IMPACT ASSESSMENT OF ECO-VILLAGE DEVELOPMENT PROJECTS

Project Report:

Next Generation
Low Carbon,
Climate Resilient
Eco-Village Development
In South Asia

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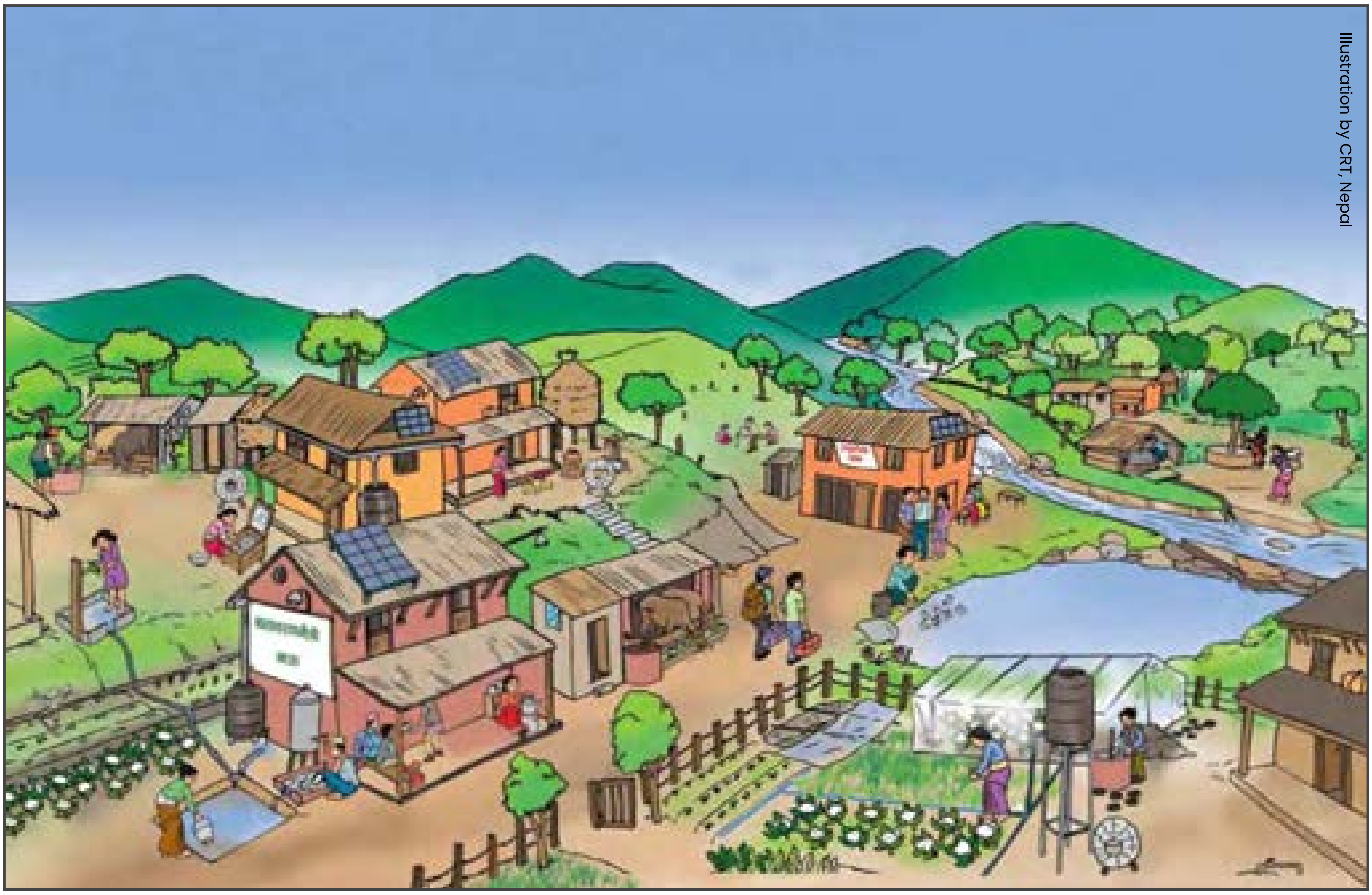

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Next Generation Low Carbon, Climate Resilient Eco-Village Development In South Asia

Impact Assessment of Eco-Village Development Projects

Project Report: Next Generation Low Carbon, Climate Resilient Eco-Village Development In South Asia

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This publication was developed as part of the project "Next generation low carbon, climate resilient Eco-Village Development in South Asia". The coordination partner is DIB, Denmark and the project is supported by the Climate and Environment Fund of Civil Society in Development (CISU), Denmark. The partners are those listed above after each author.

Back page:
Pictures from eco-villages. Photos by INFORSE, INSEDA, IDEA, CRT/N, and Grameen Shakti.

Design: Roopa Rampura, Pune, India.

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http://www.inforse.org/asia/EVD.htm and
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December 2023, 71 pages.

Contents

SECTION - I: Climate Mitigation Effects of Eco-Village Development Projects

- Introduction.......... 8
- Summary.......... 9
- Margul Village, Ratlam District, Madhya Pradesh, India.......... 11
- Kottawatte Village, Matara District, Southern Sri Lanka.......... 19
- Majherchar Village, Pirajpur District, Southern Bangladesh.......... 24
- Bhalumare Village, Marin Rural Municipality, Southeast Nepal.......... 30
- References.......... 34
- Annex 1: Energy contents and emissions of fuels for cooking and lighting.......... 35

SECTION - II: Adaptation Impacts of Eco-Village Development Projects

- Introduction.......... 37
- Recommendations.......... 40
- Country Inputs:
  - Nepal.......... 42
  - India.......... 45
  - Sri Lanka.......... 55
  - Bangladesh.......... 65

CONCLUSION.......... 70

BIBLIOGRAPHY.......... 71

Photos of participatory rural assessment as part of the eco-village development in Bangladesh, India, Nepal, and Sri Lanka. Photos by Grameen Shakti, CRT/N, INSEDA, IDEA

SECTION - I

Climate Mitigation Effects Of Eco-village Development Projects

Introduction

Implementation of Eco-Village Development (EVD) projects in South Asia contributes to low-carbon developments that improves lives and livelihoods in villages in South Asia. In addition to the improvements for the villagers, it also reduces emissions of CO_2 and other greenhouse gases.

This report contains an assessment of the climate effects of four demonstration eco-villages in South Asia, one in each of the countries Bangladesh, India, Nepal, and Sri Lanka. The villages are all rural, but are in different climatic zones and with different socio-economic situations. Some are electrified with connections to national grids, others are not. The assessment covers change in energy use and change in greenhouse gas emissions. There are also other benefits, including savings in purchase of fuels, less time needed to collect firewood, shorter cooking time, and reduced air pollution, including reduction in harmful indoor air pollution.

Solutions having climate mitigation effects with reduced emissions, include:

- Improved cookstoves
- Biogas
- Solar light
- Tree planting

Other solutions also contribute to reduce climate emissions, including solar drying, compost, organic and other forms of environmental agriculture, but their climate mitigation effects are not quantified in this report.

There are substantial differences in the selected EVD solutions in the four selected villages. Thus, the descriptions of the mitigation effects are separate for each village. There are some similarities, however, where the most striking is probably that before the EVD implementation, the majority of the villagers in all villages used traditional cooking methods (traditional cookstoves, three stones, etc) with wood and other biomass for cooking of food, fodder, etc.

Summary

The implementation of Eco-Village Development (EVD) solutions in the four demonstration villages show that considerable emission reductions are possible with the change from traditional to improved cooking, including cooking for animals and small-scale village industries. Also, solar electricity and tree planting contributes to net reductions of greenhouse emissions.

In the four villages, the majority of the families cooked primarily with traditional cookstoves (TCS) and fires, as three-stone fires. Of this majority of people, 59 – 83% changed to improved cookstoves with the project. The required contributions from the villagers to get an improved cookstove ranged from just assisting in installations, to providing materials and in one case, also a financial contribution. In two of the villages were also installed larger, institutional/village industry stoves, used for milk processing (curd production), alcohol, and cooking hard fodder for the animals. Only a smaller part of the villagers has institutional stoves, but they use considerably more wood than other families and with the EVD solutions, they can also achieve high reductions, saving some 66% of their fuel wood. The average reductions in emissions per family varied between 26% and 43% in the four villages, including the villagers that did not change.
The table below gives an overview of implementation rate and requirements.

Village	Margul, Central India	Majherchar, Southern Bangladesh	Kottawatte, Southern Sri Lanka	Bhalumare, Southeast Nepal
Families	106	218	146	88
Families with traditional stoves as main cooking appliance at start of project	106 (26 also used LPG regularly)	180	130	72
Number of improved stoves introduced in project as primary cookstoves, as number and share of families with traditional cookstoves (TCS)	82 (80% of families with TCS)	150 (83% of families with TCS)	77 (59% of families with TCS)	50 (69% of families with TCS)
Required contribution from villagers to get an improved cookstove (ICS)	Local materials, assist in construction	Local materials, install stove after instruction	Local materials, assist in construction, payment of 300 Sri Lankan Rp. (1 USD)	Provide materials with a value of 500 Nepalese Rs (4 USD), assist in construction
Reasons for not changing to improved cookstove	Some families were not available (temporary migrated), others were rebuilding homes	Project only provided 150 stoves	Conservative, not concerned with wood demand or air pollution, happy with traditional stoves	Some families want to change between cooking indoors and outdoors. This is not facilitated by a fixed, indoor stove
Wood supply	Scarce	Sustainable	Sustainable	Sustainable

In addition to improved cookstoves, the project also installed and renovated 1-4 biogas plants in each village, mainly replacing traditional cookstoves as main cooking appliances. In Marin Municipality, Nepal the project also introduced 22 induction cookers with grid electricity. The greenhouse emission reductions with biogas is included in the table below with an overview of emissions.

With EVD, in three villages the partners installed solar electric equipment (solar lanterns, solar street lights, solar home systems, water pumping) which the villagers got for free, but contributed work and local materials. In one village the solar electricity replaced kerosene and in two villages grid power. The emissions from producing the solar PV cells and batteries introduced with the project was around 1% of the reduced emissions with the replacements of kerosene and dry cells. When replacing grid electricity with solar PV, the emissions with the productions of the solar PV cells and batteries were less than 4% of the emissions from the electricity in Bangladesh. In Nepal, where grid electricity is from hydro-power, replacing grid electricity with solar electricity does not reduce greenhouse emissions.

Tree planting was another EVD solution, where the project team could quantify net emission reductions.

Of the three types of solutions with emission reductions quantified in the project, the reduction of cooking emission was by far the most important. This is the case for all four villages, also in the three villages, where there is no current scarcity of wood and therefore no deforestation. We included non-CO_2 climate effects of emissions from wood burning, including emissions of black carbon. We made the conservative assumption that there are the same black carbon emissions from all stoves per kg of wood burned, even though the particle emissions from improved cookstoves typically are smaller per kg of wood for improved cookstoves than for traditional cookstoves. We had no black carbon emission measurements from the stoves used in the project's model villages. In the below table is an overview of emission reductions in the four villages:

Total emission reduction, tons CO_2e/year	**Margul, Central India**	**Majherchar, Southern Bangladesh**	**Kottawatte, Southern Sri Lanka**	**Marin Rural Municipality, Nepal**
Household cooking	159	64	41	118
Cooking of milk for sale, alcohol, fodder	NA	NA	7	69
Solar electricity	9	2.7	NA	0
Tree planting	22	1.3	NA	10
Total emissions	190	68	50	197

Margul Village

Ratlam District, Madhya Pradesh, India

In this village in a semi-arid area lives 629 people in 106 families of which 105 families are below the Indian poverty line. 102 of the families are farming while 98 families are (also) dependent on income from work.

The EVD project has made a radical change to how the villagers in Margul cook and get light.

Margul Village, India.
Photo by INSEDA

Jwala improved cookstove installed and in use.
Photo by INSEDA

New tree grown to 6 ft (2m).
Photo by INSEDA

The implementation of the local solutions was carried out in the following way:
For the improved cookstoves, after introduction all the villagers were offered the stoves free of charge on the condition that they did some manual work needed to construct the stove together with a mason. The stove is a brick and cement stove with a chimney. The model was chosen as it fits the traditional cooking habits while removing the smoke from the kitchen, which is important for improving indoor air quality. Of the 106 households counted at the start of the project, a group was moving to a new house and found it useless to build a fixed stove into the old house. Another, equal, group had migrated, probably temporarily, which is common because of the hardship during the dry season. All the families in stable situations accepted the offer of a free stove in exchange for some smaller work. In this way 82 stoves were constructed until the end of the project, leaving 28 families, including those that temporarily migrated, with traditional chulhas.

The solar lanterns were given for free, one for each family. A few are not given to the families that have not returned after temporary migration, but are stored in the village and shall be given to the temporarily migrated families once they return. We assume that only two families will remain with kerosene as main energy source for light.

The solar street lights were given to the village.

The trees were given to the villagers as saplings while the villagers were planting them.

The tables below show the main changes for cooking and lighting respectively.

Change in cooking	Before (families)	After (families)
Traditional chulhas	106	28
Improved cookstoves	0	82
Biogas	0	3
LPG in regular use	27	0
LPG, rarely used	26	53

The number adds up to more than the number of families, as some families have more than one form of cookstove.

The improved cookstoves (ICS) were primarily the Jwala stove (81 stoves) while one family got the more advanced Heera stove. Both stoves have an efficiency around 35%.

The changes in light are shown in the table below.

Change in light	Before (families)	After (families)
Grid electricity	3	3
Solar lanterns	0	102
Kerosene lamps	104	2
Dry battery lamps/torches	101	90
Street lights (solar)	0 lamps	16 lamps

Changes in cooking energy use and climate change emissions

The change in the cooking reduces the consumption of wood, cow-dung, and LPG. The following changes have been found by detailed survey of 10 families without biogas and three families with biogas:

Families without biogas	Use before, per family	Use with ICS, per family	Change per family
Wood, average	5.9 kg/day	3.9 kg/day	2 kg/day
Dung cake, average	2.8 pieces/day	1.5 pieces/day	1.3 pieces/day
Families with biogas	Without biogas, traditional chulha	With biogas + ICS	
Wood, average	6.3 kg/day	2.3 kg/day	4 kg/day
Dung cake, average	2.7 pieces/day	1.7 pieces/day	1 piece/day

For the families using LPG regularly before the project, the estimated change in LPG use is:

- Before EVD: 1 bottle LPG/month with 13 kg LPG, total 156 kg LPG/year
- After EVD: 1 bottle LPG/year with 13 kg LPG, total 13 kg LPG.

For the families that rarely use LPG both before and with EVD, we also expect the LPG consumption to be 1 bottle/year.

For calculation of mitigation effects, we use the energy contents and emissions from wood with 50% unsustainable use given in Annex 1. For dung cake, we use the energy content for solar dried dung cake with 20% humidity, 3.5 kWh/kg.[1] The team have evaluated that the dung cakes in the village are typically 300 g each. [2]

This gives the following reductions in biomass and LPG energy use from change to improved cookstoves (ICS) and more biogas, per family:

Families without biogas (average of families with and without LPG)	Use with traditional chulha	Use with ICS	Change	
Wood, average	8614	5694	2920	kWh/year
Dung cake, average	2862	1533	1329	kWh/year
Families with biogas	**Use before traditional chulha**	**Use with biogas + ICS**	**Change**	
Wood, average	9198	3358	5840	kWh/year
Dung cake, average	2218	1737	480	kWh/year
	Before LPG use	**After LPG use**	**Change**	
LPG, families with regular LPG use before (27 families)	1997	166	1831	kWh/year

We assume that the families with rarely LPG use that did not change, have an LPG use around one bottle of LPG per year.

For the entire village, the changes in cooking energy use are then:

Village cooking energy, MWh/year	Use before	Use after	Reduction
Wood, families without biogas	1216	868	348
Wood, families with biogas	34	15	19
Families with biogas	0	6	-6
LPG, total	58	9	49
Total cooking energy	1309	898	411
Reduction			**31%**

For emissions, we will use the following values, from Annex 1, recalculated from kg to kWh, 50% unsustainable wood, dung cake with 20% humidity.

Emissions, stoves/kWh fuel	CO_2, kg	non-CO_2, kg CO_2e	Total, kg CO_2e	Unsustainable share	
Wood, stove tier 0	0.17	0.21	0.38	50%	20% humidity
Dung-cake, tier 0	0.17	0.42	0.59	50%	Dung-cake, 20% humidity
Wood, tier 2	0.17	0.21	0.38	50%	20% humidity
Dung-cake, tier 2	0.17	0.42	0.59	50%	Dung-cake, 20% humidity
LPG	0.23	0.00	0.23	100%	

For biogas plants, we will use emissions per plant per year of 200 kg CO_2e, mainly as methane emissions of 40 ltr/day (equal to 65 ltr/day of biogas with 60 % methane).

Combining these, we get the following changes in cooking emissions for the village:

Village-cooking emissions	Before	After	Change	
Families without biogas, emissions from wood	510	370	140	Tons CO_2e/year
Families with biogas, all	14	7	7	Tons CO_2e/year
Families with LPG, all	14	2	12	Tons CO_2e/year
Total, cooking	538	380	159	Tons CO_2e/year
Reduction	**29%**			

Change in energy use and emissions for light

We will include the change in emissions from the replacement of kerosene lamps and partly of dry batteries for torches with solar lanterns and solar street lamps. There are no direct emissions in solar equipment or dry battery use, but there are emissions related to the production of the batteries and equipment. We have estimated these for this analysis.

We do not include the 3 families with grid electricity in this analysis, assuming no change for these families. One of the three families replaced a kerosene lamp with a solar lantern, but we do not have information on the effect of this.

We estimate that:

- Production of a solar lantern with 6 W PV panel and 27 Wh battery produces 3.7 kg CO_2e. With 10-year lifetime, this is equal to 0.37 kg CO_2e/year. [3]

- Production of a solar street light with 75 W PV and 360 Wh battery produces 48 kg CO_2e. With 10-year lifetime is equal to 4.8 kg CO_2e/year. [4]

- Production of a dry cell (D-type) we estimate to produce 0.39 kg CO_2e [5]

- The families that migrated temporarily will get solar lanterns when they return, except two.

The EVD activities have made the following change in the families without grid electricity, including families that do not use dry cells anymore:

Effects of EVD per family	Before EVD	With solar lanterns	
Kerosene use/family with kerosene lamps	2.4	0	ltr/month
Battery (dry cell) use	9.2	5	pieces/month

This calculation of changes is based on a survey of 10 families in the village.

With emissions of 2.36 kg CO_2/ltr kerosene, thus gives the following change in greenhouse gas emissions for a family without grid electricity:

Family without grid-electricity	Before EVD	With EVD	Change	
Kerosene	68	0	68	kg CO_2e
Dry cells	43	23	20	kg CO_2e
Solar lantern	0	0.2	-0.2	kg CO_2e
Total	**111**	**24**	**87**	**kg CO_2e**

For the entire village (except for the three households with grid electricity), the total emissions from lighting are:

Village-emissions, lighting, tons CO_2e/year including production of PV and batteries*	**Before EVD**	**With EVD**	**Change**	
Kerosene	7.1	0.1	6.9	tons CO_2e/year
Dry cells	4.4	2.4	2.0	tons CO_2e/year
Solar lanterns	0	0.04	-0.04	tons CO_2e/year
Solar street lights	0	0.06	-0.1	tons CO_2e/year
Total	**11.5**	**2.6**	**8.9**	**tons CO_2e/year**

* For the three families with grid there is no change in emissions; they are not included in this sum.

Climate mitigation with tree planting

The EVD project also includes tree planting, which becomes a CO_2 sink as the trees grow and capture CO_2 from the atmosphere. We estimate that each tree during its lifetime consumes 25 kg CO_2/year.

Unfortunately, not all saplings survive, so we reduce the sapling planted accordingly. The trees are many different species, including mango, jackfruit, lemon, bamboo, guava and at least 7 other species. At the time of assessment (Spring 2023) they have grown to between 2 and 6 feet (0.6–1.5 m) in height. The resulting CO_2 capture are from the 1278 saplings planted:

Saplings planted with EVD	1278	Pieces
Survival rate	70%	Estimated after 20 years [6]
Co_2 collected/tree, average	25	kg CO_2/year over lifetime [7]
Total / year	**22**	**tons/year over lifetime**

Total emission changes in areas covered

As described above, the main changes in emissions are in cooking, light, and tree growing. The sum of emissions and changes for these three areas of emissions are

Greenhouse emissions in areas covered by EVD in Margul Village	**Before EVD**	**With EVD**	**Change**	
Cooking, 106 families	538	380	159	tons CO_2e/year
Light, 104 families without grid power	12	2.6	9	tons CO_2e/year
Tree planting		-22	22	tons CO_2e/year
Total	550	360	190	tons CO_2e/year
Total/capita	0.87	0.57	0.30	tons CO_2e/year
Reduction	**35%**			

Other emissions

There are other emissions from the village than those included in the above analysis. These are primarily:

Emissions / activities	Type	EVD activity	Reason for non-inclusion in analysis
Soil emissions, CO_2	Emissions from reduction of carbon in soil	Increased biogas fertiliser, vermicompost to replace chemical fertiliser increases soil carbon	Relatively small with only 3 biogas plants & no information on vermi-compost output, difficult to estimate
Agricultural emissions, non-CO_2	Emissions of methane and N_2O from soil and animals	None	Difficult to estimate, extensive, non-standard agriculture
Drying	Drying of crops	Solar dryer	Solar dryer in this village replaces open air drying with no energy use, only one solar dryer installed
Use of electric power	Emissions from power to 3 households, irrigation, others	None	No information available on grid electricity use
Transport	Emissions from cars, trucks, scooters etc.	None	No EVD action in this field, no cars in the village

The emissions not included are primarily for agricultural production and from outside actors (transport). Thus, the emissions included in the analysis are covering most of the household related emissions excluding food production, and are generally not including work-related emissions.

Conclusion

The Eco-Village Development (EVD) has given a reduction of emissions of some 190 tons CO_2e/year, equal to 0.30 tons CO_2e/capita or 35% of the emissions covered by the analysis. This was mainly realised with the introduction of 82 improved cookstoves and 3 biogas plants, covering 80% of the families. The families that did not take an improved cookstove, were not able to have it because of (temporary) migration or change of house. The calculations of reductions are based on a number of assumptions, including the climate effects of black carbon and the lack of sustainability of the biofuel (assumed 50% sustainability). If we assume that the lower biofuel consumption makes the remaining biofuel use more sustainable, the relative reductions are larger. Another assumption is that the temporarily migrated villagers will return and will continue to use traditional chulhas. If they do not return, the relative reductions will also be larger.

The solar light reduces emission of kerosene and dry batteries, while the emissions related to produce the solar equipment is two orders of magnitudes lower than the emissions of the energies they replace, in a 10-year perspective, equal to expected lifetime.

This shows that EVD solutions are able to realise substantial greenhouse gas emission reductions in a poor village with some deforestation, such as the Margul Village in Madhya Pradesh in India. The reductions are mainly in the household emissions, but also include tree planting with negative emissions (CO_2 uptake).

The EVD solution also improves living conditions in the village. It is one step ahead for the villagers and it reduces poverty. The solutions do not, however, fundamentally change the harsh living conditions in the area. The development over the coming years will show if the EVD with reduced cooking energy needs, move from kerosene to solar powered electric lamps and tree orchards as well as several other solutions are starting an upward development spiral bringing the villagers out of poverty and above the national poverty line.

Kottawatte Village

Matara District, Southern Sri Lanka

The village with 560 inhabitants in 146 families is in the coastal district Matara in Southern Sri Lanka.

The EVD project has introduced major changes to the cooking facilities in the households and in three village industries. The project has also introduced a number of other improvements, in particular for kitchen gardening and improvements in paddy field cultivation, cash crop cultivation of which we have not quantified their effects on greenhouse emissions. In Kottawatte village, there are no EVD activities regarding light and other electricity use as the villagers are all connected to the electricity grid, which they are satisfied with. Thus, this analysis focuses on EVD solutions in efficient cooking in households and in village industries.

The Kottawatte Village in Southern Sri Lanka.

Industrial improved stove installed in the village. Photo by IDEA

Household inbuilt Improved Cookstove (Anagi) with chimney hood installed in the village. Photo by IDEA

The implementation of the stoves started with awareness activities with a community meeting, where the EVD programme was introduced and the improved (Anagi) cookstoves were introduced. Immediately after the meeting follows a cooking session, where a standard meal is prepared in parallel with a traditional stove and with an Anagi stove. The fuel use and cooking time is recorded so the villagers can see the difference. After this, Anagi stoves are installed in 4 houses, where it is built into the kitchen with a mixture of sand, wood ash, clay and cow dung. The materials are provided by the villagers. The construction is made by a technician from IDEA and a local mason that is trained, so he can replicate it in other houses. In the following dissemination, the villagers' contributions are the materials, work to bring and mix materials and 300 Rupees (US$ 1) per stove. In this way, 77 Anagi stoves were constructed or repaired while one family got a biogas plant. 53 families remained with traditional cookstoves while three families with LPG + traditional cookstoves also did not go for improved cookstoves. The reason for the 53 families to stay with traditional cookstoves were that:

- Some are so used to using firewood conventionally and they do not see it as a major concern, they see it as a less of a priority with other issues they have - they are used to the smoke, think they have enough firewood.
- Some find that the traditional stoves/three stones are more flexible for using bigger pots, needed occasionally for boiling larger pots of water.
- Some are not willing/lazy to commit themselves to install a stove, given the nature, the attitude, and the perspectives of the family.
- Some people are mainly cooking outside, where the clay stove will be wet and will not last, even though the Anagi stove is made from burnt clay.
- Some decided not to install an improved cookstove immediately, but did intend to install it later.

In the village, three institutional stoves were installed for production of curd from milk, which is sold in the local market. One stove was broken and was rebuilt while improved cookstoves were constructed to replace the two traditional stoves. The users provided some of the material and assisted with mixing of materials and the construction.

Changes in cooking energy use and climate change emissions

With the EVD project, the majority of families and all three village industries have moved from traditional cookstoves to improved cookstoves. The improved cookstoves are Anagi stoves for households and stoves designed by IDEA and a local partner for the village industries. The changes are shown in this table:

	Households, Before EVD	Households, EVD
Village total	146	146
Households with trad. cookstove only	130	53
Households with trad. cookstove + LPG	3	3
Households with Anagi stove	3	80
Household with biogas	0	1
Other combinations	10	9
Traditional stoves for industries	3	0
Improved Industrial stoves	0	3

The stoves in village industries are located in three of the households in the village.

IDEA has estimated the following consumption of fuel for the different cooking options:

- Families with only traditional cookstove: 5.15 kg wood/day with an energy content of 7,500 kWh/year
- Families with traditional cookstove + LPG: 3.3 kg wood + 0.15 kg LPG per day with an energy content of 5,500 kWh/year
- For the families with Anagi stove: 2.8 kg wood/day with an energy content of 4,100 kWh/year

For the family with biogas, we estimate the biogas consumption to be 4,400 kWh/year equal to the energy content of 2 m^3 biogas/day produced by the biogas plant.

IDEA has found the following wood consumption for the three institutional stoves that are mainly used to process milk to curd:

Institutional stoves	Traditional	Improved	
Stove 1	4	1.5	kg/day
Stove 2	11	4.3	kg/day
Stove 3	12	4.9	kg/day
Total	**27**	**10.7**	**kg/day**

For the energy content, we use the values in Annex 1 (wood: 4 kWh/kg, LPG 12.9 kWh/kg)

With these assumptions, the cooking energy consumption in the village has changed as follows with EVD:

Energy use	Before EVD	With EVD	
Households with trad. cookstove only	970	395	MWh/year
Households with trad. cookstove + LPG	17	17	MWh/year
Households with with improved cookstoves	12	325	MWh/year
Household with biogas	0	4.8	MWh/year
Other combinations	NA	NA	MWh/year
Village industry stoves	39	15	MWh/year
Total cooking energy use	1036	762	MWh/year
Reduction		**27%**	

We have excluded households with "other combinations" of cookstoves as we have too little information about the energy use of these households.

The results show that while the savings in each household that moves from traditional to improved cookstove (Anagi) is around 46%, the savings for the entire village is around 27%. The lower relative energy savings for the entire village is because 53 (41%) out of the 130 villagers with only traditional cookstoves at the start of the project, remained with traditional cookstoves only and because 3 families had already changed to improved cookstoves before the project started. Also 17 families remained with traditional cookstoves + LPG.

The emissions causing climate change and air pollution are reduced similarly to the reduction of energy use. The area is not a deforestation area, so generally the wood that is used for cooking is replaced with new growth. Anyhow, if trees are not cut because of lower use of trees for firewood, there will be more CO_2 captured by the trees. We assume that this effect is equal to 15% of the CO_2 released with combustion. This is equal to emissions of 0.2 kg CO_2/kg firewood. In addition, the other climate change emissions (mainly black carbon) contribute to emissions of 0.47 kg CO_2e/kg wood, as described in Annex 1. The emissions of LPG is set to 2.99 kg CO_2/kg LPG as described in Annex 1.

For household biogas plants we expect a methane loss of 40 ltr/day (64 ltr biogas with 60% methane), equal to 200 kg CO_2e/year, as in Annex 1.

This gives the following emissions from cooking and village industries in the village:

Emissions in tons CO_2e/year	**Before EVD**	**With EVD**
Households with traditional cookstove only	164	67
Households with traditional cookstove + LPG	2.9	2.9
Households with with improved cookstoves	2.1	55
Household with biogas	0	0.2
Other combinations	NA	NA
Traditional stoves for industries	7	0
Improved Industrial stoves	0	3
Total, cooking emissions	176	127
Reduction		**27%**

The emissions do not include emissions from the 10 families with other combinations that we have not been able to quantify.

The emission reductions are very similar to the energy use reductions. We assume the same emissions per kg wood from the improved cookstoves than for the traditional cookstoves.

Tree Planting

86 Papaya trees were planted as a cash crop cultivation activity. Similarly to other trees, we estimate that they in average collect 25 kg CO_2e/year each during their lifetime, in total 2.2 tons/year for the 86 papaya trees. This gives a total reduction of climate emissions of:

Greenhouse emissions in areas covered by EVD in Margul Village	**Before EVD**	**With EVD**	**Change**	
Cooking - 146 families 3 village industries	176	127	48	tons CO_2e/year
Tree planting	0	-2	2	tons CO_2e/year
Total	176	125	50	tons CO_2e/year
Reduction	**29%**			

Other emissions

We have not been able to quantify emission changes from other EVD solutions in the village and in general in the village. Some of those we have been able to quantify are as follows:

Emissions / activities	Type	EVD activity	Reason for non-inclusion in analysis
Soil emissions, CO_2	Emissions from reduction of carbon in soil	Improved paddy farming Increased natural fertiliser increases soil carbon	We do not have figures for the change of soil carbon of this type of improved paddy-farming. Relatively small changes with improved kitchen gardening etc.
Agricultural emissions, non-CO_2	Emissions of methane and N_2O from paddy-farming and other farming	Improved paddy-farming with less chemical fertiliser	We do not have figures for the change of soil carbon of this type of improved paddy-farming.
Use of electric power	All houses have electricity	None	No EVD action
Transport	Emissions from cars, trucks, scooters etc.	None	No EVD action, no vehicles in village, all transport from outside actors

The introduction of improved cookstoves have started to spread to other villages in the Matar District and by June 2023 at least 100 improved cookstoves have been installed in other villages, following information and replication activities from the project. Most of these are installed in a village, where the Sri Lanka Central Bank is promoting environmental solutions to develop that village into a green village.

Conclusions

In the Sri Lankan EVD model village, 77 out of 146 households changed from traditional to improved (Anagi) cookstoves and one changed to biogas. Of the families relying on traditional cookstoves before the project, 59% changed to Anagi stoves and one family got biogas. In addition, all three village industries got improved cookstoves. This has resulted in an estimated reduction of 48 tons CO_2e/year, equal to a 27% reduction of cooking greenhouse emissions of the entire village, including those that have not changed.

53 families remained with traditional cookstoves for their cooking. They were not able or willing to pay the LKR 300 for the Anagi stove and provide some local materials (such as clay) and help with the construction. They are conservative and happy with traditional stoves, not concerned with wood demand or air pollution.

None of the three families that combine LPG and traditional cookstoves decided to change from traditional to improved cookstoves.

All the three institutional stoves for village industries (for milk processing) were changed to improved stoves.

The EVD cooking solutions have shown a good replication potential with over 100 improved cookstoves already installed in other villages in the district. The cooperation with a project by Sri Lanka Central Bank has helped this dissemination.

The tree planting with papaya trees was popular with 86 trees planted, collecting an estimated 2 tons CO_2e/year.

Majherchar Village

Pirajpur District, Southern Bangladesh

The Majherchar village is in the southern coastal district of Pirajpur of Bangladesh (subdistrict Mathbaria). It has approx. 1000 inhabitants in 218 families. Here, the EVD project introduced improved cookstoves with chimneys, biogas plants, solar home systems, solar street lights, a solar water filtration system, solar insect traps, and three planting. All this contributes to reduce greenhouse emissions, emissions from the village as well as emissions from the power system of Bangladesh.

Visiting the Majherchar Village.
Photo by Grameen Shakti

Two-pot improved cookstove in Majherchar, Bangladesh model.
Photo by INFORSE

Solar powered street light.
Photo by Grameen Shakti

Biogas plant in Majherchar Village.
Photo by INFORSE

Changes in cooking energy use and climate change emissions

With the Eco-Village Development (EVD), the majority of families have moved from traditional to improved cookstoves. The improved cookstoves are tier-2 model (single burner) and tier-3 (double burner) according to the ISO 19867 standard and recommended by the national Bangladeshi agency IDCOL.

The implementation started with 50 single burner stoves. The villagers were given the ready-made concrete stoves and the chimneys, while they were providing clay to cover it and they did the installation after getting instructions. The local partner of the project installed one stove as a demonstration. After the 50 single burner stoves, 100 double stoves were installed in the same way. The cost of each concrete stove paid by the project was 500 taka for the single burner stoves and 650 Taka for the double burner stoves, in both cases including the chimney. These costs are after subtraction of government subsidy, which is partly paid by a carbon credit scheme.

In this way, the project provided 150 stoves, the remaining 40 families can get stoves later, but were not offered stoves by the project.

The changes in family cooking are shown in this table:

Type of Stove	At project start		At project end	
	Number (pieces)	%	Number (pieces)	%
Mud stove (Single Burner)	130	63	30	14
Mud stove (Double Burner)	50	24	10	5
Induction cooker	5	2	5	2
LPG	20	10	20	9
Improved Cookstove (Single Burner with chimney)	0	0	50	23
Improved Cookstove (Double Burner with chimney)	0	0	100	46
Biogas	0	0	3	1
Total	**205**		**218**	

Grameen Shakti found the savings for families with single burner stove was 2.5 kg/day and for double burner stoves 3.17 kg/day , by moving from a traditional cookstove (tier 0, efficiency 15% or. lower) to an improved cookstove (tier 3, efficiency >35%). Based on this, we assume the reduction is from 5 kg/day to 2.5 kg/day for families with one burner stoves [and from 6.67 kg/day to 3.5 kg/day for families with two-burner stoves].

For families using LPG stoves, that has an efficiency twice as high as the improved cookstove, we assume half the energy consumption of LPG than of wood fuel. 2.5 kg wood fuel has the energy content of 10 kWh (4 kWh/kg). The use of half of that, 5 kWh/day, is equal to 0.39 kg LPG/day or 141 kg/year, equal to almost one standard bottle (13 kg LPG) each month.

For families with an induction stove we assume an efficiency of 100% and therefore an energy (electricity) consumption of 3 kWh/day.

For families with biogas, we assume the use of 2 m^3 of biogas per day with 60% methane, equal to 13 kWh/day.

With these assumptions, the energy use for the entire village before and with EVD is estimated to be:

Energy use in village	Before EVD	With EVD	Change	
Mud stove (Single Burner)	949	219	730	MWh/year
Mud stove (Double Burner)	487	97	390	MWh/year
Induction cooker	5	5	0	MWh/year
LPG	37	37	0	MWh/year
Improved Cookstove (ICS) (Single Burner with chimney)	0	183	-183	MWh/year
Improved Cookstove (Double Burner with chimney)	0	511	-511	MWh/year
Biogas	0	14	-14	MWh/year
Total	1478	1066	412	MWh/year
Reduction			28%	
Reduction/household			32%	
Average/household	7.2	4.9	2.3	MWh/year

The reduction is 28% for the village, but because the number of households included in the surveys have increased from before the EVD project to post implementation, the reduction per average household is 32%. This is well below the savings for the households that changed and saved 50%. This difference is because some households still have the traditional cookstoves as some households (with LPG and induction) did not change, and also because many families (around 50) decided to change from single burner traditional cookstoves to double burner improved cookstoves. Using the assumptions above, based on information collected by Grameen Shakti, the change from single burner traditional cookstove to double burner improved cookstove does not give so much savings in wood as change to a single burner improved cookstove, but the change improves the comfort, by having two burners instead of one.

Emission reductions follow the reductions in energy use. The wood is from sustainable sources, from the forest on the island, where the village is. Thus, we estimate net CO_2 emissions from wood combustion to 15% of total emissions, giving total emissions of 0.67 kg CO_2e/kg wood, both for traditional and improved cookstoves, following Annex 1. This is somewhat below IDCOL average of 0.99 tons CO_2/ton wood, probably because IDCOL includes unsustainable wood use, where net emissions are closer to gross emissions. For LPG, we use 2.99 kg CO_2/kg and for biogas we estimate that the greenhouse effect of methane loss is equal to 200 kg CO_2e/year for each plant. For electricity we use the emission factor for Bangladesh of 0.67 kg CO_2/kWh.[8]

This gives the following greenhouse gas emissions:

Cooking greenhouse emissions, village	Before EVD	With EVD	Reduction	
Mud stove (Single Burner), wood	159	37	122	tons CO_2e/year
Mud stove (Double Burner), wood	82	16	65	tons CO_2e/year
Induction cooker, electricity	4	4	0	tons CO_2e/year
LPG	9	5	0	tons CO_2e/year
Improved Cookstove (Single Burner with chimney), wood	0	31	-31	tons CO_2e/year
Improved Cookstove (Double Burner with chimney), wood	0	86	-86	tons CO_2e/year
Biogas	0	0.6	-1	tons CO_2e/year
Total	253	183	70	tons CO_2e/year
Average/household	1.2	0.8	0.4	tons CO_2e/year
Reduction			28%	
Reduction/household			32%	

The emission reductions for the village are closely following the reduction in energy use, driven by the change to efficient cookstoves, and limited by the lack of change for some households and the move from one pot to two pot stoves.

Solar Electricity

The EVD project have introduced solar cell panel for a number of uses:

- Solar home systems, 3 systems 200 Wp each
- Solar street light, 10 lamps, 30 Wp solar each
- Solar water pump, 1 pump/filtration system, 2000 Wp solar modules (not in operation at the time of collecting data for this report)
- Solar insect trap, 3 pieces, 30 Wp solar module each

The solar electricity can replace fossil fuel (kerosene for lamps, diesel for the pump) and grid electricity that is available in the village, but not all are connected.

Given that the village has grid electricity, we will for this calculation assume that those buying the solar equipment would otherwise have bought grid-connected electric equipment. Thus, solar electricity replaces grid electricity.

In Southern Bangladesh, the annual yield of solar panels is 1430 kWh/kWp.[9] This gives the following solar power production for each of the 4 types of solar installations:

Solar power production, each EVD solar equipment	Energy, kWh/year
Solar home systems, 200 Wp	286
Solar Street light, 30 Wp	43
Solar pump, 1	2860
Insect trap, 20 Wp	29

For the entire village, the solar power production and reduced emissions from alternative electricity use is:

Solar power production and gross emission reductions, EVD village	Energy, MWh/year	Emission reductions tons CO_2/year
Solar home systems, 3 units	0.9	0.56
Solar Street light, 11 units	0.43	0.28
Solar pump, 1 unit	2.86	1.86
Insect trap, 3 units	0.09	0.06
Total, solar electricity	4.23	2.75

Some of the electricity is stored in batteries and used later. There are losses in batteries, but with modern solar batteries, it is less than 10%[10] and we have not included the battery losses in the calculations.

While the solar installations save electricity production in Bangladesh, there are emissions to produce solar cells and batteries. We have discussed that in the above chapter on the Margul village in India. We identified production emissions of 618-646 kg CO_2e/kWp for solar equipment with batteries and 200 kg CO_2e/kWp for solar panels alone. For solar equipment with batteries, we will use the average figure of 632 kg CO_2e/kWp. With EVD is installed:

- 3 Solar home systems, 10 street lights, and 3 insect traps with batteries, total 960 Wp, all with batteries, together emitting 600 kg CO_2e in production.
- One solar pump with 2000 Wp solar panels without batteries, emitting 400 kg CO_2e in production.

The total greenhouse emissions are then 1000 kg CO_2e, equal to 100 kg/year over a 10-year minimal useful lifetime. This will reduce the annual net reductions for the solar installations to 2.65 tons CO_2e/year.

Tree planting

Within the EVD project, 300 trees were planted, which are expected to survive, according to Grameen Shakti. Using same estimate as for India and Sri Lanka, we estimate that each tree during its productive life will collect 25 kg CO_2/year, in total 7.5 tons CO_2e/year for the village.

Total Climate Mitigation with EVD

Adding the emission reductions in cooking, the reduction in grid electricity use from the solar installations compared with expected business as usual, and tree planting, the total emission reductions from the EVD project in the village are:

Total emission reductions with EVD	Tons CO_2e/year
Cooking emissions, 253-183 tons CO_2e/year	70
Electricity use	2.7
Tree planting	7.5
Total	80

Other EVD Solutions

The other EVD solutions in the village do not influence greenhouse emissions.

Conclusions

In the Bangladeshi EVD model village, 150 out of 205 households changed from traditional to improved cookstoves and three changed to biogas, in total a change for 68% of the families. In parallel, there was an expansion of the village with 13 families that, according to available information, started to use improved cookstoves. The effects of EVD combined with the increase of families have resulted in 28% reduction of energy use and of greenhouse emissions. The estimated emission reductions is 70 tons CO_2e/year. The emissions per family reduced on average 32%, higher than the village reduction of 28% because of the increase in the number of families.

40 families, equal to 20% had not changed to improved cookstoves and remain with traditional cookstoves only. Mainly because the project only had plans for installation of 150 stoves. None of the families that used LPG (20 families) or induction cooking (5 families) changed cooking energy.

Three families introduced solar homes systems and in the village were introduced three electric insect killers and 10 solar street lights as well as a larger solar water pump/filtration system. The villagers assisted in the installations. In a business-as-usual situation, the villagers could instead have used grid electricity for these functions. By going for solar instead for grid electricity, greenhouse emissions are 2.7 tons CO_2e/year lower, including the emissions to produce the solar energy equipment, which is just 3% of emission reductions. If more than 3 families will change to solar home systems instead of grid electricity, the emission reductions can be much higher.

Within the EVD project, 300 trees were planted, which are expected to be surving, and trees that over their productive lifetime will capture around 7.5 tons CO_2/year.

These bring the total climate mitigation effect of EVD in Majherchar Chor Village in Southern Bangladesh to 80 tons CO_2e/year.

Bhalumare Village

Marin Rural Municipality, Southeast Nepal

The Bhalumare village in the lower, southern part of Eastern Nepal has 516 inhabitants in 103 families. In this village, the EVD project introduced improved cookstoves, tree planting, a solar driven irrigation pump and other water supply. Among the EVD solutions, cooking and tree planting contribute to climate mitigation.

The Bhalumare Village, Marin Rural Municipality, Nepal.
Photo by CRT/N

Cookstoves from the village: 2-pot model of improved mud cookstove with chimney, conduction oven and household biogas used for cooking.
Photos by CRT/N

The implementation was made in the following way:

For the improved cookstoves, the villagers paid for the bricks as well as sugar and salt that was mixed into the clay to make it better insulating and enhancing the binding capacity, in total 500 NPR (4 USD) while the project paid other costs, around 3000 NPR (23 USD). The villagers also helped with the work to install the stoves that were all fixed stoves.

Of the 72 families that used simple cookstoves before the project, 52 moved to the improved cookstove as main cooking appliance, two turned to (repaired) biogas plants and 20 (23%) stayed with the traditional cookstove as primary cooking appliance.

The main reason for the 20 families that stayed with traditional cooking was that they cooked both inside and outside and wanted to continue that practice, so they did not want to allocate space in the house for a larger, fixed cookstove. The project did not offer portable cookstoves that could overcome this problem.

The 15 users of LPG as main cooking fuel were primarily people living in the bazaar of the village, where they did not want to increase local air pollution, which will increase when moving to firewood, even if the cookstoves have chimneys. Two of these families moved to induction cooking as their primary mode of cooking with the help of the project.

Improved Cooking Solutions

The EVD project has introduced 49 household improved cookstoves (ICS, two-pot), 15 institutional improved cookstoves (one pot, larger), 22 electric induction cookers, and renovated 4 household biogas plants. Based on this implementation and a survey after the installation, the following change of cooking (change of primary cookstove) is found for 88 families covered by the survey by CRT/Nepal:

Households according to primary cookstove	Before EVD	Before EVD	With EVD	With EVD	
	Households	Persons	Households	Persons	HH size
Traditional cookstove as primary	72	453	20	113	5.7
Improved cookstove as primary	2	7	51	333	6.5
LPG as primary	15	63	13	50	3.8
Biogas as primary	0	0	2	11	5.5
El-Induction as primary	0	0	2	9	4.5
Total	**88**	**522**	**88**	**516**	**5.9**

The survey also showed that many families have two or three types of cookstoves, for instance for the 52 households with improved cookstoves as primary cookstove, 21 indicate LPG stove as secondary cookstove and 14 indicate traditional cookstove (TCS) as secondary cookstove.

We use the same energy contents as above for wood (4 kWh/kg) and LPG (12.8 kWh/kg). For households with biogas as primary fuel, we assume the same energy consumption of gas as for households with LPG. For households using induction stoves as primary cookstoves, we assume an electricity consumption of 1/7th of the energy consumption of TCS.

Based on findings from CRT, surveying 5 families in the village moving from TCS to ICS , we have identified the following cooking energy use for food per person in the village:

Fuel use per person	**TCS primary**	**ICS primary**	**LPG + TCS**	**LPG + Induction**	**Biogas + ICS**	
Wood use per day	2.7	1.4	0.9	0.25	0.47	kg/day
Wood use/year	986	511	329	91	170	kg/year
LPG use/year	0	0	22	15	0	kg
Energy use/year	3942	2044	1603	693	971	kWh/year

For the above table, we estimate that when a wood-fired cookstove is secondary to LPG or biogas, the wood consumption will only be 1/3 and when a household only use a wood-fired cookstove as tertiary option, the wood consumption will be less than 1/10th of a household with traditional cookstove as primary option. For households with LPG, we assume that with EVD, half use TCS as secondary cooking and half use induction. Before EVD, there was no induction cooking.

In the village are also 15 institutional/village industry stoves, where CRT/N have identified a wood use reduction from 4 kg/day to 1.3 kg/day, when moving from traditional to improved stoves.

The 15 institutional stoves are in addition to cooking for food, also used to cook fodder for cows and buffalos as well as for alcohol production. The 15 families with single-pot institutional stoves produce alcohol while 16 families have cows or buffalos (12 and 4 respectively). The 15 families that produce alcohol used each 675 kg/month for this according to the baseline study (in 2019). With the improved cookstoves, the reduction is 67%, reducing wood demand for alcohol from 23 kg/day to 7.3 kg/day. The 16 families with cows and buffalo used each 265 kg/month according to the baselines study. Not all of them got institutional stoves, so we assume that they on average save 40%, reducing daily wood demand from 8.8 kg/day to 5.3 kg/day.

The energy cooking energy consumption for the village is estimated to be the following, covering the 88 families in the survey, including cooking for animals and alcohol production.

Energy use for village, cooking, MWh/year	**Before EVD**	**With EVD**	**Reduction**
Traditional cookstove as primary	1784	445	1338
Improved cookstove as primary	13	681	-667
LPG as primary	101	80	21
Biogas as primary	0	8	-8
El-Induction as primary	0	9	-9
Institutional Improved cookstoves	692	282	411
Total	**2591**	**1504**	**1086**
Reduction			**42%**

Emission reductions follow the reductions in energy use. The wood is from a sustainable source, from a community forest near the village. Thus, we estimate net CO_2 emissions from wood combustion to 15% of total emissions, giving total emissions of 0.67 kg CO_2e/kg wood, both for traditional and improved cookstoves. For LPG, we use 2.99 kg CO_2/kg and for biogas we estimate that the greenhouse effect of methane loss is equal to 200 kg CO_2e/year for each plant. For electricity we use zero emissions as the power supply in Nepal is from hydropower. This gives the following greenhouse emissions from cooking in the village:

Energy use for village, cooking, MWh/year	**Before EVD**	**With EVD**	**Reduction**	
per year for village	**tons CO_2e/year**	**tons CO_2e**		**tons CO_2e**
Traditional cookstove as primary	299	75	225	tons CO_2e/year
Improved cookstove as primary	2	114	-112	tons CO_2e/year
LPG as primary	18	10	8	tons CO_2e/year
Biogas as primary	0	1.9	-2	tons CO_2e/year
El-Induction as primary	0	1.0	-1	tons CO_2e/year
Institutional stoves	116	47	69	tons CO_2e/year
Total	**436**	**249**	**187**	tons CO_2e/year
Reduction			**43%**	

The emission reductions for the village are closely following the reduction in energy use, driven by the change to efficient cookstoves including induction cookers, and limited by the lack of change for some households.

Tree planting

With EVD is planted 250 tree saplings along roads, of which 190 are surviving, as well as 200 mango tree saplings that are all surviving. This is in total 390 trees. Using the same estimate as for India and Sri Lanka, we estimate that each tree during its productive life will collect 25 kg CO_2e/year, in total 9.75 tons CO_2/year for the village.

Total climate mitigation with EVD

Adding the emission reductions in cooking and tree planting, the total emission reductions from the EVD project in the village are:

Total emission reductions with EVD	**Tons CO_2e/year**
Household cooking	118
Institutional stoves	69
Tree planting	10
Total	197

Other EVD Solutions

The other EVD solutions including the solar water pump are not contributing to climate mitigation. The solar electricity for the pump could alternatively be provided by Nepalese grid power that has no emissions as it is from hydro-power.

Conclusions

In the Nepalese EVD model village, 52 out of 88 households changed from traditional to improved cookstoves as primary cookstove, two changed to biogas and two to electric induction stoves, in total a change for 61% of the families included in the survey of the village. In addition, all the home producers of alcohol changed to improved cookstoves The effects of EVD includes 42% reduction in cooking energy and a total reduction of greenhouse gases of 43%, estimated with a reduction of 187 tons CO_2e/year.

21 households, equal to 24% of the families in the survey, decided not to change to improved cookstoves and remain with traditional cookstoves as primary cookstove. Two households out of 15 that used LPG changed to an improved cookstove as the primary cooking device. Now, 100% of the households have access to clean cooking technology, even though not all use it as their primary cooking device.

With the EVD is also planted 390 surviving trees that over their productive lifetime will capture around 9.75 tons CO_2/year.

This brings the total climate mitigation effect of EVD in Bhalumare village in Southeast Nepal to 197 tons CO_2e/year.

References

[1] Typical calorific value of dung cake, dry matter 3800 kcal/kg, according to https://www.researchgate.net/figure/Proximate-Analysis-and-Calorific-Values-of-Coal-Cattle-Dung-Blends_tbl3_263302623
Typical water content of dry dung-cake: 20%

[2] Sample with 5 dung-cakes from village had a weight of 1.5 kg.

[3] The solar lantern has a 6 Watt PV panel. The emissions in production is estimated to 200 kg CO_2e/kW according to average of emissions in graph in https://www.iea.org/reports/solar-pv-global-supply-chains/executive-summary, which gives 1.2 kg CO_2e. The battery is 4.5 Ah, 6 volt (27 Wh, for which the manufacturing products 2.5 kg CO_2e, calculated from emission values for Chinese Li-ion battery production of 93 kg CO_2e/kWh of battery, taken as an average of figures in https://www.mdpi.com/2071-1050/9/4/504 (103 kg CO_2e/kWh) and in https://www.sciencedirect.com/science/article/pii/S0921344922004402 (82 kg CO_2e/kWh). The total is 1.2+2.5)3.7 kg CO_2e, equal to 646 kg CO_2e/kW solar cell.

[4] The solar street light has a 75 Watt battery and a 30 Ah, 12 volt battery(360 Wh), which with the same assumptions as for solar lanterns gives emissions of 15 kg CO_2e for the PV panel and 33 kg CO_2e for the battery, also using a figure of 93 kg CO_2e/kWh. The total is 15+33 = 48 kg CO_2e, equal to 618 kg CO_2e/kW solar cell.

[5] Zinc-alkaline batteries have production emissions of 26.2 kg CO_2e/kWh according to "Urban Electric Power", https://urbanelectricpower.com/wp-content/uploads/2022/02/UEP-Environmental-Impact-Report_Shareable-02-2022.pdf
A D-size battery has 1.5 Volt and 10 Ah, equal to a capacity of 15 Wh, which will give production emissions of 0.39 kg CO_2e per battery.

[6] According to information collected by INSEDA and partners.

[7] According to estimates for average trees [in South Asia] according to https://ecotree.green/en/how-much-co2-does-a-tree-absorb

[8] Information from Grameen Shakti, Bangladesh.

[9] According to to https://globalsolaratlas.info/detail?c=22.82682,88.505859,6&s=22.00811,89.802246&m=site

[10] https://ww2.redearth.energy/how-efficient-are-solar-batteries/

Annex 1:
Energy contents and emissions of fuels for cooking and lighting

We use the following energy contents and emission factors and reductions for all 4 countries:

	Energy		Co_2–total	Other GHG		Unsust. Part of CO_2	Total net GHG	
Wood	4.0	kWh/kg	1.3	0.47	kg CO_2e/kg	50%	1.14	kg CO_2e/kg
Wood	4.0	kWh/kg	1.3	0.47	kg CO_2e/kg	15%	0.67	kg CO_2e/kg
Straw	4.2	kWh/kg	1.4	0.49	kg CO_2e/kg	15%	0.71	kg CO_2e/kg
Ding, dry	4.4	kWh/kg	1.5	1.05	kg CO_2e/kg	100%	2.56	kg CO_2e/kg
LPG	12.8	kWh/kg	3.0	0	kg CO_2e/kg	100%	2.99	kg CO_2e/kg
Kerosene	9.84	kWh/kg	2.36	0	kg CO_2e/kg	100%	2.36	kg CO_2e/kg

Wood and straw are with natural water content in fuels (20% for wood, 10% for straw). Dung is for dry matter.

For wood and straw is only included the part of the emissions that would not be released if the biomass is not used for energy. The reduction compared to total emissions is from natural decay of wood and straw and for wood the net additional growth that the trees will have if they are not cut (fully or partly) for fuel. The time frame is 20 years. In areas without deforestation, the part of emissions not released if the material is not used for energy is set to 15%, assuming 15% of material not burned will contribute to soil carbon and additional tree growth. For the project area in India, where there is some unsustainable wood use, with deforestation and land degradation, the part is set to 50%, assuming that part of the tree cutting for fuel is reducing the tree growth substantially.

We made the conservative assumption that there are the same black carbon emissions from all stoves per kg of wood burned, even though the particle emissions from improved cookstoves typically are smaller per kg of wood for improved cookstoves than for traditional cookstoves. We have no black carbon emission measurements from the stoves used in the project's model villages.

For biogas plants, the emissions per plant per year is assumed to be 200 kg CO_2e, mainly as methane emissions of 40 ltr/day (equal to 65 ltr/day of biogas with 60 % methane). The CO_2 produced in the biogas plant and in the combustion of the biogas is expected to be equal to the CO_2 emitted from composting or other use of the manure.

The source of the information on emissions is the report: "White Paper: Mitigation and Adaptation with Eco-Village Development (EVD) Solutions", INFORSE, October 2018, link:
http://www.inforse.org/doc/Pub_EVD_White_Paper_Climate_Mitigation_Adaptation_2018.pdf

SECTION - II

Adaptation Impacts of Eco-Village Development Projects

Photo by INFORSE

Introduction

Rising temperatures, changes in precipitation patterns, rising intensity and frequency of disasters, are all fingerprints of climate change. The IPCC's Sixth Assessment Report confirms the fact that climate-induced disasters will become more frequent and more severe in the coming decades. South Asia's vulnerability to climate change, because of geographic location, hydro-ecological, socioeconomic factors, and political landscape, is evident from the frequency and intensity of climate-induced disasters in the region. Climate events reduce liveability, compounding inequality, and threaten lives and livelihoods of poor communities in the region. The region must take a low-cost, location- and climate-specific, inclusive and stakeholder-driven response to climate and development issues. In this context, local solutions perform the balancing act between development and the emissions agenda.

Building climate resilience of communities in the face of vicious climate impacts is crucial. There are multiple approaches and strategies that are known to raise adaptive capacity and also mitigate climate impacts. However, technological, nature-based, local solutions can address climate changes issues and provide multiple co-benefits to address complex socioecological and climate issues while increasing resilience to potential impacts. In practice, integrating diverse adaptation measures will be required to realise the transformations needed to build resilience.

Successful adaptation results in increased resilience and adaptive capacity, and reduced vulnerability in the context of a changing climate. As a consequence, new and interacting challenges, opportunities, synergies, and trade-offs could emerge out of adaptation practices. However, if the solutions and strategies are local in nature, the resultant impacts are localized and communities gain from the adopted solutions. The local solutions also address livelihood diversification issues and thus providing these opportunities have proven helpful in building resilience.

Eco-Village Development Solutions

The local solutions promoted by the Eco-Village Development (EVD) project, are a basket of simple, inexpensive, renewable energy technologies in sustainable energy, agriculture, water management and gardening customized to local weather conditions, social and cultural needs. The solutions promoted are pro-poor, pro-women and with a low-carbon approach to development. The solutions are need-based to suit communities of diverse social, economic and environmental backgrounds. The planning and implementation of solutions follow a bottom-up process that focuses on the poor in rural communities, especially women. The EVD solutions comprise small and micro level actions that are an effective tool to address climate impacts. With the support of local institutions, local government, civil society and local solutions, the communities have a chance to adapt to climate impacts, help mitigate climate change, and improve livelihoods.

The EVD solutions follow demonstration-based eco village technologies for awareness building and means of dissemination. The demo villages act as an evidence base for the effectiveness of EVD solutions. These are also used as pilot projects for advocacy at the local and regional level. In the current project, local solutions implemented in EVD model villages comprises of the following solutions and are based on the needs and priorities of communities.

Cooking solutions
- Improved Cookstoves (ICS)
- Household Biogas Plants
- Parabolic Solar Cookers
- Improved Kitchen

Lighting
- Off-grid Solar Power and Lighting Solutions
- Solar Street Lights

Irrigation
- Rooftop Rain Water Harvesting Systems
- Micro-Irrigation Systems
- Solar Water Pumps

Agriculture-based
- Organic Composting
- Organic Agriculture in general, kitchen gardening, cash crops
- Solar Drying of Agricultural and Horticultural Crops, Spices and Herbs
- Solar Greenhouse

Income Oriented
- Improved Water Mill (IWM)
- Biomass Waste for Rural Brick Production
- Hydraulic Ram Pump

The model villages where EVD solutions have been implemented are
- Village communities in Mathbaria of Pirojpur district in the Southwestern (coastal) region of Bangladesh
- Bhalumara, in the Marin Rural Municipality in the lower plain area of Nepal
- Matara district, in the southern coastal belt in Sri Lanka
- Ujjain and Indore administrative divisions, in Madhya Pradesh, India

Many of these villages are located in areas that are particularly susceptible to climate risks, such as flood, cyclone, river bank erosion, floods resulting in salinity intrusion on fertile land and contamination of drinking water in the case of Bangladesh. In Nepal, the inhabitants of Bhalumara experience acute water scarcity problems and changing climate patterns, which increased their drudgery and affected their livelihoods, mainly due to lack of water. In Sri Lanka, the villages experience floods and crop damages in certain lowland paddy areas, extreme rainfall events, and occasional mild drought events. In Ratlam district of Madhya Pradesh in India, farmers experience rise in temperature, erratic rainfall and depleting ground water levels.

Furthermore, a significant proportion of the population in South Asian villages is reliant on climate-sensitive sectors for their livelihoods, primarily agriculture and fishing. Changes in monsoon patterns, increasing salinity in coastal areas, loss of biodiversity, and increasing pest attacks due to warming temperatures pose significant threats to these sectors. In addition, these communities often have limited capacity to adapt to climate change due to poverty, lack of awareness, and limited access to resources and services, including financial services, healthcare, and education. This is compounded by infrastructural deficiencies such as inadequate housing and sanitation, lack of irrigation and drainage systems, and weak transportation networks. All these factors exacerbate the vulnerability of South Asian villages to climate change.

Local Solutions and Adaptation

Access to clean, affordable energy is one of the key inputs to lifting people out of poverty. Along with economic growth, the South Asian region has witnessed rapid growth in energy consumption. The combined development and climate challenges can be met by increasing energy efficiency and increased use of renewable energy, resulting in lower emissions and increased available energy. Solar energy, sustainable consumption of biomass and local use of hydro-power are local solutions that can contribute to both clean energy access and poverty reduction throughout the region. They can be key parts of comprehensive, development-oriented decarbonization strategies that are inexpensive and acknowledge local needs.

The local renewable energy solutions strengthen the evidence base by demonstrating the magnitude of health, environmental, and socio-economic benefits. The clean cookstoves, biogas and solar-based drying techniques supplement the agriculture-based livelihood system in village communities. These processes make agriculture and allied activities efficient and help in income generation. Thus, it adds to the adaptive capacity of the communities in a positive manner by encouraging economic development and poverty eradication.

At a larger level, the local solutions support women's and girls' empowerment (social progress, gender-based violence reduction). For instance, renewable energy technologies have positive health impacts by reducing exposure to indoor and outdoor air pollution, and access to water reduces harassment of women and girls.

By adopting sustainable agriculture practices, smallholder farmers became increasingly climate-resilient, as in the case of organic agriculture practices in Sri Lanka. Farmers constantly adjust their agricultural behaviour to adapt to the severe problems caused by extreme climate change. In order to build the resilience of farmers to unpredictable climatic events that threaten their livelihoods, climate adaptation strategies need to be integrated into sustainable poverty alleviation as well as rural development agendas.

Project interventions	Current adaptation practices	Scope for other adaptation activities
Preparation of Village Development Plan (VDP) in EVD model villages	The local communities have defined and presented their needs and asks to the local governing institutions through participatory processes	Understanding the adaptation-related challenges and taking the priorities and asks of communities to the decision makers for implementation
EVD model village	The EVD model villages have been established in each country to address the climate vulnerability of the local communities.	Need for more adaptive solutions arises to deal with climate risks (for instance in sustainable agriculture practices such as organic farming, vertical garden, floating garden, case fishing, etc
Replication	The local solutions as adaptation technologies address community needs	Adaptation co-benefits such as women's empowerment and capacity building of communities
Advocacy at local, regional and international level	Knowledge sharing, capacity building and generating awareness among stakeholders	

Recommendations

Background

South Asian villages are particularly vulnerable to the impacts of climate change due to a combination of geographical, socio-economic, and demographic factors. The region's diverse geography, ranging from the high-altitude Himalayas to low-lying coastal areas, exposes it to a wide range of climate risks. Rising temperatures, changing precipitation patterns, and increasing frequency and intensity of extreme weather events, such as droughts, floods, cyclones, and heatwaves, have significant implications for livelihoods, food security, and water availability.

A partners' workshop was organized to share the outcome of Adaptation Assessment and the draft recommendations from this project are compiled here. The background giving the situation analysis of each country vis-à-vis climate change as experienced by communities, which drew from the Participatory Rural Appraisal (PRA) exercise conducted in each project area refer to the timeline, seasonality, changes in climate, cropping pattern and income. Then the scope/need of integrating adaptation techniques to address the rising problems in the project area drew from the semi-structured interviews which captured household profiles, employment profile / income generation avenues, infrastructure available, access to government programs, relationship with government offices, etc. The third and most important section of the recommendations are the good practices promoted by the project to build resilience in the community.

A set of general recommendations on promoting adaptation measures to increase the resilience of climate-vulnerable villages against climate change impacts, are as follows:

1. **Education and Awareness:** Increasing awareness about climate change, its impacts, and adaptation strategies is critical. This can be done through schools, community meetings, and the media. Public awareness campaigns, leveraging social media platforms and digital tools, can also play a significant role in reaching a wider audience and fostering behavioral change towards sustainable practices. Engaging local leaders, opinion-makers, and influencers can help amplify the message and inspire collective action towards climate resilience.

2. **Promoting Community and Ecosystem-based Adaptation:** Communities, particularly women and vulnerable sections, must be involved to lead the overall strategy to adapt to the adverse effects of climate change by adopting ecosystem-based approaches as they have a profound understanding of their environment, its day-to-day challenges, thus bringing in the right information essential for planning and implementation. Community-based adaptation can build local capacity and resilience while addressing the socio-economic aspects of climate change.

3. **Diversifying Livelihoods:** By diversifying income sources (e.g., promoting handicrafts, apiculture, dairy farming, fisheries, horticulture and diverse cropping practices, eco-tourism), communities can become more resilient to climate-related shocks that may affect any one sector. Government programs on micro enterprises should promote rural and women-based enterprises that engage women groups into active participation and earning. The livelihood programs successfully demonstrated under this project can be integrated in the government-run programs and microfinance support given to promote this on scale.

4. **Forest Management and Reforestation:** Forests act as a buffer against climate impacts like land-

slides and floods and can also provide alternative income sources. Community forest management and reforestation using native species can be effective strategies. Forests can also be preserved and promoted for strengthening local food systems, providing nutrition to the local communities.

5. **Enhancing Social Protection:** Social protection is crucial for bolstering climate resilience in South Asia, a region acutely affected by climate change. Social protection mechanisms, such as conditional cash transfers, public work programs, and social pensions, can help communities adapt to climate change by providing them with a safety net against climate shocks. These measures not only help to meet immediate needs during climate-related crises but also contribute to long-term resilience by enabling investments in human capital, livelihood diversification, and risk reduction measures. By ensuring that social protection schemes are sensitive to the impacts of climate change, we can improve the adaptive capacity of vulnerable communities and contribute to more equitable and sustainable development in the face of a changing climate.

6. **Promoting Climate-Resilient Agriculture:** Implementing resilient farming practices is crucial. These can include crop diversification, developing and using drought and flood-resistant crops, practicing agroforestry, improving soil health through organic farming, and promoting sustainable livestock management.

7. **Water Resource Management:** Many South Asian regions face water scarcity, irregular monsoons, and groundwater depletion. Rainwater harvesting systems, efficient irrigation methods, and groundwater recharging should be promoted. Building small dams and check dams can also help to store rainwater and manage floods.

8. **Strengthening Disaster Risk Reduction and Management:** Early warning systems for extreme weather events, regular drills, and community-based disaster management teams can help prepare for and mitigate the impacts of disasters.

9. **Infrastructure Improvements:** Building climate-resilient infrastructure can ensure continued service during climate-induced disasters. This could include raised housing, roads, and bridges in flood-prone areas and heat-resistant materials in high-temperature regions.

10. **Healthcare Preparedness:** Climate change can influence the spread of certain diseases. Adequate healthcare facilities, trained health workers, and awareness programs can help manage these health risks.

11. **Policy Support:** It is essential to integrate climate adaptation into local development plans and policies, ensuring that the regulatory environment supports and promotes adaptation activities. This can be achieved through financial incentives and regulatory frameworks that encourage climate-resilient infrastructure and land use practices. Additionally, governments should invest in capacity building programs to enhance the knowledge and skills of local communities in implementing adaptation measures. Collaborative partnerships between public, private, and civil society sectors are also crucial for effective policy implementation and resource mobilization.

By implementing these measures, South Asian villages can become more resilient to climate change impacts. However, every village is unique, and adaptation measures should be tailored to the specific challenges and opportunities each village presents.

Country Inputs

Nepal

Situation analysis: Climate change and communities

In Nepal, the local target area is Bhalumara, in the Marin Rural Municipality in the lower plain area of Nepal, 100 km south-east of Kathmandu. The geographical location between the Mahabharat Range and Chure Range of Inner Terai is prone to critical water crisis which is exacerbated by the changing precipitation pattern. The critical water shortages for both irrigation and drinking water supplies caused by the drying-up of local community wells had increased the drudgery and affected the livelihoods of the locals. Due to limited availability of water, the dwellers of Bhalumara village rarely got involved in animal husbandry, which in turn limited the availability of animal-based manure and reduced soil resilience. Due to dwindling agricultural income, villagers were increasingly migrating away, particularly the younger men.

Need for integrating adaptation techniques

The situation called for interventions that enable villagers to adapt to climate change impacts and to improve agriculture and livelihood in an environmentally friendly manner. A number of different measures were identified during the Participatory Rural Appraisal (PRA) from improved water access over diversification of crops, to alternative income opportunities such as food processing and non-farming income. The firewood-based cookstoves could be improved significantly through the introduction of efficient and cleaner improved cookstoves. These interventions can contribute to improving lives and livelihoods, and thereby reduce migration. This will make the village a model village that can be used for learning and as a demonstration point for the local government.

Resilience-building practices promoted

To resort to the dire water scarcity, the next generation Eco-Village Development (EVD-4) supported by CISU, Denmark, project collaborated with "Multi-actor partnership for 100% RE" project supported by BMZ, Germany and being implemented by Prakriti Resource Center and WWF-Nepal to install a 3.2 kWp solar lifting system.

The total project cost was NPR 6,985,028 (USD 52,857) of which 11% was contributed by the EVD-4 project, 20% kind contribution and the rest was supported by BMZ.

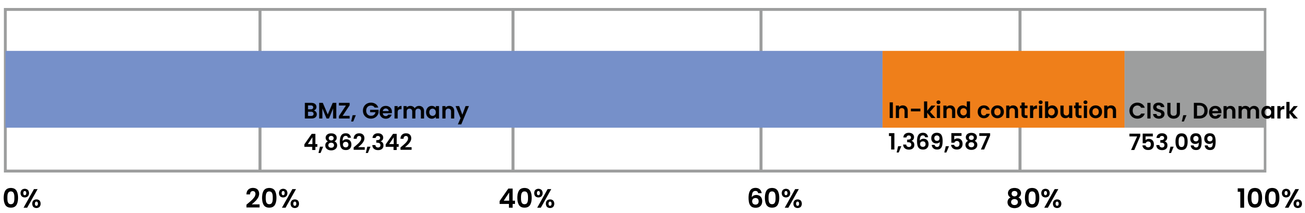


Figure: Total project cost and sources of funding

System Design Information

Parameters	Description
PV solar cell panel	32*100 Wp = 32 kWp
Pump /Head	3 HP/ 50 m
Reservoir	Ferro-cement tank 20,000 lt, RCC tank: 12,000 lt
Design sunshine	3.71 hour
Beneficiaries	100 households; 616 persons
Transmission pipeline	63 mm HDPE, 555 meter
Distribution pipeline	4,711 meter HDPE
Tap stand	97

1. Water availability has multifold impacts on climate change adaptation and livelihood enhancement. Before the project intervention, villagers did not grow vegetables and relied on rain-fed cereal crop cultivation (maize, millet and paddy). Through the project, twelve interested beneficiaries were trained on commercial vegetable farming. Ten of them were supported on installation of climate adaptation agro-technology plastic tunnel greenhouses, drip irrigation set, and safe food production farming. Further to enhance eco-friendly climate resilient agriculture practices, these beneficiaries were trained on vermicomposting, preparing bio-pesticide and liquid fertiliser from locally available insecticidal plants, capsaicin-based spices and cattle-urine.

2. The Marin river flows nearby (200-2320 m away, elevation 3-30 m from the cultivable field of the villagers), hence irrigation requires certain interventions to lift water. Thus, the project has supported three sets of portable solar pumps (320 Wp-0.34HP) and a spare pump to the local agriculture group (Bhalumara Model Agriculture Group), which is also the local project implementing partner.

Solar powered multi-use system (MUS) for water lifting.
Photos by CRT/N

3. Bhalumara Model Agriculture Group has been linked with district agriculture knowledge centre. Consequently with 50% government subsidy and 50% contribution from thirteen farmers, a well has been excavated for irrigation. These farmers were able to grow maize and potatoes during the dry season (November to February) on their field, which otherwise would remain fallow until the monsoon (late May-early June).

4. To diversify income and improve income, a vegetable collection centre has been established at the Bhalumara village with training support on Social Enterprise Model and market linkages. The improved income was aimed to increase the adaptative and resilient capacity of the beneficiaries who are involved in agriculture.

5. Soil testing was conducted where 110 samples were collected and tested in the Provincial Soil and Manure Testing Laboratory and the farmers were provided with recommendations to improve the soil productivity.

6. Since the whole Bhalumara village can be divided into five clusters, one well in each cluster is planned to be deepened and renovated to improve irrigation facility. The water can be pumped through the portable pump to irrigate the respective field of the farmers as required.

7. Apart from the beneficiaries training on commercial agriculture, the beneficiaries are encouraged to build a grey water reclamation pond to grow green vegetables in the kitchen garden.

Climate-smart agriculture.
Photo by CRT/N

Sustainability of the initiative

To ensure the sustainability of the project initiative, local implementing partner, Bhalumara Model Agriculture Group, was taken on-board and involved in all activities at the project site and taken together and introduced to all the line agencies such as agriculture resource centre, agro-vet, technology suppliers and repair centres. The local government (ward and municipality) were consulted and informed of all the project activities so as to replicate the adaptive measures on other villages. The local government expressed appreciation for the changes observed in the village. The Marin Rural Municipality allocated NPR 5,00,000 for poly-tunnel and NPR 8,00,000 for procurement of e-cookstoves.

India

Situation analysis: Climate change and communities

In India, around 70% out of 1.38 billion population lives in the villages. Although the government made several efforts to enhance access to clean cooking energy through various programs, recent studies in the poorer states of India showed that only one-third of the population uses LPG as the primary source of cooking, primarily due to poverty. The lack of use of LPG is not only due to inability to afford the LPG cylinder on a regular basis but also due to the food habits in rural areas where chapati (round flat bread), especially made of makka (corn), millets, etc. are preferred to be cooked on firewood. At the same time though the government has declared 100% electrification of the villages, several households are still deprived of electricity since a village is declared electrified even if 10% of households have access to electricity. As a result, several families in rural India continue to live in an impoverished environment. Most vulnerable among the rural poor are tribal areas where energy access is a major problem, but also other services such as education, health and economic developmental opportunities are severely lacking.

The Ratlam district (Madhya Pradesh state), where the feasibility study was conducted, has a moderate climate. It receives monsoon from the Arabian Sea, which starts sometime in the middle of June and lasts up to the end of September. July and August are the months of heaviest downpour. The average rainfall of the district is 734.5mm (in 2009-2010). The climate of the district during October is somewhat hot and humid, but comparatively cooler; this is a transitional period between rainy and winter season. Summer starts from the festival of Holi, i.e., in March, but maximum temperature can be observed in the month of May and June. January is the coldest month of the year.

The forest cover has been reduced to 20% compared to what was 50 years ago and the water level is depleting every year. The farmers are aware of climate change and they are feeling its negative impacts. While, the communities are willing to take appropriate measures to mitigate the impacts of climate change and to develop climate resilience, they have meagre income sources. The families, especially women, are keenly interested in carrying out income generation activities to meet household expenses along with maintaining kitchen garden using organic methods for income augmentation as well as ensuring availability of nutritious food.

Photo by INSEDA

Job opportunity and skill enhancement of youth are considered as key issues apart from ensuring water availability especially during summers. Improvement of health and education services, including anganwadis (crèche/ rural childcare centre), road construction, and gully plugs, were common concerns in all villages. Specific requirements of construction of new check dams, repair of old check dams, ponds, water tanks, lift irrigation and digging borewells pertaining to specific villages were raised by communities during the study.

Photo by INSEDA

The tribal communities are most vulnerable to climate change and have been deprived of development, despite various government schemes available for their development. Though the villages are only 50 km away from Ratlam city, people are deprived of development in areas of education, health and livelihood support. The tribal communities are more connected to nature and reducing forest cover has direct impact on their way of life. The six villages are around 50 km away from Ratlam district and 18 km from Routi, a small town. The villages are situated in the catchment area of the Mahi river, near the small Jamad river where Margul and Hawa Rundi are to the north of the river, while Daulatpura, Dudhi, Kheriyarundi Kalan and Sagla Ka Mal are to its south.

Due to the lack of livelihood opportunities in the villages coupled with climate change impacts reflected by erratic rainfall, droughts and shifting cultivation windows, families are forced to migrate to other places in search for livelihood for nearly six months where about one or two members from each family migrate. For example, there was a drought five years ago in the region and last year there were heavy and untimely rains which destroyed the soybean and maize crops.

Need for integrating adaptation techniques

Almost all the families depend on agriculture and labour to meet their essential day-to-day needs and practice subsistence farming for survival. Most of the households belong to the category of marginal and sub-marginal farmers with only 2 to 4 bigha land (1 acre is roughly equal to 3 bigha). The income level is very low; most of the families earn between INR 50,000 to 100,000 per year (USD 665 to 1330). At least one member of every family temporarily migrates for work for around six months. Households have minimal assets, with no car in the villages, though about 60 to 70 percent families have mobile phones.

Photo by INSEDA

Most of the families own livestock, with around 25 percent of the farmers still using bullocks for ploughing. Most of the houses are made of mud with tiled roofing, while 12.5 percent live in huts. Only 5 percent of the families have functional toilets.

The education level is very low as there are only primary schools (up to 5th standard) and only one upper primary school (up to 8th standard). Children must go to distant places to study beyond primary level. The literacy level is very low with only about 30 percent literates in the six villages, which is generally less for women. There are very few graduates.

The health services are very poor as there are no health centres in any of the six villages. Diseases like malaria, dengue, diarrhoea are prevalent, with a few cases of lung diseases.

Firewood, dung-cakes and crop residue are the main cooking fuel where traditional stoves are being used in kitchens which do not have proper ventilation. Women face drudgery in collecting firewood and cooking in smoke-filled kitchens. On an average, around 7-8 kg wood is used per family per day for cooking and 1.5 hours is spent in cooking. LPG is available, however, families use it only in case of emergency. People even have to purchase firewood sometimes at INR 1200 per quintal. Black soot on vessels and around kitchen walls is considered a problem, while many women also suffer from breathing problems due to smoke in the kitchen during cooking.

The electricity supply is erratic and though villages are considered electrified, several families have not got a connection. There are some families with connections, who don't get electricity as they have been unable to pay their bills, which have accumulated over several months. There are no streetlights in any of the villages and the darkness poses a danger for women and children as the area is snake-infested. Some families use electric pumps to draw water from wells and from the river for which they have to lay pipes every time for long distances. They have to pay a fixed amount as the fee depends on the size of the electric pump. Very few families use diesel pumps for irrigation. Last year, untimely rains caused heavy losses in agriculture, while a few years ago the huge losses were caused due to drought.

Mungbean, groundnut, maize, cotton, wheat, soybean, arhar (pigeon pea), urad (black gram) are the main crops grown in the area, mostly used for own consumption, while cotton is grown as a cash crop. Almost all farmers utilize dung from their domestic animal to make compost in a traditional way, i.e., drying under the sun in a heap which causes loss of important nutrients and humus.

The major issues among other faced by the communities are: a shrinking forest cover, with only 20 percent left as compared to 50 years ago; depleting water levels causing water scarcity, particularly in summers; climate change (heavy rainfall and periods of drought) is also being felt by farmers. most houses have LPG connections, but people use firewood, cow dung and crop residue as they can't afford the LPG refill.

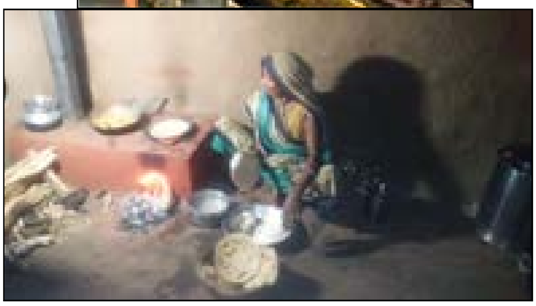
Resilience-building practices

Based on a feasibility study, INSEDA proposed different EVD solutions for the region which included a few solutions for climate change adaptation. In the current phase of the project, INSEDA developed a village development plan (VDP) endorsed by the Gram Sabha (village authority) in Margul village, inhabited by 106 tribal families, to develop it as a model EVD village. As a first step, INSEDA organized a practical hands-on training of masons, master masons, village women, local artisans and local entrepreneurs for the construction/fabrication and installation of EVD solutions. INSEDA conducted a baseline survey considering various indicators which would help in the assessment of impact on mitigation and adaptation along with socio-economic benefits of the project. The installation of the EVD solutions by

INSEDA in the model village Margul for demonstration, advocacy and to showcase scaling up of the concept, were as follows:

- HEERA multipurpose Hybrid Improved Cookstove (HICS - innovated by INSEDA) with chimney, warm water tank, small solar cell with charge controller integrated with mobile charging port, charges a battery, powers a small exhaust fan for forcing exhaust gases into a bucket of water to remove harmful particulates before releasing into the atmosphere. One was constructed during training.
- INSEDA innovated JWALA Improved Cookstove (smokeless stove with chimney)
- Grameen Bandhu biogas plants built using bamboo reinforced cement mortar (BRCM)
- Rooftop rainwater harvesting units with storage tanks built using BRCM
- Solar tunnel dryer
- Solar poly-greenhouse
- Greenhouse nurseries constructed using green nets
- Bamboo compost baskets
- Vermicompost units
- Kitchen gardening
- Energy plantation, horticulture, and household forestry
- Solar PV powered streetlights
- Solar lanterns with LED and mobile charger
- Income generation activities through Self Help Groups (SHG), e.g., poultry

JWALA and HEERA Improved Cookstoves help in reduction of use of firewood which is depleting in the project area, hence helped in adapting to cooking with reduced firewood. With JWALA and HEERA improved cookstoves, women are also extremely happy that there is almost no smoke inside the kitchen and children can also stay around with them in the kitchen. Women can now breathe easily inside the kitchen and do not have to blow air to keep the flame burning as the chimney helps in creating enough suction; on the other hand, when using a traditional cookstove, women needed to blow very hard on the fire which resulted in excessive smoke being inhaled. They are also happy that there is reduced wood consumption, so their time is also saved to some extent.



JWALA and HEERA 2-pot improved cookstoves.
Photos by INSEDA

Behera Bai is happy as the Jwala ICS has two burners for cooking, time is saved and less wood is consumed in ICS as compared to old traditional chullhas (stoves); now house is not filled with smoke as all smoke goes out through the chimney.

The Grameen Bandhu biogas plant developed by INSEDA uses bamboo instead of the environmentally harmful bricks which require good quality clay soil and biomass. The increased demand for bamboo in the improved biogas plant construction will make bamboo cultivation profitable, thereby helping farmers to compensate for loss in agriculture due to climate change. Bamboo cultivation also helps in adapting to climate change impacts by conserving soil and moisture. The biogas itself helps in adaptation to the scenario where wood is becoming scarce by eliminating use of firewood for cooking. The biogas slurry adds humus to the soil, improving the soil quality, thus adapting to climate change by reducing use of environmentally harmful chemical fertilizers. Women using the Grameen Bandhu biogas plant find that using biogas cookstoves gives equal comfort and status as compared to LPG stoves, which use less firewood, and provide other advantages such as vessels not getting coated with black soot and kitchens remaining clean. With biogas, families are not dependent on energy supply from outside and hence will not get impacted in case of extreme climate events.

Mr. Rakesh Maida is happy to have a bamboo-base biogas plant installed at his home as now cooking is fast, time of collecting firewood is saved, no additional cost is incurred, utilization of cowdung, and use of slurry as organic manure is an additional benefit.

Photo by INSEDA

Bamboo has multifaceted benefits and is used for construction of some of the EVD solutions. There is an income generation opportunity for women trained in weaving bamboo structures for components. The bamboo plantation helps in drawdown of CO_2, environment restoration, soil rejuvenation, reforestation and erosion control, moisture conservation, and is also a source of income for farmers and women as there is no ban any more on cutting bamboo, which is now classified as a grass. Bamboo also improves the local (micro) and surrounding environment and provides a good fencing material.

Rooftop Rainwater Harvesting Units are also constructed using bamboo reinforced cement mortar (BRCM) which thus help in adaptation as in the case of Grameen Bandhu biogas plants. The rooftop rainwater harvesting helps in adapting to a scenario of water scarcity.

Photos by INSEDA

Mr. Prabhu Dayal Ninama is happy to have a Bamboo Based (BRCM) Rooftop Rainwater Harvesting Unit installed. Now rainwater can be stored and utilized later for household use and for animals to drink. It is used to store drinking water after properly cleaning it once the rainy season is over. Now he can use drip irrigation for agriculture in summers as well.

The solar tunnel dryer helps in climate change adaptation by providing additional income while utilizing solar energy in drying various items like turmeric, chilly, tomato, and bari (sun-dried and spiced dumplings/nuggets) and papad (spiced dried patties). Both are mainly prepared from certain types of pulses. The dryer helps in drying perishable items thus reducing the wastage of crops in case of reduced demand of the crops, and the finished products can be sold later in the market. The dryer also safeguards the produce from wild animals, flies, and dust particles.

Photo by INSEDA

Solar poly-greenhouses and the green net nurseries helps farmers to generate income by growing off-season crops. The poly-greenhouse saves crops in the event of untimely rainfall, hailstorms, and other climate events. The frame of the solar poly-greenhouse is also made of bamboo thus helping in an adaptation as mentioned before.

Prabhu Dayal Ninama is happy with the solar poly-greenhouse; with the solar panel installed, he can grow off-season vegetables and earn a healthy amount. He doesn't need to depend on electricity for running the exhaust fans, and can also charge his mobile phone.

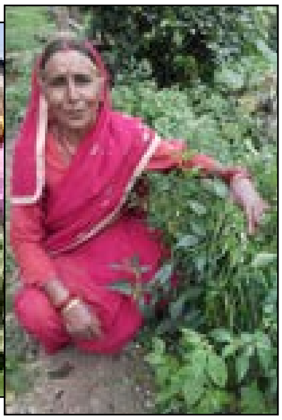
Photos by INSEDA

The bamboo compost basket also utilizes bamboo and therefore helps in climate change adaptation as mentioned above in the case of the Grameen Bandhu biogas plant. The manure helps in soil rejuvenation as explained in case of biogas slurry. It has been very popular in RaniChauri area (New Tehri district of Uttarakhand), where more than 400 compost baskets were given to farmers in the area as the quality of compost was much better as compared to open dried dung or the traditional way of making manure from dung.

Photos by INSEDA

Vermi-compost helps in converting agricultural and kitchen waste, and bovine dung into good quality manure, thus helping reduce the use of harmful chemical fertilizers while helping improve soil quality by adding humus. The humus helps in retaining moisture for longer periods, especially in case of less rainfall, while also helping reduce soil erosion in case of heavy rainfall. It has been successfully implemented by INSEDA in Margul (Ratlam) and farmers have shown interest after witnessing that good quality manure is produced through vermi-compost

Photo by INSEDA



Photos by INSEDA

Kitchen gardens help in building resilience by providing secured income in case of crop losses due to extreme weather events. The families were given good quality s**eeds for kitchen gardening**, where they also utilized the manure from the compost basket, vermi-compost, slurry from biogas plants, as well as from traditional compost. The women were very happy with the quality and taste of vegetables, which were mainly for their own consumption until recently. The nutritional vegetables also helped in building immunity among women and children.

Energy plantation, horticulture, and household forestry

Fruit tree plantations are good for adaptation as their produce compensates for crop losses in case of extreme climate events like drought, storms, hailstorms or unseasonal rains. The fuelwood trees also help in meeting energy demand within a village or even within households and reduce dependency on energy supplies from outside the village. Immunity booster plants help in resilience building among communities in case of any calamity induced by extreme weather such as heat in summers or extreme cold in winters. The roots of the trees also help in soil and moisture conservation thus adapting to climate change impacts. The saplings of fuelwood trees and horticulture trees were distributed among almost all the families. Some of the plants distributed were mango, guava, lemon, custard apple, jackfruit, Java plum, bael patra, amla (gooseberry), drumstick/moringa and bamboo.

Photo by INSEDA

The solar lights have been very helpful as the villagers can move about safely in the snake infested area. The solar lamp has also been highly appreciated as women use it while cooking and children use it for studying. The solar lamp is helpful when women and children need to go out at night for relieving themselves. The farmers can easily carry it to the field at night to operate the electric motor for irrigation. The mobile charging facility is also highly appreciated as electricity is not available sometimes for a couple of days at a stretch, even for those who have an electricity connection.

Solar streetlights and solar lamps are very helpful in case of an electricity failure, which is common in case of extreme weather events particularly because of storms where electricity failure continues for a few days in rural areas.

Photos by INSEDA

Income generation activity is an integral part of the EVD concept. Due to crop losses and fewer livelihood opportunities, people tend to migrate to other regions for livelihood. Because of migration, the EVD solutions installed in the village may not be utilized effectively. For example, the biogas plant needs to be fed on a daily basis and if the feeding is discontinued, the plant efficiency is reduced and can eventually stop functioning. Women's empowerment through **income generation activities for Self Help Groups (SHG)** is a core component of the EVD concept in view of the impact of climate change which results in losses due to crop damage because of untimely and erratic rainfall. Members of the SHGs formed were given country chicken – this would enable them to get regular additional income and livelihood support.

Photos by INSEDA

Sustainability and replicability of successful models promoted in the project with respect to adaptation

Transferring skills of entrepreneurs, masons and artisans and orientation of users on EVD solutions at the local level is key to the success in promotion of the EVD concept. Orientation and capacity building of local panchayat and local government officials is also equally important for propagation of the EVD concept.

Transferring skills to the community during the launch of the EVD project in Margul village

- **HEERA and JWALA Improved Cookstove**
  - Skills transfer to local mason in construction and for installation of fan for forcing smoke through exhaust pipe, solar panel, battery, charge controller, panel for charging mobile and lighting LED bulb
  - Skills transfer to local fabricator in fabricating the exhaust pipe and warm water tank
  - Skills transfer to women in effectively using the stove and in cleaning the exhaust pipe

- **Grameen Bandhu biogas plants built using bamboo reinforced cement mortar (BRCM)**
  - Training women in chemical treatment and weaving bamboo frames for different parts of the dome-shaped biogas plant – foundation, gas chamber, outlet tank, mixer, etc.
  - Training masons in creating moulds in the ground by digging with appropriate size for different parts of biogas plant, guiding women in weaving using the underground moulds
  - Training masons in placing, plastering and properly painting the biogas plants with utmost care to ensure there is no leakage of gas
  - Training users in effectively using the biogas, and proper way of feeding and mixing including regular maintenance of the biogas plant

- **Rooftop rainwater harvesting units (RWHS) with storage tanks built using BRCM**
  - Training women in chemical treatment and weaving bamboo frames for different parts of RWHS like foundation, walls and top cover
  - Training masons in placing, plastering and properly painting the RWHS with utmost care to ensure there is no leakage of water

- **Solar tunnel dryer**
  - Training of local artisan/ mason in construction of solar tunnel dryer
  - Training users in effectively utilizing the dryer

- **Solar poly-greenhouse and greenhouse nurseries**
  - Training of local artisans/ masons in constructing the solar poly-greenhouse
  - Training farmers in effectively using the greenhouse for growing crops profitably

- **Bamboo compost baskets**
  - Training women in chemical treatment and weaving bamboo frames for different parts of compost basket

- **Vermicompost units**
  - Training masons in constructing vermicompost beds.
  - Orienting community in obtaining earthworms.
  - Training users in effectively using vermicompost technique

- **Kitchen gardening**
  - Motivating women and farmers in initiating kitchen gardens
  - Orientation of availability of improved variety of different vegetables which can be profitably and efficiently grown in the vicinity of their homes

- **Energy plantation, horticulture, and household forestry**
  - Motivating farmers to adopt energy and horticulture plantation as home forestry in their backyard or on their farms
  - Training farmers in taking care of the plants

- **Solar PV powered streetlights**
  - Creating community committees to maintain the streetlights
  - Training community in maintenance of the streetlights and safeguarding

- **Solar lanterns with LED and mobile charger**
  - Training communities in use of solar lanterns and safeguarding the solar panel

- **Income generation activities through Self Help Groups (SHG)**
  - Identifying the common and agreed income generation activity
  - Training communities in the income generation activity

Orientation of local government officials

The orientation was given by involving district officers of NABARD (National Agriculture and Rural Development Bank), a federal government bank in Ratlam which is in the process of initiating a project to promote some of the EVD solutions under their Climate Change Fund (CCF).

The activities involved:

- Organizing visits of government officials to observe the EVD solutions installed
- Describing each technology and explaining how each can contribute to the local, national and international sustainable development goals
- Orient them on various aspects such as cost of installation, manpower to be trained
- Explain how the EVD solutions can be incorporated in Village Development Plans (VDP) and
- District Development Plans (DDP)

Sri Lanka

Situation analysis: Climate change and communities

Sri Lanka is highly vulnerable to the adverse impacts of climate change. Adapting to climate change at community level to safeguard life and livelihood is a is routine and necessary component. With handholding and capacity building, community could not only identify adaptation needs, but could develop and implement adaptation strategies to address those needs. The Eco Village Development project is a testament to the fact that with the active support from local institutions, government representatives, and civil society such as IDEA could bring in lasting changes in community approach towards climate impact. The following illustrations of adaptation action makes it clear that local solutions when deployed with the active participation of communities could act as a effective buffer against climate impacts and improve livelihood.

Need for integrating adaptation techniques, and resilience-building practices promoted

Name of the GN Division	Kottawatte
Divisional Secretariat	Thihagoda
District	Matara
Population	683
Houses	160
Families	180
Main livelihoods	Agriculture and livestock, agriculture related labour, self-employed, predominantly a paddy farming area
Major crops	Paddy (over 70%) coconut (8%)
Climate induced	Floods and crop damage in certain lowland paddy areas, extreme rainfall events, mild drought events
Electrification	100%
Cooking fuel	Over 90% on biomass
Institutions	Grama Niladhari office, Schools in 2km proximity, Divisional secretariat 4km proximity
Major challenges	Difficulty to find employment – high unemployment rates, low agricultural productivity, soil infertility due to excessive use of chemical fertilizers and pesticides, improper waste disposals, food insecurity and malnutrition issues, lower literacy rates, lack of clean cooking options, lack of entrepreneurial skills
Adaptation interventions	**Improving productivity of small holder paddy farmers - System of Rice Intensification (SRI)** The conventional small holder paddy farmers were introduced to the System of Rice Intensification (SRI) method. This method is proven to improve factor productivity of land, labour, water, and nutrients, and harness increased yields. This method utilizes a high proportion of organic fertilizers with lesser chemical usage as opposed to the conventional method. Moreover, this method is more resilient to the changes in the

Adaptation interventions	climate. Initially five small holder traditional paddy farmers adopted this method for the 2022/23 'Maha' season (Main paddy growing seasons in Sri Lanka are Yala and Maha). The yield increase was 30-40 percent in comparison with the conventional method. Moreover, no weedicides nor pesticides were utilized for any of the fields. **Promoting alternative livelihoods** Conventional agricultural livelihoods are vulnerable to the impacts of climate change, such as floods, intense rainfall and salt water intrusion. As a means of enhancing their resilience, alternative agricultural and non-agricultural livelihoods were introduced to these farming communities which are less vulnerable to climate change. These include mushroom farming, cultivation of appropriate cash crops, production of organic liquid fertilizer and plant nursery management. **Building capacity of local officials on climate change and climate resilience** It is important that local officials are aware of the importance of Eco Village Development as a climate solution. In doing so a preliminary knowledge on climate change, its impacts and how to enhance resilience is imperative. This capacity was passed on to the local development officials through interactive awareness events.

Intervention: Climate resilient, intensive paddy farming for smallholders			
Baseline condition	**Baseline solutions and issues associated with each**	**Adaptation solution**	**Benefits**
Floods, Intensified rainfall	People in this village practice only traditional method of sown paddy cultivation and are content with whatever harvest they get in the end. The harvest so achieved was very low. The returns were not sufficient even to cover their production costs, which includes the cost of excessive quantities of seed paddy that is required in the traditional sowing method they adapted, in addition to other inputs such as fertilizer and agro-chemicals resulting from high incidence of weeds and diseases due to crowded and non-productive crop. These comparatively poor farmers, mostly small-holders owning and cultivating plots of paddy lands of small extents like half acre, quarter acre or even less than that, tend to	The sustainable intensive paddy farming method was introduced to the farming community in the village as a plausible solution to curb this tendency for abandonment of such low harvest small scale farmland and to enable an enhanced return on their inputs. The project targeted plots of paddy lands of less than quarter acre in extent to introduce the intensive farming method. This initiative was launched in the Kottawatte village of Thihagoda Divisional Secretariat area in Matara District under the Eco-Village Development Project implemented by Integrated Development Association (IDEA). It involves methodical transplanting of nursery grown seedlings in a pre-prepared field. The seedlings are transplanted in rows laid out in the East-West direction enabling	This method utilizes a high proportion of organic fertilizers with lesser chemical usage as opposed to the conventional method. Moreover, this method is more resilient to the changes in the climate. Initially five small holder traditional paddy farmers adopted this method for the 2022/23 'Maha' season (Main paddy growing seasons in Sri Lanka are Yala and Maha). The yield increase was 30-40% in comparison with the conventional method. Moreover, no weedicides nor pesticides were utilized for any of the fields. The fields were able to withstand floods in comparison to traditional fields which underwent significant crop damages.

Baseline condition	Baseline solutions and issues associated with each	Adaptation solution	Benefits
	abandon cultivation because of this reason.	direct sunlight throughout the day. The spaces between the rows of paddy (around 9 inches) and that between the paddy bushes (around 6 inches) facilitates movement in the field without trampling on the paddy bushes, allows for easy manual weeding, and in disease and pest control. This also gains the maximum benefit of the available fertilizer. All available nutrients in the field will be used up by the paddy facilitating strong and luxurious growth. Thus, the resulting yield would be comparatively higher than that of traditionally sown cultivation.	

Traditional seed broadcasting practiced by the community.
Photo by IDEA

Floods in the village area.
Photo by IDEA

Climate resilient paddy farming: Methodical transplanting.
Photo by IDEA

Plot of Mrs Soma, ready for harvesting.
Photo by IDEA

Intervention: Knowledge dissemination on climate change			
Baseline condition	**Baseline solutions and issues associated**	**Adaptation solution**	**Benefits**
Lack of awareness on climate change implications and local actions of development officials	Development officials lack the knowledge on climate change and its impacts, and ways to adapt and mitigate its effects. They are not aware of low carbon, affordable, adaptive and applicable local solutions which can be implemented at the ground level	Awareness raising workshops for local development officials, village officials on climate change implications in Sri Lanka, related districts, climate adaptation, mitigation and local actions such as Eco Village Development.	Local officials are better equipped with knowledge on climate change, and solutions at local level. Ground officials have actively got involved in EVD related interventions and helped to disseminate and sustain solutions.

Climate Change awareness workshops for officials.
Photos by IDEA, Sri Lanka

Intervention: Knowledge dissemination on climate change			
Baseline condition	**Baseline solutions and issues associated**	**Adaptation solution**	**Benefits**
Floods and intensified rainfall, excessive use of chemicals and pesticides. Lack of productive and efficient utilization of local resources. Issues of soil acidification, salinity. Lack of capacity in other alternative livelihoods.	People are involved in traditional agricultural livelihoods such as paddy farming, vegetable farming, which are adversely impacted by floods, intensified rains, acidification, salinity. Primary labour force is in the agriculture sector, who are either working in their own lands, or leased lands as labourers, etc. Lack of employment opportunities, especially for women is another factor to go along with the lack of capacity.	Given the high vulnerability to the impacts of climate change (agricultural livelihoods - primarily paddy cultivation), communities are introduced to alternative livelihoods which are resilient to climate adversities. Primary target groups here are women, who are most burdened in households due to negative impacts of climate and other calamities.	Increases the income of the household as they are minimally impacted due to climate change extreme events. Empowers women and paves the way to strengthening their entrepreneurial skills. Improves food security and nourishment of the families. Food preservation techniques such as food dehydration minimizes local food wastage.
		Agricultural alternatives Mushroom farming as a household industry Promoting yams and tubers as an additional income and ensuring food security	
		Suitable cash crops such as papaya, black pepper, banana, betel	
		Food dehydration	
		Nursery management, organic fertilizer production	
		Non-agricultural alternatives Promotion of eco products - coir-based products	Strengthened resilience of livelihoods - stabilizes household income. Promotes efficient use of local resources and builds capacity of communities on how these resources can be converted in to money without compromising the environment.
		Improvement of livestock storage facilities	
		Improvements in house-based industries - dressmaking, slipper production, etc	

Food dehydration.
Photo by IDEA

Cash crops.
Photo by IDEA

Mushroom farming.
Photo by IDEA

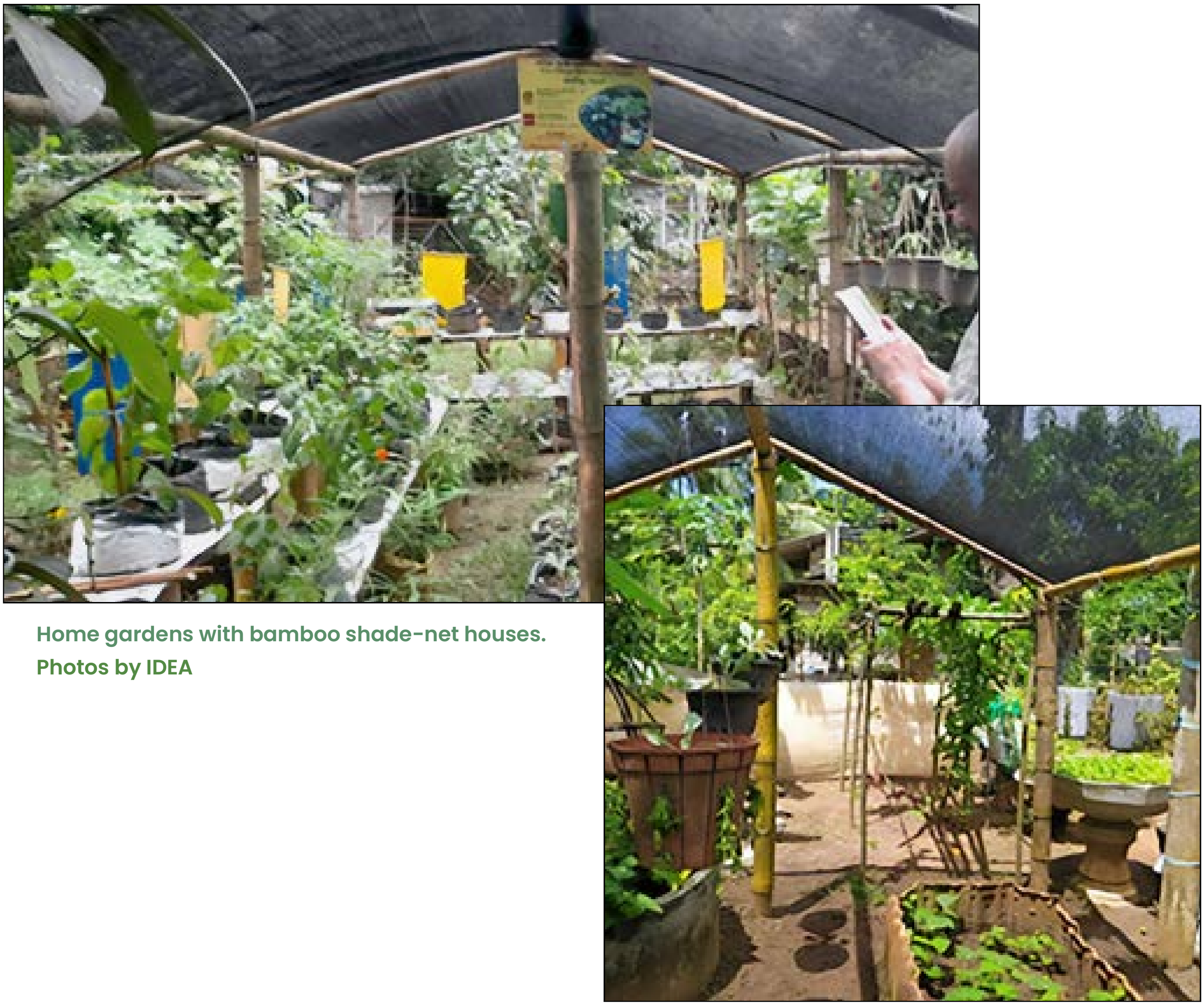
Organic liquid fertilizer production.
Photo by IDEA

Yams and tubers.
Photo by IDEA

Nursery management of cash crops - black pepper, betel, lime, etc..
Photo by IDEA

Eco friendly coir products.
Photo by IDEA

Intervention: Home gardening (bamboo shade-net houses)			
Baseline condition	**Baseline solutions and issues associated**	**Adaptation solution**	**Benefits**
Increased outside temperatures and high evapotranspiration. Intensified rainfalls, floods	Traditionally home gardening is not carried out systematically. Lack of systematic awareness and education of home gardening best practices is a key issue. Hence, home gardening is intermittent and neglected due to diverse climatic conditions.	Community was educated on organized home gardening, suitable crops, sustainable farming practices, organic fertilizer production and applications, seed banking. Bamboo structured, shade-net houses were introduced as a climate resilient practice to cope better with prevailing high temperatures (minimize evapotranspiration and stresses) and intensified rainfalls in the region. Moreover, the intervention provides an organized systematic practice to home gardening, which a household can realistically manage and sustain.	Improves resilience of communities while supporting nourishment and food security of the family.



Home gardens with bamboo shade-net houses. Photos by IDEA

Intervention: Improved biomass cookstoves for households and house-based industries			
Baseline condition	**Baseline solutions and issues associated**	**Adaptation solution**	**Benefits**
Inefficient and improper use of biomass which can lead to deforestation issues in the long run.	A majority of community members utilize biomass as the primary source of energy, predominantly used for cooking. However, inefficient and inappropriate traditional practices such as use of three-stone stoves are widespread both in households and in house-based food processing industries. This potentially increases the consumption of firewood, and leads to issues related to deforestation, in the long run.	Improved household-level cookstoves and institutional cookstoves are introduced to the community through community awareness and demonstration programs, enabling the community to get a hands-on experience. The stoves are built by trained local artisans under the guidance of technical specialists. To disseminate the installations of stoves, selected locals are trained as installers.	It is primarily a mitigation solution but attributes to adaptation. At the household level, it drastically reduces the drudgery on women in terms of reducing cooking time, preventing fire hazards, reducing indoor air pollution issues. Moreover, due to the reduced firewood consumption, the time taken to collect firewood, the cost of firewood is also reduced significantly. Environmentally, carbon emissions are reduced - black carbon. Prevents and lowers the rate of land degradation, deforestation (helps in protection of catchments and watersheds).

Cooking on 3-stones in a smoky kitchen.
Photo by IDEA

Improved biomass 2-pot cookstove and best practice with chimney hood.
Photo by IDEA

Bangladesh

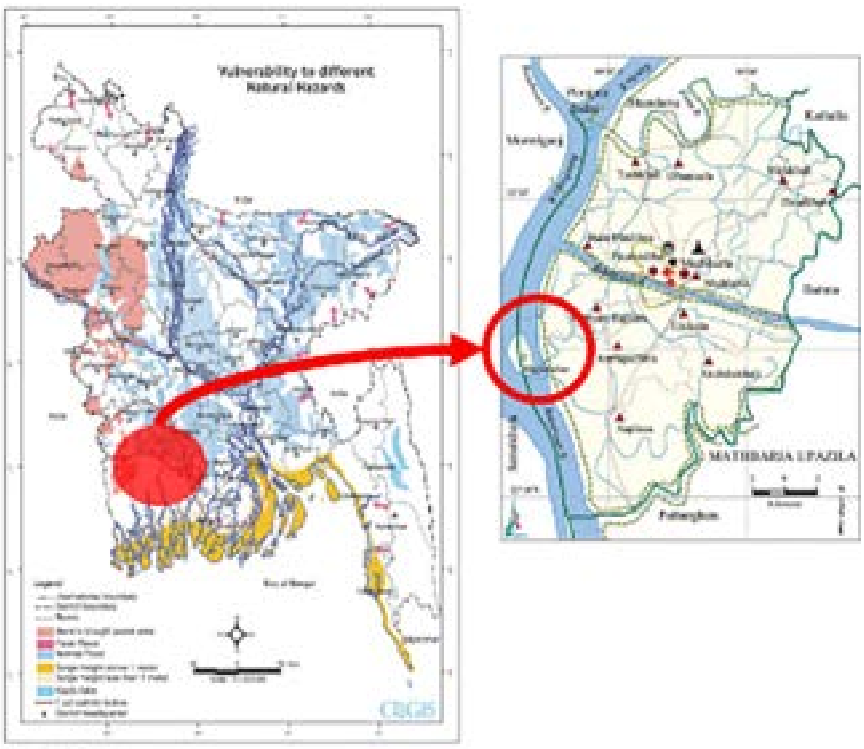
Situation analysis: Climate change and communities

Bangladesh, due to its geographic location, is highly exposed to different climatic hazards and natural disasters. Environmental vulnerability coupled with poor infrastructural and socio-economic factors in the coastal belt of the country further reduces the capacity of local communities to tackle the impacts of climatic shocks and stresses. The south-west coastal region has already been diagnosed with increasing effects of different slow onset stressors such as rising temperatures, salinity intrusion, and sudden climatic shocks such as cyclones, floods, storm surges, etc. With 19 of its 64 districts situated along the Bay of Bengal, the coastal areas of Bangladesh cover 32 percent of the country and are home to over 35 million people, which due to the limited resources and infrastructure, are among the most vulnerable communities globally. In the past 35 years, salinity intrusion in these areas has increased by 26 percent, resulting in a shortage of freshwater supply for most of the coastal inhabitants.

As part of the Eco Village Development (EVD) project, Grameen Shakti has been creating an EVD model village in an island named Majherchar, located in Mathbaria sub-district in Pirajpur district, Bangladesh, which is located in the coastal region.

In year 2007, Cyclone Sidr made a devastating landfall on the southwestern coast of Bangladesh, leaving a profound impact on the village of Majherchar. The cyclone, characterized by towering 16-foot waves, breached coastal and river embankments, and wreaked havoc on an unprecedented scale.

The relentless force of the cyclone, marked by high winds and torrential floods, inflicted extensive damage to homes, roads, bridges, and critical infrastructure. Furthermore, the cyclone had far-reaching consequences beyond the immediate destruction.



The essential resource of drinking water was compromised as debris infiltrated numerous water sources, while saline water from tidal surges inundated many others, rendering them undrinkable. Additionally, the vital sanitation infrastructure was completely obliterated, compounding the challenges faced by the affected community. This village frequently faces other natural disasters like Sidr.

Need for integrating adaptation techniques

The Majherchar village, with a population of about 800, consists of around 200 families, with an average family size of 3-5 members. The main economy of Majherchar is agriculture, fishing, remittance, etc. The major cash crops grown are rice, pumpkins, and melons. The village has no permanent road, one primary school, and one cyclone centre.

Major challenges faced by the local communities are:

1. Scarcity of clean drinking water: The community's primary source of drinking water and household usage is reliant on pond water. This situation poses significant health risks due to water contamination.

2. Limited access to reliable electricity: Although an electricity grid exists, the supply is frustratingly unreliable, leaving residents in the dark and hampering economic development.

3. Limited income-generating opportunities: The community's livelihoods are predominantly dependent on agricultural activities, but they are severely impacted by the capricious forces of nature, such as salinity intrusion, flooding, and cyclones. These natural occurrences disrupt agricultural practices and limit income opportunities.

4. Erosion of the embankment: The village Majherchar is a river island in the Baleswar river in between Sharankhola and Mathbaria. However, this village is constantly threatened by the recurrent destruction of its embankments, which poses a grave risk to the very existence of this village.

5. Lack of clean cooking solutions: Many households continue to use traditional mud stoves for cooking, which not only pose health risks but also contribute to deforestation. Regrettably, the local communities have seen limited benefits from national development programs, including the provision of solar home systems and improved cookstoves, leaving them without access to cleaner and more sustainable cooking solutions.

Resilience-building practices

As part of this project, a Village Development Plan (VDP) was designed through a Participatory Rural Appraisal (PRA) approach to assess the challenges of the communities. Based on the VDP a number of solutions were designed and implemented in the village. Among them, the following solutions contributed to build resilience in the community.

1. **Clean drinking water**

In the project areas, the critical issue of insufficient access to clean drinking water is a pervasive challenge, and the presence of unclean water sources remains a primary driver of waterborne diseases. In response, a multifaceted approach was implemented to address this concern. Rainwater harvesting systems were installed for 10 families, a decision supported by the success of the EVD project, which witnessed the installation of over 100 rainwater harvesting units by local municipalities.

Furthermore, the installation of solar-powered water pumping and filtration systems through the EVD project were also undertaken. These combined measures significantly improved the situation, with the ultimate goal of raising the clean drinking water access rate from its previous range of 10-15 percent to an impressive 80 percent. This endeavor marks a pivotal step towards ensuring a healthier and more secure environment for the local communities.

Biogas tank and solar-powered water pump installation.
Photo by Grameen Shakti

2. **Improved cookstoves**

The quality of cooking facilities for 150 families was enhanced, prioritizing the well-being of women in particular. These improvements include the introduction of durable concrete stoves that not only enhance energy efficiency but also significantly contribute to the overall health of women. Moreover, these stoves prove to be a valuable asset in disaster-prone areas due to their resilience and longevity, surpassing traditional mud stoves.

Durable concrete 2-pot improved cookstove.
Photo by Grameen Shakti

3. **Solar street lights**

We have successfully installed 11 units of solar street lights in key areas of Majherchar village, strategically positioned to enhance safety and security during the nighttime hours. These illuminations serve as a beacon of protection, particularly beneficial for the well-being of women within the community. Notably, during instances of natural disasters or power outages, these solar-powered street lights serve as guiding beacons, offering a vital sense of direction and safety to the entire community.

Solar powered street light.
Photos by Grameen Shakti

4. **Climate-smart farming**

The local farmers in our community have received valuable training in climate-smart farming practices. To further support their endeavors, a connection between the farmers and dedicated agriculture officers was established to provide assistance and guidance whenever it is needed in terms of farming practices. In addition to these efforts, planting of 300 fruit-bearing plants throughout the village was initiated. This initiative serves a dual purpose – to contribute to the economic well-being of the community by generating income from fruit production, and also playing a role in environmental conservation, promoting a more sustainable and eco-friendly environment for all.

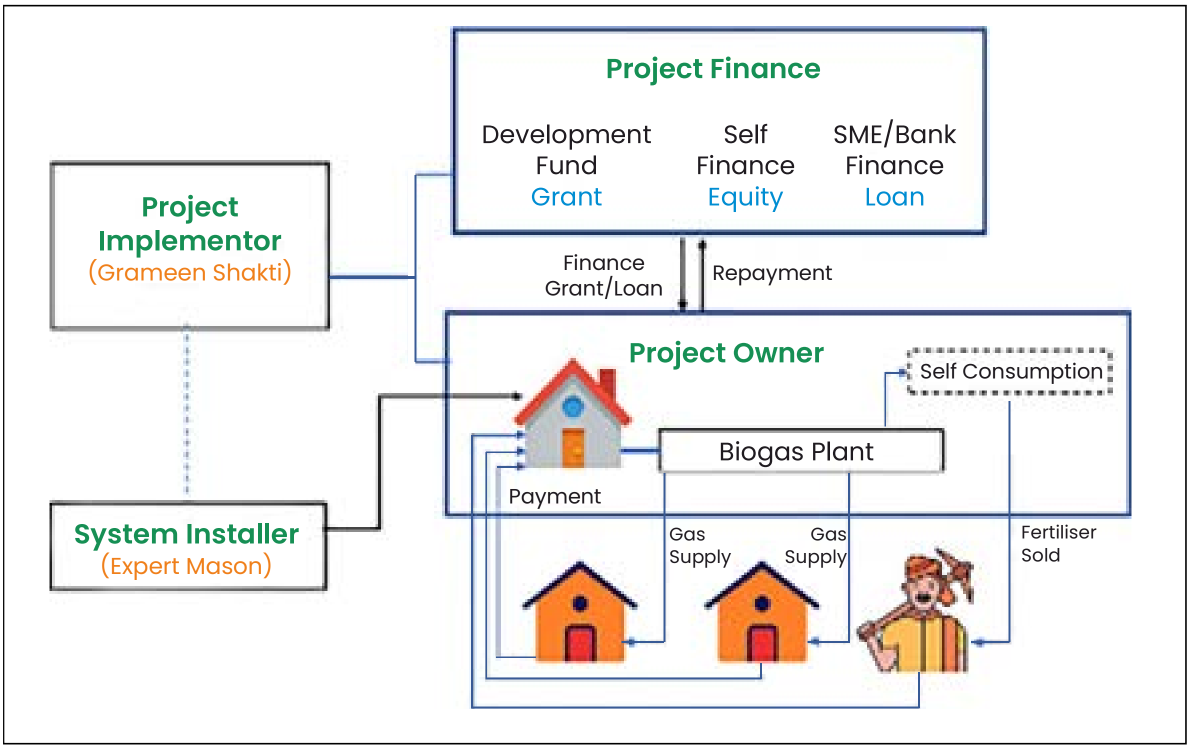
Photo by Grameen Shakti

Sustainability and replicability of successful models promoted in the project with respect to Adaptation

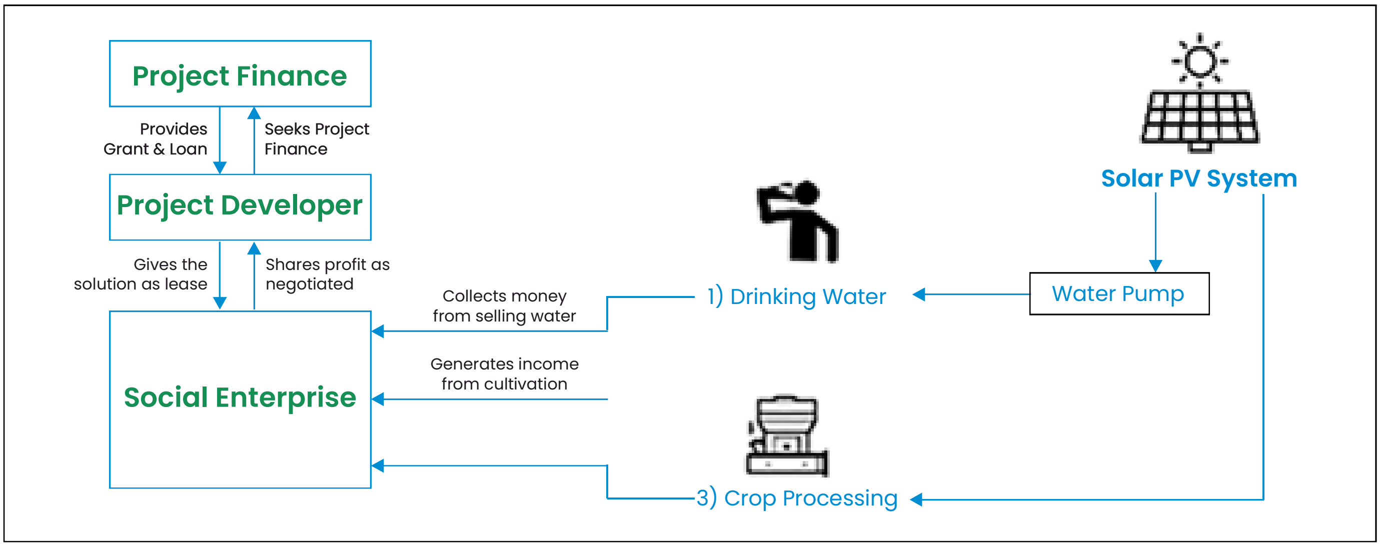
Rainwater harvesting systems were installed for 10 families, a decision supported by the success of the EVD project, which witnessed the installation of over 100 rainwater harvesting units by local municipalities.

The local farmers in our community received valuable training in climate-smart farming practices. To further support their endeavors, it was crucial to connect the farmers and dedicated agriculture officers to readily provide assistance and guidance whenever necessary in terms of farming practices.

Grameen Shakti developed the concept of a community-based biogas plant through EVD project and at present through the dedicated department for the biogas program and replicating the social enterprise model.



Currently, the process of developing a model for an integrated solar water pump for drinking, drip irrigation, and productive use appliances such as crop processing is underway.



Conclusion

While most approaches to climate change either focus on mitigation or adaptation, the Eco-Village Development (EVD) project combines both objectives along with livelihood benefits. The implementation of EVD solutions in demonstration villages has considerable emissions reduction and adaptation co-benefits. The evidence collected from the villages is a testament to the fact that community mobilisation, need analysis, capacity building, liasioning with local institutions, and convergence with local schemes and programs could bring in lasting changes to the lives of the local communities. Over the implementation period, the uptake of local solutions in the village plans and provincial (district) plan have provided impetus to local solutions. The continuous engagement with local to regional policy makers and climate negotiators resulted in recognition of local solutions as a viable alternative to traditional approaches of development. Local solutions are the appropriate response to many climate change challenges at the local level while awaiting coherent and connected policies at the national level.

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