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Building Resilience and Adaptation to Climate Extremes and Disasters

Catalogue of Climate Change Adaptation Approaches and Technologies

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Development through resource management

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Preface and Acknowledgements

Nepal is highly vulnerable to the adverse impacts of climate change. Changes in climatic patterns and overall trends in rising temperature are resulting in altered and unpredictable rainfall patterns, including less frequent but more intense rainfall events and erratic precipitation. These changes are causing longer dry spells and drought events that result in the depletion of critical existing water sources. Impacts will have a disproportionate effect in rural areas that are difficult to reach and those depend on natural resources. Enhancing the resilience capacity of farmers and vulnerable communities in Nepal is therefore essential to help them adapt and cope with the impacts.

In response to growing concerns about climate change impact in Nepal, the Ministry of Forest and Environment established the National Adaptation Program of Action (NAPA) to address immediate and urgent needs of climate vulnerable people in Nepal and to encourage community-based adaptation through integrated management of agriculture, water, forest and biodiversity. Likewise, the Ministry of Forest and Environment also established a framework to tackle specific and unique climate change-related issues of local communities and people, known as the Local Adaptation Plan of Action (LAPA) which is in revision process on the context of federal structure. The Government of Nepal has recently revised LAPA framework and climate change policy which is also very instrumental and emphasis to build resilient society.

In line with the Nepal government's climate change policies, the Building Resilience and Adaptation to Climate Extremes and Disaster (BRACED)/Anukulan, a DFID funded project led by iDE Nepal, has been implemented by a consortium of stakeholders that consists of iDE, Rupantaran, Sappros and RIMS-Nepal. This project has been implemented in 6 districts of Nepal: Bardiya, Kailali, Kanchanpur, Dadeldhura, Doti and Surkhet with the aim to improve the well-being of rural poor.

The project implemented various approaches and technologies to increase the resilience of the country's most vulnerable communities. "Catalogue of Climate Change Adaptation Approaches and Technologies" compiles and consolidates the Anukulan experiences and intends to share the same with the wider stakeholders who work in the similar field.

We would like to extend our sincere gratitude and appreciation to the Anukulan team who contributed in publishing this document. This catalogue will be excellent reference materials for farmers, agriculture technicians, service providers, marketing managers, academia and various types of organisations working in climate change adaptation and DRR sector.

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Acronyms

BRACED	Building Resilience and Adaptation to Climate Extremes and Disaster
CBF	Community Business Facilitator
CC	Climate Change
CCA	Climate Change Adaptation
CPA	Commercial Pocket Approach
DC	Direct Current
DDR	Disaster Risk Reduction
DU	Distillation Unit
FCT	Ferro Cement Tank
ICS	Improved Cooking Stove
ICT	Information, communication Technology
IEC	Information, Education and communication
IPM	Integrated Pest Management
LAPA	Local adaptation Plans for Action
LDCRC	Local Disaster Climate Resilience Committee
LG	Local Government
MFI	Micro Finance Institution
MPC	Market Planning Committee
MTJ	Modified Thai Jar
MUS	Multiple Water-use System
NAPA	National Adaptation Programme of Action
PPP	Public Private Partnership
SMUS	Solar Multiple Use Water System
TDH	Total Dynamic Head

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A. Introduction:

Sensitisation activities play a vital role to understand climate change causes, impacts, challenges, opportunities and potential strategies that can be adopted among local communities. It also helps to understand the linkages between climate change and disasters if the climate change continues it will lead frequent and severe natural hazards such as drought, flood, storm and the institution mechanisms that are existed at the local level.

Although climate change and disaster affect all, poor and marginalised communities are more vulnerable due to lack of capacity and resources. A critical first step in introducing climate change adaptation activities involves raising community awareness about the climate change and its responding measures to adapt. Educating and sensitizing communities and stakeholders requires the use of a variety of tools and techniques including: radio programmes, street dramas, awareness Campaign, orientation, trainings, posters, pamphlets and other audio-visual materials.

B. Uses and relevance for responding to climate change and disaster

Creating an understanding and sense of urgency about the risks of climate change and disaster is an essential step in the process of helping communities and stakeholders to adopt appropriate interventions that address impacts of climate change of disaster. Climate change adaptation and disaster risk reduction sensitization prepares basis for preparation DRR harmonized adaptation plans at local level.

C. Requisites and Availability

Anukulan-X has developed and used different tools and techniques for sensitising communities about climate change adaptation and disaster risk reduction. The project has also created own information, education and communication materials such as poster, flex poster, pamphlet and public service announcement. Similarly, various such materials can be obtained from other organization and open sources as well.

D. Estimated Cost/The cost factor

The cost of production of extension materials varies depending on the types, size (large/medium/small), quantity and quality of the extension materials. Likewise, the cost of the workshops/trainings varies according to the number of participants, organisational norms, systems and procedures.

E. Cautions

- Sensitisation tools and techniques should be designed with the socio-economic background and education levels of the target group in mind.
- Photo presentations alongside role playing can be very effective for community members and does not discriminate against members that may be illiterate.
- Before organizing events, a week advance preparation along with extension materials needs to be done.
- Climate change is an emerging issue, so perception of community needs to be linked to the scientific facts and figures.

Anukulan-X organized 41 events of climate change adaptation and disaster risk reduction sensitization workshops at 41 Local Governments (LGs) and 397 wards. Altogether 8,332 individuals participated in these events including 35% women. These workshops contributed to raise awareness and understanding of participants about climate change and disaster, their impacts and response measures.

2. Adaptation Planning & Mainstreaming

A. Introduction:

Figure 2: Harmonized LAPA Workshop participants, Dadeldhura

Adaptation planning should be a systematic and participatory process for assessing local climate change vulnerability, prioritising options to prevent, respond and prevent future disasters. In Nepal, there is a detailed process for this as outlined in the National Adaptation Program of Action (NAPA) and Local Adaptation Plans for Action (LAPA). The process includes engagement of stakeholders (what we refer to as 'sensitisation'), assessment of vulnerabilities (including hazards), identification of vulnerable communities, existing and potential adaptation measures, reaching consensus on adaptation measures to be implemented, prioritising adaptation options, implementation measures and monitoring. Inherent in this process is the expectation that adaptation planning will become integrated in existing development planning processes of local governments and community organisations (a process also referred to as 'mainstreaming').

B. Uses and relevance for responding to climate change

Although climate change is a global issue, its impacts are local level. Therefore it requires a community and local response in addition to national and multi-national actions. Nepal's Climate Change Policy, National Adaptation Program of Action (NAPA), National Framework for Local Adaptation Plans for Action (LAPA), disaster act and draft local disaster and climate resilience planning (LDCRP) guideline emphasize adaptation and DRR planning and implementations at the local and community level. Adaptation planning supports development of systematic intervention tailored to the unique local conditions and the specific needs and characteristics of vulnerable communities. With mainstreaming, climate change adaptation and DRR interventions can be scaled up and sustained to benefit large numbers of people.

C. Requisites and Availability

- Trained adaptation and DRR planning facilitators
- Participation of multiple stakeholders from various sectors/thematic areas with considerations to geographical, social and gender representation.
- Process should be led by Local Disaster and Climate Resilience Committee (LDCRC) and owned by local government to ensure its effective implementation.

D. Estimated Cost/The cost factor

- Each harmonised LAPA preparation workshop requires at least 3-5 days at local government level. The cost of the workshop will depend on the cost norm of the organisers for transportation for participants, stationary materials and type of workshop. There will also be cost for typing, printing and binding the finished adaptation plan

E. Cautions

- Leading role of LDCRC and ownership of local government is crucial for planning and implementing harmonised LAPAs.
- More specific the plan, the better the chances are it will be implemented.
- It is very important to address the hazards in the community.
- An understanding of the basic science of climate change and its relationship to various adaptation and mitigation interventions is required
- In DRR harmonized LAPAs, DRR related activities should be included in line with the disaster management cycle- preparedness, response and recovery.

Anukulan-X Project has facilitated formulation of 40 Local Disaster and Climate Resilience Committees at LGs. The committees were instrumental in formulation and implementation DRR harmonized LAPAs at LG level. The assemblies of LG have endorsed DRR harmonized LAPAs and considered the plans as basis for the local development planning.

3. Establishment & Mobilization of Adaptation Fund

A. Introduction:

Disaster risk reduction (DRR) activities in harmonized Local adaptation plans of actions (LAPAs) requires enormous amount of resources. Local government planning and budgeting guideline 2074 has made provision to allocate funds to implement disaster, climate change and environment related activities. This allocated fund can be utilized to implement prioritized adaptation activities.

BRACED/Anukulan Project supported adaptation fund with clear guideline and mechanism of its use through the harmonized LAPAs. Local disaster and climate change resilience committee is responsible to mobilize the fund. Adaptation fund mobilization guideline has highlighted the process of using funds in adaptation and DRR activities. Besides, DRR harmonized LAPA documents has identified the major hazards, vulnerable communities and priorities adaptation options as well. Based on the adaptation fund mobilization guidelines and harmonized LAPA documents, adaptation fund can be invested for addressing impacts of climate change and disasters of vulnerable communities.

B. Uses and relevance for responding to climate change

National Adaptation Programme of Action (NAPA) has envisioned that 80 percent of available fund should directly goes to the local level. This kind of provision ensures effective mobilization of fund to combat impacts of climate change and disasters.

C. Requisites and Availability

- Authorized institution to lead the DRR harmonized LAPA process.
- Ownership of DRR harmonized LAPA by local government.
- Clear adaptation fund mobilization guidelines and/or procedures.

D. Estimated Cost/The cost factor

- Minimum balance or the cost of opening an account as per the financial institution rules and regulation.
- Under Anukulan NRs 300,000-500,000 has been supported to set-up adaptation fund within a local government (Gaunpalika: NRs 300,000 and Nagarpalika: NRs 500,000).

E. Cautions

- Securing adequate resources locally and from similar organizations.
- Areas/sectors of investing adaption fund.
- Ensuring mobilization of adaptation fund as per DRR harmonized LAPA guideline.

Anukulan -X has supported 41local government to establish adaptation fund. Altogether NRs 17,100,000 adaptation fund been supported for 41 local governments by Anukulan project to initiate implementation of high priority adaptations. Adaptation fund is helping vulnerable communities to cope with adverse impacts of climate change and disasters.

4. Establishment of Emergency Fund

A. Introduction:

An emergency fund is a safety measure to cope with climate extremes and other natural disasters. An emergency fund can be established at different level. Local government planning and budgeting guideline be has clear provision to establish emergency fund at LG level so that in case of disaster local government will able to response immediately. Few LGs are initiating to allocate emergency fund. Anukulan has practiced to allocate certain percentage of an adaptation fund in to the emergency fund. Besides, emergency funds can also be collected locally through personal/family contributions, institutional contributions or by organizing charity events or by other appropriate methods which seek support from various government or non-governmental organizations. In order to systematically operate the account a 'procedure for emergency fund establishment and operation guideline' has been developed.

B. Uses and relevance for responding climate change

As climate change or disaster events are uncertain, an emergency fund is a good to way response the disaster victims community immediately from local level. An emergency fund ensures immediate support during emergencies when victim community are unable to do anything by themselves.

C. Requisites and Availability

- Preparation of procedures in a participatory way and by consensus.
- Convenient and trustworthy account operation by reputable financial institution.
- Signatories for the account operation.

D. Estimated Cost/The cost factor

- Minimum balance or account opening cost as per the financial institution. The local government, project/ programme can top-up and contribute the cost.
- Normally 10% of climate change fund is allocated and deposited as an Emergency Fund

E. Cautions

- Careful selection of the institutions and persons for account operation.
- Efforts to collect resources both locally and from external organizations.

Emergency funds have been established in all local governments which is very important to address needs of disaster victims immediately. This fund can be used to manage temporary shelter and food to provide relief support for victims during and immediate after disasters.

5. Bio-Gas

A. Introduction:

Biogas is a renewable fuel sources that alternates fuel wood for domestic uses. Cow dung, bio-degradable household wastes, often mixed with toilet wastes, undergoes anaerobic digestions in the biogas plant digester. The size of the digester is generally 2-8 cubic meters and produces bio-gas energy that can be used for heating, cooking or other purposes. The slurry produced as a by-product is a good manure that can be used as fertilizer on farms.

Figure 4: Toilet attached to Biogas plant in Kailali

B. Uses and relevance for responding to climate change

This technology is particularly appropriate in rural areas of low-land or mid-hill regions of Nepal below 1500 meter in altitude. The energy from biogas can be used for different purposes, including, heating, cooking and generating electricity. For Biogas replaces the use of fuel wood and so it not only supports forest conservation, but also saves time collecting firewood, particularly by women and children. It reduces smoke in the kitchen, helps to maintain the cleanliness of kitchen utensils, reduces health hazards (eye and lung problems) and supports nutrition (production of vegetables through use of slurry) and sanitation. Thus, bio-gas supports mitigation as well as adaptation/resilience to climate change.

C. Requisites and Availability

- Availability of local materials and its location.
- Sand, stone/brick, gravel and cement for plaster can be collected locally.
- Biogas stoves, regulators, rods and pipes can be purchased locally.
- Trained labor authorized by bio-gas companies.

D. Estimated Cost/The cost factor

- The cost of a biogas plant varies (approximately NRs.50,000 to NRs.75,000) depending upon capacity, location of the plant, availability and transportation cost of the materials.
- There is provision for a subsidy (NRs.20,000 to NRs.40,000) or soft loan through a revolving fund from the Government of Nepal and also from other local organizations.

E. Cautions

- Need sufficient raw/feeding material and hence commitment to cattle farming.
- Careful selection of capacity as per the availability of feed material and family size.

Anukulan has supported installation of 1,502 biogas plants in coordination and collaboration with AEPC. It has enhanced ecosystem restoration reducing deforestation, promoting forest conservation, and reducing GHGs emissions. Besides it has reduced work load of women and children to collect firewood.

6. Improved Cook Stove

A. Introduction:

An improved cook stove (ICS) is designed to reduce consumption of fuel-wood and reduce smoke emissions compared to the traditional cooking stove. It is convenient, saves cooking time and reduces health hazards, specially, for women. ICS consists of a well-designed stove framed with local brick, iron and pipe for smoke outlet.

Figure 5: ICS inKanchanpur

B. Uses and relevance for responding to climate change

The direct and indirect benefits of ICS include: increased thermal efficiency, the conservation of forests by reducing firewood consumption, (almost one fourth the quantity), reduction in women's labor, reduction in indoor air pollution (30-90%) reduction in smoke-induced health disorders, prevention of fire hazards and reduction of cooking time. ICS can be used in different geographic regions from low land to mountains of Nepal. It reduces emission of carbon dioxide (one of the greenhouse gases) by around 2.5 tons of CO2 per year through smoke, which support in climate mitigation. By improving health, conserving forests and reducing the amount of money spent for fuel-wood, it supports the resilience of the climate vulnerable households. Depending on the specific design, ICS schemes can be deemed clean development mechanisms and eligible for funding support.

C. Requisites and Availability

- The materials required for the construction of ICS are locally available and include: stones/bricks, mud/earth, straw/rice husk, iron plates/rebar/sheet, and animal dung.
- Skilled labor/ICS promoter for the installation

D. Estimated Cost/The cost factor

- Material can be found locally. The only cost will be the payment of promoters, which ranges from NRs.350 to NRs.1500 for a mud brick ICS.

E. Cautions

- Problems may arise if ICS promoters do not adhere to the technical specifications during installation or if users neglect regular maintenance.
- Smoke backfiring because of the incorrect placement of the chimney outlet, lack of regular cleaning of the chimney and slow cooking in the second pothole.

Anukulan-X Project has supported installation of a total of 2,507 Improved Cooking Stove. This has reduced the work load of women and children to collect firewood, save time of cooking and better access to efficient energy technologies. Ultimately, it has reduced the drudgery of the women.

7. Bio-Engineering

A. Introduction:

Bio-engineering is the use of living plant materials as the primary structural component (along with engineering design and technology as necessary) to reinforce soil and stabilize slopes or riverbanks from landslides or riverbank cutting. There are different kinds of bio-engineering being used in Nepal including: brush layering, brushwood check dams, conservation plantations, hedgerow on sloping land, jute netting, etc.

Figure 6: Bio-engineering, Kanchanpur

B. Uses and relevance for responding to climate change

Bio-engineering uses the combination of physical structures and vegetative measures to stabilize the land for both immediate and long-term benefits. Thus, it reduces loss and damage to the ecological system due to land/flood related disasters that are increasingly triggered (in frequency and scale) by climate change.

C. Requisites and Availability

- Locally available materials: bamboo, earth, vegetation, rock, and lumber.
- Depending upon the engineering structure design, additional materials may be required.
- Skilled as well as unskilled labor/local participation will be required.

D. Estimated Cost/The cost factor

- Local materials can be available without cost, but engineering services may be necessary and some designs may involve costs for some materials and labor. The cost varies as per the design, dimensions, location and other factors.

E. Cautions

- An appropriate design or technology is essential. Consultation and supervision by a qualified technician or experienced practitioner is necessary.
- Select the soil bio-engineering techniques most suited to the characteristics of the site, taking into account climate change trends.

Anukulan-X has given high priority to bio-engineering for controlling soil erosion from the shallow rivers. It has been found very effective in those areas where the velocity of water is not high and the gradient of the river is not high. It has contributed to restore vegetation, protect land and maintain ecosystem.

8. Micro Weather Information System

A. Introduction:

A Micro-weather station is a set of weather measuring unit that can be installed at homestead or offices to measure the local weather parameters. It is also called a personal weather station. Different brands of micro-weather measurement systems are available in the market such as Accurate, Ambient weather, Davis, etc. Most of these systems include the instruments to measure temperature, rainfall, relative humidity, wind speed and direction. These measurements can be stored in personal computers for own use and also to broadcast or share data to global platforms through the internet which enables more reliable forecast of the location. Weather underground is a global platform for information sharing and forecasting based actual local data.

Figure 7: Micro Weather Station Device

B. Uses and relevance for responding to climate change

Weather station plays an important role for various purposes such as: determining whether a particular region is ideal to grow a specific crop, safeguarding the crop against adverse environmental conditions such as hail, excess or deficient rain, help anticipate weather conditions that may aggravate plant diseases or lead to pest and insect intrusion, etc. Moreover, information obtained from weather station is also used for research activities to improve/optimize irrigation patterns, pest control models eventually improving the quality of the crop. Further, forecasting of rainfall, wind and temperature extremes helps local community for early preparation like cropping and harvesting of crops. The forecast received from weather underground of a point location valid for 4 km circumstance but multiple forecasts can generate to cover greater area. Further, integration of information dissemination mechanism with micro-weather station is crucial to maximize the benefits from the system. For instance, if MPC/CC owns the system then MPC/CC could send SMS alert in a simple word to their member farmers.

Figure 8: Microweather station, Chaumala inKanchanpur

C. Requisites and Availability

The station should provide quality data, poor quality could result false forecasting and inaccurate forecast will be worthless. At first, proper installation of sensor is essential. Secondly, several testing and calibration are needed for accuracy of data before broadcasting. For calibration we should follow the system catalogue. There are other things to be considered which are:

- Choose a location that is a wide open area, with few structures around to ensure most accurate measurements.
- Mount the sensor at least 5 feet (1.5 meters) off the ground in an open area. Higher is better for wind measurement (the National Weather Service) recommends 33 feet (10 meters) high.
- The bubble level on the top should be centered and the solar cell should be facing south.
- Place units away from large metallic items, thick walls, metal surfaces, or other objects that may limit wireless communication.
- Place units at least 3ft (0.9m) away from electronic devices (TV, computer, microwave, radio, etc.).
- Position sensor away from heaters, air conditioners, chimneys, exhaust vents, asphalt and concrete (surfaces that radiate heat).
- Avoid installing the sensor near pools, spas, or other water bodies. Water sources may impact humidity accuracy.
- Don't install the sensor where sprinkler system sprayed are used as this may impacts rainfall measurement accuracy and may force water inside the sensor.

At present these weather devices are not easily available in the Nepalese market. It is necessary to ensure availability of such devices in Nepal.

D. Estimated Cost/The cost factor

- The cost of the system varies according to the brand, and range of weather parameters measured. In general, cost range from $150- $1,000 for system only. Additional cost required for internet and electricity and backup system. For smooth operation, provision of electricity backup is required.
- Similarly, provision of PC and SMS packages for generation of forecast and dissemination of information add value in it.
- 6 micro-weather stations have been installed by Anukulan/BRACED project as a piloting in three districts. The average cost for installation of a system was NRs. 1,23,000 including weather device, laptop, internet service, backup system and installation charge.

E. Cautions

- Normally open location with no obstruction is preferred for more accurate measurement.
- Large number of weather stations in particular locality can generate more reliable forecast.
- Careful operation and handling of device is required.

Anukulan-X has supported MPC to install six (6) micro weather information system in coordination with local governments. They are providing weather advisory services which is supporting local communities in making proper plan for crops cultivation and harvesting as well as other social events and activities.

9. Cultivation of Essential Oil Crops and their Distillation

A. Introduction:

Essential oil crop cultivation and their processing is relatively a new intervention in agricultural sector in Nepal and is becoming popular among farmers. Essential oils are extracted by steam distillation process. Anukulan/BRACED make has promoted stainless steel steam distillation units (DUs) to distill the quality essential oil crops. The DU is designed with a system of siphon funnel in the vessel for cohabiting overflow of distillate from the condenser to maximize oil recovery.

Figure 9: Essential oil Distillation Unit, Beldadi, Kanchanpur

In the distillation process, the essential oil crop is partially dried to reduce the volume of the plant material to ease the transportation to distillation sites. The wilted or partially dried plant material is loaded in the distilling vessel uniformly. Firing at the bottom of the vessel will change water kept at the bottom of the vessel into steam that evaporates essential oil when it comes in contact with oil glands of the crops. The steam and oil vapors are channeled into the condenser where they are condensed into water and oil due to cool water circulation.

The distillate (oil and water) is collected in the oil receiver. The light essential oil accumulates above the water in the receiver. The oil from the receiver is collected in the separation funnel where oil is separated from water.

Figure 10: Chamomile oil collection, Amar Gokul CFUG, Punarbas Municipality at Kanchanpur

B. Uses and relevance for responding climate change

DU is appropriate for rural Terai or valley areas where cultivation of annual (Mentha, Chamomile, etc.) and perennial (Citronella, Palmarosaetc) essential oil crops could be grown. Anukulan/BRACED initiated cultivation of Mentha at farmers' field during fallow period between wheat harvesting and rice cultivation season, mostly during February and March. Chamomile is cultivated in the farmer's field by replacing wheat crops. Perennial essential oil crops are cultivated in barren land in community forests or public lands.

Figure 11: Chamomile crop cultivation Bishnu CFUG Kailari rural Municipality, Pavera.,Kailali

Essential oil crops are high value crops as the oil seeks higher prices in national and international markets, open options for crop diversifications and avoid wildlife crop damages for farmers residing in buffer zone areas. Essential oil crops provide an additional avenue for income generation that builds climate resilience for vulnerable households. Additionally, cultivation of essential oil crops creates a favorable environment for regenerating forest species on barren community forest land. Essential oil crops are more resilient to droughts, floods and pests providing increased income.

C. Requisites and Availability

- Steel essential oil distillation unit that can be purchased/imported from Barabanki, India (Swaraj Harbal Company) by ordering as per the specific design.
- Private or community forest land, water tank, shade, oil container, store house, separating funnel, funnel, weighing machine that can be available at the local level.
- Trained DU operator and unskilled labor.
- Seeds or suckers for essential oil crops can be collected from areas where there is already a practice of cultivating these crops.

D. Estimated Cost/The cost factor

- The cost of a DU varies. Steel DU with Anukulan design and capacity from Baranbanki, India is approximately NRs. 475,000 including transportation and installation cost.
- The other cost for infrastructure including shade, water supply system, store house and others is approximately NRs. 500,000.

E. Cautions

- Feasibility study and design by an experienced technician is necessary.
- Maintaining quality in production and storage of the essential oil product.
- Before planning for commercial production farmer/producers are encouraged to arrange processing facilities and to have an assured market for their production. Essential oil entrepreneurs should know their production cost and set their prices by competing with other producers. Essential oil market prices fluctuate like any other good, depending on supply and demand.

Fifteen new Distillation Units (DUs) have been installed and 42 existing DUs have been repaired, maintained and upgraded by Anukulan and Anukulan-X period. This has contributed to diversity and raised additional income for the vulnerable people from essential oil crops.

10. Marketing and Planning Committee

A. Introduction

In order to raise the income of farmers, it is important to concentrate not only on the production of agricultural goods, but also the marketing of those goods. For this purpose iDE Nepal **(BRACED/ Anukulan Project)** has established a model centered around the development of a marketing and planning committee, which primarily works in commercial pocket areas to help with production and marketing programs. These programs focus on improving the production and marketing of vegetables, high value and off season crops in order to help generate and sustain higher sources of income with climate change adaptation for the farmers.

Figure 12:Chuamala collection center in Gauriganj, Kailali

The MPCs are composed of the representatives of farmers groups and traders and also 3-4 members advisory committee from the representative of agriculture service centre, municipality and others stakeholders.

The primary goal of the establishment of MPC is to help farmers to develop a self-governed system for collection, marketing, and sale of farm outputs. The MPC also works to build agricultural knowledge and coordination, and establish market linkages for improved agricultural technologies. The establishment of a Marketing and Planning Committee will assure farmers to sell their vegetable products in the collection centers, gives opportunity to generate additional income expanding commercial pocket areas, introducing improved technologies, increasing access to inputs and so on.

B. Uses and relevance for responding to climate change

In order to build adaptive capacity, market access and linkages with traders is essential. MPCs enable smallholders to address climate change and other impacts on agriculture. It also supports poor and vulnerable farmers to improve their knowledge and increase production by providing access to climate smart agricultural knowledge and technologies. They help farmers in seeking solutions from government extension services, the private sector and development stakeholders. Through MPCs, different market led services become accessible to poor smallholders. MPCs provide a range of services including market access, detailed crop calendars, climate smart agriculture knowledge and technologies, linkage to finance and crop insurance company, and linkage with government services. They reduce the transaction costs for communicating with smallholders and facilitate the expansion of last mile supply chains.

C. Requisites and Availability

- Public private partners (PPP) to support basic infrastructure such as a private or public shed or building for a collection center, furniture, weighing machine and post-harvest materials are essential, which can normally be obtained from different service providers.
- Active and functional marketing and planning committee, as well as a collection center and a regularly operating collection center.

D. Estimated Cost/The cost factor

- The cost depends upon the functions and services provided by the marketing and planning committee. Normally NPR 100,000 is required to create a functioning MPC/CC in starting stage.

E. Cautions

- Feasibility study by an experienced technician is necessary prior to starting an MPC.
- Selection of the site should involve consultation and participation of local farmer groups and local governments.

The total of 57 Marketing and Planning Committees (MPCs) of 57 collection centres have been established and strengthened. These collection centers have improved access to market and exchange of information on agriculture crops, agri-inputs and technologies among farmers. In some pilot sites, they are also providing weather information.

11. Commercial Pocket Approaches (CPA)

A. Introduction

Figure 13: A woman farmer in Bheriganga Surkhet

Commercial Pocket Approach ensures the availability of agro-services and flow of market information to smallholders while enhancing their participation as key market players. Commercial Pockets consist of well-functioning market chain actors including Farmer Groups, Collection Centers, and Apex Committees. These intermediaries create a cohesive economic ecosystem linking smallholder farmers to more lucrative local and regional markets, while providing an avenue for advocacy, access to new technologies, and technical support. The establishment of Marketing and Planning Committees (MPCs) represents a valuable governance intervention, enabling local communities to articulate their needs and demand access to public services and investments. Through a focus on building the capacity of MPCs and private service providers, system improvements continue after project support has ended.

B. Uses and relevance for responding to climate change

Commercial pocket approach is a holistic approach which directly addresses the climate change through involvement of all actors for the sustainability of vegetable production and helps to increase the resilience of smallholders by ensuring regular income through selling of the vegetables. It also helps to increase the production and productivity of the vegetables.

C. Requisites and Availability

- In commercial pocket approach, there must be the value chain actors and harmonized relationship among the actors. That makes the win-win situation and increases the area, production and productivity of the vegetables. The commercial pocket approach enhances the public and private sectors partnership (PPP). There must be vegetable producers groups, agri-input suppliers, marketing and planning committee/collection centers.
- The project has facilitated the preparation of Local disaster and climate risk management plan at all 41 local governments. Thus, the local governments are familiar about the approach and they are willing to incorporate the activities in their plans. The first step towards development of the commercial pocket is incorporation of the activity in their plans.
- There must be active, well-functioning and well managed farmers groups. They are the vital actors who are ready to produces the vegetables in all seasons with getting profitable.
- There must be agri-input suppliers who can provide the quality inputs in fair price and on time to the farmers. They can introduce/promote climate smart technologies. The Community Business Facilitators (CBFs) are the marketing representatives/agents of the agro-vet/input suppliers; they provide the technical support to the farmers groups and supply the seeds, IPM tools and bio fertilizer/ pesticides, drip and other required materials in cash.
- The project capacitated CBFs on sales skill, technical knowhow, plant doctors and also supported on seed sales and pesticide retailer training. These also supported to CBFs to establish the new agri-input suppliers in the villages.

- Water is very important for drinking and also for irrigation system. The project supported for the construction of MUS and facilitated to apply drip and sprinkler for the efficient use of water under changing climate.
- Marketing and Planning committees/collection centers are very crucial in commercial pocket development. The MPCs/collection centers are very much responsible in the marketing of the vegetable produces. They are umbrella organization of the farmers groups and they can support for the construction of MUS, conduction of plant clinic and facilitate crop assurance and disseminate weather and agriculture information.
- Microfinance institutions (MFI/Cooperatives) are one of the major components of CPA. Smallholders can receive loans easily from MFIs as and when necessary for the production.
- Information is the power and save the losses due to the climatic hazards and also helps the technology transfer through SMS. Thus project incorporate the ICT for the development of commercial pocket.

D. Estimated Cost/The cost factor

- Commercial pocket approaches is an integral part of any project and programme. It includes various intervention and stakeholder engagement for integrated services such inputs supplier, collection centre, community business facilitators, market actors, farmer groups etc. for commercialization. Therefore, the cost for the CPA depends on the scale of the interventions and coverage.

E. Cautions

- All actors' participation and their active engagement need to be ensured.
- Public private partnership should be ensured.
- The quality services of the private sector services providers should be maintained e.g., quality inputs supply

12. Multiple Use Water System (MUS)

A. Introduction:

Multiple Use Water System (MUS) is an improved water management that uses spring water source to supply rural communities with both domestic and productive water. Water in excess of that needed for domestic use can then be used for high-value crop production utilizing micro irrigation. MUS enable farmers to grow high-value crops year-round and to use limited water resources efficiently. In MUS systems:

Figure 14: MUS- Phaneri Khola Ghantehswari, Doti

- Water quality is preserved by maintaining good sanitation above and around the intake;
- Water is piped from the constructed intake to a storage tank (Thai Jar) to supply household drinking water (for human and livestock) as well as water for irrigation purposes.
- A gravity system can be used if the water source is at an elevation that is higher than the elevation of the storage tank. If the water source is lower in elevation than the tank site, a water lifting system will be required. If the water source is near the electric grid, an electric pump can be installed to lift the water. Alternatively, a solar lifting system will be necessary.
- In order to store the surplus/overflow of domestic water, an underground tank is constructed to supply irrigation water, preferably using micro-irrigation technology like drip-irrigation.
- Drinking and irrigation water supply systems can be designed separately, as a two-line system; or together as a one-line system or by constructing Thai jars for each household.
- An existing drinking water system can be modified into a MUS system that can then also be used for agricultural uses.

B. Uses and relevance for responding to climate change

- MUS systems are highly relevant for rainfall dependent communities, particularly in hill areas with limited availability to water for both drinking and vegetable cultivation. MUS enable households to shift production and income from unreliable rain-fed agriculture to more reliable piped irrigation.
- MUS provide an efficient system for both drinking (for humans and livestock) and irrigation purposes. MUS enable the adoption of water saving micro irrigation such as drip and micro sprinklers.
- It reduces the chance of crop loss and also enhances production and income generation for climate vulnerable small holders by efficiently supplying water that would otherwise be wasted for irrigation.
- Climate change is creating water scarcity and an increased incidence of drought. MUS support adaptation and resilience in the face of these challenges by the effective and efficient utilization of

limited water resources.

- MUS empower women by greatly reducing the time that primarily women and girls spend carrying water. They enable girls to concentrate on their studies. The reduced time from carry water more than offsets the time spend for high value agricultural production.
- MUS system construction and maintenance is dependent on mobilizing community leadership, including the eventual formation of a water user group to oversee development, operation and maintenance of the system. This leadership mechanism becomes a vehicle for the identification and development of other group led climate change adaptation interventions.

C. Requisites and Availability

- The structural frame for Thai jars, pipes, and micro irrigation systems need to be purchased from recognized hardware suppliers such as agro-vets, technical agencies or other authorized suppliers.
- Cement and local materials (stone, sand and gravel) can be raised by the community.
- Skilled technicians (if available) and unskilled labour should be provided by community residents benefiting from the MUS system.
- Community participation throughout the planning and development process is essential.
- It is important for MUS to be co-developed with agriculture value-chains. MUS become more profitable where value chains provide access to needed inputs and markets. MUS also increase the profitability of rural collection centers and value chains by increasing year round production volume.

D. Estimated Cost/The cost factor

- The cost depends upon the type of system, distance from the water source and capacity of the system. A knowledgeable technical person is necessary to perform a detail survey, design and cost estimate. Current projects have costs ranging from around NRs. 100,000 to NRs. 4, 00,000.
- Community residents providing local materials and labour make a significant in-kind contribution.

E. Cautions

- Both technical and financial feasibility studies must be conducted for the system.
- Water source needs for the MUS must be registered to avoid potential conflict with other users.
- Water sources also need to be evaluated for output, in recent years climate change and environmental impacts are decreasing spring yields.

The total of 182 Multiple Water Use Systems (MUS) are established. These providing improved access to irrigation services as well as clean drinking water to local communities, specially, smallholder farmers. These are contributing in diversifying agriculture crops for additional household income, improved health and sanitation practices and also protect water sources.

13. Solar MUS

A. Introduction:

Solar Multiple Use Water System (SMUS) are piped systems to provide water for domestic and agricultural use for communities that reside above the water source. The pumped water is collected in a reservoir and distributed through a gravity system to households. Large numbers of settlements with poor and marginal communities are above the water sources.

The size of the system depends on several factors including: geographical setting, water flow at source and water demand. Similar to gravity fed system, water in excess of that needed for domestic use can then be used for high-value crop production utilizing micro irrigation. SMUS also enable farmers to grow high-value crops year-round and to use limited water.

Figure 15: Solar MUS- Solar PV, Dhapreni, Kailali

Figure 16: Reservoir Tank of SMUS, Jugepani, Doti

- Solar MUS system utilizes water sources lying lower elevation than community settlement.
- Water quality is preserved by maintaining good sanitation above and around the intake;
- Water is piped from the constructed intake to a storage tank to supply household drinking water (for human and livestock) as well as water for irrigation purposes.
- In order to store the surplus/overflow of domestic water, an underground tank is constructed to supply irrigation water, preferably using micro-irrigation technology like drip-irrigation.
- Drinking and irrigation water supply systems can be designed separately, as a two-line system; or together as a one-line system or by constructing Thai jars for each household.

B. Uses and relevance for responding to climate change

- SMUS systems are highly relevant where gravity-fed water sources are not easily accessible.
- SMUS systems are also highly relevant for rainfall dependent communities, particularly in hill areas with limited availability to water for both drinking and vegetable cultivation. SMUS enable households to shift production and income from unreliable rainfed agriculture to more reliable piped irrigation.
- SMUS enables the adoption of water saving micro irrigation such as drip and micro sprinklers.
- It reduces the chance of crop loss and also enhances production and income generation for climate vulnerable small holders by efficiently supplying water that would otherwise be wasted for irrigation.
- Climate change is creating water scarcity and an increased incidence of drought. SMUS supports adaptation and resilience in the face of these challenges by the effective and efficient utilization of limited water resources.
- SMUS empower women by greatly reducing the time that primarily women and girls spend carrying water. They enable girls to concentrate on their studies. The reduced time from carry water more than offsets the time spend for high value agricultural production.

- SMUS system construction and maintenance is dependent on mobilizing community leadership, including the eventual formation of a water user group to oversee development, operation and maintenance of the system. This leadership mechanism becomes a vehicle for the identification and development of other group led climate change adaptation interventions.

C. Requisites and Availability

- Solar MUS requires comparatively high capital cost for construction than gravity.
- Secure funding or matching for the development before the implementation is necessary. A knowledgeable technical person is necessary to perform a detail survey, design and cost estimate.
- Cement and local materials (stone, sand and gravel) can be raised by the community.
- Skilled technicians (if available) and unskilled labour should be provided by community residents benefiting from the MUS system.
- Community participation throughout the planning and development process is essential.
- It is important for SMUS to be co-developed with agriculture value-chains. SMUS become more profitable where value chains provide access to needed inputs and markets. SMUS also increase the profitability of rural collection centers and value chains by increasing year round production volume.

D. Estimated Cost/The cost factor

- The cost depends upon the total dynamic head (TDH), distance from the water source and capacity of the system. Current projects have costs ranging from around NRs. 15,00000- to NRs. 60,00000.
- The average cost per meter lift is around NRs.30,000 and average cost per liter water demand is about NRs 160.
- Community residents providing local materials and labour make a significant in-kind contribution.

E. Cautions

- The location for installation of solar PV should be open, shade free and sunny area.
- Both technical and financial feasibility studies must be conducted for the system.
- Water source needs for the SMUS must be registered to avoid potential conflict with other users.
- Water sources also need to be evaluated for output; in recent years climate change and environmental impacts are decreasing spring yields.

The total of ten Solar Multiple Water Use Systems are installed. Solar MUS significantly improves the provision of safe and clean drinking water, reduced water borne diseases, saved time of rural poor women to fetch water and also reduced workload. Besides, due to multiple use of water, they are also creating additional employment/income generation opportunities at community level.

14. Solar Sunflower Pump

A. Introduction:

Solar sunflower pump is small size solar-PV pump. The pump has three main parts: the PV panel, an 80W solar panel upgradable to 120W to convert sunlight into electrical energy; the motor, a specially designed DC motor to use the electrical energy to turn the flywheel; and the pump, a reciprocal piston pump to draw water out of a tube well, well, river, or pond.

Figure 17: Sunflower Pump, Fulbari, Kailali

B. Uses and relevance for responding to climate change

- The sunflower solar pump is highly relevant where ground water and surface water within suction limit of centrifugal pump i.e. pump can operate easily upto 6-7 meter of depth. Therefore, it is best suitable in terai area and low lift in hills.
- There is no fuel and electricity cost for the operation of the pump.
- Emission free technology no harm on environment at all
- The pump can be easily installed in tube well of 1.5 inch diameter,
- The system is farmer flexible, i) panel is easily detachable that reduces theft risk. ii) Dissembling and assembling of the other parts are also very simple and easy. A single person can dissemble and assemble whole pump within 10-15 minutes.
- Women friendly technology as women can easily operate pump by just switching on the button.

C. Requisites and Availability

- The water level of both groundwater and surface water should be within suction limit.
- The diameter of the tube well should be at least 1.5 inch to pump water.
- The water should be free from debris and silt as far as possible. High silt contain water is not appropriate.
- If tube well is new then cleaning of the wells requires before pump installation. Other electric and diesel pumps can be used in first cleaning.
- A stable foundation must prepare to rest and balance the pump. The height of the foundation should be at least 10 cm above the ground level.
- The user must have flexible delivery pipe of 1-1.5 inch diameter either to store water or applied in the field efficiently
- The pump is easily available in Nepal through pump's national supplier (Koshati Trading, Biratnagar) and its regional distributors.

D. Estimated Cost/The cost factor

- The total cost of the 120 Wp capacity pump is NRs. 85,000. Additionally, about NRs. 5,000-7,000 required to develop new tube well and pump foundation.
- The new tube well development cost varies with the rate of mason and materials.

E. Cautions

- Careful handling, regular cleaning of the solar PV is essential. The PV panels should direct towards sun perpendicularly.
- The shade and very low sunshine (< 300 W/m2) stops the pump operation so open and clear sunshine is desirable
- Application of lubricant (oil/grease,/mobil) in moving part is vital for noise free and smooth operation
- The joints in suction site are should be leak free. Small air leaks in suction side results tremendous decrease in water flow sometime no flow.

The total of 62 Sunflower solar pumps are installed. This has increased access to irrigation facilities with access to renewable energy and reduced cost of production, and reduced the work load, especially, of women farmers.

15. Recharge Pond

A. Introduction:

A recharge pond collects water, primarily from rain, in areas upstream of watershed. A recharge pond supports recharge of underground water sources to maintain water supplies in downstream communities. In a recharge pond system:

- A pond is dug, constructed and maintained in an appropriate area.
- A dike is maintained around the pond using: 1) soil excavated from the pond; 2) stone masonry; or 3) soil-cement.
- Inlets and outlets are constructed to collect and remove excess water.
- The size of the pond varies depending on the available land, required capacity and financial resources available.
- A recharge pond system can be constructed in the southern Terai plains.

Figure 18: Recharge Pond, Thali, Kailali

B. Uses and relevance for responding to climate change

A recharge pond is relevant for rainfall dependent areas particularly in mid-hill areas with medium or high-water scarcity. Climate change is creating either too much or too little water. A recharge pond helps adapt to climate change by storing water when it is abundant in the rainy season and helps to maintain a supply in the dry season. A recharge pond system supports water for both irrigation and human consumption, thereby supporting public health and the livelihoods of the community. It is useful for:

- Ground water recharge to maintain water supplies to downstream communities.
- To recharge underground water in the Terai plains.
- For livestock and crop irrigation, particularly in the dry season.
- To control fire hazards during the dry season.

C. Requisite and Availability

- Excavation tools, dikes, inlet/outlet materials (bamboo/stones) and labor are available locally.
- Local people need to provide labor.

D. Estimated Cost/The cost factor

- The cost varies based on the size and capacity and the land type.

E. Cautions

- The recharge pond must be fenced to avoid children and animals falling into the pond.
- The site must be selected carefully to avoid landslides and soil erosion.
- The water holding capacity of the pond floor and dikes must be maintained.
- The inlets and outlets must be designed carefully to avoid siltation and soil erosion.
- Written permission from the authority (Local Government for public land/pond) is necessary.

16. Water Source Protection

A. Introduction:

Figure 19: Water Source Protection, Dhanbreni, Kailali

It is defined as protecting of surface water (such as: lakes, rivers, manmade reservoirs etc) and ground water (such as: spring, dug/drill wells etc) sources from overuse and contamination. Water contamination is a result of human activity. Agriculture, industrial activity and urban development all affect the quality and quantity of surface water and ground water sources. Some of the land-use activities such as: urban development, decrease the surface area available for water to penetrate into the ground. As a result, water simply flows across the land's surface (surface runoff) instead of recharging. Furthermore, water quality can be threatened by over/ inefficient use and human activity which directly and indirectly introduce contaminants into both surface water and ground water. Implementing water source protection requires a legal framework which usually involves: a protection plan, formulating responsibilities, specific protection measures and basic rules that are applied to water source users and all community members.

B. Uses and relevance for responding to climate change :

Source protection and management is usually maintained through certain protection plan and procedure. It is usually protected by ensuring certain communities to develop collaborative, locally-driven and science-based plans to keep water clean in wells, rivers, streams and lakes. It is easier, cheaper and safer to keep water clean at its source than to make an effort to clean it up later.It is useful for;

- Maintain the sustainability of source.
- Cost saving (treatment and cleanup).
- Maintain of ecological balance and recharge of water.
- Improvement in public health.

C. Requisite and Availability:

Adequate operation by water users and frequent maintenance by a local caretaker can ensure a safe long term usability of the water. Operation and maintenance activities are best organized through a local management plan. The responsibility of caretaker involves the: inspection, cleaning and repair of spring and well (e.g. cracks in apron, leaking parts, etc.); monitoring activities in the surrounding area; up keeping the protection zone/repair of the fence and monitoring whether the basic rules are followed by the users or not. The guidelines developed by Nepal government on rural water supply and safety can use as a reference in source protection activities and plan.

D. Estimated Cost/The cost factor:

Water source protection is a key to improve water quality and purification costs. The costs of source protection are site specific and the level of protection measures taken. In case of more vulnerable source the level of source protection to be taken is higher while just for plantation around the source could be cheaper. The protection measures are simple and can be constructed with locally available material by local people.

E. Cautions:

- Proper location / selection of the water source (never close to pollutant source).
- Construction of retaining wall, diversion ditch, catchment dam or cut off wall, spring box and valve chamber.
- Fencing the area around source, collection chamber
- Set up rules for community members such as: don't defecate close to the water source, don't let your animals to graze close to the source, don't throw/deposit garbage around water sources etc.

17. Plastic pond

A. Introduction:

A Plastic Pond is a low cost water storage tank technology. It consists of an underground pond with smooth sidewalls and floor finishing and is covered with 220 gsm plastic to store water from rain or other local water sources. Size can vary as per the required capacity (5000-60000 litre).

Figure 20: Plastic Pond Thali, Kailali

B. Uses and relevance for responding to climate change

- Highly relevant for rainfall dependent water scarce areas particularly in the mid-hills.
- It is highly useful for areas where transportation of sand and cement is difficult.
- The stored water is generally used for irrigation purposes, preferably using micro-irrigation technology like drip.
- In the present context when climate change is having significant impacts on water sources, it stores water from rain, springs and tap water and supply
- It supports adaptation to climate change and builds resilience by facilitating irrigation of vegetable and other crops for both domestic and commercial purposes.

C. Requisite & availability

- Plastic (220 gsm) as per designed size, excavation materials like spade, crow bar, shovel, pickaxe, etc. and mud masonry.
- Skilled labor and unskilled labor.
- Plastic can be ordered and purchased from local agro-vets.
- Other tools and materials can be collected by the household owner or from skilled labor.
- It is important that plastic ponds are fenced, gently sloped, and shallow for safety. It is also important that ponds are kept partially filled to prevent rodent damage and livestock are kept out.

D. Estimated Cost/The cost factor

- The cost varies (approximately NRs.4, 000-NRs.7, 500) as per size/capacity (6-15 cu.m.) and the land type.

E. Cautions

- Fencing to avoid damage.
- Maintain minimum water in the pond to avoid damage by mice and other animals.
- Site selection should be carefully done to select land that will not collapse or slide.
- It should be located above the land to be irrigated.
- Use the recommended plastic thickness.

18. Modified Thai Jar

A. Introduction:

Modified Thai Jar (MTJ) is a low cost water storage tank technology. It is a technology derived from a modification of a jar from Thailand and is similar to a Ferro-cement tank, though it differs in size and has an improved shape. A MTJ storage tank has a capacity of 1500-3000 litres. The MTJ is made of 12.5 mm cement plaster.

Figure 21: Modified Thai Jar Gokula Khola, Dadeldhura

B. Uses and relevance for responding to climate change

A MTJ is highly relevant for rainfall dependent areas particularly in the mid-hills with medium to high water scarcity. MTJ is a simple, low cost technology for collecting water (primarily rain water). Climate change is creating either too much or too little water. A MTJ adapts to climate change by storing water when it is abundant and helps maintain a supply when it is not.

Uses:

- Domestic purposes.
- Irrigation purposes in a home-garden, preferably using micro-irrigation technology such as drip.
- MTJ can be linked with a MUS system and used for drinking water.
- Stores waste water from drinking taps or springs which can be used when needed.
- Supports sanitation and family health.
- Supports adaptation to the impact of climate change and builds resilience by provisioning fresh vegetables for household consumption.

C. Requisites and Availability

- Sand, stone, aggregate, cement, white cement, GI wire 12 gauge, 6 mm diameter rod, chicken wire mesh, binding wire, jute bag, outlet fitting set, rope, wood, ladder and other general construction materials.
- Local materials can be collected by the household owner. Most materials can be purchased from local market-hardware.
- Frame to meet the size and capacity needs must be ordered from a manufacturer or can be constructed with local skilled labor.
- Skilled labor and unskilled labor required.

D. Estimated Cost/The cost factor

- The cost varies (NRs.8,000-10,000) based on size and capacity.

E. Cautions

- Site should be carefully selected to avoid land that might collapse or slide.
- The MTJ site should lie between the upstream water source (up) and the level of land to be irrigated (down).
- The tank must be cleaned periodically and regularly checked for any leakage.
- Annual white cement painting is recommended.

19. Ferro Cement Tank

A. Introduction:

A Ferro Cement Tank (FCT) is a strong and durable water storage tank technology, though it is a bit more costly than other storage tank technologies. It consists of a tank constructed underground using chicken mesh wire, reinforce cement and is plastered twice with cement and sand mortar (1:2 ratio). Size can vary as per the required capacity. The underground location reduces the likelihood of leakage and collapse. An FCT collects water from a source and can distribute it for both drinking and irrigation purposes. It reduces the need for two separate tanks for storing drinking and irrigation water.

Figure **22:** *Phaneri Khola, Doti*

B. Uses and relevance for responding to climate change

- Highly relevant for water scarce areas particularly in mid-hills.
- It is a strong and durable water storage tank that can be used for drinking and irrigation purposes, preferably adding micro-irrigation technology such as drip.
- It ensures the supply of hygienic water due to improved sanitation.
- In the present context when climate change is having great impact on water sources, FCT stores drinking water from the source and supports its efficient and effective utilization for drinking, but can also support irrigation usage.
- It supports climate change adoptation and helps build resilience by facilitating off-season irrigation of fresh vegetables for household consumption.

C. Requisites and Availability

- Sand, stone, aggregate, reinforcement cement, GI wire 14 gauge, chicken wire mesh, binding wire, inlet/outlet fitting set, overflow washout and other general construction materials.
- Skilled labor and unskilled labor is required for construction.
- Most materials can be purchased from local market-hardware.
- Other tools and materials can be collected by the household owners or through skilled labor.

D. Estimated Cost/The cost factor

- The cost varies (NRs.12,000-40,000) as per size/capacity (3-10cu.m.) and the land type.

E. Cautions

- Fencing is needed to avoid damage.
- Site selection should be carefully done to select land that will not collapse or slide.
- It should be located between the water source (up) and the level of the settlements where water is to be supplied (down).

20. Drip Irrigation

A. Introduction

A drip system is a micro-irrigation technology used to collect and efficiently distribute water for irrigation. A drip system is a simple, low cost and effective system for small holders who are otherwise dependent on rainfall. A drip system:

- Consists of a plastic tank that can hold 60-200 liters of water, a mainline pipe (one to two meters in length), four to 24 drip pipes and 80 to 480 drippers.
- Irrigates 80-500 square meters. The cost of a drip system increases as the size of the system increases.
- Delivers water directly to plant roots rather than generally irrigating surrounding soil.

Figure 23: *Drip Irrigation system within Plastic Tunnel*

B. Uses and relevance for responding to climate change

A drip system is highly relevant for rainfall dependent areas-- particularly in mid-hill or valley areas with high water scarcity. A drip system supports effective and efficient utilization of water limited by climate change. A drip system reduces the water requirement to the crop and helps the efficient use of water to the crop. Thus it reduces the crop losses and enhances production and income generation for climate vulnerable small holder farmers.

Uses include:

- For commercial and home gardens between 80-500 square meters.
- In areas where construction of irrigation channel is difficult due to technical or financial challenges.
- For smallholder climate vulnerable households engaged in vegetable or essential oil cultivation.

Advantages and relevance for responding to climate change include:

- Irrigation of a relatively larger area compared to ordinary and flood irrigation;
- Time savings because there is no need to hand water each plant individually;
- Reduces growth of weeds as it only irrigates intended crops and other areas remain dry, this represents and IPM technology as it limits insect vectors;
- Reduces chances of both soil compacting and soil erosion;
- Can supply plant nutrient and fertilizers mixed with water;
- Reduces water wastage, with water use efficiency up to 90%.

C. Requisites and Availability

- Drip system (tank, mainline pipe, drip pipe, dripper) can be ordered through local agro-vets. The authorized manufacturer is Sital Thopa Sinchai, Gwarko, Kathmandu. NETAFIM India and Herbal Azute ltd.
- Bamboo, wood, spade, planks, rope, etc. can be supplied locally.
- One skilled labor and one unskilled labor needed for installation.

D. Estimated Cost/the cost factor

- The cost varies from NRs.2300 to NRs.10000 depending upon the size of the system, including the capacity of the tank.

E. Cautions

- Regular care and maintenance is necessary. The filter should be cleaned once a week and the dripper holes should be checked regularly.
- The system should be stored out of the weather when not in use.
- In a high temperature area, the plastic tank should be wrapped with a gunny bag.

Anukulan has promoted 1,414 drip irrigation schemes to promote efficient use of scarce water for irrigation especially in vegetable farms. This technology has raised income of the rural poor communities.

21. Micro-Sprinkler

A. Introduction:

A micro-sprinkler system is a simple micro-irrigation technology used to collect and distribute (by showering/sprinkling) water for irrigation. In a micro-sprinkler system:

- The water supply is provided by a pipe directly connected to the water source or to a tank. The head height MUST be 12-20 meters in order to establish sufficient pressure.
- Plastic sprinkler heads with different shapes are available; however, an 'O' shape is recommended.
- Area of irrigation varies from 240 square meters (4 sprinkler heads with 12-15 meter pressure) to 500 square meters (8 sprinkler heads with 15-20 meter pressure).
- A micro-sprinkler system is simple, low cost and effective for small holder climate vulnerable people.
- The main components are a line filter, PVC tubing's, plastic fittings and micro sprinkler heads with base and stakes.

B. Uses and relevance for responding to climate change

A micro-sprinkler system is highly relevant for rainfall dependent areas, particularly in mid-hill areas with medium water scarcity. A micro-sprinkler system supports effective and efficient utilization of water limited by climate change. A micro-sprinkler system reduces crop loss and enhances production and income generation for climate vulnerable smallholder farmers. Similar to drip irrigation, uses include:

- In a home garden of around 240-500 square meters.
- In areas where construction of an irrigation channel is difficult due to technical, financial or soil conservation constraints.
- For small holder climate vulnerable households engaged in vegetable or essential oil cultivation.
- Advantages and relevance for response to climate change include:
- Conservation of soil carbon, soil moisture and soil texture.
- A relatively larger area can be irrigated compared to ordinary and flood irrigation.
- Time savings because there is no need to irrigate individual plants.
- It is also very much helpful to maintain the temperature in summer season

C. Requisites and Availability

- Sprinkler system (sprinkler head, gate valve, filter and mainline pipe) can be purchased from recognized agro-vets.
- Bamboo, wood, spade, rope, etc. can be supplied locally.
- Labor is provided by local people with basic skills in pipe fitting.

D. Estimated Cost/The cost factor

- The cost varies from NRs.200 to NRs. 1300 depending upon the size and capacity of the system.

E. Cautions

- Adequate pressure is a prerequisite for a micro-sprinkler system. A micro-sprinkler system requires gravity water pressure to rotate the sprinkler heads or another method to create water pressure.
- A micro-sprinkler system is useful only for low spacing and low height crops.
- Possible loss of water due to quick evaporation.

Anukulan-X has promoted 3,173 sprinkles to promote efficient use of scare water for irrigation especially in vegetable farms. This technology has raised income of the rural poor communities and also reduced the work load.

22. Vegetable Cultivation in Plastic House or Tunnel

A. Introduction:

Plastic house or tunnel is a technology/practice that provides a protective green houses for vegetable crops during the off-season or during harsh weather periods. The plastic house or tunnel helps maintain acceptable temperatures, since vegetable plants generally flourish in temperatures above 10°C or below 30°C. Water must also be supplied, usually via drip micro irrigation. There are three types of houses;

Figure 24: Drip Irrigation in Plastic house at Bheriganga Municipality Sisneri, Surkhet

1) Plastic House- made of bamboo with the upper half covered in plastic (ventilated) during rainy season. Plastic can also be removed when necessary.

2) Plastic Tunnel- made of bamboo and full plastic coverage in a half moon shape for winter season and primarily for short growing season crops or nurseries.

3) Iron or Steel Plastic House– for permanent or commercial farms.

Recommended size of the plastic house to be used with drip is generally 12 m x 5 m x 3.5-4 m and its orientation needs to be east-west. Height of the plastic house needs to be higher in the Terai and lower in higher altitudes. Life of the plastic is at least 5 years if it is kept in good condition.

B. Uses and relevance for responding to climate change

It allows for production of crops in a controlled environment early, late and during the off-season. In other words, it protects crops from harsh weather conditions including heavy rains. It supports production of off-season vegetables by providing warmer temperatures (5-15^{0}c higher than the outside temperature) for crops even in winter and prevents crops from receiving too much water during the rainy season. Production in plastic houses has been found to result in increased production of 4-5 times that obtained in an open field. It also reduces weed growth and insect pest infestations while improving the quality of the yield. It is a very useful climate adaptation technology that is used primarily in hilly areas. Because off-season crops generally bring a higher price, it supports income generation and helps build the resilience of the climate vulnerable smallholder farmers.

C. Requisites and Availability

- Flat areas for the construction of the plastic house and/or tunnel.
- Bamboo, ropes, sealing material for poles, transparent plastic of 45-120gsm (higher gsm is useful for hailstone areas), screws can be available upon order from local agro-vets.
- Skilled and unskilled labor.

D. Estimated Cost/The cost factor

- The overall cost of a plastic house 12 m x 5 m x 4 m ranges from NRs.15, 000 to NRs.20, 000. If materials are available locally and the household can contribute labor the cost will be minimized greatly.
- Small tunnels for nurseries are much less costly.

E. Cautions

- The construction site should not be in shade, water logged or a high wind area. It is best to have a minimum of 6 hours of sunshine and minimum air circulation.
- The greater the thickness of the plastic the lower the sunlight/radiation penetration inside the house, which causes lower crop yields by yellowing the crop (Etiolating effect).
- The wide side of the plastic house should be in wind flow direction to minimize the effect from high winds.
- Quality of plastic may vary depending on the nature of the weather event the house is intended to provide protection from (rain water, frost, hailstone etc.)
- Height of the plastic house should be location specific based on altitude; the higher the altitude the lower the plastic house height and vice versa.
- Support structures should be kept to a minimum to maximize light penetration.

Anukulan has installed plastic tunnels for demonstration at community level. Besides, it has been promoting installation of plastic tunnels in coordination and collaboration with different government and non-government stakeholders. Farmers are able to secure increased income from seasonal and off seasonal vegetable production by the use of plastic tunnels.

23. Tande Nursery/ High Raise Nursery

A. Introduction:

A nursery is a place where seedlings are carefully grown from seeds or other plant vegetative parts (suckers or cuttings) with intensive care for a short period of time before transplanting them in the field. A nursery is generally 1 meter in breadth with flexibility in length (generally around 10 m) depending on the required capacity. There can be different kinds of nurseries depending upon the plant species, location, or weather.Tande is a special type of raised nursery bed where a flat roof-like nursery bed is prepared at a height of one meter from the ground surface with the support of scaffolds. Approximately 25-30 cm thickness of solarised virgin, fertile soil is placed on the bed and may be mixed with farm yard manure (FYM). It is important to maintain the optimum soil moisture for seed development. The length and width of a Tande nursery should not be more than 5 meters by 1 meter for management purposes. Nurseries are also ideal for utilizing IPM solutions including use of bio-agents such as trichoderma to prevent soil borne insects/disease and netting to prevent insects and spread of viral diseases.

Figure 25: Raised Bed (Tande nursery) in Plastic tray with Coco peat) at Hirapur Farmers group, Gaira ,Doti.

B. Uses and relevance for responding to climate change

Sound nursery practice is the foundation for a successful crop whether it is for vegetable or forest seedlings. The Tande nursery is most beneficial during the rainy season by protecting seedlings from soil born diseases such as fungal diseases and from soil-dwelling insects such as red ants, white ants and white grubs. The Tande nursery can produce seedlings earlier than simple raised beds. This allows farmers to transplant the seedlings as soon as their fields have optimum moisture. This also helps with earlier off-season production when vegetable prices are at their highest. The Tande nursery was developed to adapt to local weather conditions and supports in climate change adaptation by reducing the risk to young plants from unfavorable climatic shock.

C. Requisites and Availability

- Locate in a sunny area, but not necessarily in a flat area.
- Local materials such as bamboo or wooden stand/scaffold, ropes, pin/screw, fertile soil.
- A person with good knowledge of nursery practices.

D. Estimated Cost/The cost factor

- Tande can be prepared from locally available wood or bamboo so the cost will normally be around NRs.500-1,000 depending up on the size of the Tande. The cost could increase with the addition of a plastic tunnel to protect the seedlings from rain or hail or the addition of nursery trays.

E. Cautions

- The Tande structure should be strong enough to carry the weight of soil and FYM and should not be susceptible to moisture damage.

24. Integrated Pest Management (IPM)

A. Introduction:

Integrated Pest Management (IPM) means careful consideration of all pest control techniques. It integrates the appropriate measure that discourages the pest population. The principle of IPM is to grow the healthy plant, to protect the beneficial insects, to observe and monitor the crop regularly and capacitate the farmers. It emphasizes the bio pesticide and integrates the physical, mechanical cultural methods. It combines techniques that utilizes biological measures such as bio-fertilizers and bio-pesticides instead of using chemical fertilizers, insecticides and chemical pesticides. IPM is used to control crop damage from weeds, insects, and diseases while increasing yield and quality. It avoids use of chemical insecticides which kill not only unwanted pests, but also beneficial organisms. If conditions cannot be managed by the IPM products and measures, secured chemicals (green) can be used as the last option. There are several types of IPM techniques available, including the use of pheromone.

Figure 26: IPM Demonstration at Bheriganga Municipality, Sisnery

B. Uses and relevance for responding to climate change

IPM techniques reduce the use of harmful chemicals in crop production which benefits consumers and the farmers who avoid exposure to the chemicals. IPM also supports climate change mitigation. It is an easy, low cost, environmentally sound and sustainable technique as it uses locally available biological materials. Climate change is intensifying and expanding the range of exotic pests and diseases.

C. Requisites and Availability

- Local biological materials such as Asuro, Titepati, Nim, Bakaino, Tulsi, ash or cow urine are used for the preparation of organic fertilizer and bio-pesticides.
- A gallon of water to prepare Jholmol.
- Pheromone traps, insect repellent, as well as insect sticky material.
- Technical training is necessary at the outset.

D. Estimated Cost/The cost factor

- IPM is a low cost technique as it uses local materials. However, cost may increase with the purchase of advanced packages of bio fertilizers and bio pesticides.

E. Cautions

- Bio pesticides and fertilizers (bio-agents) are often living materials with a limited life span that varies up to 6 months.
- Bio fertilizers and bio pesticides need to be stored in a separate place from chemical fertilizers and pesticides.
- Bio-agents should not be mixed with other chemical products during application.

25. Off-Season Vegetable Cultivation

A. Introduction:

Off-season vegetable cultivation is a technology/practice which enables production of crops in seasons other than their usual growing season or when there is a shortage of certain vegetables in some local areas. Off-season vegetables can be produced by the use of: 1) plastic houses; 2) plastic tunnels: 3) plastic bags: 4) or a permanent green house and also by appropriate selection of site, time, crop species or crop patterns.

Figure 27: Hirapur Farmers group, JorayalRuram municipality, Gaira, Doti

B. Uses and relevance for responding climate change

It is particularly appropriate in areas convenient for regular oversight and with good sun intensity. Though crops require intensive care, off-season vegetables have a relatively better market and bring higher prices than peak season crops. Off-season vegetables support not only family nutrition, but help generate additional income for small as well as commercial farmers. This ultimately supports climate change adaptation and resilience development.

C. Requisites and Availability

- Plastic, bamboo, rope, seed etc. as required by the selected technology/practice.
- Most of the materials will be available locally, from agro-vets or from research centres.
- Skilled and unskilled labor.

D. Estimated Cost/The cost factor

- The cost depends upon the selected crop and the type of technology or practice.

E. Cautions

- Careful supervision is must as off-season vegetables are highly prone to attack by insects, pests and diseases.
- Appropriate crop and variety selection.

26. Crop Diversification

A. Introduction:

Crop diversification is the practice of mix-cropping in the same piece of land. Crops are chosen depending upon the species and their habitat. The diversification can involve:

1) Horizontal- mixing of crops, preferably high value crops in the same level;
2) Vertical- mixing of crops that grows at a different height or multi-story.

Figure 28: Hirapur Farmers group, Jorayal Rural Municipality, Gaira, Doti

B. Uses and relevance for responding climate change

In the context of growing demand, the production of multiple crops from the same land supports family nutrition and income generation for climate vulnerable small holders. It also supports conservation of bio-diversity and soil, as well as the control of insect pests. Because different crops have different preferences and tolerances, it reduces total damage to crops from both climatic and non-climatic disasters. Accordingly, it supports adaptation and resilience to climate change.

C. Requisites and Availability

- Cultivable land/home garden in any area (nearby settlement).
- Agriculture tools.
- Seeds or seedlings of varieties of crops as per the design; usually available from local agro-vets.
- Farmer or labor and some technical support.

D. Estimated Cost/The cost factor

- Varies as per the crop selection.

E. Cautions

- Careful selection of variety of crops and type of crops in consultation with a technician is mandatory.

27. Crop Assurance/Insurance

A. Introduction:

Crop insurance is safety measures that support farmer households or groups in case of loss or damage to their crops by climatic or natural disasters. Farmers must deposit a premium amount (as per their investment in the crops and the organization norms/policy) to the concerned financing institution or insurance company.

Figure 29: Dhangadhi Submteropolitan City, Ghusuwa, Kailali

Crop insurance scheme implemented by the Agriculture Development Bank in Nepal is called crop assurance. The scheme is supported for the Small and medium scale enterprise promotion program of the Government of Nepal. In the scheme, a farmer group must deposit a premium amount equivalent to 25% of the investment cost of the crop on which the bank provides the additional 75% of the premium. The premium charge per Ropani is NRs 15,000.00 in hill and in low lands per Kattha is NRs 10,000.00. In Plastic house per Kattha Nrs 20,000.00 and per Ropani NRs 30,000.00. In total premium, the farmers will pay 25% and Agriculture Development Bank (ADB) will deposit remaining of 75%. Farmer groups or cooperatives can apply for crop assurance scheme and they can receive the return of their premium when there is no loss or damage to the crop.

Alternatively, crop insurance schemes are provided by private insurance companies, generally in coordination with district agriculture development offices. Premium amounts are relatively lower than in crop assurance, but provide support to the individual farmers in case of loss or damage of the crop.

B. Uses and relevance for responding to climate change

Climate change is creating uncertain weather conditions that, in turn, create loss and damage to crops. Crop assurance or insurance schemes can provide support to climate vulnerable farmers so that they can sustain their livelihoods despite of climatic variations

C. Requisites and Availability

- Group or Cooperatives must be register in Agriculture Development office or at Cooperative division office.
- Orientation of farmers regarding the policies and provisions.
- Collection and deposit of premium amounts and follow other procedures.
- Technical support on verification and recommendations.

D. Estimated Cost/The cost factor

- The cost of opening a bank account by Crop assurance sub-committee is Rs.5000.00 and the premium pay by farmer is Rs 200 per kathha and Rs 300 per ropani.

E. Cautions

- All the farmers need to understand and follow the applicable policy and provisions.
- Because it is a new concept, it has yet to be practiced in many locations.
- At initial stages the scheme amount is low and could not assure if there will be huge losses due to climatic hazards and disasters.

28. Information, communication technology for crops

A. Introduction

Information and communications technology (ICT) is a broad term that includes any simple or sophisticated communication device or application like radio, television, cellular phones, computer and network hardware and software, satellite systems and so on used in producing distribution, processing and transforming information (Marcelle, 2000). The project mainly disseminates the weather, agriculture and market information to the farmers through SMS system.

Figure 30: Sample Crops massage through ICT (Bulk SMS)

B. Uses and relevance for responding to climate change

ICT is very much useful to the farmers in responding to climate change. The forecasting system mainly weather forecasting system helps to minimize the risks of losses of crop due to climatic hazards. The uses include:

- Disseminate the agriculture technology information for e.g. cropping system, disease and insect pest management techniques to the farmers
- Disseminate the prices information of the vegetables to the farmers that helps the farmers to get the appropriate price of their produces.
- The weather information is very crucial in climate change condition. The weather information helps the farmers for scheduling the harvesting, sowing and pest management of crops. It minimizes the losses of crops due to climatic hazards.

Advantages and relevance for responding to climate change include:

- Information is the power; the information disseminated to farmers is basically categorizedis basically into three categories; weather information, agriculture technology information and market price information. All these information are very much useful and advantage to the farmers.
- Through these information, farmers can manage the disease and pest and protect the crops losses due to pest.
- Farmers also get information on vegetable market price and that helps the farmers for scheduling their sale.
- The weather information is very much effective to the farmers for planning and caution e.g. tomorrow will be hailstorm and farmers are going to harvest the wheat crop, if there is early forecasting system and informed to all farmers, the farmers will postponed the harvesting schedule and helps from the losses and contributes to food security and climate change adaptation.

C. Requisites and Availability

- Weather instruments, sensor, laptop/smart phone is prerequisite
- The ICT service provider is needed.
- Training is needed to ICT operator for the operation of ICT.

D. Estimated Cost/the cost factor

- The cost varies from the number of SMS system. NRs.200,000.00 to 250,000.00 will cover the all cost of weather equipment's and ICT.

E. Cautions

- Validation of the information and care and maintenance of weather equipment's etc.

29. Plastic Mulching System

A. Introduction

Mulching is an agricultural cropping technique that involves placing organic or synthetic materials on the soil around plants to provide a more favorable environment for growth and production. Organic mulches are being used traditionally by the farmers. The use of plastic mulch has brought a considerable change in vegetable productionIn temperate countries the year round production of vegetables has been possible with the use of plastic mulches. The plastic mulch may be transparent, black, red, yellow or others depending on the purpose of the mulch but mostly the black colored plastic is used for the mulching purposes.

Figure 31: Plastic mulch at Heerapur Farmers group, Gaira, Doti

The plastic mulch can be laid before the sowing/or transplanting the crop and also after sowing the crop.

- There is simple plastic mulching system and also advance plastic mulching system. In advance plastic mulching system, the drip irrigation system is below the mulching materials.
- The plastic will cut roundly in the planting area of the crop.
- The mulching helps the crop for moisture retention, weed control and maintain the soil temperature. It also increases the organic matter.

B. Uses and relevance for responding to climate change

Plastic mulch helps the conservation of soil moisture. It is very much fruitful in the context of climate change. It helps to retain the moisture into soil that reduces the number of irrigation schedule in water scarce period. The plastic mulch uses and helps for

- Maintain and conserve Soil moisture
- Control Weed
- Control Pest
- It reduces the fertilizer losses through leaching and volatization
- It helps to maintain the soil temperature and also helps to warm the temperature during the winter season.
- It reduces the cost of weeding

Advantages and relevance for responding to climate change include:

- It reduces the irrigation requirements for crop in water scarce condition which is very important in the context of climate change because it conserve the soil moisture.
- It controls the weed and which is also ultimately reduces the pest and that reduces the cost of production of the crop.
- It conserves the organic matter in soil and reduces the losses of fertilizer which is very much advantageous for responding the climate change condition.
- The cucurbits, tomato and cole crops are very much beneficial.

C. Requisites and Availability

- Black plastic is required
- If drip system is tailored, large drip system can be used.

D. Estimated Cost/the cost factor

- The cost of plastic mulch is per kg 300-500 depending up on the quality and GSM of plastic mulching materials.

E. Cautions

- Regular care and maintenance is necessary. The serrate type of weed can damage the plastic thus must be care and uprooted the weeds.

30. Home Garden/ Kitchen Garden

A. Introduction:

A kitchen Garden or Home Garden is a small land where nutrients herbs and vegetables are grown around the house for household daily use. A small plot near to the house is used for growing a variety of vegetables according to the season. Local varieties such as radish, cauliflower, cabbage, broad leaf mustard, chilly, beans, pumpkins, etc. are all grown in the kitchen garden.

With worsening economic conditions and increased interest in organic and sustainable living, many people from low economic groups are turning to vegetable gardening as a supplement to their family's diet and good nutrition for healthy living.

Figure 32: Kitchen garden Gurbakot -9, Sahare Surkhet.

B. Uses and relevance for responding climatic change:

For people to stay healthy it's very important to have a healthy diet. A healthy diet in relation with climatic change means a balanced mix of vegetables that contains all required vitamins and minerals for healthy growth. Vegetables are a very important part of a good diet as they contain various nutrients for many body functions. For growing, energy and protection against disease, vegetables play an essential role. Vegetables are especially important for the young, and for pregnant and nursing women.

- Fresh and healthy vegetables can be grown easily by the farmers themselves.
- Daily consumption of rich minerals and vitamins contains vegetables.
- Increase in income which saves the cost of buying vegetables and others nutrients herbs.
- Organic waste resources from kitchen and sweeping can be recycled into the ground as fertility.
- Wasteland near the house can be productive and a healthy environment.

C. Requisites and Availability:

A good managed kitchen garden gives a good production of various nutrients vegetables. To give a best production, the following things are important which are easily available within the village.

- Site can be easily selected for wasteland near to house which could be a new sites or old sites for good production based on quality of the soil, sunlight duration. Make a plot in such a way which can be easily accessed from house.
- It is important to provide enough moisture for the vegetables to grow which can be done through covering with green manure, providing shade and timely irrigation, which can be done through collecting water from tape waste water from kitchen regularly.
- The quality of the soil must be fertile. If the soil is not fertile add some manure from domestics cattle. Also it can be done through collection of organic waste materials from kitchen as mulching, collection from sweeping pit and liquid manure.
- Make a selection of seasonal seeds from local traditional vegetables. The seeds should be good so that it will grow and rise as healthy plant which will transform into healthy kitchen garden with full of nutrients vegetables.

D. Estimated Cost / The cost factor:

- The cost for kitchen gardening varies (approximately NRs.500 – 2000) depending upon the area for gardening and materials like quality seeds, fence for protection, pipe for irrigation.

E. Cautions:

- The areas need to be protected from very start from livestock and a permanent fence should be made.
- The vegetables within the garden needed to be protected from pest and plant related diseases.

31. Early Warning System

A. Introduction:

Early warning system (EWS) is implemented as a system of information communication mechanism and comprises sensors, event detection and decision subsystems. The system forecast and signal disturbances that adversely affect the stability of the physical world, providing the lead time for the response and prepare for the adversities and to minimize impacts.

Early warning system actively involves the communities at risk, facilitate public education and awareness of risk, effectively disseminate alters and warnings to ensure there is constant state of preparedness. A complete and effective early warning system supports four main functions; risk analysis, monitoring and warning, dissemination and communication and a response capability.

Figure 33: Early warning system

Early warning systems (EWS) are recognized in both the Hyogo Framework for Action 2005-2015, and the Sendai Framework for Disaster Risk Reduction 2015-2030 as an important element of disaster risk reduction, and hence to the achievement of sustainable development and sustainable livelihoods.

Anukulan has been working in flood related early warning system and supported establish manual river gauze and auto telemetric.

B. Uses

To flow right information on right time to the downstream community so that downstream vulnerable community can save their life and assets from disaster especially flood.

C. Requisites and Availability

- Decision from DDRC to support for the installation of early warning system.
- Communication mechanism/Channel set up to flow early warning information.
- Provision of river gauge reader in case of manual early warning system
- Linkage and coordination with hydrometeorology department for automatic early warning system to upload in website.
- Identification of downstream communities and selection of focal person to flow information on time.
- EWS Telephone dairy developed and distributed in the all districts.

D. Estimated Cost / The cost factor:

- The cost of river gauge river (manual) varies the location and number of gauges. Manual river gauge river is not so high for installation, it costs varies from one lakh to one lakh fifty thousand. But the operation cost is high to mobilize river gauge reader.
- Automatic river gauge reader cost is high to make structure and also to purchases the set of machine. Cost of automatic machine varies from Npr 500,000 to more than 10, 00,000 based on brand of company, its function and information provided of different climatic parameters.

E. Cautions:

- Before installation, need to decide from DDRC/DEOC
- Location of installation should be technically feasible
- Proper communication channel should be established prior set up the system.

Anukulan-X has supported the installation of manual and automatic river gauges in Bardiya, Surkhet, Dadeddhura, Kailali, and Kanchanpur. Flood prone community are able to receive information related to river water level and the condition of water level, whether it is normal, or reaching dangerous level. Once community receive the information they prepare accordingly. Hence, they are contributing towards saving lives and assets of flood vulnerable communities.

Please contact for additional information:

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