available through UNFCCC and UNEP. The programme would profit from greater recognition at the policy-making level and additional quantitative assessment.

MDG BOOST ↑1, ↑4, ↑5, ↑6, ↑7

Sources: ECA Working Group (2009), NAPA, Burundi (2008), NAPA, Bhutan (2006)

Very low | Low | Medium | High | Very high

WATER STORAGE FACILITIES

6

Building water storage facilities for household and emergency use.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✓
CO-BENEFITS	High				
FEASIBILITY	High	Short-Term	✓	Implementation Lapse	Typically within 2 years
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 4 years

Expense: $200,000 +

Impacts Addressed: **Agriculture, water scarcity**

Water storage facility programmes rate highly across all assessment categories. Implementation is possible within two years. Co-benefits include improvements to agriculture and livestock, better human health, and improved water quality. Potential barriers to implementation include insufficient space to build a water storage structure, social resistance to water conservation techniques, and inadequate financing. Since the programme is dependent on rainwater, it will serve little purpose in areas of low rainfall. Projects have been successful on some islands in Tuvalu but have failed on others.

Training programmes are accessible through UNDP Global Environment Facility's Small Grants Programme International Waters Resource Guide. Peer-reviewed studies are available through UNFCCC and UNEP, but the programme would profit from greater recognition at the policy-making level and from additional quantitative assessment.

MDG BOOST ↑1, ↑4, ↑5, ↑6, ↑7

Sources: ECA Working Group (2009), NAPA, Samoa (2008) , NAPA, Tuvalu (2007), GEF (2010), GEF SGP Mauritius (2001), de Fraiture & Molden (2010)

Very low | Low | Medium | High | Very high

CANAL LINING

7

Lining canals to reduce water losses, since water losses in unlined irrigation canals can be high.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✓
CO-BENEFITS	Very High				
FEASIBILITY	High	Short-Term	✓	Implementation Lapse	Typically within 2-4 years
SCALABILITY	High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $5 million - $10 million

Impacts Addressed: **Agriculture, water scarcity**

Canal lining programmes rate highly on co-benefits, feasibility, and scalability.

The project leads to increased food crops, which leads to increased household income. It is also beneficial to women and children, as it reduces the time and effort needed to search for water. In Tanzania, a rehabilitated irrigation canal and water reservoir increased food crops and introduced a new cash crop. Sales of the surplus provided families with income, reducing poverty and unemployment.

Potential project hurdles include a lack of local engagement and participation, and a lack of external funding. Extreme weather conditions may also affect implementation.

Guidelines, technical assistance, and training are usually incorporated as part of the overall programme. Studies have been carried out as part of UNFCCC and UNDP projects, but the programme could benefit from further cost-benefit analysis and greater attention at the policy-making level.

MDG BOOST ↑1

Sources: ECA Working Group (2009), GEF (2004), NAPA, Cambodia (2006), de Fraiture & Molden (2010)

Very low | Low | Medium | High | Very high

INTEGRATED PEST MANAGEMENT (IPM)

8

Understanding how climate change affects pest outbreaks. Such a programme can result in more cost-effective pest management and is sensitive to the effects on vulnerable communities and women.

ASSESSMENT	High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✓
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 3-5 years
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $5 million +

Impacts Addressed: **Pests, drought**

Integrated pest management programmes rate highly on cost-effectiveness, co-benefits, and scalability. Analyses have shown a 0.1 cost-benefit ratio for the programme in India.

Protecting crops from pests results in higher agricultural output. Long-term results for a programme in Uganda include decreased pest outbreaks, ecological shifts of vector-borne and communicable diseases and pests, improved human health, and sustained socio-economic development.

The programme is especially relevant in low-income countries, where natural resources are a main income source. The programme provides training and tests various pest-management technologies as part of the implementation process. Feasibility challenges may include inadequate funding and insufficient community mobilization and response. Natural hazards, disasters, and civil conflicts will also impede the programme's success.

The programme can result in improved food security, better human and animal health, and a reduction in diseases such as malaria. Recognition of the programme is increasing at the policy-making level, but it would benefit from additional research.

MDG BOOST	↑1, ↑4, ↑5, ↑6, ↑7

Sources: ECA Working Group (2009), NAPA, Uganda (2008)

Very low | Low | Medium | High | Very high

GROUNDWATER MANAGEMENT

9

To improve the operation and use of underground water in order to protect its quality and optimize water supply.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Very High	Immediate	✗	Quick Start	✗
CO-BENEFITS	Very High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 3 years
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 3 years

Expense: $100,000 +

Impacts Addressed: **Agriculture, drought**

Groundwater management programmes rate highly on cost-effectiveness, co-benefits, and scalability. Analyses show a 0.7 cost-benefit ratio for the programme, with implementation possible within three years. In Mauritania, the co-benefits of a groundwater management improvement programme include more effective cultivation methods, higher agricultural productivity, and improved water quality.

Technical specifications and guidelines for the programme are available through local and global NGOs. Where implemented, local training is included as a component of NAPA projects.

Potential programme difficulties include conflicts between governing agencies over areas of jurisdiction, training of technicians, and obtaining equipment such as pumps. Water sources are also sensitive to pollution and harmful effects.

Peer-reviewed studies are available through UNFCCC programmes. The programme also complements water, sanitation, and energy sector reform.

MDG BOOST ↑1, ↑4, ↑5, ↑6, ↑7

Sources: ECA Working Group (2009), NAPA, Mauritania (2004) , NAPA, Niger (2006), de Fraiture & Molden (2010)

Very low | Low | Medium | High | Very high

MANGROVE RESTORATION AND PROTECTION

10

In addition to building up land and protecting shorelines, mangroves serve as a habitat for many fish and wildlife species. The main techniques for restoring and protecting mangroves include 'planting alone', hydrologic restoration, and excavation or fill.

ASSESSMENT	High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	Very High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 3 years
SCALABILITY	Very High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $250,000 - $1 million

Impacts Addressed: **Forestry, fisheries, and coastal protection**

Mangrove restoration and protection programmes rate highly on co-benefits and scalability. Rehabilitated mangrove forests provide coastal protection and can also improve economic production. In the Gulf of Thailand, fishing, environmental benefits, and flood proofing were cited as programme advantages.

The programme is highly relevant, since many low-income nations have lost high percentages of mangrove coverage. UNESCO and university programmes have developed many guidelines and specifications for techniques and training in mangrove restoration.

In the Gulf of Thailand, the restoration of 1,200 hectares of mangrove forest resulted in an estimated $100,000 economic gain to fisheries. Costs of restoration would be recovered in 2.4 - 8.4 years. The price of restoration per hectare can fluctuate significantly, depending on the method of restoration.

Programme success can vary widely depending on the environment and the techniques used. If the method of restoration is self-repairing, the project depends on the presence of waterborne seeds or seedlings from adjacent mangrove stands. Restoration also requires that normal tidal hydrology is not disrupted, further complicating implementation. Although there is already a high level of recognition for the programme at the policy-making level, the programme's success also depends on being able to raise public awareness of the value of mangroves.

MDG BOOST	↑1, ↑7

Sources: ECA Working Group (2009), NAPA, Mauritania (2004) NAPA, Cambodia (2007), Lewis III (2001)

Very low | Low | Medium | High | Very high

COMMUNITY FORESTRY

11

Tree and mangrove planting to prevent deforestation and promote agroforestry.

ASSESSMENT Very High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	High	Short-Term	✗	Implementation Lapse	Typically within 3 years
SCALABILITY	Very High				
EVIDENCE BASE	Very High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $5 million +

Impacts Addressed: **Deforestation**

Community forestry programmes rate highly in all areas. The cost-benefit ratio has been estimated to be between 0 and 1 for medium-income households. A community reforestation project in Tanzania aims to improve the livelihood of communities around Mount Kilimanjaro by providing alternative sources of income and food through replanting of trees and economic diversification.

Implementation risks include natural hazards and pests, insufficient funding, and civil conflicts. Forest plantations in arid and semi-arid zones may have little beneficial effects unless they are closely related to the needs and priorities of local inhabitants.

So it is important to integrate forestation into farming systems not only for the purpose of growing trees but also to improve the welfare of rural families.

Programme guidelines and training are available through UNCCD's globally launched Thematic Programme Networks (TPNs) and the "Mediterranean Forest Action Programme" (MED-FAP).

MDG BOOST ↑1, ↑7

Sources: UNCCD (2004), Dahal (2006), Waithaka et al. (2010)

Very low | Low | Medium | High | Very high

IMPROVED CROP MANAGEMENT

12

Changes to crop-planting dates to maximize yield under new climatic conditions; can be combined with changes to fertilizer and irrigation.

ASSESSMENT High

COST-EFFECTIVENESS	High
CO-BENEFITS	High
FEASIBILITY	High
SCALABILITY	Medium
EVIDENCE BASE	Medium

EFFECT		IMPLEMENTATION TIMEFRAME	
Immediate	✓	Quick Start	✓
Short-Term	✓	Implementation Lapse	Typically within 0.5 years
Long-Term	✗	Programme Cycle	Typically 2-3 years

Expense: Unknown

Impacts Addressed: **Drought and/or excess rainfall**

Programmes for improving crop management rate highly in cost-effectiveness, co-benefits and feasibility. Though there is no clear determination of the programme's cost-effectiveness, in theory, planting dates can be changed without any extra cost, and such a programme can be implemented within a harvesting season.

Co-benefits include increased food security. If the new planting schedule is adopted on the regional or national scale, the programme may also assist in preventing food shortages. Poor subsistence farmers are the main beneficiaries of this programme, although it is relevant to all groups.

A drought-adaptation programme in Uganda that shifts planting seasons to maximize on shortened seasonal rains will also result in better quality of food consumed, leading to improved nutrition. And an increase in crops to sell raises the household income.

Access to weather data and research in drought-resistant crop varieties is necessary for successful implementation. Shifting weather patterns and quality of weather data are also factors to consider. Programme results may vary depending on regions and crops.

The programme is highly relevant in low-income countries, especially since it is low-cost and effective. Although overall guidelines for the programme exist, it should be implemented case-by-case based on geographical location and crop type.

MDG BOOST ↑1, ↑7

Sources: IPCC (2007), Easterling et al. (2007)

Very low | Low | Medium | High | Very high

DESALINATION

13

Seawater desalination is a well-established process, mainly for drinking-water supply, in water scarce regions.

ASSESSMENT	High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	Very High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 1 year
SCALABILITY	Very High				
EVIDENCE BASE	Very High	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $0.50 - $1.50/m^3 water

Impacts Addressed: **Water scarcity**

Desalinisation programmes rate highly in co-benefits and scalability. The programme benefits populations in water scarce areas as well as the agricultural sector. If conducted well, the programme can also result in environmental benefits to coastal sites. In Mauritius, a project developed locally-constructed solar water desali¬nation units and installed them in the remote community. Livelihood benefits include improved health and a reduced burden on women, who previously had to walk 3-5 hours per day to find drinking water.

There are many well-documented case examples, and the programme is highly relevant for all arid and drought prone/water scarce zones. Renewable energy is increasingly being used as an energy source in community-based projects.

If scaled up, this technology could offer an option for non-fossil fuel dependent water access.

The cost-benefit ratio of the programme depends on the technique used. The costs are still too high for full use of such a programme in irrigated agriculture compared to other methods such as wastewater treatment. But used for drinking water it has proved its cost-effectiveness.

Project success is highly variable. The programme normally requires long-distance transport of desalinated water to its site of use. Fluctuating energy prices are also a risk factor, as energy costs for running a desalination plant account for up to half of the programme cost.

MDG BOOST	↑1, ↑3, ↑4, ↑5, ↑6, ↑7

Sources: Ghaffer (2006), UN (2009), GEF/UNDP (1997), Beltrán & Koo-Oshima (2004)

Very low | Low | Medium | High | Very high

SALT-TOLERANT CROPS

14

Growing salt-tolerant crops on land irrigated with water pumped from the ocean.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	Very High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 1 year
SCALABILITY	Very High				
EVIDENCE BASE	Very High	Long-Term	✓	Programme Cycle	Typically 3 years

Expense: $606 per acre, on average

Impacts Addressed: **Food insecurity, water scarcity**

Salt-tolerant crops programmes rate highly in co-benefits and scalability. The programme benefits populations in arid, drought-prone, coastal nations.

Salt-tolerant crops are currently used to feed livestock. It also has potential for use in producing bio-friendly fuels. Two requirements must be met if salt-tolerant crops are to be cost-effective. First, they must produce yields high enough to justify the expense of pumping irrigation water from the sea. Second, researchers must develop agronomic techniques for growing seawater-irrigated crops in a sustainable manner.

Halophytes (plants that naturally grow in saline environments) have been singled out as the most suitable salt-tolerant crop. Research has been conducted in salt-tolerant crops for agricultural purposes but is not yet able to match the same production scale as crops intended for livestock.

MDG BOOST ↑1, ↑7

Sources: UN (2009), Hendricks & Bushnell (2009), Glenn, Brown & O'Leary (1998), Beltrán & Koo-Oshima (2004), GEF/UNDP (1997)

Very low | Low | Medium | High | Very high

ENERGY EFFICIENT BIOMASS STOVES

15

Substituting traditional stoves (such as three-stone cooking fires) with more efficient chimney-fitted stoves to save energy and time.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	Medium				
FEASIBILITY	High	Short-Term	✗	Implementation Lapse	Typically within 2 years
SCALABILITY	High				
EVIDENCE BASE	High	Long-Term	✓	Programme Cycle	Typically 3 years

Expense: $200,000

Impacts Addressed: **Deforestation, respiratory illness**

Energy-efficient biomass stove programmes rate highly on cost-effectiveness, feasibility and scalability. Although no cost-benefit ratio has been determined, the programme can be fully implemented within two years.

Successful implementation depends on community awareness and willingness to adopt new cooking and heating methods. The programme is highly relevant in low-income countries, where significant populations have limited access to energy. Guidelines and training programmes are available through NAPA projects and the World Bank. The World Bank's "Fuel Source Module" also contains training resources for the programme.

The programme is projected to have a large impact on human health, biodiversity, and quality of life. Lower-income households benefit the most, since they rely more on traditional fuels than higher-income households do.

MDG BOOST ↑1, ↑4, ↑5, ↑7

Sources: NAPA, Burundi (2008), Barnes et al. (2004)

Very low | Low | Medium | High | Very high

WEATHER STATIONS

16

The application of meteorology to agriculture is essential, since every facet of agricultural activity depends on the weather.

ASSESSMENT High

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	High	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Very High	Short-Term	✗	Implementation Lapse	Typically within 1 year
SCALABILITY	Very High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 3 years

Expense: $500,000 +

Impacts Addressed: **Food insecurity, agriculture**

Weather station programmes rate well on all assessment levels. They are cost-effective in agriculture when applied correctly and use automatic solutions.

If automatic weather stations are used, costs are consistent. The programme can be implemented within a short timeframe, but its full effects are more long-term, since an automated system requires weather data collected over time. In Bhutan, where even slight changes in monsoon patterns can result in significant changes in agricultural productivity, co-benefits include higher agricultural productivity, better food security, improved living standards, and sustainable use of natural resources.

Risks are low if the technical capability is on hand to set up the stations. Dissemination and distribution of weather data is key. If automated, standard, weather stations are used, then sensitivity to external factors is very low. However, there are key gaps in the understanding of and ability to predict the global climate system. The deteriorating state of the climate observing system in Africa, for example, presents an impediment to understanding climate effectively.

Technical guidelines and training programmes are available through the World Meteorological Organization.

MDG BOOST ↑1, ↑7

Sources: NAPA, Bhutan (2008), Stefanski et al. (2007), Plummer et al. (2003), WMO

Very low | Low | Medium | High | Very high

AQUACULTURE DIVERSIFICATION

17

Establishment of marine protected areas, restoration efforts targeting the health of corals and fish, and stock enhancement to maintain a vigorous coral reef.

ASSESSMENT Medium

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 3 years
SCALABILITY	Medium				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 4 years

Expense: $500,000 - $1 million

Impacts Addressed: **Loss of marine fish stocks**

Acquaculture diversification programmes have substantial co-benefits: They improve food security, future biodiversity, and fish stocks. In Vanuatu, a community-based marine management programme aims to use national fisheries to support economic growth, create jobs, and enable sustainable development.

The programme's cost-effectiveness is unclear. Implementation may be hindered by a lack of funding and conflicting policy interests (such as fear of decreasing tourism due to restricted area access). The programme requires an awareness and understanding of local communities.

The programme is highly relevant to low-income countries due to their large dependence on natural resources. Unfortunately, few guidelines and training programmes are available. The effects of global warming on fisheries are currently not well understood but are beginning to receive attention.

MDG BOOST ↑1, ↑7

Sources: NAPA, Vanatu (2007), NAPA, The Gambia (2007), FAO (2010)

Very low | Low | Medium | High | Very high

SHELLFISH BREEDING

18

Shifting vulnerable populations of shellfish to suitable sites and using marine or onshore breeding programmes will result in the natural breeding of shellfish and regeneration of the shellfish population.

ASSESSMENT Medium

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	Medium	Short-Term	✗	Implementation Lapse	Typically within 3 years
SCALABILITY	High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $250,000 +

Impacts Addressed: **Loss of marine fish stocks, sea temperature rise**

Shellfish breeding programmes have significant co-benefits and are easy to scale-up. In Tuvalu, coral reef resources are the most easily accessible and main protein source of food for low-income and subsistence families on all islands of Tuvalu. The programme will enhance coral reef fishery biodiversity and improve socio-economic conditions in the related communities.

Guidelines from various local NGOs exist. Training programmes are primarily locally based in connection with a larger project.

The programme is estimated to be relatively high-cost, but no comprehensive evaluation has been made yet. Cost-effectiveness will most likely determine what type of breeding practice is adopted.

Community cooperation and funding availability are vital components of the programme. The programme requires an awareness and understanding of the local community.

MDG BOOST ↑1, ↑7

Sources: NAPA, Tuvalu (2007), FAO (2010)

Very low | Low | Medium | High | Very high

CORAL RESTORATION

19

Monitor, restore, and enhance coral reefs to prevent coral bleaching; establish marine protected areas.

ASSESSMENT Medium

		EFFECT		IMPLEMENTATION TIMEFRAME	
COST-EFFECTIVENESS	Medium	Immediate	✗	Quick Start	✗
CO-BENEFITS	High				
FEASIBILITY	High	Short-Term	✗	Implementation Lapse	Typically within 3 years
SCALABILITY	High				
EVIDENCE BASE	Medium	Long-Term	✓	Programme Cycle	Typically 5 years

Expense: $500,000 +

Impacts Addressed: **Loss of marine ecosystems, food insecurity**

Coral reef restoration programmes have significant co-benefits and rate highly for feasibility and scalability. The programme increases the breeding of certain fish species, positively impacting biodiversity and food security. In Kiribati, coral reefs are critical to subsistence and artisanal fisheries that are the main life-supporting activities of local communities.

Implementation risks include a lack of funding and awareness and a lack of interest in implementing programmes at the local level. Increased tourism, which puts additional pressure on coral reef ecosystems, also poses a major risk to established programmes.

Programme guidelines are locally and globally available. Local NGOs are involved in training for project implementation. The programme could benefit from additional peer-reviewed study and assessment.

MDG BOOST ↑1, ↑7

Sources: NAPA, Kiribati (2007) , UNFCCC (2009), FAO (2010)

Very low | Low | Medium | High | Very high

Redeveloping community in the Maldives. Source: IFRC.