Domestic PLUS

Adding up productivity to domestic WASH

A Source Book

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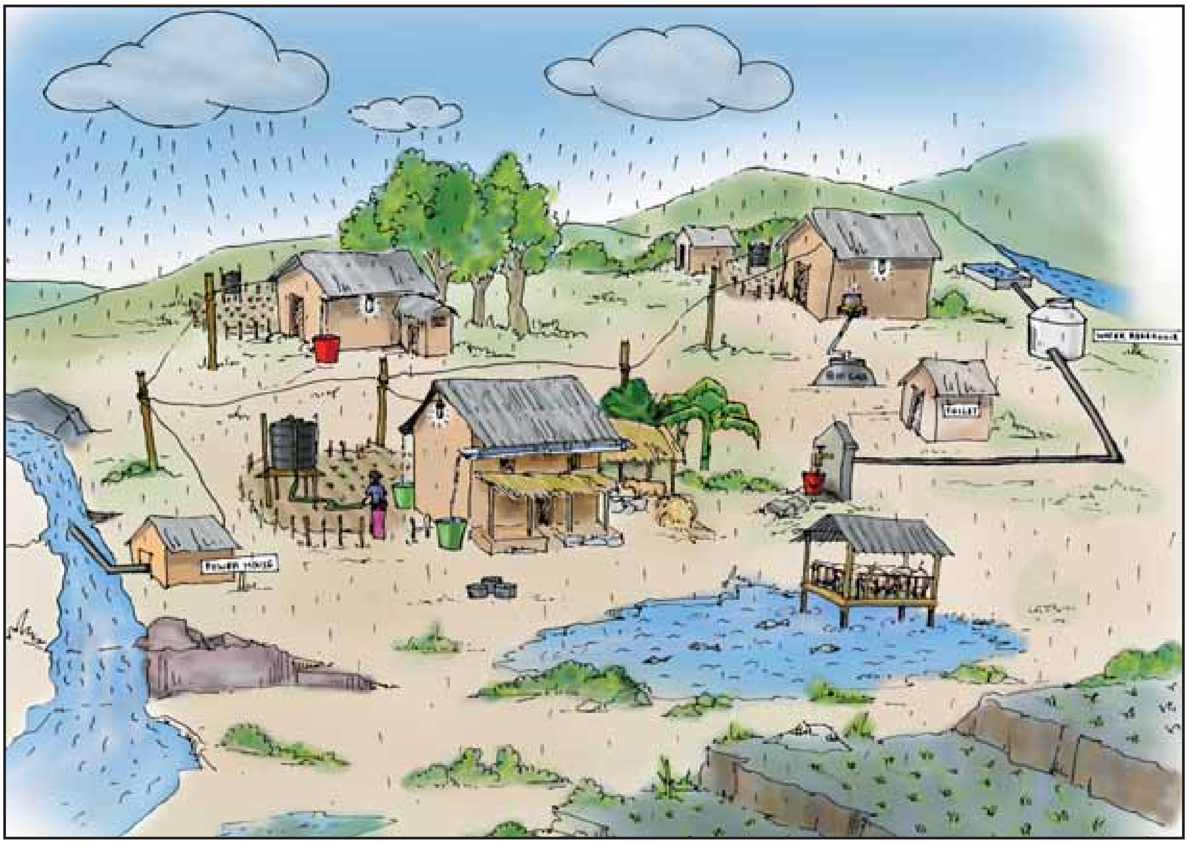

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Acknowledgement

The Domestic PLUS approach conceived in 2009 is built on field experiences, lessons learned and best practices. The foremost vote of recognition goes to Concern Worldwide for providing an opportunity for the Nepal programme to pilot this initiative. Our special thanks go to Mr. Phillip Miller, former Country Director of Concern Worldwide Nepal for his positive support and for being instrumental on developing this initiative. Our heartfelt thanks also to Ms. Moire O'Sullivan, present Country Representative of Concern Worldwide Nepal, for her continuous support and encouragement along with her technical support in bringing out this document.

At the ground level, the approach implementation was possible only through the support and dedication of our two major implementing national partners Nepal Water for Health (NEWAH) and Karnali Integrated Rural Development and Research Center (KIRDARC). We are grateful for their hard work and commitment thus enabling us to live up the Domestic PLUS aspiration. Finally, we would like to thank our beneficiaries for their participation and from whom we learned so much.

Summary

This book is a compilation of information from the Domestic PLUS approach initiated in Nepal by Concern Worldwide with support from its national implementing partners NEWAH (Nepal Water for Health) and KIRDARC (Karnali Integrated Rural Development and Research Centre). This document is developed with an intention to provide the readers with packaged information on the basics to understand the perspective of this approach.

Chapter 1 is on the approach adopted for implementation of Domestic PLUS in Nepal. This chapter is aimed to provide a clear framework to enable WASH practitioners to develop appropriate strategies as well as to guide them on how multiple water uses and multiple benefits can be accrued whilst staying within the WASH sphere.

Chapter 2 is on the benefit cost analysis research conducted for the Domestic PLUS water service provision against the conventional domestic water supply service provision. The research is set to test if Domestic PLUS systems are more beneficial than their conventional counterparts.

Chapter 3 is on another research conducted on technology and gender dynamics in Domestic PLUS approach. This research is set in to see the linkage between technology introduced within the Domestic PLUS approach and its effects on the practical lives of both women and men beneficiaries.

Last but not the least, **Chapter 4** gives short overview on most of the simple yet proven technologies introduced within the approach.

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Dalit women wait for their turn to fill their water pots in Jajarkot District, 2008, Photo: Cecial Adhikari

Approach for Implementation of Domestic PLUS

Written by **Cecial Adhikari**

Summary

From the household's perspective too, it is often artificial to classify a source of water as purely for drinking, or for personal hygiene, or for irrigation. With poor people in particular, demand for water is usually for water in general, not just for single purposes. Despite this, domestic water projects are generally designed with domestic uses primarily in mind. Improved health is often the common objective and water is considered only for drinking, sanitation, hygiene, cooking, and washing. This has placed Water, Sanitation and Heath (WASH) projects in the social or health sector, leaving its link with the economic and productive sectors has been largely disregarded.

Having implemented a WASH programme in Nepal since 2006, Concern has learned that a community's water demands and needs always extend beyond that for pure domestic water. In fact access to water is seen as a key step towards diversifying their own livelihoods. This is because people often tend to use domestic water around households for productive uses which include a range of small-scale activities that enable people to grow household food, produce fruit and vegetables for sale, keep livestock, rear fish etc.

Staying within the WASH sphere whilst building upon field experiences, Concern in 2009 developed an approach called "**Domestic PLUS**" that focuses at homestead level and targets ultra poor families. Similar to the global concept of Multiple Use Water Services (MUS), Domestic PLUS is an approach that meets people's multiple water needs in an integrated manner whilst prioritizing and ensuring vital domestic water sources for consumption and basic sanitation. Depending on the water source capacity it also emphasizes productive uses at community level (and not just at household level) like medium scale irrigation for fields that are located away from homestead as well as small scale electricity generation. Domestic PLUS gives equal importance to sanitation. With little additional cost, if sanitation is considered as more than 'just' human excreta disposal, benefits like cooking gas, lights and fertilizers from biogas attached toilets can be obtained. Similarly, human faeces and urine that are enriched with organic matter can be utilized as fertilizers from ecosan (urine diversion) toilets.

This chapter is aimed to provide a clear framework to enable WASH practitioners to develop appropriate strategies as well as to guide them on how multiple water uses and multiple benefits can be accrued whilst staying within the WASH sphere.

To provide evidence of the impact of this approach as well as document best practices, Concern with its local partners Nepal Water for Health (NEWAH) and Karnali Integrated Rural Development and Research Center (KIRDARC) implemented 10 water supply and sanitation schemes with Domestic PLUS add-ons in Jumla, Jajarkot, Dailekh and Udayapur Districts. Whilst these schemes are still in their early stages, there are already preliminary indications that small-scale management of water resources can give the poor a chance of a higher, more diverse and more secure income. These schemes have been received with great enthusiasm by the poor communities in which they were implemented. This in itself is a good indication that this is what development agencies should be doing.

Introduction 1.0

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2.0 Multiple Use Water Services

2.1 Multiple Use Water Services (MUS) - a Global Collaboration

The concept of multi-use services (MUS) is based on the truism that people use water from multiple sources for multiple uses (Van Koppen et al., 2009). MUS has been defined as 'a participatory, integrated and poverty-reduction focused approach in poor rural and peri-urban areas, which takes people's multiple water needs as a starting point for providing integrated services, moving beyond the conventional sector barriers of the domestic and productive sectors' (Van Koppen et al., 2006).

A thematic group known as PRODWAT (Productive Uses of Water at the household level) was established in 2003 to gain better recognition of the many productive uses of domestic water supplies and their role in contributing to the reduction of poverty. In 2006, reflecting a broader focus on improving the delivery of multiple use water services at the household level by agencies traditionally associated with both the domestic and irrigation (productive) water sectors, the group name was changed to the Multiple Use Water Services (MUS) Group (www.musgroup.net).

People's demands are multi-purpose. Yet water services are usually provided for 'domestic use' or 'irrigation' or for a single use only. Single use mandates leads to 'projects' that operate in parallel with each other, even when they serve the same user at the same site (Van Koppen et al., 2009). Different analysis has demonstrated that rural water supply systems meant for single uses were de facto being used for multiple purposes by communities (Van Koppen et al., 2006).

2.2 Practice of MUS in Nepal

Winrock International, being one of the core partners of the MUS thematic group, applied MUS approach in their Nepal Smallholder Market Initiative (SIMI project), a project funded by USAID and implemented by International Development Enterprises (IDE). Generally referred to a as hybrid system, the project designed in 2001 gravity-fed piped water systems to meet the demand for domestic and small-scale irrigation. Thanks to the low cost of the system and the high returns gained that improved smallholders' livelihoods, the project integrated the MUS design into many of their agriculture and irrigation schemes. Since then, it has been implemented in over eighty schemes.

Rational utilization of water resources, including utilization and management, has been ordered by way of Nepal's Water Resource Act, 2049 (Nepali years). According to this Act, first priority goes to drinking water and domestic uses, followed by irrigation, then agricultural uses such as animal husbandry and fisheries, before the remaining uses can be serviced (Gurung and Adhikari 2010).

In the systems developed by SIMI, spring sources are tapped and use gravity to provide water to a domestic water tank. The water then overflows into an irrigation tank which uses two separate distribution lines for domestic and productive water provisions (IDE, 2008). The alternative design includes a single tank and single distribution system. Combined with drip irrigation and other water conserving irrigation techniques, communities are able to grow a variety of valuable fruits and vegetables that can be sold for a small profit. The SIMI program has also made the important step in linking new suppliers with local markets (WaterAid, 2008). According to Mikhail (2010), this system has received high praise from the communities, and resulted in better outcomes than if SIMI had worked only on micro-irrigation without developing the water source.

2.3 Water service provisions

Water services are the benefits or the outputs received from water resources. This may be water for domestic, irrigation, fisheries or other productive purposes. The infrastructure and delivery system makes these services available to users. Smits (2008) defines water service as the provision of water of a given quality, quantity and reliability at a specified place.

It is also relevant here to mention about water security. Water security means that people and communities have reliable and adequate access to water to meet their different needs, are able to take advantage of the different opportunities that water resources present, are protected from water-related hazards, and have fair recourse where conflicts over water arise. For water managers, it is also fundamental to understand poverty and water security linkages.

It is important to note that, while providing water services for the poor it should not be aimed at a final solution, but instead as a step by step approach. Starting with the needs and existing capacity of the poor, the services should allow for later expansion and upgrades.

Water services are made either to provide single use or multiple use services. Van Koppen et al. (2006) made the distinction between de facto and planned multiple-use services. The former category refers to systems which were developed with a single use in mind, but which are de facto used for multiple purposes by users themselves. This is probably still the most common type of system, and includes for example irrigation schemes designed for field crop irrigation only, but used for cattle or backyard irrigation as well. Planned multiple-use services are services that have been planned from the outset for multiple purposes.

Moriarty (2008) has suggested two paradigms on rural water service provisions. These are the 'domestic paradigm', also known as the WASH (for water, sanitation and hygiene) paradigm; and the irrigation or 'productive paradigm'.

3.0 Domestic PLUS Approach

3.1 Why the Need for a New Term?

Multiple Use Water Services (MUS), though popularly used and understood, is considered traditionally as part of productive sector. In the context of Nepal and some other countries, WASH actors are slow to take up MUS and to move away from just water for domestic purposes.

Domestic PLUS approach, developed by Concern in Nepal, aims to provide a clear framework to enable WASH practitioners to develop appropriate strategies as well as to guide them on how multiple water uses and multiple benefits can be accrued whilst staying within the WASH sphere. Whilst there is a slow realization of the enormous benefits that can be accrued through productive use of domestic water, the needs of the poor have often been seen as simply providing drinking water within a WASH program. This single use focus could be due to shortfalls on understanding how to implement MUS or Domestic PLUS or an inability to convince donors to fund more than WASH programs.

Domestic PLUS is not a specific type of technology or system. It is rather an approach of water service provisions that involves integrated management of water. The rest of this document will explain how the productive uses of domestic water can be systematized to address health as well as improve nutrition, food security and increase income.

The major difference between MUS and Domestic PLUS is their starting points. MUS starts with considering all water uses, while Domestic PLUS starts with ensuring water is available to meet life-giving domestic needs. Once these domestic requirements have been met, the excess water can be channeled into productive uses. In additional, Domestic PLUS equally emphasizes the multiple benefits of sanitation which is not restricted to mere disposal of human excreta.

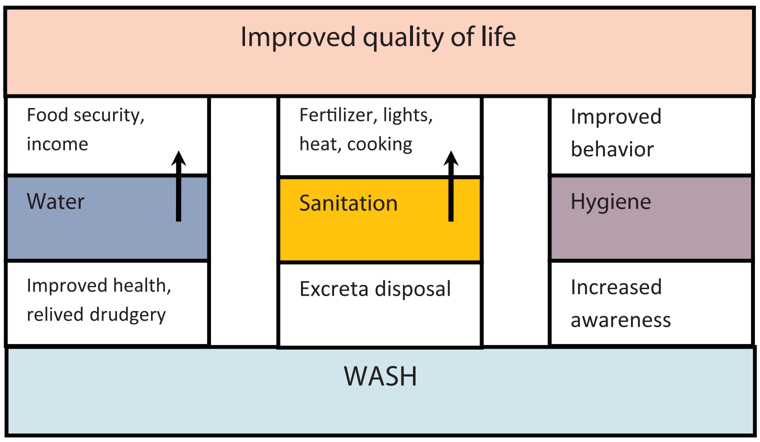


Figure 1 *Multiple benefits from WASH Project*

Domestic PLUS Approach 3.0

For conceptual clarity, the approach is further explained by Figure 1, above. Water, sanitation and hygiene are the three major elements within the WASH sector. The water component is aimed to provide improved and equitable access to increased quality and quantity of water for drinking, cooking, personal and hygiene.

Sanitation component is generally safe disposal of human excreta as the first barrier to excreta related disease through toilet construction. Having no proper means for excreta disposal is a great inconvenience. Women and girls in particular face problems of distance, lack of privacy, and personal safety. Sanitation is targeted to increase access to toilet by each household with acceptable standards to stop open defecation. This is also extended to the school by providing toilet that is built with separate units for boys and girls ensuring the privacy for girls.

The hygiene element comprises of software activities that are aimed for modification and improvement of target communities' hygiene behavior leading to improved health status. Any WASH project cannot have substantial impact unless it is able to improve the hygiene behaviour of the villagers.

Productive water use is defined as a quantity of water over and above domestic 'basic needs' that is used for small-scale productive uses.

As mentioned above, Domestic PLUS is also about multiple benefits from sanitation. Most projects meet their objective of improved sanitation by providing acceptable access to toilets that reduces open defecation. Domestic PLUS proposes that multiple benefits can be provided to people from integrated sanitation management like organic fertilizers from ecosan toilet (urine diversion) and biogas attached toilets to increase land productivity. Gas produced from the biogas plants that are attached to toilets can be trapped for lighting and cooking. Bio briquettes[1] can be used for heating homes during winter as well as for cooking. Briquettes are called environmental friendly as they do not produce smoke or utilize forest products as raw materials. This can be good alternative to wood that produces heavy smoke when burned that causes indoor air pollution, a health hazards that causes respiratory diseases. In addition it helps contribute to a reduction in deforestation.

There are also substantial time savings from having taps and toilets close to households which allows people to have more time for productive activities. Where adequate water is available, the most common productive water use is vegetable gardens. These are generally small kitchen gardens of a few square meters, where onions, tomatoes, and leafy vegetables are the typical production. Many houses also have fruit trees.

The technologies required for the provision of PLUS activities of the approach are not new or special. The skills needed for technical designs and details are conventional basic engineering and can be managed by typical NGO technical staffs that are involved in survey, designing and implementing current WASH projects. The major difference from the conventional WASH projects is that the components are reassembled in different ways.

[1] Briquettes are made from a combination of forest waste (usually an invasive weed called banmara); soil or sand and, often, rice husks as filler; and a binding material such as clay.

3.0 Domestic PLUS Approach

3.2 How does Domestic PLUS Work?

Within Domestic PLUS, the current focus of WASH programmes on meeting domestic water needs must be expanded to cover water for homestead-based income generating activities that are crucial for poverty reduction (vegetable garden, livestock rearing, mini fish ponds, etc). It is accepted that people should have access to a basic domestic water supply ranging between 25 and 50 litres per capita per day (lpcd). In Nepal, rural water (domestic) supplies are designed to provide 45 litres per capita per day which is the locally applied standard.

The MUS's multiple-use water ladder sets 20 lpcd (liters per capita per day) at and around homesteads as sufficient for basic domestic use; 20-50 lpcd for basic MUS; 50-100 lpcd for intermediate MUS; and more than 100 lpcd for high-level MUS (Van Koppen, 2009). Even below basic domestic service levels, poor people prioritize water for small-scale productive activities over personal hygiene. The ladder shows that to facilitate substantial water-dependent productive activities, some 50-100 lpcd needs to be made available within a short round-trip of the homestead, and of these, at least 3 lpcd should be safe for drinking (Renwick, 2007).

Domestic PLUS prioritizes water service provision in the following order:

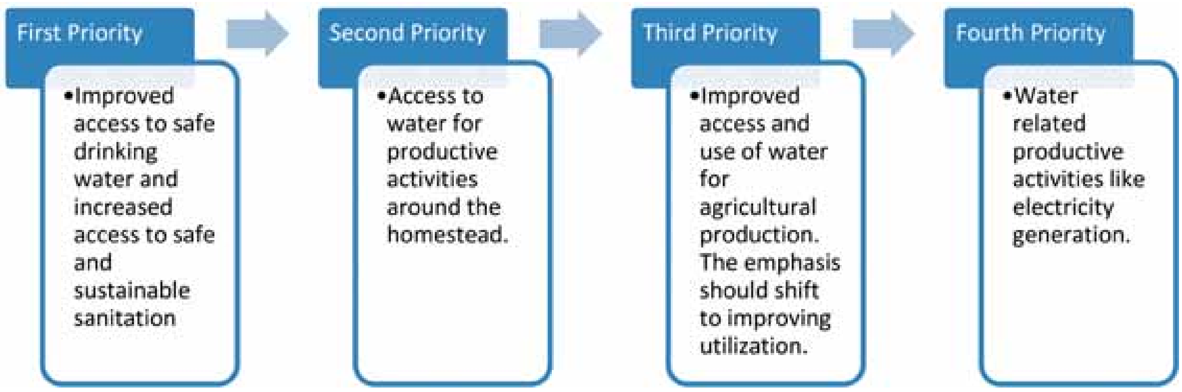


Figure 2 *Priority Order for Domestic PLUS Approach*

Domestic PLUS Approach 3.0

There are many ways in which Domestic PLUS can be implemented:

1 The multiple uses of water can be accommodated from the beginning **during water service provision design**. This can be done by increasing the capacity of abstraction, storage, and delivery of infrastructure by augmenting the diameters of pipes. The addition of productive capacity represents a cost-effective option in some schemes if it is pursued at the time of domestic water supply systems construction. Multiple reservoirs can be created to fulfil the demand for both domestic and productive water. Through this method, the provision of clean drinking water remains the primary priority.

2 Domestic PLUS can also be implemented by **installing add-ons**. This involves adding productive infrastructure on already existing WASH projects or developing WASH projects in villages where productive schemes already exist. The add-ons can be met by collecting waste water or grey water into collection tanks and diverting it to vegetable or fruit gardens. Based upon available water resources and discharge capacity, other productive water service provision like fish ponds, medium irrigation and small hydro electricity can be harnessed.

3 Domestic PLUS can be planned for from start up phase but implemented through a **phased expansion** depending on available resources. All available water resources within the village catchment as well as the community demands and needs shall be assessed. Appropriate water service provisions can be met based on their feasibility in subsequent phases.

4 **Different water sources can be used simultaneously** e.g. springs, streams, rain water, surface runoff, or waste water and each source can be used for the most appropriate purpose.

5 Different sanitation benefits can be discussed with individual households. This should be explained well to community members to create demand. Software activities would back up these discussions such as using fertilizers for increasing productivity, biogas cooking, house warming fuel and lights.

Table 1 *below shows water and sanitation sources, available simple and appropriate technologies, and outputs that can be driven from each system.*

Water sources	Technologies or System	Outputs
Spring	Gravity fed open or closed water supply system	Domestic water consumption
Stream	Sprinkler system or drip irrigation	Energy generation
River	Micro hydro through peltric set	Vegetable and fruit production
Ground water	Improved water mill	Grinding and hauling
Rain water	Ram pump	Fish farming
Waste water	Rope pump	Staple foods
Surface runoff	Treadle pump	
Sanitation sources	**Technologies or System**	**Outputs**
Human urine and excreta	Biogas attached toilet	Lights
Animal excreta	Ecosan toilet (urine diversion)	Heat
Degradable wastes	Bio briquette	Cooking fuel
Forest wastes		Fertilizer

Table 1 *Water Sanitation Sources, Technologies System and Outputs*

3.0 Domestic PLUS Approach

3.3 Framework for Domestic PLUS

This framework for Domestic PLUS is aimed to deliver conceptual understanding of the approach so to ease implementation on the ground. A prerequisite for planners is to think widely and plan for water more broadly than for basic domestic needs alone, but to consider water for multiple uses and from multiple sources.

A thorough assessment should be carried out of all water sources (rain, surface water, ground water, surface runoffs etc) within catchments considering quality, quantity, and reliability. Consideration should be made of current and likely future domestic water needs and productive uses. Those implementing the project should suggest a range of feasible and appropriate options, from which communities can choose the most suitable option.

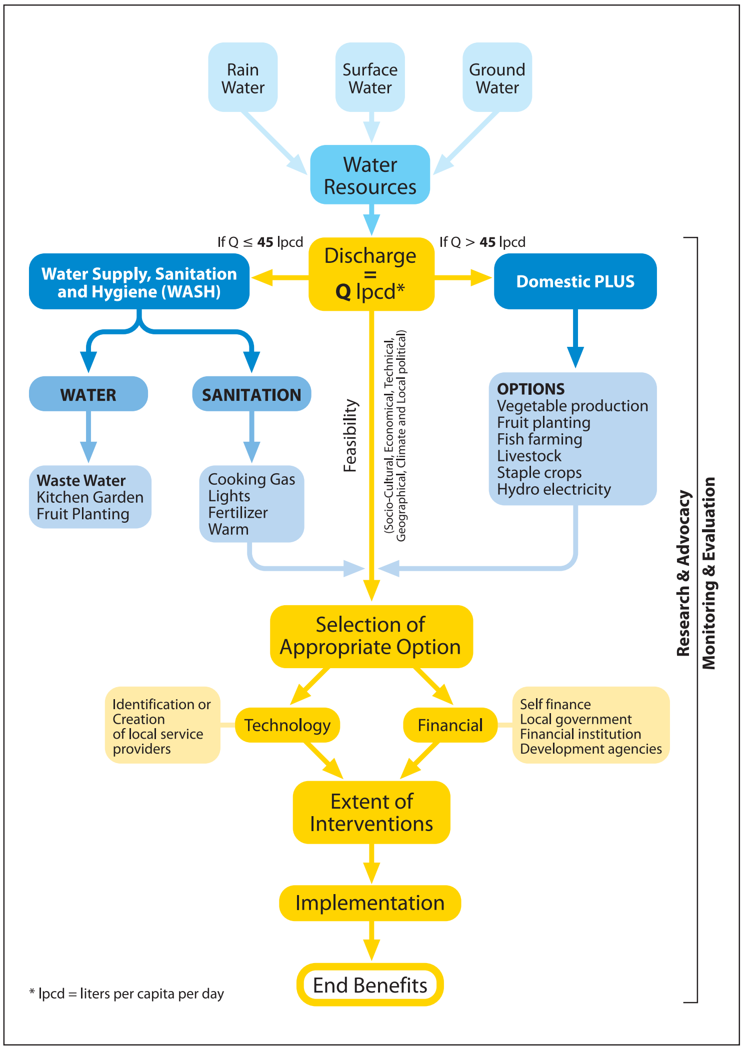


Figure 2 *Framework for Domestic PLUS Approach*

Domestic PLUS Approach 3.0

If the **water discharge at the source is equal to or less than 45 lpcd**[2] , the project will be limited to providing WASH services. As people always use domestic water for productive purposes, this can be systematized by installing add-ons, like constructing waste water collection tanks at the end of tap stands with diversion to kitchen gardens. In such circumstances, micro-irrigation systems could either be sprinkler or drip irrigation.

Similarly, sanitation facilities (toilets for excreta management) can have additional benefits by extracting biogas that can produce gas for cooking and lights as well as slurry for fertilizers. Human faeces and urine can be used as fertilizer if obtained from ecosan (urine diversion) toilets.

If **water discharge is more than 45 lpcd**[3], then a wide range of Domestic PLUS activities can be implemented i.e. kitchen gardens, fruit planting, fish farming, livestock, staple crop production and small hydro electricity generation. The available options shall be selected based on the feasibility assessment considering socio-cultural, economical, technical, geographical, climatic, and local political situation.

The options chosen and their extent will be determined by two main factors: financial resources and available technologies. The extent of intervention refers to how big or small the intervention will be. For example, irrigating 20 hectare or 2 hectare, generating 5 kilowatts or 2 kilowatts, water pumping to 20 meters or 100 meters etc. Financial resources can be through support from local government, financial institutions like micro-finance at local level, through development agencies international and national NGOs or through self-financing.

Appropriate technologies can be identified and selected, with services provided through private service providers. For sustaining any technological interventions it is always appropriate to create service providers at the local level so that people do not have to walk far or spend more money to fix their problems. People always spend money when they see the clear benefits. Some of the technologies applied at the field are provided in Section 6.0

Research and advocacy is an integral part of the approach. This is so as to demonstrate the benefits of the intervention by documenting experiences and learning, and influencing others to replicate the best practices. Thorough monitoring and evaluation systems should be in place for measuring impact and providing feedback during implementation.

[2] litres per capita per day
[3] this can be multiple sources

3.0 Domestic PLUS Approach

3.4 Conducting Assessments for Domestic PLUS

The assessment process and information required to design Domestic PLUS interventions may overlap with the assessments conducted while planning and designing WASH projects. Therefore, the collection of supplementary information required for Domestic PLUS activities can be included during a single WASH assessment process.

The assessments should be carried out considering various technical and social issues in order to identify the most appropriate option. This involves collecting secondary information, utilizing PRA tools and household questionnaires for primary information.

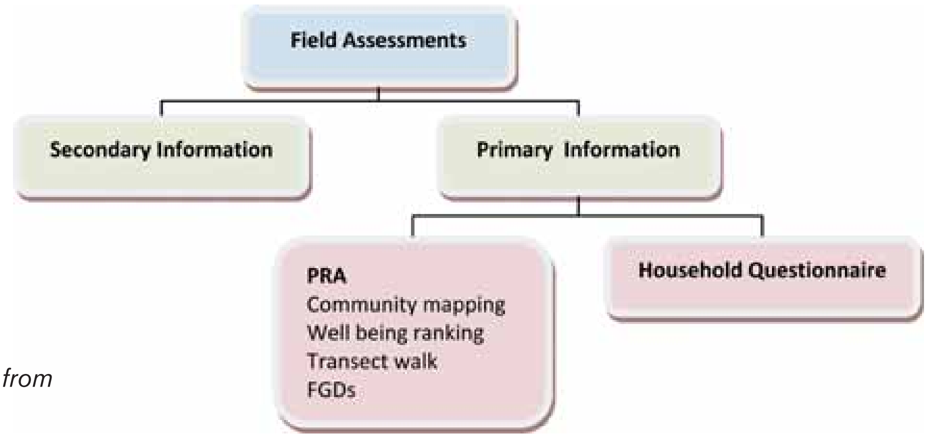


Figure 3
Information Gathering from Field Assessments

Secondary information includes hydrological data of the specific location or neighboring location. Similarly, contour maps, land use maps or other relevant maps can be obtained of the area.

Primary information is collected using PRA tools that involve community mapping, well being ranking, seasonal mapping, transect walks, and focus group discussion. After producing community maps and categorizing into well-being ranking, household questionnaires can be filled on selected households.

Community mapping is useful for knowing about the number of households by ethnicity and caste. Existing community infrastructure like water supplies or other productive infrastructure should be included in the maps, with all the water sources available within the communities and the catchment.

Well being ranking involves community members identifying and analyzing the different wealth groups within a community. It is useful to learn about the socio-economic stratification of the community and local people's definitions and indicators of wealth/well-being. Currently, Concern Nepal's WASH project four categories (A-D) are used:

Well being rank	Criteria for classification
A (Ultra poor)	Very limited land for agriculture, food supply from own production only for 3 months of the year; labouring work is primary source of income; no regular employment; chronically in debt.
B(Poor)	Less than six months food supplies for the whole year from own production; often engages in labouring work; often in debt.
C (Medium)	6 to 12 months food sufficiency; no loan required for household expenses; small-scale business; paid jobholder.
D (Better Off)	Adequate food from own production and can produce a surPLUS; permanent house; land in market area; engaged in business; loan provider etc.

Table 2 *Well-being Ranking and Criteria for Classification*

Transect walks (exploratory walks through the area guided by local and knowledgeable people) are made to observe the main features of the resources, uses, any potential hazards, any problems, as well as the main natural and agricultural zones. The information from the transect walk can be verified with the key informants during focus group discussion. The transect walk is coupled with technological assessments including discharge measurements at each water source, water quality tests, and technological inspections of existing infrastructures. Community consultations can be done to identify pertinent issues during the transect walk.

Focus Group Discussions (FGD) are a useful PRA tool for qualitative information collection. FGDs are conducted amongst different castes, women's and men's groups to get information about the village and to know issues related to water use, demand, and needs. Each FGD should consist up to 15 people from different houses.

Household Questionnaire surveys are conducted in selected households following sampling methodology that is proportional representative from well being ranking. This questionnaire will mostly be closed ended questions that are primarily focused on identifying water related issues at household level.

Whilst conducting assessments and option planning, the following aspects should be taken into account:

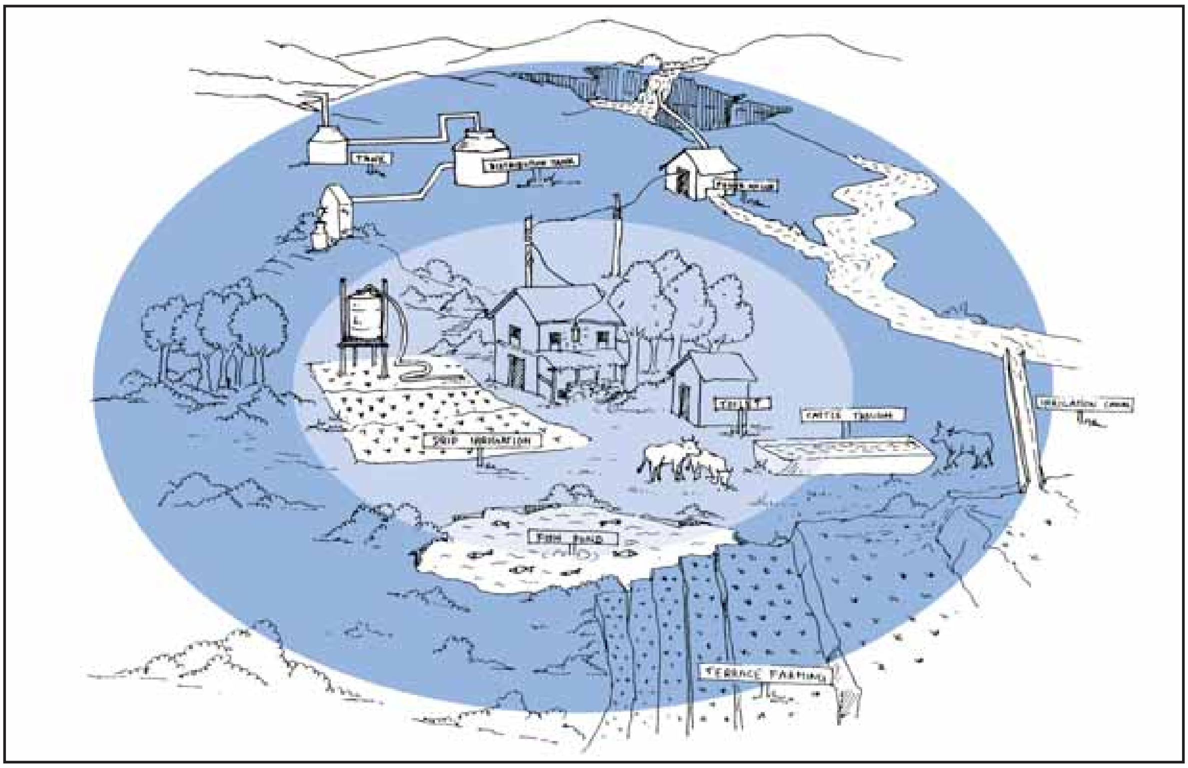
- Water services should be planned together with communities according to their priorities for multiple end uses, in particular at and around homesteads and within villages.
- Past, current and potential future sources where people can get water from (multiple sources) should be considered. Assess the pros and cons of various sources, which sources are good for which uses, and how the communities may want to and can develop or improve these.
- Introduce villagers to the technologies and financial opportunities available to them, and explain (within the livelihoods context) the options that exist.
- Assess the current sanitation situation, people's habits, and explain to them opportunities that exist in integrated sanitation management.

4.0 Scale of implementation

Different households have different needs, so the scale and nature of domestic and productive water use can vary greatly within any community. Though homestead and community scale is more relevant to the Domestic PLUS approach, it also necessary to recognize that sustainable water management has to be considered at hydrological boundaries. Efforts should be made to solve any problems that result from the introduction of catchment based management of natural resources on which so many livelihoods depend. One could also argue to move from basin scale and trying to relate this with Integrated Water Resource Management (IWRM)[4].

Homestead scale here refers to the home and the immediate surrounding land used by the family. Many small plot production activities happen at this level including vegetable production, fruit production or household fish farming. However the systems to provide water services are located at the community level, like water reservoirs, distribution systems, communal taps and other infrastructure, where the community is responsible for their operation and maintenance. Communal level Domestic PLUS activities include medium irrigation through streams to grow staple foods where fields are located relatively farther than the household. The adjoining Figure 4 demonstrates activities, system and services that occur at homestead and community level.

Figure 4
Activities at Homestead and Community Level



Most of the poor spend a very high proportion of their income on food as they do not have enough land to produce food for all of their needs. They grow some produce on small plots of land around their homestead or on common property resources or common lands. Homestead plots are easily developed under individual initiative. Growing vegetables within the homestead is also more convenient and secure. More importantly, the entry costs to poor people for using domestic water for backyard irrigation are low as there are no committees to join and little equipment is needed. In some cases accessing resources becomes difficult and political for ultra poor families.

[4] *Global Water Partnership (GWP) has defined, Integrated Water Resource Management (IWRM) as a process which promotes the co-coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystem.*

Scale of implementation 4.0

Figure 4 also shows that Domestic PLUS emphasis should be given at homestead level if more ultra poor are to benefit.

While relating the scope of the approach with the principles of IWRM, Moriarty et al. (2000) in his six IWRM principles for drinking water supply sector recognized that catchment management and source protection are essential if multiple supply and uses of water are to be encouraged. This is in fact where IWRM principles and the WASH sector interface with each other. According to Van Koppen et al. (2009), the MUS approach starts with people and their uses and needs for water. IWRM focuses on higher aggregate scales of sub-basins, countries and trans-boundary basins, recognizing that water resources are used by many users for many purposes.

MUS integrates where integration matters, most by meeting people's multiple water needs from multiple integrated sources. Another difference lies in the fact that MUS is seen as a service delivery approach, whereas IWRM is often understood as an approach to coordinating the management of water resources between sectors.

WaterAid Nepal within Integrated Water Resource Management (IWRM) has developed a framework that is applicable at the community scale. It has defined this as a participatory process of community engagement in an integrated development and management of water resources ensuring sustainability of ecosystems and socio-economic development. Concern Nepal in 2008 designed a WASH project called Environmental Health Programme (EHP)[5] that is based on integrated water resource management principles, that was aimed to deliver holistic water resource planning through equitable and efficient sharing of water resources for domestic and productive uses at the catchment level. The framework for EHP project is provided in Figure 5.

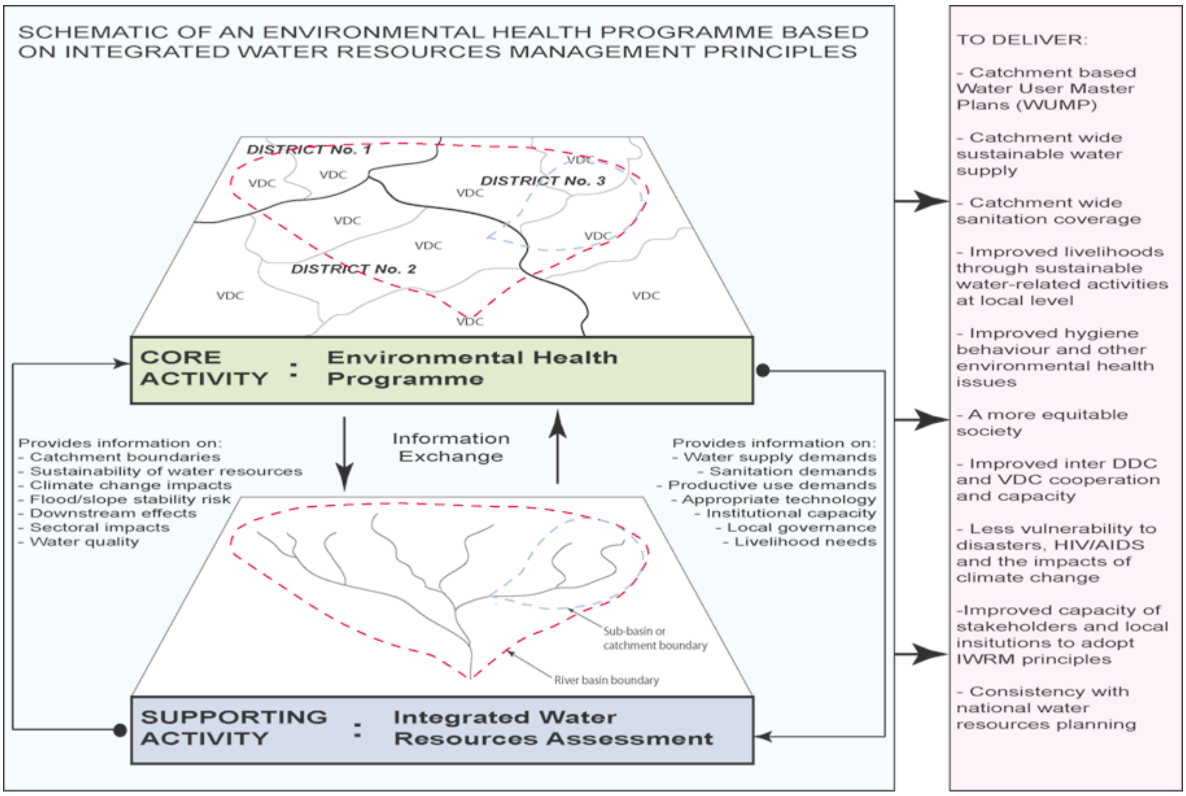


Figure 5 *Schematic of Environmental Health Programme (EHP)*

[5] *This EHP program was later modified to Water Environment and Local Livelihoods (WELL) as the concept of working at catchment level was not feasible on available time frame of one and half years after Concern decided to close it Nepal operation by 2010.*

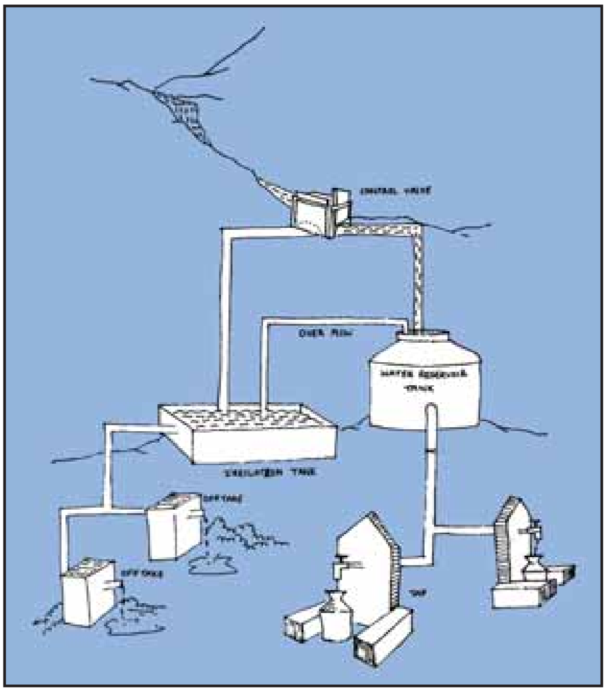
5.0 Implementation of Domestic PLUS Examples from the Field

To demonstrate the Domestic PLUS approach, Concern implemented 10 Water supply and Sanitation projects in different geographical locations. Table 3 below gives information regarding the project locations and type. Though all the projects have water service provision for domestic and productive uses, each are different in terms of the system and technology applied.

SN	Name of Scheme	WASH Intervention			Domestic PLUS Intervention			
		Tap stand	Budget	HH	Service Provision	Output	Budget	HH
1	Lamaragothi Scheme, Dasera 1, Jajarkot	10	1,489,041	56	Micro irrigation	7 off takes	222,173	45
2	Darpakha Scheme, Salma 8, Jajarkot	12	1,311,253	88	Micro irrigation Medium irrigation	10 off takes 16.56 Ha	169,876 219,401	38 88
3	Luhadaha Scheme, Majakot 3, Jajarkot	10	1,966,519	61	Micro irrigation Medium Irrigation	7 off takes 7.76 Ha	279,262 633,060	45 143
4	Badaban Scheme, Dasere 8, Jajarkot	10	1,141,029	68	Micro irrigation Medium irrigation	9 off takes 10.02Ha	14,087 35,068	58 141
5	Mathillo Ganma Scheme, Pagnath 4, Dailekh	26	2,738,618	92	Micro irrigation Fish Pond	4 off takes 2 pond	449,403 60,000	72 72
6	Handetola Falma Scheme, Dasera 2, Jajarkot	28	2,501,705	100	Micro irrigation	12 off takes	266,397	46
7	Ghodasina Scheme, Patmara 3, Jumla	9	2,543,507	97	Micro irrigation Medium irrigation	10 off takes 6.1Ha	1,023,693	97
8	Lorpo Scheme, Dillichaur 3, Jumla	8	1,097,681	69	Micro irrigation Fish Pond	6 off takes 1 pond	224,756 44,000	91 69
9	Sirise Scheme, Sirise, Udaypaur	16	1,481,345	65	Micro irrigation Small hydro electricity	8 off takes 7 kilowatts	123,000 1,777,500	56 105
10	Kolbot Scheme, Syano Damar 9, Udaypur	9	1,536,416	46	Micro irrigation Fish Pond	7 off takes 14 ponds	112,000 2,500 per pond	32 14

Table 3 *Project implemented considering Domestic PLUS approach in different locations*

Implementation of Domestic PLUS Examples from the Field 5.0



To illustrate current field practices, four illustrations are presented here as examples. In **illustration 1**, a source has been tapped to provide water for both domestic and productive uses. The diameter of pipe has been increased along the transmission line before the water reservoir tank to accommodate additional water for irrigation. This system has two tanks, a primary one for domestic water use, and a secondary tank (filled by overflow from the primary tank) for irrigation. Households can irrigate their plots for small scale production through constructed offtakes by attaching drip irrigation, sprinklers or loose pipes.

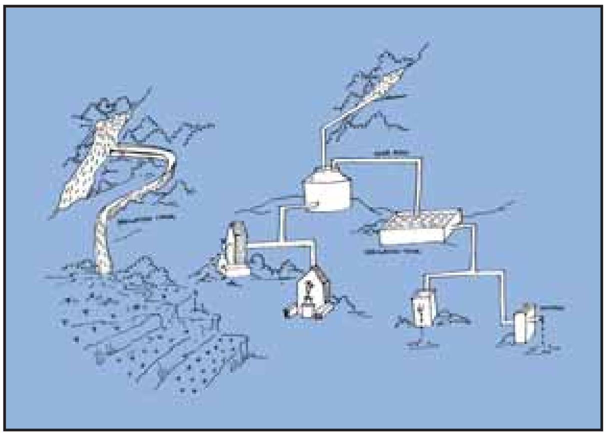


Illustration 2 demonstrates the mixture of a WASH project with micro and medium irrigation. The water supply for micro irrigation and the WASH system is the same as Illustration 1. For medium irrigation, the stream source has been tapped and used for irrigating a larger farm for staple food production.

5.0 Implementation of Domestic PLUS Examples from the Field

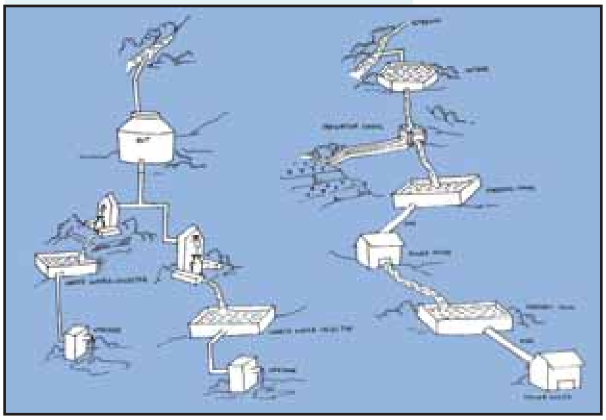


Illustration 3 demonstrates an example of WASH, micro and medium irrigation, and multi staged micro hydro electricity generation[6]. This example is taken from a project in Udayapur district in eastern region. Though medium irrigation and electricity generation is occurring, water supply for domestic consumption and micro irrigation is under construction. The WASH scheme is similar to the examples from previous illustration. However, a waste water collection pond will be constructed to provide water for kitchen gardens.

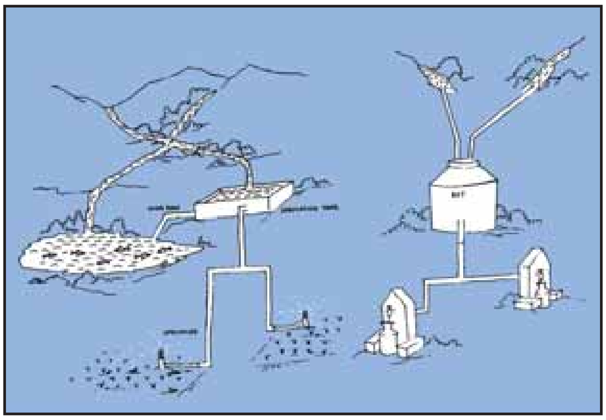


Illustration 4 has water for domestic supply (similar to previous illustrations) and another source is tapped to provide water for micro irrigation through sprinkler system and water is also supplied to fish ponds.

Water service provision can therefore be categorised into the following five systems:

1. Single source for single use i.e. either for domestic consumption or productive purposes.
2. Single source multiple uses with the multiple uses accommodated within a single infrastructure.
3. Multiple sources but single use: this is in the case where the capacity of single source is inadequate to meet the demand for single water use.
4. Multiple sources for multiple uses using single infrastructure like common reservoirs.
5. Multiple sources for multiple uses through different infrastructure.

[6] *Hydro electricity are non consumptive water uses*

Appropriate Technologies 6.0

A range of simple and appropriate technologies already exist to provide different levels of access (both in terms of quantity and quality) and none of these technologies are new. Chapter 4 provides technological briefs on each technology used. A short brief is provided below on each of these technologies:

Improved water mill: This involves improving existing traditional water mills to produce increased power, not only to operate mechanical appliances such as cereal grinders (for maize, wheat, millet etc.), paddy hullers, oil expellers, and sawmills, but also to produce electricity by coupling it with a generator.

Peltric Set: This is a small vertical shaft pelton turbine with an induction generator coaxially coupled with it. It generates electricity power from a small quantity of water which is dropped from a height to operate it.

Hydraulic Ram Pump: This is an automatic pumping device which utilizes a small fall of water to lift a fraction of the supply flow to a much greater height i.e. it uses a larger flow of water falling through a small head to lift a small flow of water through a higher head.

Rainwater Harvesting: This is the gathering/accumulating and storage of rainwater. Rainwater harvesting has been used to provide drinking water, water for livestock, and water for irrigation. Rainwater collected from the houses, tents or from specially prepared areas of ground can make an important contribution to drinking water.

Sprinkler Irrigation: This is a method of applying irrigation water which is similar to rainfall. Water is distributed through a system of pipes. The system is to irrigate a small piece of farmland by making artificial rain through the use of sprinkler. The system comes under small-scale irrigation system and used for increasing the efficiency of scarce water resources.

Drip Irrigation: This is a method of watering plants close to their root zone where it is most beneficial. Drip irrigation is suitable in areas of scarce water availability, where there is porous soil or unlevel land where surface irrigation is not feasible.

Bio Briquette: Biomass briquetting is the densification of loose biomass material (agricultural and forest residue) to produce compact solid composites of different sizes with the application of pressure. Briquetting of residues takes place with the application of pressure, heat and binding agent on the loose materials to produce the briquettes. This is one of the alternative methods to save the consumption and dependency on fuel wood.

Biogas: Biogas is a mixture of gas, mainly methane, produced by methanogenic bacteria while acting upon biodegradable materials in an anaerobic condition. The feed (cow dung and/or human manure) is mixed with equal volume of water and fed into a dome shaped digester where it is acted upon by methanogenic bacteria under anaerobic condition.

7.0 Research and Advocacy

Concern adopted the Domestic PLUS approach based on the assumption that the net benefits of multiple-use approaches are greater than those of single-use approaches, and that this approach addresses more comprehensively the multi-dimensional aspects of poverty than single-use approaches. Concern conducted a number of researches to gain better insight on the linkages between the provision of water services and growth, and to promote replication by demonstrating tested examples. From the below listed reports; Cost and Benefits, Technology Used and Gender Dynamics are included at Chapter 2 and 3 respectively.:

1. Cost and benefits of Domestic PLUS approach.
2. Technology used and gender dynamics.
3. Scaling up practice of Kitchen Gardening into WASH program.
4. Practice of Integrated Water Resource Management (IWRM) in WASH program.
5. Delineation of water sub catchments at Karnali River Basin to initiate WASH program at the river basin level.
6. Explorative Study on Scaling up Current Practice of Saving and Credit into WASH program.
7. Compilation of technologies used in Domestic PLUS.

Though there has been insufficient time to determine the impact of these activities initiated in 2009, different examples have already demonstrated that the approach has been able to address some of the limitations and challenges that poor people are facing.

Sustainability 8.0

There have been examples to show that the sustainability of water supply systems can be increased explicitly by including productive water uses that enhance livelihood means, which increase in turn motivation for people to engage in the management of the systems.

Improved water supply can reduce water collection time. The time saved can be invested in increased social, human, economic or political capital at the community level through activities such as rural enterprises for generate income, literacy classes, formal education for children, more time to prepare nutritional meals for children[7], community meetings and committees, social solidarity etc. These investments can reduce poverty and empower especially women to participate more in decision-making in their households and in their communities.

Water, when there is too much or too little, may also affect the poor, as they are the most vulnerable to water-related hazards, such as extreme floods, droughts, major storms landslides, pollution, and so on. The concept of Domestic PLUS approach should therefore go beyond tangible uses like water for households for domestic and productive uses, and embrace also other functions such as reducing the risk of local disaster that can have negative impact on the lives of poor.

[7] *Concern's study of health systems in Bardiya district found that one of the prime constraints to improved nutrition is that many women simply do not have the time to prepare nutritional meals for their families.*

9.0 Conclusion

The Domestic PLUS approach was conceived in 2009. Its implementation is still nascent. However the concept itself is not new due to its foundation that is built on field experiences, lessons learned and best practices. Domestic PLUS is an attempt to provide a framework for organizations working in the WASH sector to move beyond the sector to focus on providing additional benefits to their beneficiaries.

In the context of Concern leaving Nepal in 2010, Domestic PLUS will be implemented from now on by its partners, NEWAH and KIRDARC, who were part of the initial initiative. For Concern Worldwide Nepal, an international dissemination workshop organized in July 2010 will be an opportunity to influence other stakeholders including participants from other Concern country offices and head office.

In many cases, the initiatives presented here were received with great enthusiasm by the poor communities in which they were implemented. If water resources management continues to follow a business as usual approach, then the poorest of the poor will surely be left out. Poverty reduction is only possible if the poor people have secure access to safe and sufficient water for domestic and productive purposes. A more reliable domestic water supply combined with increased economic opportunities and a supportive environment not only has a direct impact on the income of the poor but also reduces their vulnerability during times of adversity.

In many communities, one finds many committees like, a water supply and sanitation committee, an irrigation committee etc. The domestic PLUS approach, which considers different uses of water, is expected to bring all sub-sectors together and increase coordination.

The water sector is dynamic. There are consequently no final solutions, but only stepwise improvements on the present situation. In due course, these improvements will turn out to be insufficient, requiring further enhancements. Technologies and infrastructure come and go, but water management capacity that is institutionalized is likely to stay and help tackle future challenge.

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A woman digging a pipeline in Jumla, 2008. Photo: Mukunda Bogati

Benefit Cost Analysis of Domestic PLUS Water Service Provision

Written by
Sugandha Priyadarshani Gurung

Executive Summary

Working together with its national partners NEWAH and KIRDARC in 2009 and 2010, Concern Worldwide Nepal implemented nine "complete" Domestic PLUS WASH schemes in Jumla and Jajarkot districts from 2009 to 2010 benefiting more than 4,000 people. In addition, five "add-on" Domestic PLUS schemes were also implemented in Dailekh, Udayapur and Siraha districts where existing domestic water supply schemes were already in place.

This research was initiated to look at the benefits and costs involved in Domestic PLUS systems over conventional domestic water supply systems. This is given the hypothesis that one service catering for multiple water and sanitation uses costs less than having separate systems.

The **total cost** includes the operation and maintenance cost and support cost, along with the total capital costs of setting up a complete water supply system. The **total benefit** comprises benefits from time saved, improved health, better nutrition, increased education, decreased labour migration, and productive water use.

To compare different types of water supply schemes, the following 3 scenarios were taken with 2 schemes being studied per scenario (with a total of six WASH schemes being studied):

Case I: CWN supported conventional Domestic WASH schemes (Parale and Lewa)

Case II: CWN supported Domestic PLUS WASH schemes (Luhadaha and Handetola)

Case III: Non-CWN conventional Domestic WASH schemes (Dasera and Chankhila)

Water service levels in all six WASH schemes had reached the basic multiple-use service level with surplus water for some productive water use (level 3 of the 5 level household water multiple use ladder).

On the expense part, the increased PLUS cost ranged between 7 % to 10% of the total cost of Domestic PLUS water supply schemes. This is not large compared to the normal total cost of conventional water supply schemes in the study areas. Also the research shows that with little additional increment in cost on the PLUS component of those schemes, around four folds of benefits can be expected, though some of these were difficult to monetise. Benefit findings show that:

Executive Summary

- In a day, a household now saves between 10 minutes to 2 hours 45 minutes time, time which is assumed to be used now for other productive activities around the house.
- People from the schemes spend on average from 2,500 NRs to 17,000 NRs per year for diarrhoeal treatment of family members. This money and time used for treatment can be saved now due to increased health benefits from access to clean water.
- The people from these schemes used to spend 200 NRs to 850 NRs per month to purchase green vegetables for their family's consumption. This money is saved due to vegetable production within homestead kitchen gardens.
- Though the number of days children miss from school has reduced, children from Hadetola, Lewa, Parale and Dasera are still missing school on an average of four days a month for collecting water.
- Benefits from the Domestic PLUS activities are being reaped at household level in the form of consumption of the outputs such as green vegetables, livestock meat, fruits, grains, etc. by family members. This is contributing largely to the diet and nutrition of the family members as well as the quality of life as opposed to providing direct income.

Commercial vegetable production is not possible in Jajarkot district due to its difficult topography and remoteness from road access. The study instead took the example of a successful commercial vegetable farming case under Domestic PLUS approach from Dailekh to calculate how much income Jajarkot residents could potentially make if commercial vegetable production was viable. However even with this extrapolation, the benefit cost ratio for the Domestic PLUS schemes was less than one i.e. negative. This implies that the research hypothesis was not supported i.e. that both types of system cost more than they provide in benefits. However, numerous additional benefits remained uncalculated as they were too difficult to monetise albeit they were more tangible. In addition, small monetary returns at local level cannot compete against the costly water supply systems.

Overall, this study concludes that, despite the costs outweighing the potential value of benefits, these systems are still necessary as a basic requirement for living for people living in rural Nepal.

1.0 Background

Multiple users take water from multiple sources, and use and reuse it for multiple purposes (Van Koppen et.al, 2007). Population, weather, water use habits, accessibility to water, housing condition, level of income, and price are some of the factors that bring about demand for water (Tadle, 1990).

The provision of water or water based services in rural context are provided to people for specific activities under two large and mutually exclusive paradigms - a **domestic paradigm**, focused on public health, and a **productive paradigm**, focused on food production (Moriarty, 2008). The domestic paradigm focuses on water consumption and proper sanitation leading to public well-being. The productive paradigm on the other hand focuses on use of water for increasing the productivity of land (or water) in the form of irrigation, which ultimately leads to increased economic gains for people. However, the domestic need for water goes beyond just consumption. In rural areas, there is often a demand for water for small-scale productive uses such as backyard gardens, livestock, crop processing, and micro-enterprises. These productive activities make a major contribution to rural communities, generating income, securing food, and helping in the fight against poverty. However, water service providers usually do not take into account the needs of small-scale productive users when they plan domestic water supply systems, and in some cases, such practices may even be prohibited. This has a detrimental impact, limiting the economic benefits of water supply systems and limited chances of sustainability. This always leads to a situation wherein systems designed for single water use are used for multiple purposes, often in an unplanned way (Van Koppen et al., 2009). For instance, domestic water supply systems are fed into irrigation uses, while irrigation water systems provide domestic needs as well without taking into consideration the capacity of the respective systems.

Understanding this gap in the rural and peri-urban water supply sector, the concept of Multiple Use Water Supply System (MUS) has evolved under the leadership of the International Water and Sanitation Centre (IRC) and International Water Management Institute (IWMI). The concept of MUS is a combination of both domestic and productive paradigms that caters for small-scale productive uses in combination with basic domestic uses.

To supply water in the hilly terrains of Nepal, a spring(s) at an elevation higher than the location of the village is used. A pipeline is built to bring the water, using the force of gravity, from the source to community tap stands below. Most springs do not have uniform discharge throughout the year. The discharge is highest at the end of the rainy season and reduces gradually through the dry season. As such, water is subject to seasonal availability and can have varying levels of contamination. Construction of a reservoir for surface water can ensure continuous water supply. Wells are also a good alternative for ground water supply.

Background 1.0

The MUS concept was introduced in Nepal by Nepal Smallholder Irrigation Market Initiative (SIMI[1]) project, with the support of International Development Enterprises (IDE) and Winrock International. The system consisted of collection tanks or a reservoir near village settlements wherein water from springs or small stream diversions were collected by gravity

flow through a pipe. These systems supplied primarily for both domestic purposes and homestead horticulture of 10 to 40 households. Small scale drip irrigation systems were introduced that supported the farmers to use water more efficiently, to save labour and to help better plant growth (Nepal SIMI, 2004). As such, communities were able to grow a variety of fruits and vegetables that can be sold in the market. This way, the SIMI project played an important part in linking the new agro-produce suppliers to the local markets. MUS system is an important livelihoods based option for hill communities in Nepal, who seek both access to drinking water as well as to improvement productivity and value of their small landholdings (WaterAid, 2008). Although domestic water provision could be linked with any productive use component in a multiple water use system, the SIMI project combined its domestic water portion with micro irrigation for high value crops. In this way, less water was used, and during production rapid changes could be observed in one growing season. This quick achievement was significant in encouraging the MUS concept with farmers as well as partners (Mikhail and Yoder, 2008).

Concern Worldwide Nepal (CWN), with support from its national implementing partners Nepal Water for Health (NEWAH) and Karnali Integrated Rural Development and Research Centre (KIRDARC), has implemented Water Sanitation and Hygiene (WASH) programmes since 2006 in the remotest districts in Mid-Western region of Nepal. Within its WASH interventions, CWN introduced a new approach called Domestic PLUS. The crux of this approach was that water service provision met people's multiple water needs in an integrated manner, whilst prioritizing and ensuring vital domestic uses for consumption and basic sanitation. Altogether nine "complete" Domestic PLUS WASH schemes were launched in Jumla and Jajarkot districts benefiting more than 4,000 people. Five "add-on"[2] Domestic PLUS schemes were also implemented in Dailekh, Udayapur and Siraha districts.

There has been a great deal of discourse regarding the benefits of MUS over other water system approaches. A major assumption has been that MUS costs less and is cost effective, with a claim that investment in one service for multiple uses costs less than separate systems (Smits, 2008). To test this hypothesis, CWN carried out their own cost benefit analysis.

The objective of this research paper is to provide better insight into the benefits and costs of multiple use water services (Domestic PLUS) over single water service provision (Domestic supply).

[1] SIMI was a USAID funded project in Nepal being implemented by Winrock International as the lead organization with IDE and local partners: CEAPRED, SAPROS and AEC

[2] These schemes previously had provision of water supply for domestic uses and were upgraded to multiple water service to provide additional water for the productive use.

2.0 Conceptual Framework

The Multiple Use Ladder is given in Table 1 (extracted from paper by Smits et.al (2008)). It describes the range of having no water available, even for domestic use, to having adequate water available for more than domestic uses. The locally applied standard for rural domestic water supply in Nepal is estimated at 40 litres per capita per day (lpcd). The total household water requirements where water for productive uses is also required is in the range of 50 lpcd to 200 lpcd.

Table 1 *Household multiple-use ladder*

Service level	Distance or roundtrip	Quantity (lpcd)	Potential needs met
5. Maximal multiple-use service	Water at the homestead	> 100	All domestic needs Not all but in some combination: • Livestock • Extensive gardening • Small-scale enterprises
4. Intermediate multiple-use service	Water at the homestead, or within 5 min roundtrip	50-100	Basic domestic needs Not all but in some combination: • Couple of large livestock • Gardening up to 50 m2 • Some micro-scale enterprises
3. Basic multiple-use service	Roundtrip less than 15min, or at a distance between 150-500 m	20-50	Basic domestic needs Not all but in some combination: • Some livestock • Some gardening, especially with re-use • Some micro-scale enterprises
2. Basic Domestic service	Roundtrip up to 30 min, or distance less than 1 km	10-20	Sufficient for drinking and cooking Hardly sufficient for basic hygiene
1. No service	Roundtrip more than 30 min, or more than 1 km	< 10	Sufficient for drinking and cooking Insufficient for basic hygiene

Source ***Smits, Renwick, Renault, Butterworth, and Van Koppen (2008)***
Note The dashed area represents the standard level of rural domestic water supply in Nepal

The hypothesis tested in this study is that the net benefits of the Domestic PLUS (multiple use) water use system are greater than those of just domestic (single use) water use systems. The boundary area selected for this study is the homestead level i.e. enough water available to meet basic domestic and sanitation needs of each household for sustainable livelihoods. The key concepts in the framework shown in Figure 1 are benefits and costs, which need to be defined and measured in order to fulfil the objective of this study. The service level will be followed as per the five water service level given in the household multiple-use ladder in Table 1. Limited by measurement problems, the aim of this analysis is to only include the most tangible and measurable benefits. This approach is also taken because the benefits considered are the ones most likely to occur in all settings.

Conceptual Framework 2.0

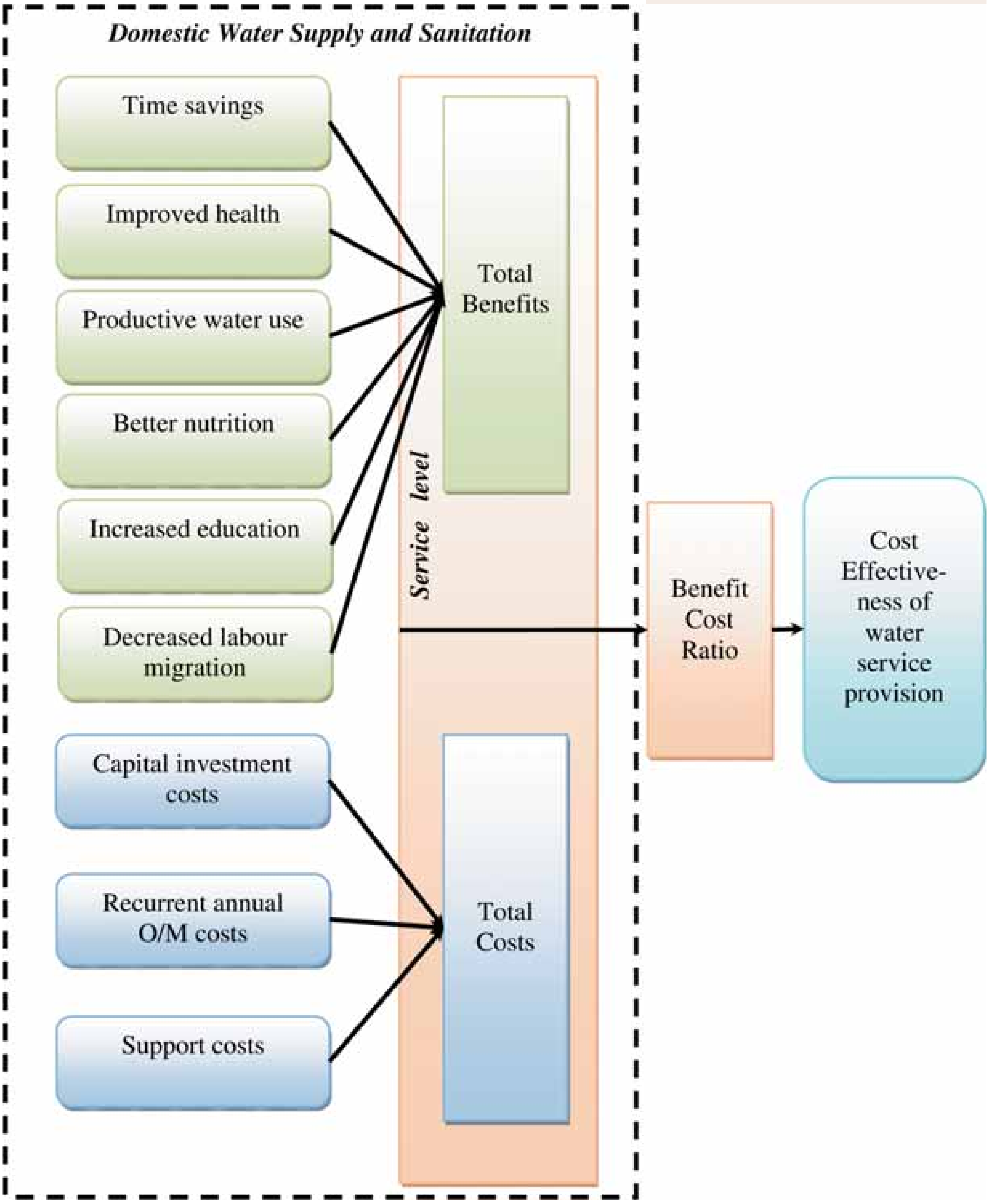

Figure 1 *Conceptual framework of the research*

2.0 Conceptual Framework

2.1 Definition of concepts

BENEFITS

Benefits in this study are additions to]the supply of goods and services to the economy. The anticipated benefits are as below:

Time savings There is a value attached to time saved each day in fetching water because otherwise that time can be used productively to earn wage, an act common in a rural scenario. The idea is to estimate the value of the time that water carriers could have potentially earned. Valuation of the time saved is possible using rural agriculture wage rate as the indicator. The wage rate is the average basic hourly wage or minimum daily wage, depending upon the wage system prevalent in the area under study.

Improved health Improved health implies reduction in incidence of diarrhoeal diseases as a result of water availability leading to basic sanitation and hygiene practice. Treatment (medical) costs avoided is the indicator of improved health. Value of productive days gained due to avoided illness is another indicator. This valuation is obtained by using the rural agriculture wage rate as in the case of time savings above.

Productive water use Additional income from productive use of water (obtained mostly from common water use activities such as livestock and kitchen garden which are additional to basic domestic consumption) are the direct benefits obtained as a result of multiple uses of water. Per capita income estimates act as an indicator of productive water use value.

Better Nutrition

MUAC (Mid Upper Arm Circumference) is a simple and easy tool for assessing the nutritional status of children between 6 months and 5 years. Their dietary habits and frequency are also indicators of nutritional status, and expenses incurred dedicated to nutrition gives its value.

Increased Education Increased education refers to the increase in school attendance of children from time saved from water collection. Its valuation is in terms of lost school days avoided and the tuition fees paid by the households.

Decreased Labour Migration This benefit implies avoidance of migration due to income generation opportunities created from the productive use of water. Time saved from migration has comparatively lesser value but is an important social benefit.

Better nutrition, increased education, and decreased labour migration are benefits drawn in terms of defining poverty dimensions.

COSTS

Anything that reduces real income is termed as economic cost. For the estimation of real costs involved in the water system proposed, all the costs that have to be incurred for realizing the benefits attributed to the water system are taken into account. In general, a new system design will mainly have three types of costs:

Capital costs These costs are all the expenses involved in the installation of the system from design phase to the construction of the unit, including cost of land, and relocation or land development costs too if there are any.

Operation and maintenance costs (O/M costs)

After the installation of the system, it is periodic repairs and parts replacements are likely. As such, operation and maintenance costs will be incurred.

Support costs Subsidiary costs acquired to ensure smooth operation of the system are kept under support costs. These expenses could be for supervision work, trainings, user group formation, etc.

Data Methods 3.0

This research is aimed at identifying additional benefits and costs for an extended Domestic PLUS water supply system. This was done by comparing the additional benefits and costs of a Domestic PLUS system with a conventional domestic water supply system. For comparison's sake, the following three cases were taken up for this study:

Case I: CWN supported conventional Domestic WASH schemes
Case II: CWN supported Domestic PLUS WASH schemes
Case III: Non-CWN conventional Domestic WASH schemes

Two scheme locations per case were chosen.

3.1 Site selection

Based on discussions with Concern's implementing partners, appropriate sites based on case types and sample size were selected. Data for this analysis was taken from three different cases of WASH intervention in Jajarkot district in Mid Western region of Nepal. The details on the selected six schemes are given in Table 2.

Table 2 *Selected study areas and total number of household beneficiaries*

SN	Name of Schemes	Number of Beneficiary Households	Type
1.	Luhadaha	61	Case II
2.	Hadetola	102	Case II
3.	Lewa	91	Case I
4.	Parale	61	Case I
5.	Dasera	-*	Case III
6.	Chankhila	-*	Case III

** The data is unknown for non-CWN WASH schemes*

To conduct the beneficiary household survey, selected households were randomly sampled with 20% of households being surveyed in communities bigger than 100, and 25% in communities under 100 households. If the village was very small (with only 25 to 35 households), more than 50% were taken for this study.

4.0 Analysis of costs and benefits

4.1 Water service level

Table 3 below gives an overview of the existing water service levels in the chosen study areas:

Table 3 *Outline of water service level at the study areas*

	Luhadaha	Hadetola	Lewa	Parale	Dasera	Chankhila
Quantity (litre/second)	1	1.02	0.46	0.51	-	-
Quality (%)	100	96	100	100	96	100
Reliability (%)	100	100	100	96	88	100
Average distance (minutes)	10	15	11	18	22	17
Average consumption (litres/HH/day)	22	21	22	21	23	23

The total source water discharge available at each of the selected scheme areas was obtained from consultations with NEWAH water technicians. Similarly, from the respondent households, the information on quality and reliability of the available water facility was acquired. In Handetola, 38% of the respondents filter and 8% boil their drinking water. Likewise, 4% of the total respondents from Dasera boil their water, while 4% treat the water before drinking, mostly with chorine solution. Water treatment before consumption is at its early phases, and from experience of the diarrhoeal outbreak in Jajarkot district in 2009, this trend is expected to rise. The water points are within 10 to 20 minutes roundtrip distance in all of the four CWN WASH schemes. In an average household family size of six, the average daily water consumption is between 15 litres to 23 litres in the selected six schemes. Therefore, according to the household multiple-use ladder in Table 1, all of these schemes fall either in the basic domestic service level (level 2 of 5 levels) or basic multiple-use service level (level 3).

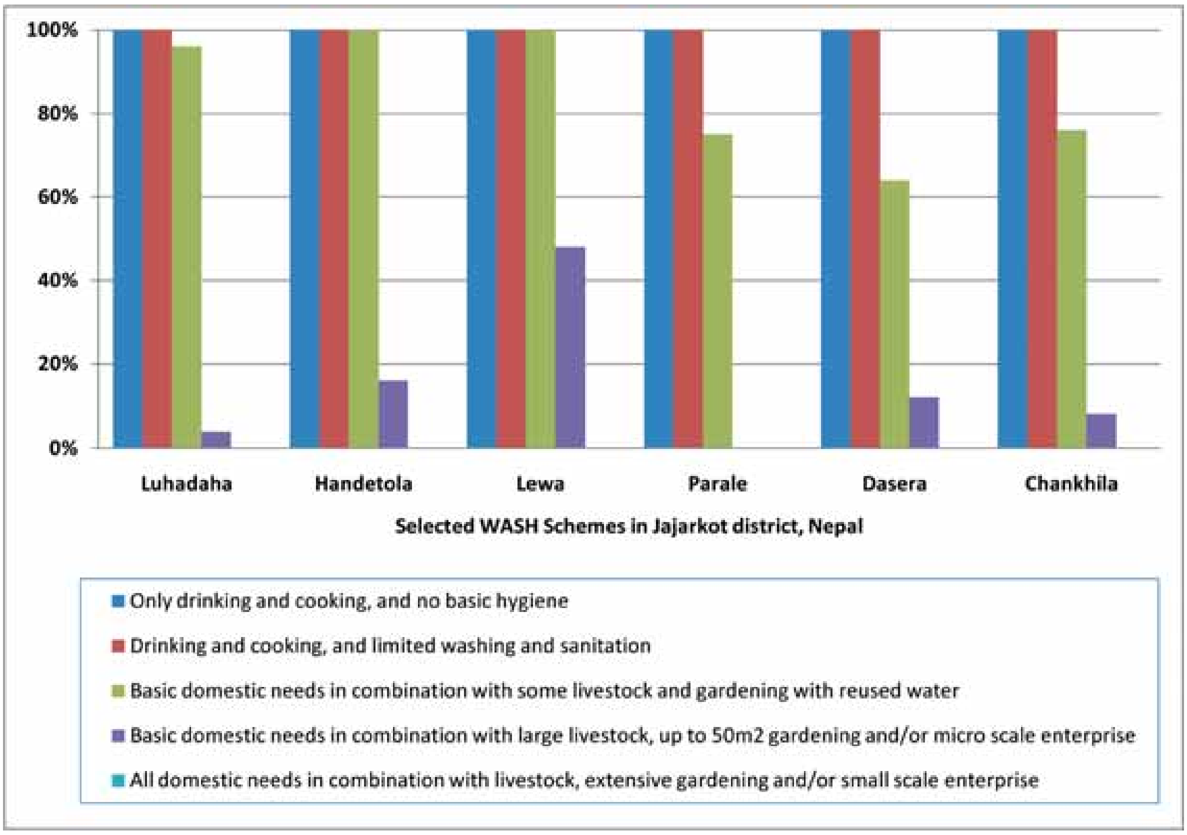

Figure 2 *Level of needs met from current level of water supply*

It is visible from Figure 2 that the majority of respondent households in Lewa has access to enough water to meet their maximum requirements i.e. up to level 4 of intermediate multiple-use service level (according to the household multiple-use ladder given in Table 1). Most respondent households in all six WASH schemes have reached the basic multiple-use service level (level 3) at present with water surplus for some productive use of water.

4.0 Analysis of costs and benefits

4.2 Total costs

The actual total capital costs of both conventional domestic WASH schemes as well as Domestic PLUS WASH schemes were obtained from CWN and NEWAH's programme database. As mentioned in the methodology, the total recurrent operation and maintenance costs were taken as 10% of the total capital costs. Likewise, the total support costs were 40% of the total costs. All of these three types of costs were annualized estimating the total lifespan of all the systems to be 20 years each, as anticipated by technical experts. All the costs were annualized for appropriate comparison with annual benefits later in the study. The annualized costs of the four CWN WASH schemes are shown in Figure 3 below.

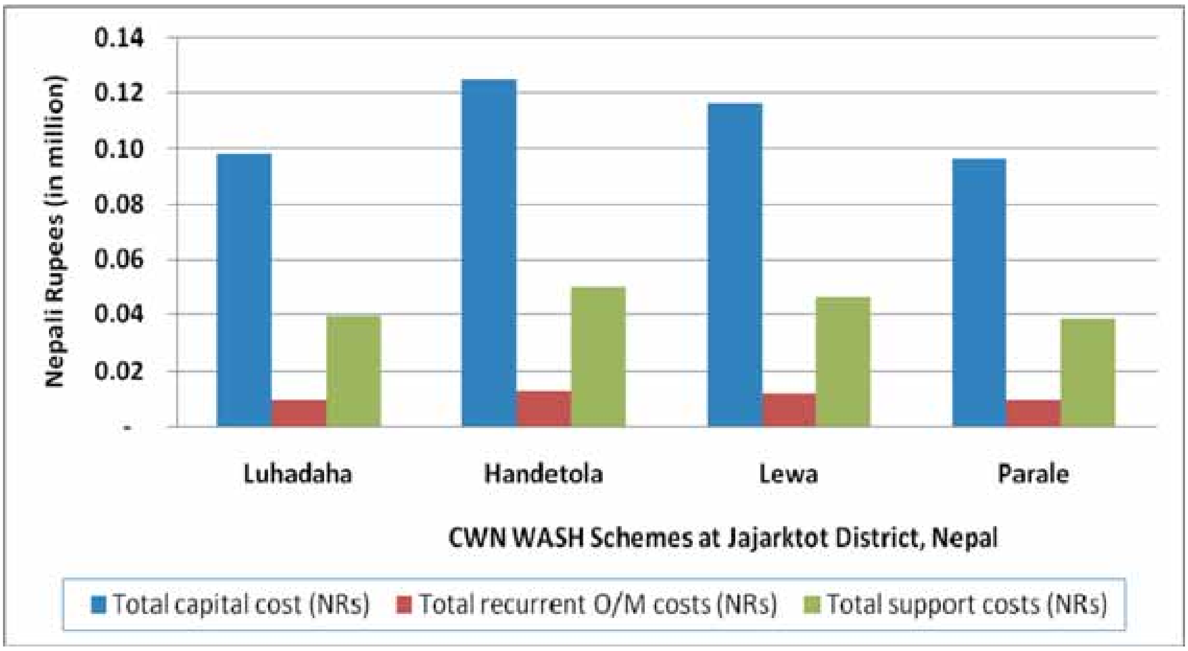

Figure 3 *Annualized breakdown of total system cost of selected WASH schemes*

In terms of total costs, there is not much difference among the four CWN WASH schemes. The reason for this is that CWN and NEWAH ensured consistency in budget allocation, especially for higher costs of non-local construction materials, their handling, and transportation.

Analysis of costs and benefits 4.0

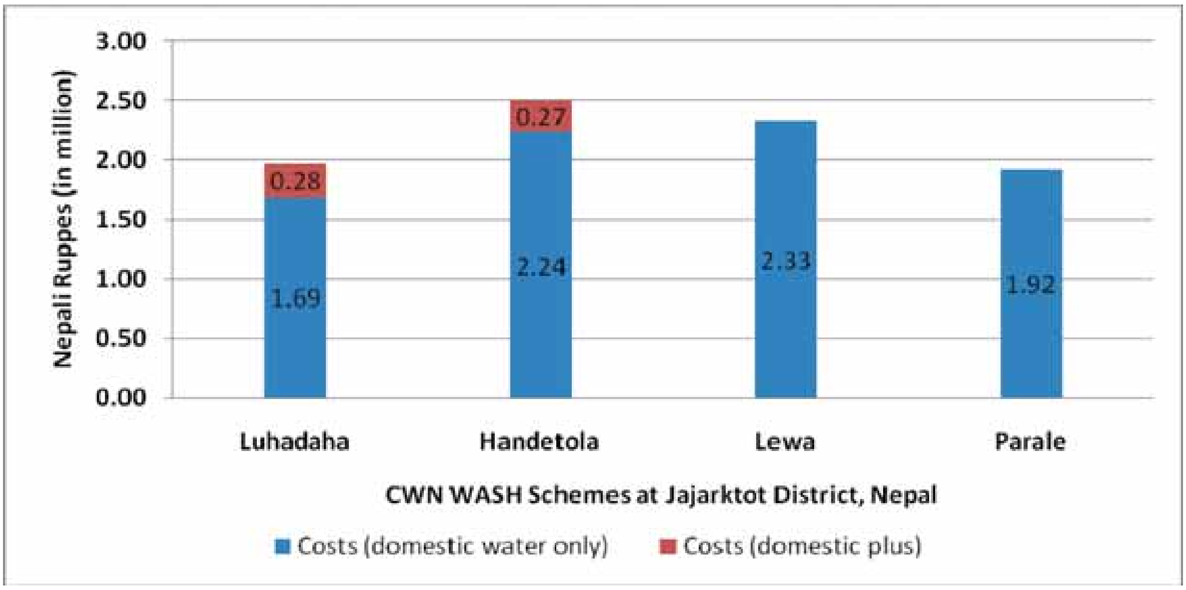

Figure 4 *Actual cost of domestic and PLUS component of the selected WASH schemes*

Figure 4 shows the actual capital costs of the systems differentiating the costs involved in the basic WASH intervention from the expense involved in the "add-on" or PLUS component. The increased PLUS cost ranges between 11 % to 14% of the total cost of Domestic PLUS WASH schemes, which is not large compared to the normal total cost of conventional WASH schemes in the study areas.

4.3 Total benefits

Time saved from water collection

Some respondents from Parale and Handetola said that, in addition to the tap water supply, they still fulfilled some of their household demands from the nearest spring source.

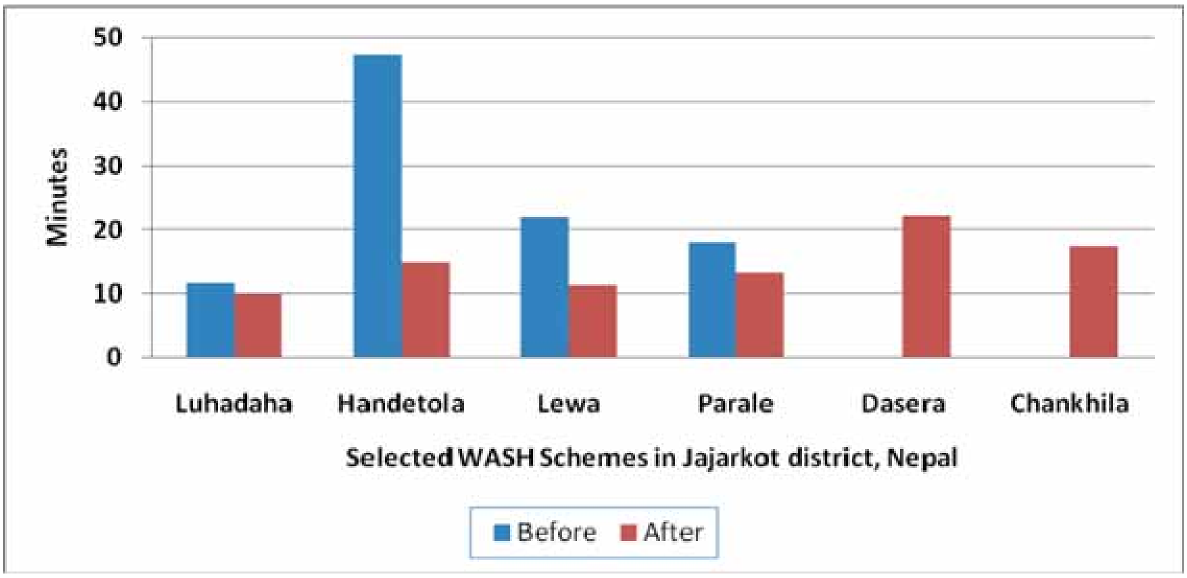

Figure 5 *Average time taken for each roundtrip*

The measure, as given in Figure 5, shows that the average time taken for each roundtrip has reduced in all the four CWN WASH schemes. The time savings per roundtrip ranged from around 2 minutes in Luhadaha WASH scheme to around 32 minutes in Handetola WASH scheme. Therefore, per day, a household saved anything from 10 minutes to around two hours 45 minutes. It is assumed that the time saved was used for other productive activities around the house. For the non-CWN WASH schemes in Dasera and Chankhila, information was available for the average time taken per roundtrip only after completion of project implementation. Therefore, time savings per roundtrip for these two schemes have not been calculated.

The normal working agriculture wage rate in the chosen areas in Jajarkot district is 100 NRs per day. Although paid agriculture work is not very regular, this amount is used by this study to monetize the saved time from water collection for productive work.

Improved health

The past year's information from the study illustrates that out of the total respondent households in each WASH schemes, 64% in Luhadaha, 44% in Handetola, 60% in Lewa, 79% in Parale, 16% in Dasera, and 44% in Chankhila experienced diarrhoeal cases. The treatment on average took one week. This impinges on the productive time of both the patient and family caregiver accompanying him/her to the health centre.

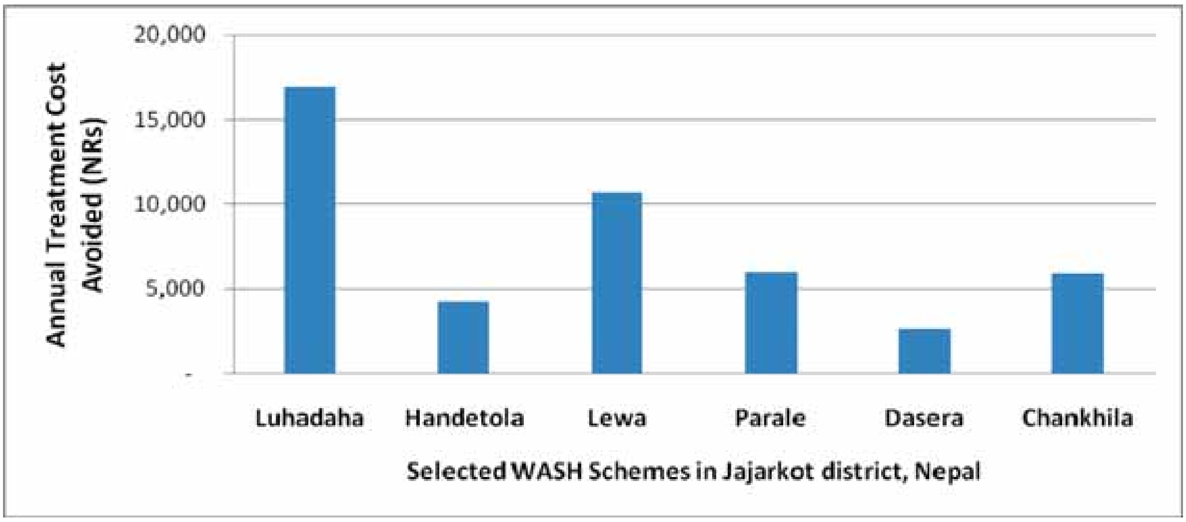

Figure 6 *Annual treatment cost avoided for diarrhoeal diseases*

Access to good quantity and good quality water helps leads towards proper sanitation and hygiene practices. This in turn reduces incidence of diarrhoeal diseases. As a result, household medical expenses can be saved as well as productive time gained. In line with this, Figure 6 shows the results of annual treatment cost avoided for diarrhoeal diseases in the six WASH schemes. Luhadaha, followed by Lewa, have considerably more number of people visiting health centres and buying medication for diarrhoeal diseases.

The people from these villages are spending on average 2,500 NRs to 17,000 NRs per year for diarrhoeal treatment of their family members. This figure, in addition to the possible average value of productive days lost due to treatment, gave the average annual monetary benefit gained for improved people's health.

4.0 Analysis of costs and benefits

Better nutrition

Rural Nepali people on average have two meals per day. The respondent households had two meals per day too which mostly comprised of rice and lentil, and green vegetables at least once per day to supplement their diets with nutrients.

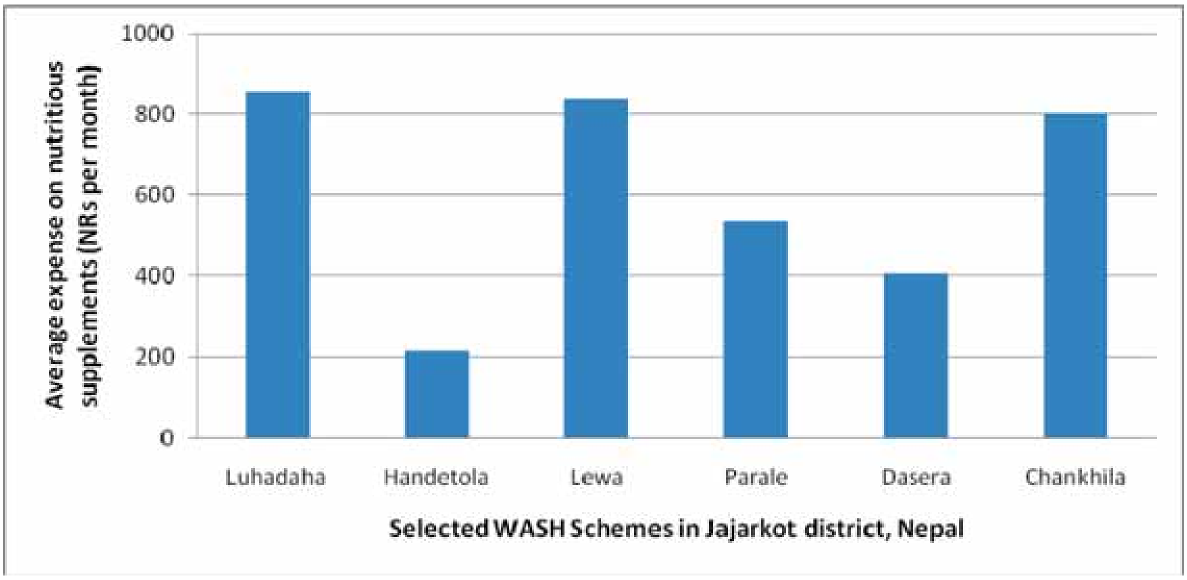

Figure 7 *Average monthly expense on nutritious supplements*

Figure 7 gives the overview of average monthly expense on nutritious supplements, specifically on green vegetables. The people from these schemes spend from 200 NRs to 850 NRs per month on greens.

There are other physically visible indicators of better nutritional status, such as the MUAC test whose result is given in Figure 8 below. To get the economic benefit value, the expense saved on nutritious supplements was annualized to give the monetary benefit for better nutrition.

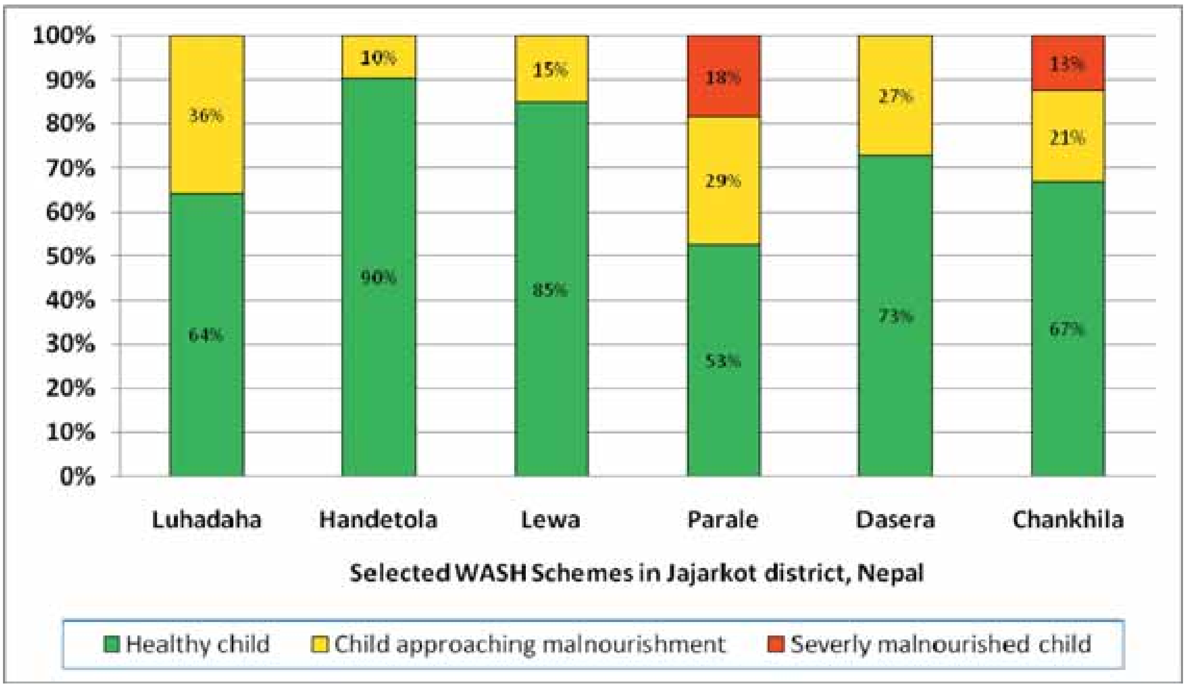

Figure 8 *MUAC test results*

The MUAC test conducted on children between six months to five years from the respondent households is given in Figure 8. Interestingly, one of the CWN schemes Parale shows incidence of severely malnourished children in need of immediate medical attention. Out of seven cases of acute malnutrition in Parale, six were girls of age group six months to two years, and one was a one year old boy.

4.0 Analysis of costs and benefits

Increased education

Easy access to quality water can not only improve the health and hygienic status of children, but also save time that they previously spent on collecting water for their families. This time that they can use on attaining a proper education. Education is particularly valuable for girls who can later on pass on the benefits from their education to their children.

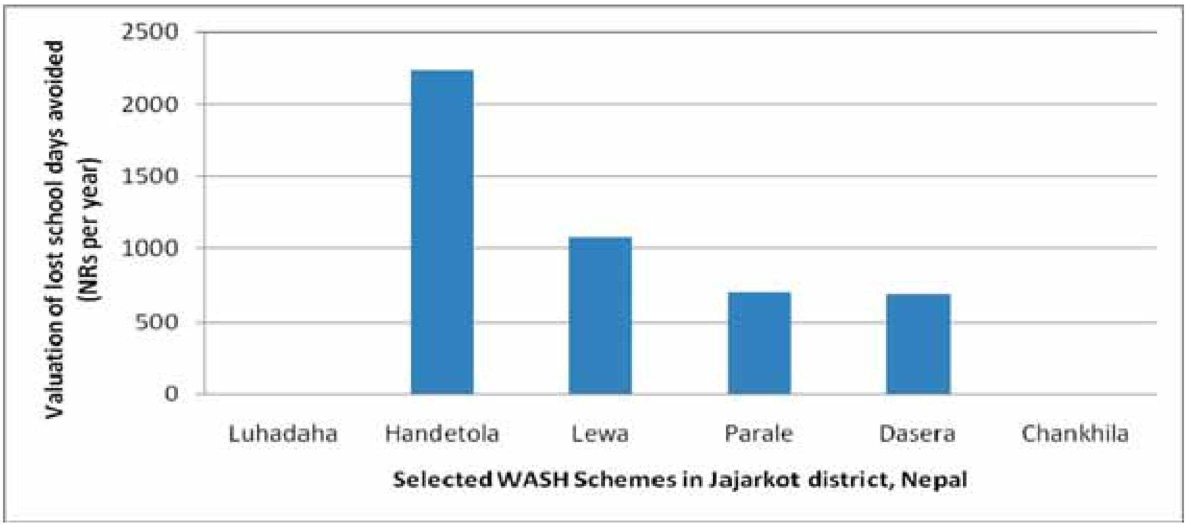

Figure 9 *Value of annual lost school days avoided*

Figure 9 gives the overview of valuation of lost school days avoided by both boys and girls from not having to miss school to collect water. The results from Luhadaha and Chankhila is very positive with none of the children from respondent households missing school in order to fetch water. However, for the other four schemes, children are still missing school on an average of four days a month for that purpose. Because of this, in Handetola WASH scheme for example, the parents are loosing more than 2,000 NRs a year from school fees paid.

Decreased labour migration

Assuming that productive use of water will create local level income generation opportunities, it is probable that migration of villagers to neighbouring countries for low paid unskilled labour will decrease. A comparison is made in this study between estimated amount of total money spent on travelling to and fro for unskilled labour versus the amount they can earn abroad and the money that they could earn locally. The result of this is shown in Figure 10 below:

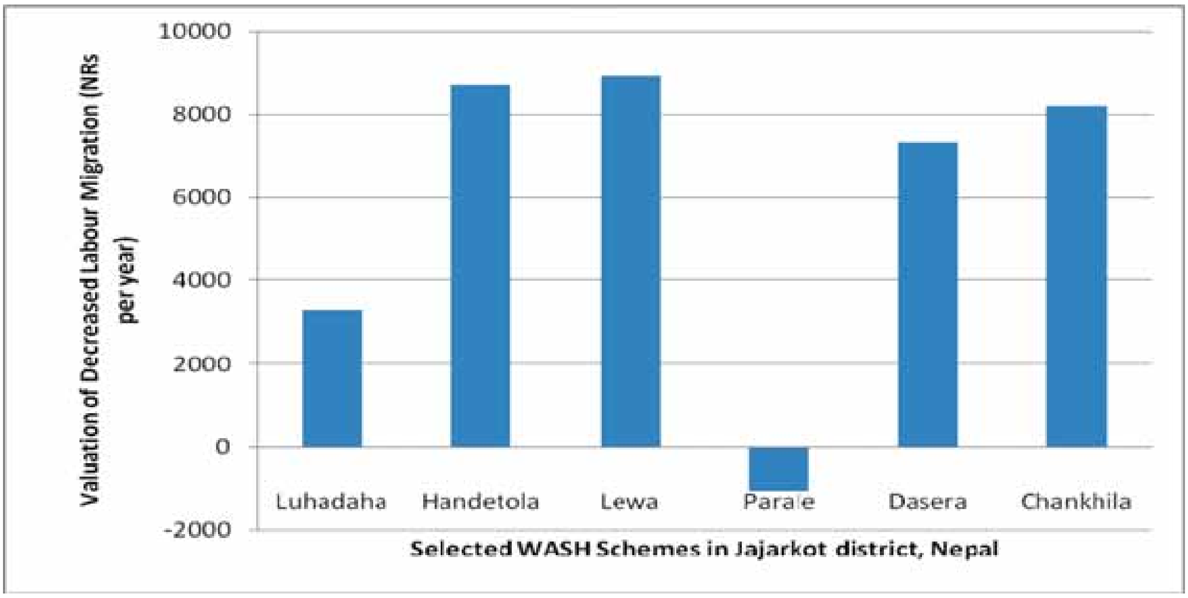

Figure 10 *Value of annual decreased labour migration*

The beneficiaries from Dasera and Chankhila WASH schemes are travelling to India only once a year for unskilled labour. However, beneficiaries of the CWN WASH schemes at Luhadaha, Handetola, Lewa and Parale are travelling one to two times a year to India for unskilled labour employment. The labour migrants are all male members of the family, mostly the household heads. Annually, people are spending over 7,000 NRs to travel to and from India, and bringing back on average 18,000 NRs in a year.

As expected, it is visible from Figure 8 that the monetary benefit from decreased labour migration is not significant and ranges from 3,000 NRs to 9,000 NRs per year. There is a negative value for this in Parale scheme because of the smaller margin between the expense on travelling and the actual income from labour, and this is accentuated by the highest number of productive days lost in working abroad.

4.0 Analysis of costs and benefits

Productive water use

Domestic PLUS activities are initiated in CWN programme areas bearing in mind the community demands as well as water availability. Based on this, the most common PLUS activities so far have been kitchen gardens and water facilities for livestock. Table 4 below gives a brief overview of the identified appropriate PLUS activities, and the extent of support and technology provided based on the water available in the two selected schemes.

Table 4 *Domestic PLUS activities and their components*

Domestic PLUS WASH Scheme	Identified appropriate PLUS activities	Estimated extent of support	Approximate water requirement	Appropriate technology
Luhadaha	Kitchen/ vegetable garden	8000 sq meters	7 litres per sq meter per day	- Pond to collect overflow from RVT - Off take construction - Loose pipe connection for water distribution - Sprinklers run by loose pipe
	Water for livestock	500 numbers	10 litres per animal per day	
	Paddy field	8500 sq meters	10 litres per sq meter per day	
	Orange trees	1500 numbers	6 litres per tree per day	
Hadetola	Kitchen/ vegetable garden	51816 sq meters	15 litres per sq meter per day	- Stone masonery pond for water collection - Sprinklers and off takes with loose HDPE pipes - Waste water collection chamber
	Water for livestock	1020 numbers	10 litres per animal per day	

As seen from Table 4, the chosen Domestic PLUS WASH schemes for this study have more kitchen gardening and livestock watering, with some small-scale irrigation as the PLUS component. Apart from these, PLUS interventions in other areas included fish farming, rain-water harvesting, and micro-hydro electricity generation.

Analysis of costs and benefits 4.0

Research data, as well as CWN's recent reports, indicate that benefits from the Domestic PLUS activities are being reaped at household level in the form of consumption of the outputs such as green vegetables, livestock meat, fruits, grains, etc. by family members. This is contributing largely to the diet and nutrition of the family members as well as the quality of life. In addition, a report submitted by FORWARD (Forum for Rural Welfare and Agricultural Reform for Development) to CWN on scaling up of kitchen garden remarks that commercial vegetable production is not possible in Jajarkot district due to its difficult topography and remoteness from road access (CWN, 2009). Vegetable production is cost effective if the site is at least three hours walking distance away from the road head. This is therefore not currently a viable option for people living in Jajarkot district. Hence, the biggest setback for this research came in the form that additional benefits are there and even visually accessible, but they are too difficult to be converted into monetary terms. This issue will be discussed further in **section 5.**

Since kitchen gardening is one of the major PLUS activities initiated here, a case study was taken of an area quite similar to the study's schemes where successful commercial vegetable farming was achieved using the Domestic PLUS approach.

Extrapolation of Case Study on Productive Water Use

CWN's also works in Dailekh district, which borders Jajarkot district, doing Domestic PLUS implementation. In Dailekh, a farmer was able to produce an average income of 15,000 NRs per year from his 1,017 square meters of land. Therefore, assuming fresh vegetable market access, a similar output in Luhadaha and Handetola Domestic PLUS WASH schemes in Jajarkot could be hypothetically possible. Taking the figure from Dailekh, the assumption followed that at least 55% of the total beneficiary households have kitchen gardens. The benefit cost ratio output from this assumption case is further given in section 4.4.

Taking this extrapolation, a 10% increase in incremental costs of the total system led to estimated 9% rise in incremental benefits from vegetable marketing in Luhadaha. Likewise, a 7% increase in incremental costs of the total system led to an estimated 29% rise in incremental benefits from vegetable marketing in Hadetola WASH scheme.

4.0 Analysis of costs and benefits

4.4 Benefits to costs

Henceforth, using a 10% discount factor, benefit cost ratio is calculated as the result of present value of total benefits relative to the present value of total costs. Table 5 below gives the benefit cost ratio results for both domestic and Domestic PLUS WASH schemes of CWN.

Table 5 *Benefit cost ratio results for each WASH scheme*

Scenario 1: Without additional benefits of Domestic PLUS				
	Luhadaha	**Hadetola**	**Lewa**	**Parale**
Benefit Cost Ratio	0.24	0.18	0.25	0.11
Scenario 2: Including hypothetical case of additional benefit of Domestic PLUS				
	Luhadaha	**Hadetola**	**Lewa**	**Parale**
Benefit Cost Ratio	0.26	0.25	0.25	0.11

As explained under the findings from productive water use, the difficult in calculating the additional benefits of Domestic PLUS led to a division of findings into two scenarios. The first scenario was where the additional benefits of Domestic PLUS are not considered at all. In the second scenario, an extrapolation of additional benefit from commercial vegetable production is taken. The benefit cost ratios obtained from both scenarios is shown in Table 5. When both the scenarios are looked at individually, the benefit cost difference is narrower in the extrapolated case as compared to Scenario 1. However, in both the scenarios, the benefit cost ratio is less than one. This implies that the research hypothesis is not supported i.e. in monetary terms. For both types of system, the costs outweigh the benefits.

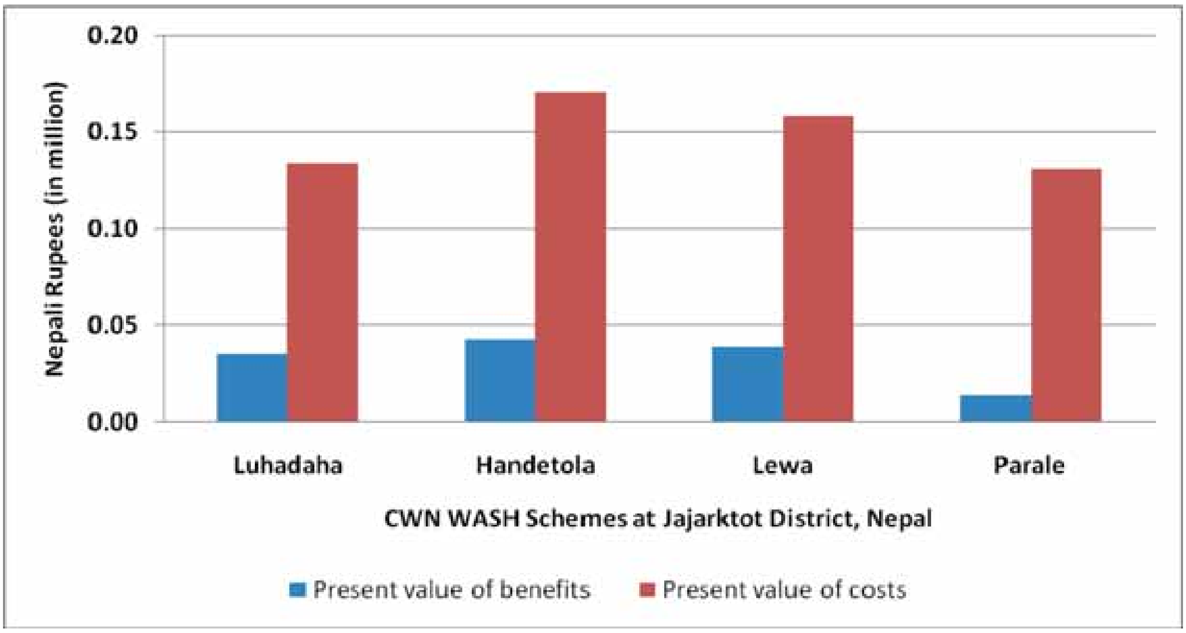

Figure 11 *Present value of benefits and costs of CWN's WASH schemes at Jajarkot*

Figure 11 shows the present value of benefits and costs of the four WASH schemes of CWN considered within this study, using the extrapolation in scenario 2. The total costs in Luhadaha, Handetola and Lewa WASH schemes are around four times the total benefits. In Parale scheme, this difference is nine fold.

Discussion and Conclusion 5.0

Many studies link social exclusion to the poverty status of the excluded. In Nepal's case, the socially excluded are the ones lowest in the caste hierarchy, mostly Dalits[3] and Janajatis[4]. The poverty status is generally depicted by a lack of access to landholding, low income levels, poor nutritional status, and restricted access to education among others. Interestingly, the beneficiary database of CWN and NEWAH shows that there are no Dalits and Janajatis households in the Parale WASH scheme. However, MUAC test conducted during this study in the Parale scheme showed high incidence of children approaching malnutrition, and children already with acute malnutrition and in need of immediate medical attention. This revealed a high poverty incident outside of social exclusion rhetoric.

Water supply programme areas of CWN are among the remotest parts of the country. The programme focus was on achieving access to basic services to alleviate poverty rather than raising economic status. As such, the expected outcomes or benefits from the programme activities were basic services and not income per se. This was one of the biggest impediments for the benefit cost analysis research whose target was to demonstrate monetary benefits from the Domestic PLUS water supply programmes.

Domestic water supply schemes are high-priced. In Nepal's context, the cost is elevated even more if such schemes are established in remote locations due to the high costs involved in transportation of non-local construction materials. Additionally, the benefit cost analysis research was conducted towards the end of programme implementation, and therefore, estimation of incremental benefits remained largely hypothetical. In light of these challenges, the benefit cost ratio for both conventional water supply schemes as well as the Domestic PLUS water supply schemes came below the value of 1 i.e. negative research hypothesis. However, the negative result cannot truly conclude that Domestic PLUS water supply schemes are not cost effective. This comes from the reasoning that many non-monetized benefits or impacts remain uncalculated for the reason that benefits such as nutrition, convenience, and well being, though more tangible, are very difficult to measure. For example, other benefits remained elusive to quantify such as economic valuation of benefits from improved nutritional status of local communities especially children, intellectual growth of children from time availed for education, social and personal cohesion due to decrease in labour migration, etc.

With road infrastructure comes market access and economic opportunities. The absence of road access is a huge impediment for people of Jajarkot. Availability of infrastructure for market access could increase their monetary benefits, and this could add in more value to the benefit calculation presented here.

On the expense part, the increased PLUS cost ranged between 7 % to 10% of the total cost of Domestic PLUS water supply schemes. This is not large compared to the normal total cost of conventional water supply schemes in the study areas. Also, on a positive note, the research shows that with little additional increment in cost on the PLUS component of those schemes, around four folds of benefits can be expected.

In terms of current water service level, the beneficiaries are already rising up the household multiple-use water ladder with increasing numbers of activities thanks to the availability of productive water sources.

[3] A group of people traditionally regarded as of lower class
[4] Indigenous people, group or community in reference to particular location, and most possibly politically underprivileged

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Woman doing commercial vegetable production using drip irrigation at Udayapur district, 2010. Photo: Cecial Adhikari.

Technology and Gender Dynamics in Domestic PLUS Approach

Written by **Ms Ambika Rai, Consultant**
Edited by **Sugandha Priyadarshani Gurung**

Executive Summary

In most developing countries, water collection for domestic use is the responsibility of women and the female children. Maintaining hygiene around the house, for which substantial water is required, is also the responsibility of women. Having clean water sources close to the homestead not only reduces a woman's workload, but also saves them time spent on water fetching. This time can be used otherwise for productive activities to ensure food security and enhanced wellbeing of her family. In rural Nepal, men are responsible for managing larger agricultural fields whilst women tend to smaller household kitchen gardens if they have one. Similarly, men are the ones responsible for money matters.

Domestic PLUS is an approach initiated by Concern Worldwide in Nepal (and its partners) in 2009 in which water service provision meets people's multiple water needs in an integrated manner whilst prioritizing and ensuring vital domestic uses for consumption and basic sanitation. The "PLUS" activities include water uses at the household level for a range of small-scale activities that enable people to grow food, earn income, and eventually enhance the quality of their life.

Though strategic changes in gender dynamics were not planned within Concern's Domestic PLUS activities, some interesting examples from the field showed that the usual gender behaviours (given above) changed during the project lifespan. These impromptu findings lead to this research. The objective of this study was to document evidence of the influence of introducing technologies on the gender dynamics of communities that had adopted the Domestic PLUS approach. The research findings come from the Domestic PLUS schemes in three areas, namely Sirise, Rajena and Paganath Village Development Committees (VDCs) of Nepal.

This research shows marked **practical** differences in the lives of women and men in the areas of routine work (of women and children), division of gender roles, benefits from access to excess water, management skills of women, decision making roles at both household and community level, and maintenance of societal and gender harmony. However, there was negligible change with regard to access to and control over resources as such **strategic** change would have to be addressed explicitly from the beginning of the intervention.

The practical changes observed were as follows:

- Electricity produced from the peltric set technology has allowed women to extend their working hours into the late evenings. School going girls and boys can now study in bright and smoke-free environment due to the clean production of electricity and light.
- Men were observed to help women in not only household chores, but also in the vegetable gardens, partly due to the availability of water facilities closer to homesteads.
- Both women and men actively participate in productive water use services such as kitchen garden and fish farming, though with different perspectives. Men are more interested in the monetary benefits, whereas women are focused on the nutritional benefits to the family.
- Women are aware of the importance of maintaining a basic hygienic environment around the households.
- Though men still maintain control over household resources, women have evolved to participate and speak confidently in communal activities, as well as claim access to both resources as well as programme benefits.
- With both men and women actively participating in productive activities, harmony has been maintained at the household level.
- With the needs of both men and women regarding food insecurity being addressed by the Domestic PLUS approach, changes of programme sustainability has been enhanced.

Given the opportunity to take part in community management works, women have proven their capabilities. Reaching out to the needs of both women and men can lead impressive outcomes. However, to attain more strategic differences such as changes in attitudes and power dynamics, gender relations need to be strategically addressed during the design of water and sanitation programmes.

Background to Gender and Equality within the WELL Programme 1.0

Extreme poverty is not experienced in the same way by all[1]. Just as geographic targeting recognises that people are poorer in certain places, it is vital to recognise that what keeps people in extreme poverty and what prevents them getting out of it differs according to natural and social characteristics such as gender, caste, ethnicity, disability, HIV status and age. Hence, within a group of people identified as the extreme poor there may be significant differences.

Gender inequality is a reality in almost every country in the world. Women are disproportionately represented amongst the extremely poor. Addressing gender inequality requires changes in power and relations between men, women and society. Without attempting to address the effects of inequality on the lives of the extreme poor, Concern's interventions may only contribute to short term change. This is why Concern recognizes that, at a minimum, gender analysis must be part of context analysis and the promotion of gender equality must be a feature of programme design.

From 2009 to 2010, Concern implemented its Water, Environment, and Local Livelihoods (WELL) Programme in Nepal. As part of its contextual analysis and design process, analysis of gender and equality was done. Based on this analysis, equality was mainstreamed within the programme rather than being a strategically planned output.

Within development programming, two types of gender related changes can occur:

Practical changes in the lives of women and men i.e. Changes in workload, increases in productivity and household wellbeing, improved health and increased incomes.

Strategic changes in gender relations i.e. giving women more control over decision making, household assets, a shift in the division of labour between men and women and changes in attitudes and behaviours around gender equality.

Current thinking is that, to achieve strategic changes, programmes need to have been designed in a specific way. The box below outlines some of the principles that can be built into programme design to achieve such strategic changes:

Criteria for assessing potential of development programmes to contribute to women's empowerment

Are equality principles built into the design of the programme?

Are training and resources allocated to enhance women's capabilities with a view to securing economic independence and wellbeing (health, both mental and physical, and freedom from violence)?

Is the social and economic empowerment of women an explicit goal with definable impacts? Do the policies acknowledge in their design, and where necessary assist with, care-giving (childcare arrangements, time management)?

Is transforming oppressive gender relations central to the programme (including/involving men and boys in ways that help to secure one or more of the above objectives)?

Do participants have voice in programme aims, design, evaluation and management?

Are participants provided with 'citizenship' skills (legal and political literacy training)?

Source: Molyneux, 2009, p. 46 Conditional cash transfers: A 'pathway to women's empowerment'? Working Paper 5, Pathways of Women's Empowerment RPC, IDS: Sussex. Available online

[1] *Concern Worldwide (2009). Why addressing inequality is central to Concern's mission.*

1.0 Background to Gender and Equality within the WELL Programme

The WELL programme did not include such strategic objectives or aim to bring about changes in gender relations and power imbalances. Instead it concentrated on **practical changes** that could benefit in particular women's lives. This is detailed in the equality section extract from the WELL programme proposal below:

Equality Section of WELL Programme Proposal, 2009

Appropriate project methodologies will be employed to ensure that women and Dalits have, as far as is possible, an equal role in all matters relating to project planning, implementation, monitoring and evaluation at community level.

Especially in regards to women, they will be the primary focus of hygiene promotion (without excluding men) in recognition that food preparation and child care is largely a women's burden. Local hygiene promoters will be women.

Although the provision of water and sanitation will benefit every community member, a higher proportion of benefits will accrue to women. This is because it is women who customarily have primary responsibility for ensuring that there is water in the home and thus water fetching takes an inordinate amount of their time and energy. Further, caring for ill family members such as children with diarrhoea is invariably the responsibility of mothers.

As well as significantly reducing these burdens, there will be secondary benefits related to use of waste water for kitchen gardening for women. Money that they raise from sale of excess vegetables usually goes directly to women, who in turn tend to spend it on the family wellbeing.

To reduce the risk of women being sexually assaulted during bathing, tap stand construction along the roads will be discouraged and current piloting by NEWAH on proving bathing space will be replicated based on its success.

The introduction of technology within the programme did not have a specific purpose of addressing gender equality. Instead the programme acknowledged that technology could potentially reduce both men and women's labour costs and time. However it was obviously insufficient to change the power structures between women and men that are deeply embedded in society. The introduction of technology did however have unintended consequences that were gender differentiated, and this paper sets out to document those cases.

Background to Domestic PLUS, multi-use water supply 2.0

In the past, most water supply projects focused only on single-use services, either on providing domestic water supply or water solely for irrigation purposes. Increasingly though water supply interventions are becoming more multi-purpose, multi-use, and multi-user.

From 2006 to 2008, Concern provided water, sanitation and hygiene service delivery to the poorest households in the remotest areas in Nepal. Seeing the need to move towards more multi-dimensional interventions, Concern Worldwide in 2009 adopted an approach called "Domestic PLUS". This approach focused on providing water that would meet people's multiple water needs in an integrated manner whilst still prioritizing and ensuring vital domestic uses for consumption and basic sanitation. The "PLUS" activities included water uses at the household level and covered a range of small-scale activities that enabled people to grow food, earn income, and enhance their quality of life. The technologies identified by Concern and its local NGO partners NEWAH and KIRDARC for supporting PLUS activities included ram pumps, rope pumps, rain water harvesting, irrigation ponds, sprinkler irrigation, and improved water mills.

3.0 Technology and Gender Dynamics in Domestic PLUS Approach

The main objective of this research was to find out and document if the introduction of Domestic PLUS technologies had any influence, both positive and/or negative, in bringing about practical changes in the lives of women and men in Nepal rural communities.

Three areas were selected for this research, namely, Sirise VDC of Udayapur district in Eastern region, Rajena VDC of Banke district, and Paganath VDC of Dailekh district, both in the Mid-western region of Nepal.

The WASH interventions in all these three districts implemented 'add-ons'[2] to implement the Domestic PLUS approach.

The research findings are based primarily on qualitative information. Primary information was collected from field visits and this was supplemented by relevant secondary sources. Several discussion sessions were held with relevant Concern program staff to agree on study methodologies and field visit plans. Altogether six programme sites in Udayapur, Banke and Dailekh districts were visited.

[2] There are many ways in which Domestic PLUS can be implemented. One way is that the multiple uses of water is accommodated from the beginning during water service provision design. Alternatively, Domestic PLUS can also be implemented by installing 'add-ons. 'Add-on' involves adding productive infrastructure on already existing WASH projects, or developing WASH projects in villages where productive schemes already exist. The add-ons can be met by collecting waste water or grey water into collection tanks and diverting it to vegetable or fruit gardens. Based upon available water resources and discharge capacity, other productive water service provision like fish ponds, medium irrigation and small hydro electricity can be harnessed.

Beneficiary community and programme interventions 4.0

4.1 Drinking water, proper sanitation and hygiene

The drinking water supply, sanitation and hygiene programme in Sikre and Sanodamar villages in Udayapur district, and in Tallo Ganma and Mathillo Ganma villages in Dailekh district covered approximately 260 households. The programme's primary objective was to meet the water demands for domestic consumption and to provide water in latrines for proper sanitation and hygiene. The add-on PLUS activities included using homestead excess water for watering kitchen gardens, feeding animals, and maintaining fish ponds.

The drinking water and sanitation services provided directly affected women's lives in particular. This is because they are the ones socially responsible for water management for all domestic requirements. Women therefore perceived to have registered more benefits than men with regard to access to water services.

4.2 Water for productive use

4.2.1 Fish farming in pond

Household level fish pond in Sanodamar, Sirise Ahale - 9, Udayapur district

In Sanodamar village of Sirise VDC in Udayapur district, 13 fish ponds are operated by local communities at household level. The community comprises members of the Janajati and Dalit castes. They use excess runoff water from drinking water supply system for fish farming. The fish produced by the ponds is consumed within the home. The community are very interested in raising fishes and have requested a variety of fingerlings along with training on pond management and fish farming management.

Community level fish pond in Paganath VDC, Dailekh district

Communities in ward number 4 and 5 of Paganath VDC had already developed interest in fish farming after the sufficient water was made available in the village. Construction of the fish ponds was already complete and the communities were waiting for the fingerlings at the time of the research field visit. Four irrigation reserve tanks existed that could supply water for fish production.

4.2.2 Waste water collection ponds

In all program VDCs visited, waste water collection ponds had been constructed to hold waste water produced from washing clothes and utensils. The water collected in these ponds was being used for kitchen gardening. Women were particularly involved in the management of the kitchen gardens. They said that with the reuse of waste water, water shortages for vegetable production had decreased. The increased availability of water meant they could also feed their livestock more easily. The women did not consider their involvement in vegetable farming as an additional work burden for them.

Locally constructed wastewater collection pond at Dailekh district, 2010. Photo: Sugandha P Gurung

4.0 Beneficiary community and programme interventions

4.2.3 Peltric set for electricity generation

Peltric sets that generate electricity have helped 67 households of Ahale, Rautkhark and Khanibhanjyang villages in ward 1 of Sirise VDC in Udayapur district. The electricity generation units are managed by the Peltric Set Users Committees. These 9 member committees were formed by the local community. The committees include women with them holding at least one treasurer and one general member position. The committees themselves are responsible for the overall maintenance of the electricity unit and the powerhouse. They are also responsible for the allocation of electricity charges per unit per house and for regulating the fund maintenance collection.

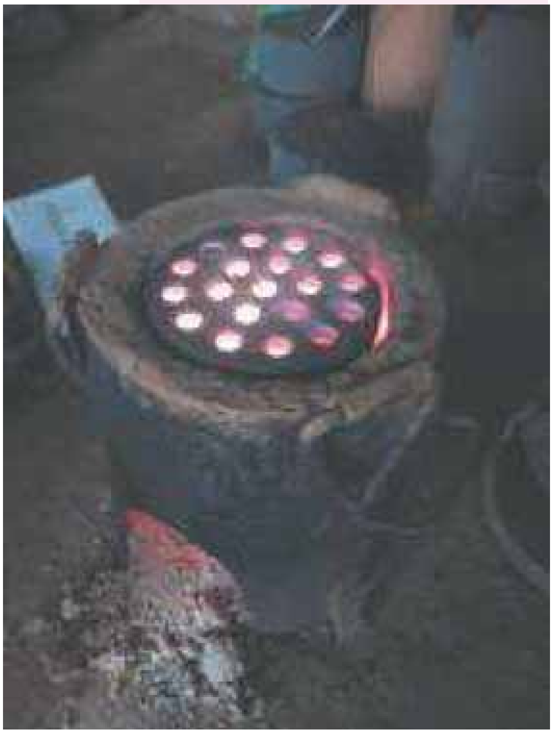
The Peltric Set Committee members confirmed that both women and men equally participate in decision-making processes. They stated that the community owned and managed the power supply scheme without any outside interference from, for example, local politicians or the electricity authority.

A total of 67 household members from Kshetri and Janajati communities have stopped using kerosene oil lamps in Bobaldanda Ahale village of Sirise VDC. Initially they used to spend 65 to 70 Nepali Rupees (NRs) per month on kerosene oil for household purpose. They now save 25 to 30 NRs by using the power supply from the peltric set.

Peltric set unit for electricity generation at Sirise, Udayapur district, 2010. Photo: Shiva Basnet

4.2.4 Technology for bio-briquette production

Bio-briquettes have been included within the Domestic PLUS approach. This is because it is considered to be a cleaner fuel (as compared to fire wood and kerosene) for cooking and heating. Srijanshil Mahila Bachat Tatha Lagani Samuha is a community level women group with 18 members formed in Saktitol village, ward number 4 of Rajena VDC in Banke district. All the members of this group received a 4 day training on bio-briquette preparation through NEWAH on February/March 2010. After receiving the training, these women produced bio- briquettes in particular for cooking meals. Besides household uses, some women were involved in selling the product for 170 NRs in the local market at Kohalpur. Nandakali Rana Magar, one of the group members, said that her husband helps her in wheeling the briquette machine to make dust out of charcoal. She also said that other neighbouring villagers were also keen to learn how to make bio-briquettes for cooking and income purposes.



A burning beehive bio-briquette at Kathmandu, 2010. Photo: Sugandha P Gurung

4.2.5 Sprinkler system for irrigation

8 plastic sprinklers and 4 metal sprinklers irrigation system were introduced for vegetable production in ward number 4 and 5 of Paganath VDC. The community have started to produce vegetables for household consumption using the waste water in their kitchen garden through the use of sprinklers. After the introduction of this small technology, male members of the household have shown interested in helping their female counterparts in looking after the vegetable gardens.

5.0 Gender dynamics and basic WASH service delivery

5.1 Drudgery reduction

Community friendly water supply, sanitation and hygiene schemes have benefited both men and women equally in the community. It has also helped in reducing workloads, particularly for women and girls. After the introduction of increased drinking water availability supply in Sirise and Paganath VDCs, the workload women and girls has reduced as they do not have to walk far in order to fetch water. They use the saved time in other productive activities such as managing kitchen gardens and improving the cleanliness of their homes. Likewise, with the new availability of latrines within the homestead level, women and adolescent girls now have more space for privacy while relieving themselves, as well as maintaining hygiene during their menstruation period.

The introduction of bio-briquettes in the community has helped reduce the time taken up for finding fuel wood. It has also reduced respiratory problems from indoor firewood burning and hard labour in cleaning black pots that used to be caused by use of wood as fuel.

5.2 Women's participation in skilled work

An equal number of women and men from the communities were provided skilled training such as plumbing and mason works. Later on, these trained people worked on the pipeline and on other water supply construction activities. Skilled work is comparatively new for women within the programme areas. However, it has helped raise their confidence to work at community level as well as provided them with the chance to provide an income for their families.

Gender dynamics and productive WASH service delivery 6.0

6.1 Influence on routine work of women and children

Women often suffered the most from a lack of electricity in their village. This is because they have to start their household chores very early in the morning and rush to complete them before dark. Similarly, school going boys and girls struggled to study at night under kerosene lit lamps. These poorly lit and smoking oil lamps affected their sight and respiration. All of these difficulties were overcome after the community received power from the peltric set. Now women can afford to rest during the day time and complete their tasks in the evening due to the available electricity. School children can study at night with the peltric set generated light.

6.2 Division of roles

Development interventions are often designed to maximise the equal participation of men and women. Women are also encouraged to participate in development activities such as receiving skill trainings and in managing local level technical infrastructures.

Shared role

Availability of water has helped redress the imbalance of male and female roles in household tasks. Men have started to become involved in household tasks such as cooking, washing clothes, cleaning and maintaining latrines, waste water collection pond, and kitchen gardens. Similarly young boys also help in fetching water, cleaning dishes, and collecting firewood. In Kshetri and Brahmin caste families, men's involvement in household chores has increased. This level of involvement was not the case before the Domestic PLUS intervention. With the introduction of sprinklers, men are also interested and encouraged to participate in kitchen gardening activities. This has ultimately helped women to reduce their work load.

Productive role

After the introduction of technologies that lead to increased availability of productive water use services, men and women have both started to participate in income generation activities. Some women have even surpassed the stage of just being responsible for the production part of vegetable farming. They are now involved in its local marketing. Their male counterparts have also shown enthusiasm towards small scale commercial vegetable production.

Ms. Bipi Maya Tamang, Sanodamar, Sirise VDC

"I have started vegetable plantation from one small plot to a bigger plot of about one Ropani (5476 sq. ft). This production is enough for household consumption and the excess production is for marketing. My husband has supported to construct a cement tank for collection of waste water to use in vegetable production and other requirements. I have also taken training on off-seasonal vegetable plantation."

6.0 Gender dynamics and productive WASH service delivery

6.3 Benefits from access to excess water

Most of the households with drinking water supply have used excess water in their kitchen garden. The vegetables produced from kitchen garden are first used for domestic consumption. As such, all the family members (especially pregnant women and children) are directly benefiting through increased nutritious intake and increased food variety in their daily diet. Before the Domestic PLUS intervention, women ate whatever they had in their kitchen, which was mostly rice. Only people who could afford bought green vegetables for consumption.

Currently women still play a major role in managing the kitchen garden. However they face problems regarding insecticide and disease management. Therefore, they have been supported by the male family members who have occasionally sought information on insecticide management from the local market and more informed people.

6.4 Managing skills of women

Women use water in reproductive sectors (fetching, storing, cooking, washing, cleaning, making hygienic home, and marketing) as well as productive sectors (vegetable and fish farming, agriculture). This reveals the managerial skills of women. They have not only managed larger work areas, such as irrigation and vegetable production, but they also manage basic hygienic environment around households like covering water jars, keeping a water supply in latrine, cleaning and drying utensils, and cleaning around the homestead. A noticeable difference since the Domestic PLUS intervention has been that there has not been any serious cases of diarrhoea in Paganath VDC, Dailekh. Availability of water alone could not have made this possible, as this requires that water is properly managed. Water management is largely done by women. For example, before the program, due to a lack of water as well ignorance regarding proper sanitation and hygiene behaviour, women kept the children's clothes soiled with excreta for 4 to 5 days. Nowadays, they ensure that dirty clothes are washed immediately.

A drying rack at Dailekh district, 2010.
Photo: Sugandha P Gurung

6.5 Access to and control over resources

Mainly male family members have access to and control over resources such as land, houses, livestock, extension services, etc. Women have limited access to such resources. However, the introduction of Domestic PLUS has helped challenge such trends to a certain extent. Women now do not hesitate to speak in a crowd to put forward their needs and demands. Any infrastructure or skill development training programs are planned for by taking into account of both men's and women's needs. Planning is done in consultation with both genders. On the other hand, women have equal access as men to drinking water, irrigation, nutrient food/vegetables, trainings, and information. They are accessing some materials/assets such are drying rack, washing slab, and waste water collection ponds.

6.6 Decision making role

Household level

Female members within the study areas are still hierarchically second to men in terms of decision making at the household level. For example, if they want to sell some property, they need to ask their husbands or the household head (who is generally male). However, exposure to development projects has raised their awareness of equal opportunities. Male family members encourage the women to attend meetings, trainings and other community activities. Ethnicity wise, Magar and Tamang families in Sirise VDC of Udayapur district were found to be more liberal in terms of presence of their female members and their say in decision making.

Community level

Though both men and women are aware of the need for equal participation in development activities, awareness levels are still nascent. Each water and sanitation user committee has started to include women in vice-chairperson, treasure or general member positions. As such the number of women participating in communal activities has increased. Each member in the executive committee has an equal decision-making role as per their position. A good example is Mrs. Bipi Maya Tamang, who is the chairperson of Sanodamar scheme in Sirise VDC. Being the chairperson, she is committed to develop Sanodamar into 'a hygienic and clean model village'. At an individual level, like all the other members, she has started her own small scale commercial vegetable production using excess water.

6.7 Contribution to social and gender harmony

Both male and female members of the family are engaged in both household and community activities in addition to their regular work. The opportunity for social as well as family harmony has been raised since the Domestic PLUS intervention. Interviews suggested that productive water opportunity has led to less household violence towards women and children.

In terms of respect, women in the executive committee as well as other well positioned women receive respect and response from the entire community. In the study area, men of each community (Kshetri, Barhman, Janajati and Dalit) responded that women of each household have participated in all program activities. This has enhanced women's knowledge and capacity, and programs have become successful thanks to equal participation of both men and women.

6.8 Gender roles, Domestic PLUS and sustainability

If the beneficiaries continue to use and manage the Domestic PLUS water supply schemes, this programme will be prosperous and sustainable. Diverse productive activities such as vegetable cultivation, fish farming, and livestock rearing through the involvement of both men and women has contributed to diversification of food in rural families and which ultimately contributes to their nutrition level and quality of livelihoods. Smooth operation of water related services have also created livelihood opportunities. The high levels of participation are a sign of potential sustainability of benefits.

Conclusion 7.0

Life is hard in rural communities. A women's life is comparatively harder due to extended household chores, traditional practices, powerless roles, scarcity of basic needs and gender discriminative societies. The Domestic PLUS approach took into consideration other productive water priorities apart from the basic domestic water supply and consumption. The introduced technology has influenced beneficiaries' lives. In line to this, though gender roles differ, responsibilities have been divided through cooperation within the family. Women are found to be more responsible for tending to kitchen garden and livestock feeding, whereas men are responsible for the water supply to the respective activities. With regard to marketing products, men are more interested in this compared to women who are motivated by reasons of family nutrition and food diversity. For communal activities such as trainings, meetings on management of schemes/program, fish farming both men and women are equally involved. Shared roles between men and women help women to reduce their drudgery to some extent. It helps to create families and social harmony so that women are respected and confided in more.

One lesson learnt from this research is that, given the opportunity to take part in community management works, women have proven capable. Men also support women in their chores if their time as well as interest allows. A lot was recorded during this research on the practical and behavioural changes brought about in the lives of women and men from the Domestic PLUS intervention. However, for more pronounced differences, such as changes in attitudes and power affairs, gender relations should be strategically addressed within a water and sanitation programmes as part of its design.

From the information obtained, it can be concluded that the technology based interventions from Domestic PLUS water supply interventions has helped increased cohesiveness and shared responsibilities between both women and men, and helped them work towards a common goal of self and community development.

8.0 Case Studies

Case I Using waste water for healthy livelihood

31 years old Mrs Sabitra Adhikari is a mother of three children and resident of Paganath VDC-7 in Dailekha district. She has built a small pond near the water tap to collect all the run off waste water produced from household activities such as washing clothes, utensils, etc. She uses the waste water in her kitchen garden to produce vegetables for her family's consumption. From this, not only is she able to provide supplementary nutritious greens in her family's diet (thereby improving their health), but also, due to easy availability of water nearby the house, she has found her husband keenly interested to help her out in the kitchen garden. She used to have to occasionally travel some distance to the local market to purchase vegetables. Now, since she has her own vegetable garden, she saves time and money, and yet is still able to nourish her family. She has both seasonal and off-seasonal vegetables in her garden. She emphasizes that all of this would not have been possible if she did not have an easy access to water supply and did not have the knowledge to build a waste water collection pond for vegetable farming.

Mrs Sabitri Adhikari at Paganath, Dailekh district, 2010. Photo: Ambika Rai

Case II Woman of mettle

Mrs. Man Maya Budhathoki is working as a treasurer for Ahale Rauthkharka Peltric Set Users Committee in Sirise VDC of Udayapur district. She is a mother of two children and her husband Mr Ema Bahadur Budhathoki has temporarily migrated to the city to work as a daily wage labourer. Therefore, Mrs. Budhathoki has the overall responsibility to look after the family and household matters. Despite such a large responsibility at home, she has actively managed her time to do community works too. Being one of the leading members of the committee, she actively participates in all committee meetings and puts her concerns forward whenever necessary. According to her, if women are given a chance to take part in community management work, they can prove they are capable in doing so, and she takes her own example for being one among. Not only is she involved in peltric set committee, but, she is also involved in other community activities ongoing in her village and nearby with other development programmes and agencies. She believes she has the capacity and confidence to be involved and maintains a balance in both household and community development works. The villagers have confidence in her capabilities as well.

Mrs Man Maya Budhathoki at Sirise, Udayapur district, 2010. Photo: Ambika Rai

Rope pump being tested at Siraha District, 2009.
Photo: Kumar Silwal

Briefs of simple technologies introduced with Domestic PLUS

Prepared by **Center for Rural Technology (CRT) for Concern Worldwide Nepal**

Executive Summary

Different available and appropriate technologies were introduced in Domestic PLUS with the motive to reduce work load and increase efficiency. Appropriate technologies are generally developed and applied at low cost, using mostly local materials and skills to meet the requirement of rural communities that suits the local context.

This chapter includes a technical brief of some technologies that were part of the Domestic PLUS intervention. There is large potential of rainwater harvesting for both domestic and productive uses, and simple methods like roof rainwater harvesting and plastic lined ponds to capture rainwater and/or run offs diverted directly to the agriculture fields. However, this is not included in this chapter. The ranges of technologies or systems and outputs that can be achieved are already included in Chapter One. The technologies that are included herein are;

1. **Improved water mill**
2. **Peltric set**
3. **Hydraulic Ram Pump**
4. **Sprinkler irrigation**
5. **Drip irrigation**
6. **Bio gas**
7. **Bio briquette**
8. **Eco san latrine**

This technical brief on the technologies was prepared by Center for Rural Technology (CRT[1]) in Nepali context as a separate document for Concern Worldwide Nepal. CRT is engaged in developing and promoting appropriate rural technologies in Nepal. For other details regarding these technologies are easily available and can freely down loaded from web sites. Pictures used in the document other than mentioned are from CRT source.

Selection and use of appropriate technologies alone will not be sufficient. There have been various examples on failure or no operation of technologies after certain time. One of the major reasons for this being lack of capacities of the users to manage, operate and maintain the system.

[1] *www.crtnepal.org*

Improved Water Mill 1.0

1. Background

There are many traditional water mills running in many hill areas of Nepal and being used as an important source of energy from centuries for grinding their food grains in very inefficient way. Most of these mills are located at the bank of streams and rivers. Improvement of such traditional mills is important to provide additional income to rural water millers as well as provide efficient and diversified services to the local community members.

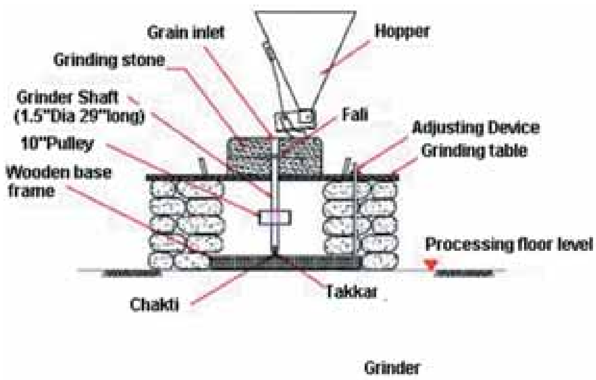


Fig *Sketch of Improved Water Mill*

2. The Technology

Improved Water Mill is mainly the improvement of existing traditional water mills to produce increased power not only to operate mechanical appliances such as cereal (maize, wheat, millet etc.) grinder, paddy huller, and oil expeller, sawmill etc. but also to produce electricity by coupling it with electric generator.

The improved water mill is a modified version of traditional water mill. Improvement of traditional water mill is done by improving its various parts but the major break through is made by replacing the traditional wooden runner with hydraulically better shaped metallic runner having cup shaped blades. This increases its operational efficiency as well as making it more useful with additional machines. After the improvement, the water mills have increased capacity by more than 100 %.

3. Basic Functional Features of Traditional and IWM

Comparison Parameters	Traditional Water Mill	Improved Water Mill
Functional Range		
Length of canal (m)	20-200	20-200
Working Head (m)	3-7 (max.)	2-7
Water Discharge (lps)	40-100	30-100
Output Power Capacity (kW)	0.2-0.5	0.5-3
Thickness of Grinding Stone (")	3-10	5-15
Diameter of Grinding Stone (")	24-34	24-34
Operational Efficiency (%)	Below 25	30-50
Repair/Maintenance	High	Low
Life Span	2 Years	10 Years

4. Types of improved water mill

According to the differences on shaft used in the improved water mill, it is classified as

- **Short shaft**

It is used for the operation of the improved water mill. It has a few end uses. Length and diameter of short shaft are 4 ft and 1.5 inch respectively.

- **Long shaft**

It has many end uses. Length and diameter of long shaft are 4ft and 2 ft respectively.

5. Components of the Technology

The various components of an improved water mill are as follows:

a. Metal plate

It is an upper part of IWM metallic structure. It holds the upper grinding stone and transmits mechanical power. It places in the groove of lower surface of upper grinder and on the key of the shaft. A rectangular hole is grooved in metal plate to place on the key of shaft.

b. Shaft

It places on the Base Plate with Pivot (as a bearing) and holds runner. It transmits mechanical power from the runner to the upper grinder through Phali. There is a key, which is constructed on the top part of the shaft to hold the Phali.

c. Runner

It consists of fourteen numbers of buckets joined with runner hub by arc welding and to give it a circular shape with the help of runner strip and guide ring. It is attached with the shaft by nut-bolts. It converts the kinetic energy of waterfall into mechanical energy. It is attached with shaft by not-bolts. It is a main part to convert the kinetic energy of waterfall from chute or penstock into mechanical energy, which is ultimately transmitted to the grinder. Fourteen numbers of buckets are joined with runner hub by arc welding and it is become into continuous circular shape with help of runner strip and guide.

Fig *Runner*

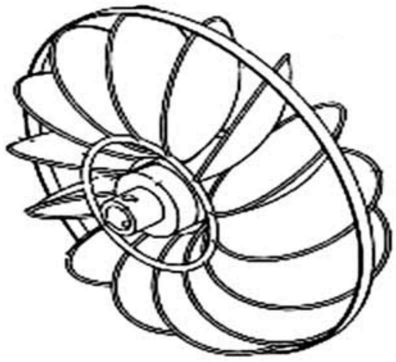
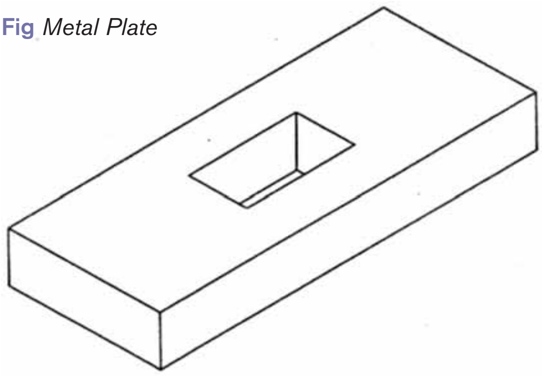


Fig *Metal Plate*



d. Pivot

It is placed in the lower hole of the shaft and the Base Plate. The pivot and base plate jointly work as a bearing for shaft. The water works as a coolant for the pivot and base plate.

e. Base plate

It is a base plate for the Pivot and shaft. It is joined to the wooden column at the ground surface with a screw.

f. Hopper

The hopper is normally made of wood or tin and used for feeding the agro products into the grinding stones for processing.

g. Penstock

Penstocks convey water from the source from a required height on to the runner to rotate it and produce mechanical energy. The penstock can be made of wood or plastic pipes.

6. Operating Procedure

- Fill the hopper with grinding materials
- Allow water to enter the penstock pipe, which is slowly passed on to runner through chute (penstock) tilted at 300 with the horizontal
- The water strikes the blades of the runner and helps it to rotate, which is the main source of the power. When the runner rotates, the upper grinding stone also rotates at the same speed
- The mill is operated only for grinding. It is operated by keeping the grinding stones at the top of the shaft. The feed to the grinding stone should be controlled from the hopper itself with the help of wooden liver.
- In case of additional end use connect it to the shaft coupled a pulley using flat belts

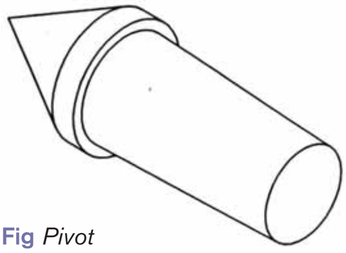


Fig *Pivot*

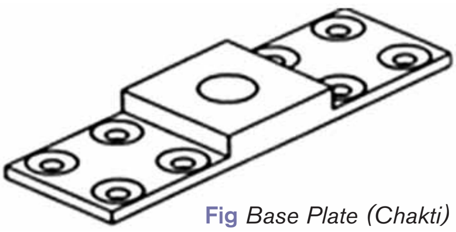


Fig *Base Plate (Chakti)*

Fig *Traditional penstock made of wood*

Fig *Penstock pipe made of PVC pipe with nozzle*

7. Precaution and Maintenance

- Maintenance is basically ensuring that the water supply from the water channel is maintained and that leaves, sticks and other debris trapped in the trash rack are removed from the canal and penstock pipe.

- If a De-settling basin has been incorporated into the inlet channel this will need occasional flushing as well the end of the channel below the turbine intake.

" Allow water slowly to enter the penstock pipe

" Check every week how Pivot and base plate are working

8. Cost and Government Subsidies Policies

Tentative Cost

Short Shaft:	NRs.25000.00-30000.00
Long shaft (with Rice hauling):	NRs. 50000.00-60000.00

9. Subsidy from government:

Short Shaft:	NRs.12000.00 + additional NRs.2000-3000	for remote
Long shaft	NRs.27000.00 + additional NRs.3500.00-4500.00	for remote

Peltric Set[2] 2.0

1. Background

Demand for rural electrification in the country is increasing. Although there is huge potential for hydro-power development, so far very little has been tapped for meeting the increasing demand. Electrification from central grid is not possible in all the areas. Water of small streams and rivulets flowing near human settlements in the hills and mountains could be used to produce electricity through the use of micro-hydro that can be used for variuos end uses. However, micro-hydro also does have a number of limitations. All sites do not have sufficient water for running water turbines. The technology available for low water flow with high head is called Peltric set which is a miniaturized and local version of a pelton turbine that is used for electricity generation. Many of such plants are already in operation to provide electricity locally in number of Nepalese villages.

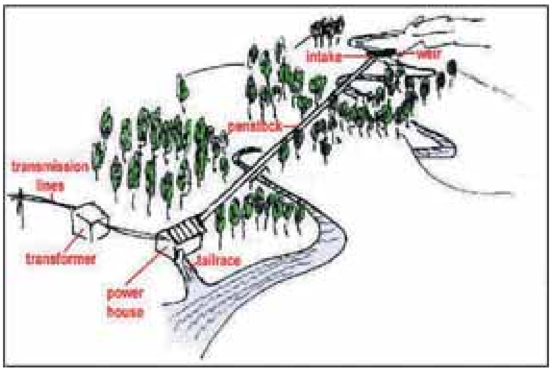


Fig *Schematic layout of micro hydro system*

2. Technology

A Peltric set is small vertical shaft pelton turbine with an induction generator co-axially coupled with it. It generates electricity power from a small quantity of water which is dropped from a large height to operate it. The turbine derives its power from the water pressure caused by a high head which flows through a nozzle that accelerates the water before striking a number of especially designed small bronze buckets attached round the periphery of the wheel.

The induction generator attached along the turbine shaft produces electric power when it revolves at its designed speed, given the right amount of excitation capacitors.

Fig *Peltric set unit for electricity generation at Sirise, Udayapur district, 2010. Photo: Shiva Basnet*

[2] *Small-scale hydropower in Nepal is divided into micro-hydro (<100 kW), mini-hydro (0.1-1 MW), and small hydropower plants (1-10 MW). Pico hydro, has been used for the very smallest of plants that produces up to 5kW to cover demand for electricity of a few households. Peltric set and Improved Water Mill are complementary of Pico-hydro technologies that have been quite popular in Nepal,*

3. Technical Features

Some of the technical specifications are:

Required water flow	2 - 20 lps
Required vertical head	45 - 50 m
Power output	500 - 5000 watts
Weight	35-40 kg
Operational efficiency	50-60 %
Speed(rpm of the shaft)	1500-1600
Life span	10-12 yrs

The power output is calculated as follows;

Power (W) = Quantity of water (Q in lps) x Vertical head (H in m) x 0.5

4. Advantages of the Technology

a) Appropriate for rural and remote hills
b) Requires less water flow
c) Produces power ranging from 50 to 5000 watts
d) Easy to install, operate and maintain
e) Easy to transport and cost effective using HDPE pipes for penstock
f) Can be operated using break pressure tank of rural water supply system

5. Various Components of Peltric Set

a) **Runner:** It is made from bronze buckets bolted on and securely locked by dove-tail grooves on a disc. The runner is keyed directly on to the generator shaft.

b) **Casing:** It is fabricated from 6 mm thick MS plates to ensure long lasting resistance to rust.

c) **Generator:** It is the induction type, brushless and self-excited. It is durable and virtually trouble free except that the bearings have to be changed every 10,000 of running.

d) **Control Box:** It contains all the necessary excitation circuits, volt meter, indicator lamp and main switch. The miniature circuit breaker allows no overloading on the generator.

e) **Inlet:** It consists of a gun metal stop-cock to put the set on and off, but it does not regulate the flow.

f) **Nozzle:** It is fabricated from MS (mild steel) and is conical in shape.

6. Installation and Operation

A feasibility survey is required before installation. Peltric set is fabricated by the manufacturer on the basis of requirement and site specification. Civil works such as canal, intake, forebay, and tail-race discharge facilities are also involved. Although simple, the technology is generally installed by trained technician.

For the operation of the Peltric set, water is slowly passed on to runner through nozzle. The water strikes the blades of the runner and helps it to rotate. Because of the movement of the runner, the shaft attached to it automatically rotates which again operates the induction generator coupled with it and thus generates the electricity.

7. Applications

Peltric Set can be used to generate electricity that can have the following applications; lighting households (1-5 kW of electric power can light 10-50 rural households), heating water and cooking in low watt cookers, battery charging, running micro-enterprises such as poultry raising, noodle making, running knitting machine and power looms etc. It can also be used for operating radios and televisions.

8. Repair and Maintenance

It is easy to repair and maintain which can easily be done by the communities. Since the machine is strong and efficient, its lifespan is around 10 years.

9. Cost and Government Subsidy

The cost varies as per the site and locations. However, it is estimated that the cost per KW is around Rs.150000-175000. To promote rural electrification there is provision of government subsidy from Rs. 97,500 per kW up to the size of 5 KW.

3.0 Hydraulic Ram Pump

1. Introduction

A hydram (Fig. 1) is an automatic pumping device which utilizes small fall of water to lift to a much greater height ie., it uses a larger flow of water falling through a small head to lift small flow of water through a higher head. Nepal is full of mountains and there are lots of villages whose settlements are above the water sources. Presently, there is no cost-effective and reliable means of pumping water up to the hills. Hydram can lift water for about 100 meters without additional energy.

The main virtue of the hydram is that only moving parts are two valves, the waste valve and delivery (check) valve and it is therefore mechanically very simple. The unit also consists of an air chamber and an air (snifter) valve. The operation of a hydram is intermittent due to the cyclic opening and closing of the waste and delivery valves. The closure of the waste valve creates a high pressure rise in the drive pipe. An air chamber is necessary to prevent these high intermittent pumped flows into a continuous stream of flow. The air valve allows air into the hydram to replace the air absorbed by the water due to the high pressures and mixing in the air chamber. This gives it very high reliability, minimal maintenance requirements and a long operation life.

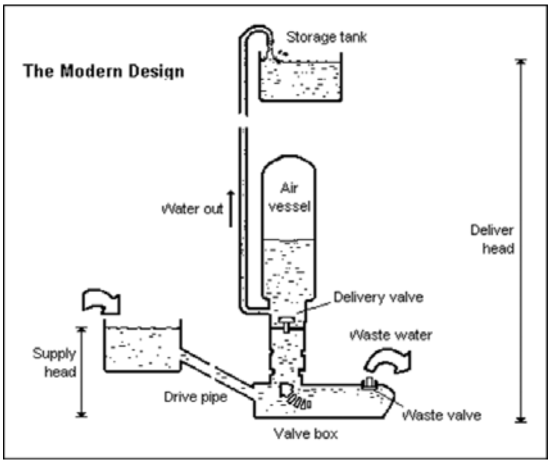


Fig *Typical Hydraulic Ram Pump*

Components of a hydram system:

The diagram (Fig 2) below shows all the main components of a hydram system. To construct a system requires basic construction and plumbing knowledge.

The main parts of a hydram and their functions are:

- **intake:** structure at source that diverts flow of water to the hydram system;
- feed pipe or canal: delivers water from the source to the drive tank;
- **drive tank:** provides storage to ensure a constant flow to the hydram and removes sediment from the water;
- **drive pipe:** feeds water to the hydram;
- hydram: pump unit that delivers a small amount of the drive flow to the delivery pipe;
- **pump house:** to protect the pump and fittings from accidental damage or theft;
- **delivery pipe:** delivers water from the hydram to the delivery tank;
- **delivery tank or pond:** stores the water pumped by the hydram. Can be a cement based structure or a lined pond;
- **distribution system:** distributes water to the users.

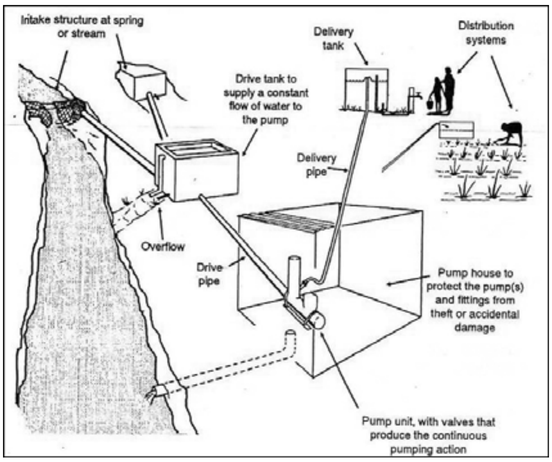


Fig *The main parts of a hydram system*

2. Applications

- Household water supply and sanitation
- Medium and micro Irrigation
- Livestock raising, agro-processing, fishponds, etc.

3. Impacts

- As a rural technology, the hydram can benefit users in many ways, including:
- Improve health through access to clean water, enabling better hygiene and sanitation;
- Reduce drudgery, especially for women and children;
- Increase agricultural yield and income for farmers';
- Reduce farmers' vulnerability through irrigation and crop diversification.

4. Effectiveness of the Technology

The technology can be introduced in areas where there is an abundance of water located at a source some distance below the settlement. It can be used in situations where there is no electricity to operate electrically-driven pumps. Depending on the source, the water can be used for drinking as well as irrigation purposes.

5. Cost and Subsidy provision

The cost of hydraulic ram pump depends on the size of hydraulic ram pump. However, the average cost range from NRs. 150,000 to 300,000

Fig *Hydraram unit at CRT Office Kathmandu, 2010. Photo: Cecial Adhikari*

4.0 Sprinkler Irrigation

1. Introduction

Sprinkler Irrigation is a method of applying irrigation water which is similar to rainfall. Water is distributed through a system of pipes. The system is use to irrigate a small piece of farmland by making artificial rain through the use of sprinkler. The system comes under small-scale irrigation system and used basically for increasing the efficiency of scarce water resource. This system is common for vegetable gardening.

Fig *Sprinkler device used at Dailekh for irrigation, 2010. Photo: Cecial Adhikari*

2. Usefulness

- The system needs less water to irrigate
- The system is also appropriate in sandy soil or loamy that does not retain irrigated water for long
- It helps in keeping the soil intact and does not erode during irrigation
- It also does not take away the fertilizers in the soil
- This system can also easily work in sloppy lands where other means are not feasible
- The system uses piping system for irrigation. As such, it does not need to have separate channeling system and thus saves lot of water from getting seepage
- It can be used along with the water supply system
- The farmers can easily install and operate the system after short training

3. Technical Feature

- Due to the head of the water, certain pressure is developed on the sprinkler nozzle and the pressure helps to rotate the nozzle and spry out water.
- The technical specifications of the single nozzle and double nozzle sprinkler are as follow:

SN	Particulars	Single Nozzle Sprinkler	Double Nozzle Sprinkler
1.	Size of Nozzle (mm)	4	4.5
2.	Water spray out distance (diameter in meter)	25	27
3.	Required Head to run the Sprinkler (m)	20	20
4.	Discharge of Sprinkler (l/s)	0.31	0.48
5.	Time taken to irrigate 100 sq.m. land (min)	16	12.6

4.0 Construction

4.1 Required materials for the construction

The followings are the main parts of the system.

SN	Parts	Function
1.	Sprinkler Nozzle	It emits the water out of pipe
2.	Lateral Pipes	It is joined with the main pipe and riser
3.	Main Pipe	It is joined with the main tank and lateral pipes
4.	Riser	It stands upward and is joined with lateral pipe and sprinkler
5.	Water tank	It supplies the water through main pipe
6.	Coupling, Reducer, Valve, L-bow, T-socket, Union etc.	They are used in fixing the pipes

4.2 Methods of construction

The followings are the construction process.

- First of all the tank is fixed at certain height.
- A gate valve is fitted to the water tank so as to control the flow of water.
- The main pipe is aligned as per the shape of the land and is joined with the tank.
- Lateral pipes are joined to the main pipe, in parallel position as far as possible.
- Risers are raised through lateral pipes maintaining certain equal distance depending upon the capacity of the sprinkler to cover the area.
- Sprinklers are placed in such a way that there is overlapping of the coverage to certain extent.
- Sprinklers are joined to risers properly.
- All the fittings are properly so that there is no leakage.
- The construction has to be done by a trained plumber.

Fig *Vegetable cultivation by sprinkler system*

4.3 Precautionary Measures

- Water tank needs to be kept at proper height to have enough force for sprinkling.
- If the water is muddy, sprinkler gets clogged and needs constant needling.
- Constant watching is required to stop possible leakage from tank and pipe fittings.
- Duration of sprinkler depends on the type of soil.
- Oil and grease should not be used at the mouth of the nozzle to stop clogging.

5. Repair and Maintenance

- Every 30 days, the tank needs to be cleaned to save from clogging problem.
- Frequent checking for leakage has to be done and rectified if any.
- Frequent cleaning of nozzle by needle or a small pin is required.
- Washer of the sprinkler needs to be changed when not properly working.
- After long use, the swing arm of the sprinkler gets loosened and needs to be tightened.

6. Cost

NRs. 10,000 to 15,000 (including pipes) depends on the area of the land need to be irrigated.

Simple Drip Irrigation System 5.0

1. Introduction

Drip irrigation, also known as trickle irrigation or micro irrigation, is an irrigation method which saves water and fertilizer by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, tubing, and emitters. Drip irrigation may be defined according to a number of performance parameters including flow rates, wetting pattern, pressure rating and construction material.

Fig *Woman doing commercial vegetable production using drip irrigation at Udayapur district, 2010. Photo: Cecial Adhikari.*

2. Advantages

Drip irrigation is the targeted, intelligent application of water, fertilizer, and chemicals that when used properly can provide great benefits such as:

- Increased revenue from increased yields and quality
- Decreased water costs
- Decreased labor costs and time saved during irrigation
- Decreased fertilizer costs
- Easy to operate, low cost and high income
- Easy installation and operation
- Due to drop irrigation, no chances of soil erosion

3. Installation of drip irrigation

- Drip irrigation system can be installed based on crop type and making easy for operation work. Making a wooden or bamboo basement, 50-100 liter water tank should be placed in 1 meter above the basement. Water can be fetch in the tank by pipe connection or using plastic mug.
- Disk filter should be managed by putting at the bottom of the water tank to avoid blockage of the holes.
- Gate valve for main source water control, outlet set, level pipe and two set of close/open valve should be installed in the system.
- Drip pip should be connected with t pipe to create 90 cm distance between two plants for irrigation.
- Dripper should be placed in every 60 cm position for proper dripping the water.
- All the pipes used in the drip system are made of plastic so it is easy to transport and install the system as well as there are no chances of rusting in the pipe. In each connection, pipe fitting is used.

4. Repair and Maintenance

- Frequent repair maintenance is required for continue operation.
- Presence of enough quantity of sand particles may destroy washer, so source water at reservoir tank should be checked frequently.
- Sand and soil in the disk filter should be cleaned timely.

5. Cost

Tentative cost of drip irrigation varies from NRs. 1,000 to 3000 depending upon the capacity of system. Materials used in the system are mainly plastics available in the market. Cost of the system depends on location specific.

6.0 Bio Gas

1. The Technology

Biogas is a mixture of gas, mainly methane, produced by methanogenic bacteria while acting upon biodegradable materials in an anaerobic condition. The feed (cow dung and/or human manure) is mixed with equal volume of water and fed into a dome shaped digester where it is acted upon by methanogenic bacteria under anaerobic condition. From the initial starting of a biogas plant, it needs approximately 25 days for the gas to be generated. After that, a continuous supply of gas can be drawn provided the prescribed amount of feed is used in the digester daily.

Although there are several models of biogas plants, but work on one of the two basic designs available.

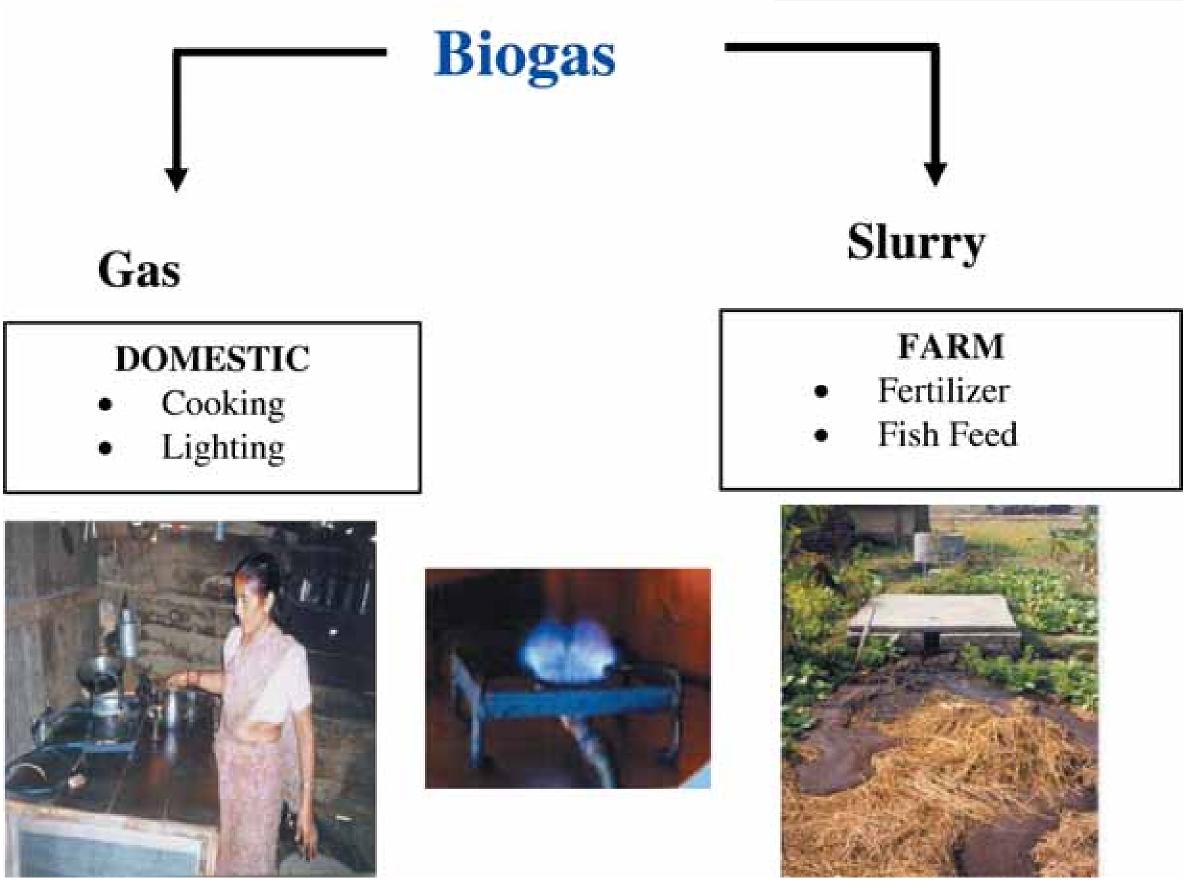
- Floating metal drum type,
- Fixed masonry dome type,

A fixed dome designed called as GGC 2047 is most common design of biogas in Nepal. It is constructed by bricks, sands, rod mesh and cement for its construction. The important point to be considered is that the size of plant has to be selected on the basis of the available dung and not on the family size. At least 6-7 kg dung is required for 1 m3 of plant capacity.

Fig *Bio Gas Unit.*

Bio Gas 6.0

Biogas has the following Uses:



2. The Fixed Dome (GGC 2047 Model) biogas plant has following characteristics:

- Sizes 4,6,8 and 10 cubic meters
- Feeding materials:
- Cattle dung & water
- Human excreta
- Individual household plant
- Feasible up to 2,100 meters altitude
- Modified GGC-2047 with heap composting technique is recommended for up to 3,000 meters altitude

3. Plant Feeding & Stove Burning Hours

Plant Size M^3	Initial Dung Feed, Kg.	Daily Dung Feed, Kg.	Daily Water Feed, Litres	Daily normal Stove Burning Hrs.
4	2,025	24-30	24-30	2:24
6	2,900	36-45	36-45	3:36
8	3,930	48-60	48-60	4:48
10	4,490	60-75	60-75	6:00

4. Technology Components

GGC 2047 Model Biogas Plant is currently promoted by Biogas Sector Partnership Nepal (BSP- Nepal)[3]. The components of this biogas plant are;

- A digester in which the slurry (dung mixed with water) is fermented;
- An inlet tank used to mix the feed and let it into the digester;
- A gas holder/dome in which the generated gas s collected;
- An outlet tank to remove the spent slurry;
- Distribution pipeline(s) to take the gas into the kitchen; and
- A manure pit, where the spent slurry stored

5. Operating Procedure

- The required quantity of dung and water is mixed in the inlet tank
- Allow the mix to decompose inside the digester.
- The gas produced in the digester is collected in the dome, called as the gasholder.
- The gas is supplied to the point of application through the pipeline
- The digester slurry flows to the outlet tank from the digester through manhole.
- The slurry then flows through the overflow opening to the compost pit where it is collected and composted for use as fertiliser or fish feed

Therefore, the slurry should always be fed according to the prescribed amount. Further, for efficient performance when deciding on a site for biogas plant construction the following point should be kept in mind:

- Right temperature needs to be maintained inside the digester. This requires a sunny site for the installation of the biogas plant.
- The plant must be located near the cowshed and water source need to close to the site too.
- The site has to be close to the kitchen or place where the biogas utilities are present.
- The plant needs to be at least 10 meters away from the well or any other ground water sources to protect water from pollution
- The plant also has to be at least two meters away from the house or any other building.

[3] *www.bspnepal.org.np*

6. Probable Problems and their Solutions

Problem	Possible Cause	Possible Solution
Gas does not Burn	Initial gas from the plant may not burn	Remove gas for the first couple of times and try burning again
Plenty of Gas in the dome but not transmitted to the burner	Main valve may be closed	Open main gas valve
	Gas tap or jet may be blocked	Clean gas tap and gas jet
	Pipe line may be blocked	Open main gas valve. Remove water or slurry through the water outlet from
Less Gas Production	Inadequate feeding	Follow recommended feeding pattern
	Temperature low	Insulate plant with composting
	Water quantity high in the digester	Use less water in the toilet and add water as recommended
	Inflow of toxic substance from the toilet (toilet cleaner)	Clean toilet only with brush and water
	Leakage in the pipe line	Check for leaks and repair
Flame is weak and red	Impurities in the gas tap and stove	Clean gas Tap and stove every week
	Insufficient gas in the plant	Close gas tap and collect gas in the gas
Gas burns with long flame	Blockage in the air regulating hole and ring	Clean hole and ring
Slurry comes through the pipe	Inadequate feeding	Feed the plant adequately
	Frequent use of gas	Close for about 10 hours
	Gas leakage	Check for leakage and repair or contact the company

7. Cost and Government Subsidies Policies:

Currently, GoN of Nepal provides the following subsidy for the biogas plants which is limited to less than 8 Cubic Meter (CUM) plants of family size.

SN	Plant size in CUM	Total cost (NRs)	Subsidy /plant (NRs)	Additional subsidy to deprived sector (NRs)
1	4	33000-42000	8000-16000	2000-3500
2	6	38000-47000		
3	8	45000-55000		

7.0 Bio Mass Beehive Briquette Manufacturing

1. Introduction

Biomass briquetting is the densification of loose biomass material (agricultural and forest residue) to produce compact solid composites of different sizes with the application of pressure. Briquetting of residues takes place with the application of pressure, heat and binding agent on the loose materials to produce the briquettes. This is one of the alternative methods to save the consumption and dependency on fuel wood.

Two different types of densification technologies are currently in use. The first, called **Pyrolizing Technology** relies on partial pyrolysis of biomass, which is mixed with binder and then made into briquettes by casting and pressing. The second technology is **Direct Extrusion Type**, where the biomass is dried and directly compacted with high heat and pressure.



2. Bee-Hive Briquette Manufacturing in Charring Drum (200 liter capacity)




The stepwise process of Bee-Hive Briquette production through pyrolizing techniques using charring drum is described below:

- Collect the required biomass materials such as forest wastes, agricultural residues and industrial wastes, loose wood logs etc and get them dried in sun.
- Placed the perforated cone (funnel) with chimney attachment inside the charring drum. An entire load of chopped loose woody biomass and forest waste material is stacked next to the drum and fire is ignite
- After the first portion of biomass material starts to burn, another layer of biomass material is added, covering the burning layer and chimney extension is then placed on top of the inner chimney
- More biomass is placed on to the fire, avoiding that the fire extinguishes. The dark color smoke will now escape through the chimney. The entire drum is gradually filled with the biomass, leaving sufficient space for smoke to escape.
- When the smoke starts turning from dark (containing water) to light grey and blue, this indicates that the process is complete and the raw materials have been carbonized.
- The additional chimney pipe is removed and the lid placed on the drum.
- The fire will slowly extinguish inside the drum and the biomass will be charred in about two to three hours. Let the drum cool down for a few hours (about 2 hrs)
- This carbonization process requires slow- burning fire of about 2-3 hours depending on the type of raw materials used.
- Total one-day production of two batches would produce about 50-60 Kg

3. Advantages of briquette over other fuel

- It takes about one minute to ignite.
- No need to cater to briquette once it starts to burn.
- It is almost smokeless and odorless.
- It leads to conservation and utilization of biomass resources.
- Saves money by reducing to purchase other fuels.
- The calorific value of briquette is high compare to Kerosene

4. Capacity of one Briquette

- Can boil 7 liter of water.
- Can cook food for one family of 5 persons
- Can fry 1.5 Kg peanut

5. Uses and Places

- Can use as domestic fuel for cooking and space heating, barbequing
- Can use in bakery, restaurant and hotel
- Can use in small scale industrial use
- Briquettes and be ignited with the help of piece of well dried wood or agri residues.

6. Precaution

- Never use briquette in close room.
- Never store briquette in humid place.
- Initially ignite the briquette in open place.
- Keep away from children reach
- Never pour kerosene in the briquette

7. Bee Hive Briquette Specification

- **Weight of briquette:** 450-500 gms
- **Burning time:** 80-90 minutes
- **Calorific value:** 30 MJ/Kg
- **Binder Material:** Clay
- **Binder composition:** 25%

8. Cost of equipments

a) **200 liter capacity vertical charring drum:**
Rs. 15000.00

b) **Quality charcoal production horizontal drum:**
Rs. 8000.00

c) **Accessories for Pit kiln method**
Rs. 2000.00

d) **Metallic Briquette stove:**
Rs. 700.00-800.00

e) **Manual Briquette die:**
Rs. 500.00-600.00

f) **Power Grinding Machine-**
(Electric generating Motor (1HP) + rotary):
Rs. 27000.00

g) **Power Pellet Briquette Machine-**
(Electric generating Motor (1HP) + rotary):
Rs. 37000.00

8.0 Eco San Latrine

1. Introduction

Ecological sanitation (Eco san) is an environment friendly sustainable sanitation system which regards human waste as resource for the agricultural purposes and food security. In contrast to the common practice of linear waste or excreta as something which views waste or excreta as something that needs to be disposed, Eco san seeks to close the loop of nutrients cycle, conserve water and our surrounding environment.

2. Basic Principles of Eco San latrines

- Offers a safe sanitation solution that prevents disease and promotes health by successfully and hygienically removing pathogen-rich excreta from the immediate environment
- Environmentally sound as it doesn't contaminate groundwater or save scarce water resources
- Recovers and recycles the nutrients from the excreta and thus creates a valuable resource to reduce the need for artificial fertilizers in agriculture from what is usually regarded as a waste product

3. Factors influencing design and management of Eco san latrines

- **Climate:** temperature, humidity, precipitation and solar radiation.
- **Population density and settlement pattern:** The availability of space for on-site/off-site processing ,storage and local recycling
- **Social/cultural:** the customs , beliefs, values and practices that influence the design of the social components of a sanitation system and its acceptability by a community
- **Economic:** the financial resources of both individuals and the community.
- **Technical capacity:** the level of technology that can be supported and maintained by local skills and tool
- **Agriculture:** Characteristics of local agriculture and homestead gardening
- **Institutional support:** Legal framework, extent of support for the Eco San concept in government, industry, financial institutions, universities and NGOs.

4. Methods of dealing with the faeces

- **Dehydration:** Lowering the moisture content of the material in the processing vault or container to less than 25 % through evaporation and addition of dry material.
- **Decomposition:** It is a complex biological process in which organic substances are mineralized and turned into humus. The speed of decomposition is influenced by a number of environmental factors inside the pile sucha as the amount of oxygen (aeration), temperature , moisture ,pH value ,the ratio of carbon to nitrogen (C:N ratio) ,competition among micro-organisms for nutrients and the toxic by-products of decomposing organism.

5. Types of latrines considered under Eco San systems

a) Urine Diversion (UD) Latrines

- Two outlets and 2 collection systems; one for urine and other for faeces in order to keep excreta fractions separate.
- May or may not mix water and faeces, but do not mix urine and faeces at the point of collection in the toilet

b) Wet Eco San (UD) latrines

- It has partition in the toilet bowl isolating bowl for urine in front and a bowl for faeces in the back
- Urine pipe stays open and receives a certain amount of flushing water when the bowl is flushed.
- Urine pipe is closed by a valve and receives no flushing water

c) Dry Eco San (dehydration) Latrines

- The faeces /excreta are collected in a dry state in a chamber below the toilet and excreta in-side the processing vault are dried with the help of sun, natural evaporation and ventilation
- High temperature in the chamber, together with sufficient ventilation is the most important mechanisms in the drying process
- Flush water is not used at all

d) Composting latrines

- Use natural processes to produce compost from the faeces.
- Biological dehydration of excreta in the specially designed chamber by the use of additives. Earthworms may be used as additives.

6. Maintenance

All systems require periodic inspection and removal of the end products. Particularly urine collectors, pipes, and containers/tanks need to be monitored.

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