An Evaluation of Multiple Use Water Systems in Mid-hills of Nepal

A Case Study of Phulbari Multiple Use Water Systems in IDE's Project Area of Shyangja District

M.Sc. Internship Report by Raj Kumar G.C.

August,2010

Irrigation and Water Engineering Group

WAGENINGEN UNIVERSITY

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The research might be an asset to IDE Nepal, and for them who are interested in issues of small scale water resources development and management in the mid-hills of Nepal. The research not only detects the value of developing the small scale water resources scattered around the mid hills of Nepal, but also generates scientific insights valuable to understand the bigger picture of water scarcity.

Cover page pictures

Upper Left: Double tank MUS system (Photograph by Bimala Rai Colavito)

Upper Right: Eka Maya Bastola showing tomato, Mauja, Kaski (Photograph by Ananda Dahal)

Left Bottom: A farmer filling his drip tank from off-take, Phulbari, Syangja (Photograph by Unknown)

Right Bottom: A women fetching water in multi use tap, Phulbari, Syangja (Photograph by Raj G.C)

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Master Internship Irrigation and Water Engineering Submitted in Partial Fulfilment of the Degree of Master of Science in International Land and Water Management (MIL) at Wageningen University, the Netherlands

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August,2010

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Raj K. G.C.
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LIST OF ABBREVIATIONS

APP	Agriculture Perspective Plan
CBS	Central Bureau of Statistics
DADO	District Agricultural Development Office
DM	District Manager
DOI	Department of Irrigation
EPD	Engineering Program Director
FCL	Ferro-Cement Lined Tank
HVC	High Value Crops
ICWE	International Conference on Water and Environment
IDE/N	International Development Enterprises, Nepal
I/NGO	International/Non Governmental Organization
MIL	International Land and Water Management
MIT	Micro-Irrigation technology
MTJ	Modified Thai Jar
MUS	Multiple Use Water Systems (in a general sense)
MWG	Millennium Water Goals
PRISM	Poverty Reduction through Irrigation and Smallholder Market
RPI	Rural Prospective Initiative
Rs.	Nepali Rupees
SIMI	Smallholders Irrigation Management Initiative
TS	Technical Supervisor
UN	United Nations
USAID	United States Aid
VDC	Village Development Committee
WECS	Water and Energy Commission Secretariat
WI	Winrock-International

CONVESION FACTORS

1 Hectare=	19.675 Ropani
1 Ropani=	508.26 m^2
1 Anna=	31.76 m^2

EXCHANGE RATES

1 Euro ≈	100 Rs.
1 Dollor ≈	70 Rs.

FARM SIZE CLASS

<1.0 ha =	Small Farmer
<0.5 ha =	Marginal Farmer

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EXECUTIVE SUMMARY

In Nepal, multiple use water systems (MUS) was first conceptualized and field tested by International Development Enterprises (IDE/N) Nepal in 2001 in Palpa district. Based on the testing of the systems, it was expanded to several projects of IDE/N. Smallholder Irrigation Market Initiative (SIMI project), a collaboration of IDE/N and Winrock, formally introduced MUS system in Nepal in 2003 to enable hill farmers to use their limited water supply to grow small plots of vegetable and to meet the drinking water needs of the community. Since then, 130 such schemes (up to the research date) have been implemented by different projects with the involvement of IDE/N in the mid-hills. Improving marginal and small landholder household's access to water by introducing appropriate and cost-effective irrigation technologies for productive agriculture use was a key element of SIMI.

This study outlines the outcome of a case study carried out in Phulbari village of Syangja district and a small survey undertaken in three other systems in the mid-hills (in Kaski, Syangja and Tanahu districts). The research took about 4 months, from August to November, 2009. The Phulbari MUS system is a gravity fed double tank, two line distribution system designed by SIMI in 2005. The system serves low-caste people (100% *dalits*) who had never practiced vegetable cultivation. Given this background, the experiences and outcomes of the Phulbari MUS are triggered my interest. I wanted to know how these people dealt with the technology and how they fared in the dynamics of vegetable production. So, I evaluated the performance of the technology and tried to assess the benefits for the farmers (using IDE's definition of impact). I was particularly interested to find out how these were perceived by the farmers. The construction and management of the system is briefly examined. Open-ended, semi-structured and structured interviews with the farmers and staffs were conducted. I also attended a district-level MUS workshop in Syangja for the purpose. The methodology for investigation and the procedure of analytical interpretation is inspired by the case study approach. The research studies MUS technology as an adoptive socio-technical system for water control for high value crops (HVC) production. In addition, I apply 'IDE approach to technology promotion' as a conceptual basis of the research.

The result shows that farmers (who were used to grow one season rainfed traditional crops) have been able to grow high-value cash crops in three seasons (monsoon, summer and winter). As a consequence, the total cost of MUS was recovered in the year it was installed. A financial analysis of associated costs and projected benefits of the system showed that MUS yields the cost - benefit of 1: 4.7 within the projected 10 years of its life, following that level of benefit (C/B : 1/ 4.7) in all the years (except the year of implementation). Besides this, the use of improved seeds, crop planning, market knowledge, increase in fresh vegetable consumption and improvements in health and sanitation, reduction of time (about 50%) in carrying water and labor saving, change in intra-household roles and equity are the encouraging results stimulated by MUS. It largely impacted in creating awareness in the community, developing leadership, improving social cohesion, bringing women in the mainstream of decision making. This is in fact a breakthrough in the social transformation in the particular social setting of Phulbari.

A comparison between the MUS-users and non-users shows that non-MUS farmers are lagging behind in this transformation. The results further indicate that management of MUS through water users groups needs to be strengthened. Without addressing this issue, the sustainability of MUS systems is becoming a question.

Despite the fact that MUS has addressed the scarcity of water, scarcity of land is a major barrier of Phulbari farmers to further extend their vegetable production to meet the daily income of 1 dollar per day (present increase in income is ½ dollar per day) as per the IDE/N economic definition of impact. But, the other impacts as described above sought by IDE/N has fully been satisfied.

Finally, the result concludes that MUS showed positive impact to the community, ultimately improving the incomes of the smallholders and social transformation. This way, farmers have perceived MUS as a low-cost, appropriate and reliable technology.

1. INTRODUCTION

This chapter discusses reasons for undertaking the internship research and provides an overall outlook of the research. This chapter then presents the general introduction of multiple use water systems (MUS) and micro irrigation technology (MIT), and the relation between MIT and MUS. It further outlines the concept of MUS in relation to water management in the mid-hills of Nepal.

1.1 Research Context

I worked in International Development Enterprises, Nepal (IDE/N) as a research intern from September to December 2009. There are few principal motivations why I decided to carry out this research in IDE/N. As a former Agricultural Engineer (working from 2006 to 2008 in the same organization) and as a student of International Land and Water Management (MIL), I strive to contribute to a sounder and more conscious way of dealing with what is given by nature (sustainable management of natural resources) and use these optimally. Water professionals and scientists believed that water resources are prone to be environmentally sensitive due to climate change, new development interventions and increased population. Apparently, there is interlink of water resources management issues are linked to the wider development context of agriculture and the growing water demands. Water resources constitute the means of livelihood and well-being for the population in the rural areas, especially in the developing countries like Nepal. These situations call for the management of water resources by exploring its multiple use and benefits.

In this context, the small scale water resources and their use for multiple use water systems (MUS) stimulated my interest. The richness of IDE/N's experiences, as a pioneer organization promoting MUS in Nepal, would be useful. On the other hand, IDE/N wanted to evaluate the impact of MUS in order to apply the research outcomes in their upcoming projects and programs. The IDE/N terms of reference (TOR) given to me clearly mentioned, "*We are developing business plans for micro-irrigation users now, it will be great to integrate these research outcomes into our business plans*"**.** This shows that they were interested in me and wanted to pick my brain for it. At the same time, I was motivated to make the best use of my knowledge and skills learned during the courses of my master's studies in Wageningen, the Netherlands. So, I decided to evaluate the performance of MUS from multiple dimension of its benefits, use and management.

Over the last 7 years, IDE/N has been implementing MUS focusing on the mid-hill districts of Nepal to enable smallholder farmers to use their small and scattered water resources around the hills to grow small plots of vegetables and to meet the drinking water needs of the community. As such, IDE/N aims to increase the incomes of these rural poor household through high-value crop production (such as tomato, cucumber and climber plants) by providing access to irrigation in small plots of land. The irrigation technologies are supposed to be low-cost and designed for smallholders. The main goals of MUS promotion are to explore ways to reduce poverty and to improve livelihoods through linkage of farmers to their local market for the sale of the vegetables.

Different sources of literature (Mikhail and Yoder, 2008, Eco-Tech Consult, 2004 and Pant *et.al*, 2005) showed that MUS potentially benefits communities in the mid-hills of Nepal. However, it is difficult to validate or replicate the results obtained in one place to another (with different socio-economic settings). So, I decided to study the case of Phulbari community (in Syangja district) which is a special case because the MUS-users belong to the *dalit* minority group, who cultivate marginal land and who never practiced vegetable cultivation. Implications and impacts of the technology in such a particular setting are poorly understood. As such, I focused my investigations on (1) construction and management of MUS system in this particular context of Phulbari, and (2) the extent of benefits offered by the IDE/N promoted MUS in improving the income of farmers, and (3) subsequent impact on the lives of smallholder farmers. For this, I studied MUS technology as an adaptive system of sociotechnical water control for high value crops (HVC) production. I tried to link this to IDE's approach to technology promotion. By doing so, I could understand the technology in the context of water use by farmers, and I could grasp the impact produced by the technology.

Finally, I believe that my small effort to evaluate MUS in the mid-hills of Nepal through this internship would function as a feed-back system for the policy makers and the IDE itself. As such, looking from a broader angle the main theme of this work in my final report is entailed "*The research might be an asset to IDE Nepal, and for them who are interested in issues of small scale water resources development and management in the mid-hills of Nepal. The research not only detects the value of developing the small scale water resources scattered around the mid hills of Nepal, but also generates scientific insights valuable to understand the bigger picture of water scarcity*."

1.2 Multiple Use Water Systems

Locally available water in rural areas has traditionally been used for both domestic and productive purposes (Yoder *et.al*, 2008). Productive uses include kitchen gardens, livestock, crop processing, and micro-enterprises. These productive activities make a major contribution to rural communities – generating income, securing food and helping to reduce 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. This is a pity because it limits the economic benefits of water supply systems and it affects sustainability. The single use approach involves the design, provision and management of water services for only a single use such as for drinking water purposes or irrigation. As such, gravity-flow water systems designed to integrate both domestic (drinking, bathing, washing and sanitation etc.) & productive (irrigation, livestock watering, brick making and micro-enterprises etc.), needs are called as Multiple Use Water Systems (MUS).In the system, water from a higher elevated spring source is collected in reservoir/s and conveyed by gravity through high density polyethylene (HDPE) pipes to the village, which is then distributed to households through two types of delivery structures—'multi use tap' and 'irrigation off takes'.Generally speaking, a MUS is a combination of system of *Water Source-Pipeline-Storage Tank- Tap Stands*-Micro irrigation technology (MIT) –High value crops *(HVC[1])*.Generally, the systems supply water for both domestic purposes and vegetable plots of 10-40 households.MUS is referred as a low cost (approx. $ 3115 per scheme) and community managed system and is basically targeted to smallholders and marginal households of rural and peri-urban areas. It is meant for poverty reduction and improved livelihoods through linkage of farmers to their local market for sale of the vegetable (IDE/N, 2009). The foundation of MUS is built upon a concept to provide reliable water supply to meet the water requirements for domestic need, while applying the 'excess' water for irrigation with the use of MIT making it possible to use very small sources of water for irrigation.

1.3 Water Resources Management and Rationale for the Birth of MUS Idea in Nepal

People might be thinking that people in Nepal do not have to worry about water when people look at the wide scene of the white snow capped mountains and people may assume that Nepal is blessed with abundant water, and at the same time when people see the heavy rain of the monsoon. Indeed , Nepal has abundant water resources with an average annual availability of 225 billion cubic meters (BCM) of water in the form of rain and snow that precipitate in country's 147,181 square kilometers of area (Koirala,2007). Nepal has more than 6,000 rivers, which provide a dense network of rivers with steep topographic conditions that drain from north to south towards the Ganges in India (IAHS, 2003). Similarly, the mean annual precipitation is about 1500mm, ranging from 300mm in the northern and western areas to over 2500mm in the eastern region (Marasini, 2008). At the same time, lack of irrigation is considered a major constraining factor for agriculture extension and poor performance of agriculture, and a higher risk of poverty is pronounced among these farm households without access to irrigation (Sharma, 2002). It has been reported that many of the problems for the situation are related to improper management of the water resources. In my eyes, there exist a lot of challenges and opportunities for the development and management of water resources in Nepal, especially in the hills.

[1] HVC are the crops that has high market demand and value throughout the year, such as, cucumber, tomato etc.

On the other hand, the following processes have further intensified the problems that are directly or indirectly linked with the situations described above. Firstly, in hills, normally communities have no access to irrigation, and are primarily dependent on rainfall for their crops and farming under rain fed conditions, because farmers in the hills in general have too much water during the monsoon rainy season (June –September) and too little water in rest of the year. So, most springs do not have uniform discharge throughout the year, as the discharge is highest at the end of the rainy season and reduces gradually through the dry season. Eventually, majority of the small farmers have to depend on seasonal rains for irrigation. Secondly, traditional furrow or flood irrigation requires large quantities of water, and they are costly if it is to be harvested by pumping or by making a channel from a distance source. Thirdly, most of the farmers in the area are smallholders and they need an affordable technology. Lastly, ground water is unavailable in the hills which are perceived easier to develop (like Terai).

Coupled with the above discussions, numerous natural rivulets and springs provide promising opportunities[2] for the development of smaller irrigation and water supply schemes from unused and scattered spring sources (even up to 0.1 ltr/sec) available around the hills. With this in mind, it can be argued that development of those small water resources would serve to bridge the gap between these promising opportunities and challenging circumstances.

1.4 MUS: A Technology Combination with Micro-Irrigation Technology

IDE/N perceived MUS a unique combination of Ferro-cement lined tank (FCL) [3] tank and Modified Thai jar (MTJ) [4] developed as a single technology. Besides this, MIT is an important combination of MUS at the farmers plot. However, the cost of MIT is not included in total cost of MUS. These technologies are developed low cost, because they are constructed from the locally available materials and local technicians as far possible. The tanks (FCL and MTJ) are not only the components of MUS, but also used separately to collect spring water from upland sources and/or rainwater harvesting in water scarce situations. Depending on the amount of water available in the source (scarce, moderate, and abundant), MUS systems are designed in such a principle that "right technology for the right place" with the combination of those low cost technologies (Annex-2).

According to Mikhail and Yoder (2008), MUS projects in Nepal have demonstrated that the use of MIT in conjunction with MUS is a unique combination to optimize the productive portion of MUS. This way, the major goal of incorporating MIT into the MUS systems is to enable farmers to grow HVC both on on-and off-season. Quoting the "community lessons" from their work, the same authors declared that the major problem of the farmers in the mid-hills was lack of water. So, it can be said that the base for effective MUS system lies within the implementation of the MIT. Drip irrigation technology is often combined with MUS to optimize the use of limited water because of less pressure head[5] required for operation.

[2] Natural spring sources are normally located at an elevation higher than the villages, and as such are appropriate for developing into a MUS.

[3] FCL tank is a pit dug in the ground with a soil and ferro-cement plaster lining. The size of tanks (6000 and 10,000 litres) designed for MUS are based on the flow rate of spring and the projected need of the future population of the cluster.

[4] MTJ is made with Ferro cement (a mixture of sand and cement which is applied as a plaster) and mesh-wire netting (for reinforcement). Based on the design requirements, 1000, 1500 and 3000 litres of MTJ tanks are combined with MUS.

[5] Minimum recommended head of a drip tank is 1 meter above the ground level, but a minimum pressure head required for the operation of customized 4 head micro sprinkler system is 8-10 m.

Hence, IDE/N introduced drip technology in the hills to enable farmers to use their limited water supply to grow small plots of vegetables, while dealing with the increasing problem of water scarcity that supported the farmers in more efficient water use, labor-saving and better plant growth (Eco-Tech Consult, 2004).

1.5 Linking MUS to Global and National Issues

It is my personal interest to apply the insights gained during academic education in the field of water resources management in MIL, where I had an opportunity to learn issues of water scarcity and its management from multiple dimensions. I'm aware of the interlink of water resources management issues with the wider development context of agriculture, the water demands and the potential adverse effects of water scarcity pressures on the environment. With the research in this section, I attempt to provide an understanding why water scarcity issues are important to discuss in relation to MUS in global and national level.

1.5.1 Global and Regional Issues: Connecting to MUS as a Management Tool

It is evident that the world's supply of fresh water is running out day by day. It is widely being concerned that water scarcity continues to be a global issue that grows more serious with the ever expanding human populations (Gregersen *et. al*, 2007). In the face of growing populations and the uncertainties like climate change require a great attention to the sustainable management of water resources. Arguably, in this case, developing sustainable water resources management systems is needed. Hereby, I consider MUS as a small tool for sustainable water management. My belief is that MUS serves water management as a vehicle for an integrated approach, which cater for productive uses in combination with other uses. Koppen *et.al* (2009) defined MUS as a participatory, integrated, and poverty reduction focused approach which takes people's multiple water needs as the starting point for providing integrated services. In line with the above discussions, International Conference on Water and Environment (ICWE) is widely known in the water sector, which was held in 1992 in Dublin, Ireland. The Dublin Conference report sets out recommendations for sustainable water polices for action at local, national and international levels, based on four guiding principles as listed in Box 1 (that inspired me here to link those principles in this context of water management discussion). The principles highlighted the necessity of integrated water resources management, locally adapted water management institutions, active participation of stakeholders, and economic value of water and role of women in water management.

Box 1 The Dublin Principles

Principle.1: Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.

Principle.2: Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.

Principle .3: Women play a central part in the provision, management and safeguarding of water

Principle .4: Water has an economic value in all its competing uses and should be recognized as an economic good.

Source: **Rahaman & Varis (2005)**

Next to that, UN Millennium Water Goals (MWG), Johannesburg Summit, 2002 has made a strong commitment to reduce the proportion of people by one half without access to hygienic sanitation facilities and without sustainable access to adequate quantities of affordable and safe water by 2015. To achieve this, the summit has pointed the need for holistic approaches and integrated management principles to develop sustainable systems.

The growing attention to water in recent years reflects the increasing scarcity and competition for this vital source. Gregersen *et.al* (2007) are concerned about that the poor are often the people hurt the most by water scarcity because poverty and access to water are closely linked. This is because poor will not be able to buy water rights for their livelihoods when the scarcity reaches to a certain limit of crisis. As such, the challenges to water resources management is getting more complex, demanding greater attention. Based on the understandings, it can be agreed that supply of freshwater will be a major concern in years to come. At the same time, we must produce more food and agricultural products with less water, obviously as agriculture is the major sector suffering from reduced water availability.This situation calls for enhancing productivity of water to ease water scarcity and provide food security. To make this possible, water needs serving the dual purpose of improving the productivity and meeting the drinking water needs.

1.5.2 National Issues

Nepal is predominantly a rural hilly (hill region-15%), mountainous (mountain region 68%) and agricultural country. Agriculture is considered the backbone of national economy - generating about 40% of the Gross Domestic Product (GDP) and employing over 80% work force (Sharma,2002), in which most rural and some urban populations get employed in. However, agricultural productivity is considerably low. This has resulted in a 42% of the population below the poverty line (Sharma, 2002), and about 18% belonging to extremely poor group (Chapagain, 2002). Water and Energy Commission Secretariat (WECS) (2001: in Koirala, 2007) has mentioned its water sector goal as: "living conditions of Nepali people are significantly improved in a sustainable manner through the long term development of water resources". Hence, the debate on 'development and management of local water resources' makes more sense, when the concept "more crop per drop of water" for increasing productivity (Koirala, 2007) would have been included. This is because the smallholders and marginal sections of community can benefit from the increased production with their limited resources (Ex- land, water and financial resources).

In light of the above discussions, it can be said that agriculture sector is pivotal for any attempt to increase income, alleviate poverty and uplift living standard of the people. To achieve this, irrigation is generally perceived by policy makers and development workers the most prominent water use sector in Nepal. As mentioned in the previous section 1.3, lack of access to irrigation is generally pronounced as one of the major factors linked with rural poverty. So, poverty reduction is impossible without expanding the economic opportunities and employment generation through proper utilization of available water resources.

Table 1 Potential Irrigable Area by MIT/MUS

Region	Cultivated Area (Ha)	Irrigated Area by SI*(Ha		Potential MI/MUS Area (Ha)?
Terai	13, 60,265	13, 37,580		22,685 (1.7%)
Hills	10, 54,280	3, 68,541		6, 85, 739(65%)
Mountains	2, 27,197	59,718		1, 67,479 (73%)
Total	**2641742**	**1765839**	**(67%)**	**8, 75, 903 (33%)**

Source: Rajauria (2007)

*Surface Irrigation

According to DOI, a total of 26, 41, 742 ha of land is cultivated, of which around 67% of land is irrigated from conventional irrigation system and rest 33% are non irrigable with the system. Since 65% of the land in the hills can't be irrigated with surface irrigation. So, supplying water through an irrigation network to increase production in hilly areas has been very challenging. In such a case, IDE/N believes MIT/MUS as the best options in the hills as described in the previous sections. This way, IDE Nepal claims that MUS is a technology suitable for the topographical and ecological conditions of the hills of Nepal in combination with MIT.

Recently, MUS is emerging on the National Agenda (including the Government departments like DADO and DoI) - formally has been started from village development committee (VDC). VDC Fund Mobilization Guideline of 2008 mentioned that development budgets received from the central authorities to VDCs can be allocated and spent for the development of MUS and MIT systems.Kailash Sharma, Engineering program Director (EPD), IDE/N reasoned that these institutional changes became possible because of IDE/N taken MUS learning alliance approach. The approach aims to create partners for project implementation through stakeholders platforms (formal workshops at national and district levels for sharing information).The funding interest of Government in MUS might materialize the opportunity of developing thousands of undeveloped water sources throughout the region, which could be used by thousands of smallholders to increase their incomes.

2. PROBLEM STATEMENT, RESEARCH OBJECTIVES AND CONCEPTS

This chapter outlines the problem statement, research question and research objectives. I then examine the theoretical concepts used in this study and explain how Sociotechnical approach and IDE Approach to Technology Promotion are operationalized for this research.

2.1 Problem Statement

The background to the MUS described above shows that 'on paper', MUS bears the potential of benefiting communities in the hills.However, it is difficult to validate or replicate the result obtained in some places to other socio-economic settings such as the case of 100% *dalits* minority groups with marginal land who never practiced vegetable cultivation over the history of their generations. Implications and impacts of the technology in such a particular setting are poorly understood.

2.2. Research Objectives

How did the construction and management of MUS system in Phulbari take place and to what extent are the IDE/N promoted MUS effective in improving the income of farmers, and subsequent impact on the lives of smallholder's farmers in mid hills of Nepal with reference to Phulbari MUS of Syangja?

To operationalize the main research question, I formulate more sub-questions to be answered during my research.

1. How did the construction and management of MUS take place in Phulbari village (in relation to the water resources across the area)?

2. What are the real and potential benefits that can be gained from MUS (focus on the changes in income, shift in irrigated areas, impact on crop choices, changes in water use, farmers' practices shift in production and production decision making after the intervention of MUS)?

3. What other effects/impacts can be observed (empowerment, social transformation)?

4. What are the perspectives of farmers on the technology (MUS)?

5. What are the dynamics of Phulbari MUS farmers with other MUS farmers of the mid-hills and how?

2.3 Conceptual Foundation

It is my personal interest to apply concepts and insights gained during my academic education in the field of irrigation and water management at Wageningen University. Concepts like the sociotechnical approach, water as contested resources and the utilization of water as an agent of change inspired my understanding of water reforms and shifts. The choice of an appropriate strategy is largely determined by the nature of the study and the kind of information to be generated. There are multiple perceptions about how one could best analyze and frame water management issues. This research studied MUS technology as an adaptive system sociotechnical of water control for HVC production. For the adaptability of the system, two fold dimensions were studied .Firstly, it can be seen as an integration of low cost technologies that enables users to meet both productive and drinking uses of water. Secondly, it can be seen as an adaptive technology, yielding tangible and intangible benefits. In order to obtain a long term and effective adoption, the productivity offered by technologies should meet the needs and characteristics of smallholders and marginal farmers in the area, i.e. both male and female farmers should benefit. All in all, the basic premise for developing the conceptual framework is to build up an understanding of the relations of technology in the larger context of water use by farmers and households with impact produced by the technology. Hereby, the question is: How does MUS technology benefit farm households? And, to what extent, do the farmers perspectives of 'success'' differ from IDE/N's definition of success; what are the discrepancies. IDE/N had a strategy to end poverty by increasing income from small-plot agriculture. IDE led the SIMI project with the purpose to develop and disseminate efficient small-plot water technologies (that are affordable for the rural poor), and assuming that increases income of farmers with $1 a day. In line to this reasoning, **'**community oriented technology with adaptive properties (sociotechnical approach)' coupled with 'IDE approach to Technology Promotion' (discussed in 3.3.2) has been used for interpretation of my research findings. The conceptual basis summarized in this section, and that will be discussed in the following will be used to respond my research questions.

2.3.1 Sociotechnical System

The research object will be approached and interpreted from an understanding that social and technical dimensions of technology are related, and can not be studied separately in a meaningful way. Vincent (2008) argued that technology is socially constructed; has social conditions of use; and has social effects**.** In this case, interdisciplinary approach is most relevant to socio-technical innovation (Leeuwis, 2006).This is because interdisciplinary approach considers all social and technical aspects of this research.

An important factor for successful adoption of a technology is to get a right technological package for the smallholder farmer. Besides this, the technologies offered should be "technically appropriate". An irrigation technology can be technically effective in improving the livelihood of a household, but it can simultaneously be socially unfit for the distribution of benefits among all participating households. In the contexts discussed, I found interesting to use Mollinga's framework of sociotechnical approach in this research.

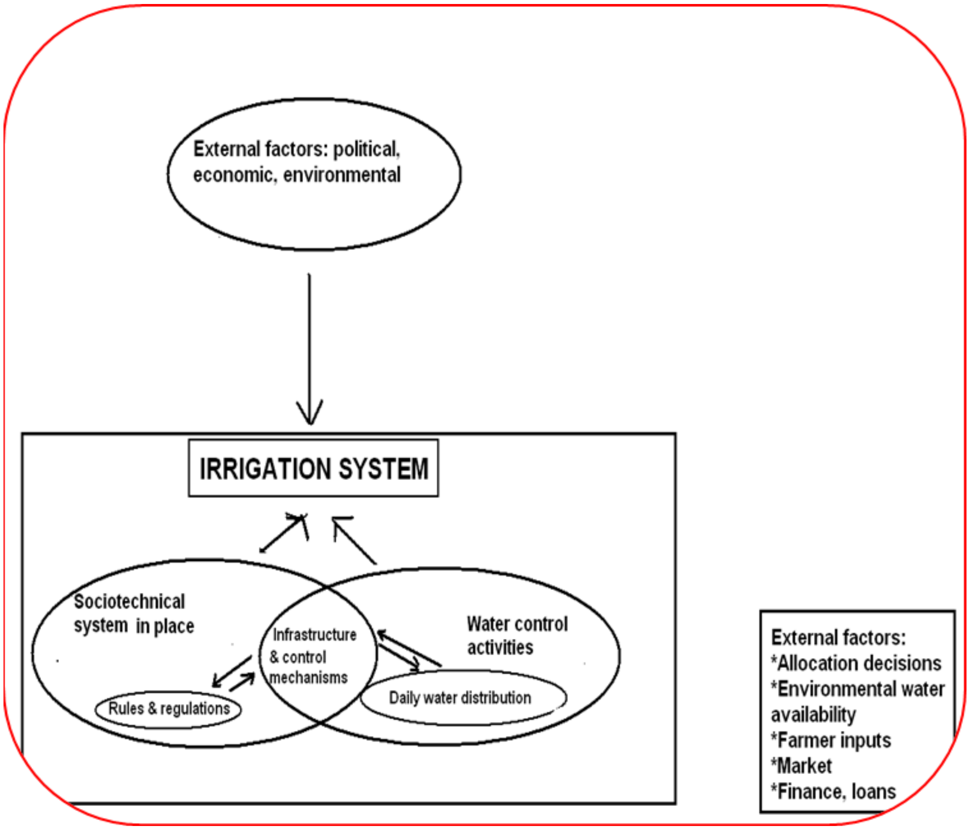

Figure 1 Mollinga's Framework of Sociotechnical Systems

The framework of Mollinga (1997) describes the infrastructure, rules and regulations at which water distribution activities on the other hand are daily management activities using the technical control mechanisms (off-takes, multi-use taps, valves etc.). In this research, external factors are considered when necessary. Generally, the technicians allocate water to fix duration and frequency of water supply, most of this operation depends on technical works, and however the question rises whether this technological design serves or fit with the social structure, water management practices and culture of water management. Therefore Van Halsema (2002) mentions that the irrigation management is a 'complex sociotechnical process'**.**

2.3.2 IDE Approach to Technology Promotion

The IDE approach to technology promotion was established in 1981 by a Canadian psychiatrist, Dr. Paul Polack (He is also a chairperson of IDE International). The approach aimed to reduce poverty of smallholder farmers with a concept of 'right technology for a right farmer'. Hence, he believed that poverty could be reduced by technology interventions. With this in mind, IDE claims the water technologies are designed and marketed as per the need of consumer which includes; product has to be low cost, simple, easily maintainable, durable, user friendly, low in maintenance cost and affordable. Further, it should be easily operated and maintained by both male and female member of the smallholder farmers (refer annex 4 for detail).

IDE takes a PRISM (Poverty Reduction through Irrigation and Smallholder Market) value chain approach as its guiding principle and it seems that IDE has managed to adapt its mission and vision in consent with the approach(IDE website). PRISM value chain approach is inspired by principles: focus on small farmers, market services to the poor, improve water control and sustainable resources management (IDE website).This way, research and promotion of low cost water technologies and marketing them through the chain of researcher- manufacturer –assemblers- local dealers – farmers is the key of the value chain approach. The approach also concentrates on the development of value chains for high-value marketable agricultural products utilizing these technologies (refer detail in annex-7). Linking low-income and small plot farmers to markets to enable them to increase income through some low cost and adaptive technology forms the basis of the PRISM value chain approach.

2.3.3 IDE Approach and Sociotechnical Approach: Putting Together

A strong direct relation is perceived by IDE between technologies, income from agricultural productivity and poverty; because the majority of the poor live in rural areas making their living from agriculture. IDE/N considers and introduces the concept of "critical role of small-plot irrigation[6]" in its projects, acknowledging 'small-plot' irrigation play an important role in increasing agricultural productivity.

I understand that the 'sociotechnical' concept is an 'academic concept' to understand and analyze irrigation technology and its use. The PRISM approach is an 'intervention concept' to improve irrigation technology and agricultural practice. Hence, in a way the concepts can't be compared simply, because the concepts serve different goals. However, I study the PRISM approach from a sociotechnical perspective, to understand the real and potential benefits of such interventions. The key principle of the PRISM approach puts a lot of emphasis on the multiple benefits of rural poor with socially accepted technology to produce social welfare as central driving force of its projects. Similar to socio-technical approach, PRISM approach integrates both hardware (production technologies) and software (resource management practices) in such a way that both must be designed to suit the characteristics and resource availability of smallholders.

In sum, in this research, control over water for irrigation is an essential input in making a successful transition to HVC production. Control over water – a central concept in the sociotechnical approach – provides a conceptual foundation for this study.

[6] IDE defines small-plot irrigation as self-contained irrigation technologies for use on small plots of land, by small groups of people and without the need for collective infrastructures.

3. RESEARCH METHODOLOGY

The chapter introduces my study area and disuses why I choose certain methods or tools to obtain datas and how I operationalize them for my research. At the end, I give a reflection on my learning experiences.

3.1 Methodology

The methodology for investigation and the procedure of analytical interpretation is a case study of Phulbari MUS. Walliman (2006) highlights the effectiveness and particularity of case study method in small samples, on-site research and preference of qualitative analytical methods. Likewise, Long (1989) points out that the chief advantages of case study are that it provides the opportunity to highlight, and analyze the processes by which social actors actually 'manage their everyday world'. The relevant field parameters (of Phulbari MUS) is discussed in the following.

3.2 Study Area

The section includes the introduction of study area with reference to its geographical and socio-economic characteristics.

3.2.1 Location, Demographics and Climate

Syangja district is situated in mid-hills of Western Development Region of Gandaki Zone of Nepal, extending in an area of 1164 km sq. The district headquarter is about 29.6 km from Pokhara, a famous tourist area of Nepal. Syangja is surrounded by Kaski, Tanahu, Palpa, Parbat and Gulmi districts. Different ethnicities of people live in this district. The major groups consist of Brahman, Chhetri, Thakuri (high castes people with a Parbatiya background), Gurung, Magar, Newars ('ethnic' groups of Nepal with a Tibeto-Burmese background) and others. Brahmins are the dominant group across the district. According to CBS (2001), the population of the district is 3, 17,320. Agriculture is the main source of income in the district. Cereal crops like paddy, wheat, maize, millet, barley, cash crops like potato, oil seed and other crops like lentil, chickpea, black gram are grown in the district. Among these crops and fruits, the orange of Syangja is famous all over the country. Main source of water in the region comes from springs and small rain fed streams.

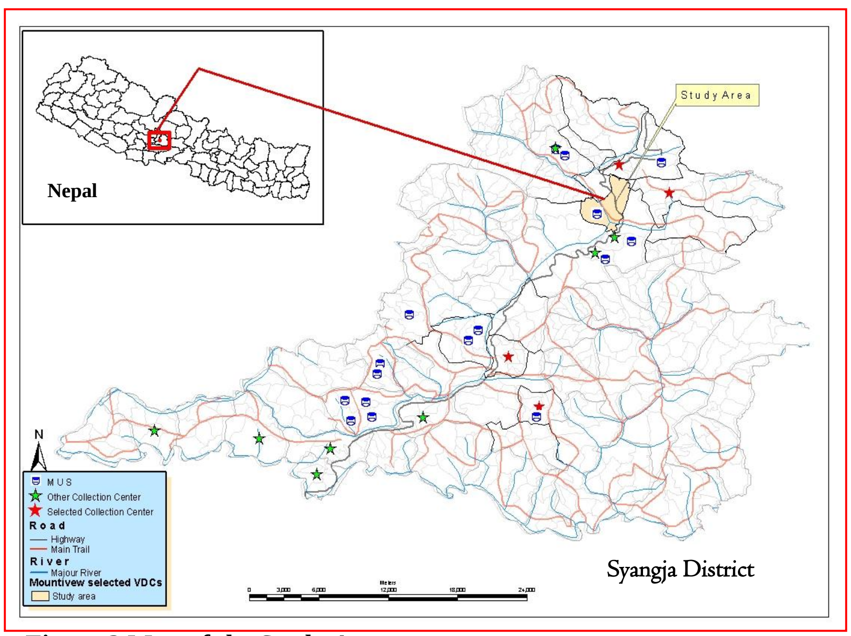

Figure 2 Map of the Study Area

These sources have seasonally high discharge variability and may have less water in the dry season. Water availability differs across the region and even within the district. Generally, plenty of water is available from June to October, during the monsoon. The period of most severe water scarcity starts from February to May. Kaligandaki, Andhi, Jeidy, Darau, Seti khola, Lubhdi are the main rivers flowing through Syangja. The general trend in the district is that water scarcity is observed for vegetable cultivation in winter and spring seasons. The region falls on the regime of sub-tropical monsoon climate ranging 9.5˚C (Min) to 28˚C (Max) and annual rainfall of the district is 2665 mm (CBS, 1996). In general, temperature during both summer and winter months decreases from South towards North. Figure 2 shows the location of Phulbari.

3.2.2 Socio-economic Characteristics of Households

The people in Phulbari community have settled for many generations ago and even the elderly in the village do not know where they came from and when. The Phulbari village has 16 households with a total population of 74, making the average family size 4.6. All the families in the village belong to *Dalit* caste ‘Sunar’ expect two households of Thapa (Chhetries: upper caste). In the village, four households have been found working in the village as a semi-skilled labor (mason and carpenter), one was in a Gulf country to undertake unskilled labor and one had wholesale shop nearby the village. The rest of the households were fully dependent on agriculture and unskilled labor.

The average farm size of all households was about 28 *Ropani* (0.7 ha), the vast majority of them cultivating plots less than 2 *ropani* in size. Of this land, 40% is *Bari*[7] and remaining 60% is *Khet*[8]. The *Khet* supports them about 3 months for food survival. The villagers had buffaloes, cows, and goats with an average of five animals per household. Livestock provide them with meat, milk, and small income. The sale of livestocks was not a significant source of income for them. The present average daily income[9] of the farmers was estimated 2.5 dollar per day (which they had to share among household members) slightly just above the international poverty line of $2 per day (World Bank, 2003).The educational characteristics of the people showed that about one third (30%) of the residents were illiterate, about 46% were up to primary level , 19% up to secondary school level, and a small percentage (5 %) were above high school level.

3.3 Data Collection

Before moving to field work, a series of meetings were held with Er. Sharma, EPD of IDE/N to decide upon the site and objectives of the research (refer 3.4 for detail).The study started with the collection of both primary (interview data) and secondary data (different MUS reports, the crop calendars, district profiles and other relevant secondary sources of information). In this study, a variety of techniques of data collection has been applied. The qualitative techniques included semi-structured and structured interviews. Quantitative data included the primary information gathered on production. Two separate questionnaires were designed: first was used in-depth survey of respondents and the second for interviewing IDE staffs. Face to face interviews with all the 16 households of Phulbari were carried out for in-depth survey of the households.

[7] Bari - Upland (usually rain fed land near by the houses, but can used drip and sprinkler system when water available)
[8] Khet - Lowland, rain fed upland rice fields
[9] Increased income after the intervention of MUS.

3.3.1 Data from Mid- hills

Next to the case study area, I interacted with few farmers (out of them, I present four cases in the report) in three MUS schemes in Kaski district and one scheme in Tanahu district. Since I was interested in understanding the various dynamics of MUS impact in the mid-hills, I was looking for a reliable method in order to show the impact of MUS in various field realities. As long as a research method cannot be an accurate, because different people define the same situation differently, use different knowledge to interpret it and apply different arguments. With this in mind, I selected the four farmers from the mid-hills. Under my set criteria, I selected those cases with the help of field staffs. I selected two MUS from Kaski- Patneri MUS and Kunathar MUS. Prior to MUS, the people of Patneri were compelled to use river water and water from a distance source prior to MUS. So, I felt important to draw the impact of MUS. As I met Moti Lal Subedi, a MUS user of the village, I captured his story. In another case of Kaski, I interviewed Maya B.K , a *dalit* women undertaking vegetable cultivation in absence of head of her family (i, e husband in Gulf country for undertaking unskilled labor work). I selected Sita B.K., *dalit* women from the Okhelkuna MUS of Tanahu. She represents pioneer newly introduced MUS in Tanahu (6 month old first MUS up to my field visit). I selected Kaka from Phulbari of Syangja. He belongs to a farmer of my case study area, and the most successful farmer in Phulbari. He was as well the president of WUG and recipient of best farmer award of IDE/N. So, I thought his perspectives would be appropriate to better understand various aspects of MUS in his village.

3.3.2 MUS Workshop

I attended a district level MUS workshop organized by Mont View program, Syangja. This provided me a good opportunity to interact with representative farmers (from all the MUS of Shyangja district), IDE field staffs and representatives of line agencies, which helped me to understand various issues of MUS that came from the series of discussions among the participants. This made me easier to verify my previous findings. Hence, this increased the reliability of my research. Annex 1 shows the features of various MUS implemented in Syangja.

All the interviews, discussions and other verbal interactions in the field were noted on paper, as I realized the record might be sensitive to generate desired information, especially with farmers and the staffs. In Syangja MUS workshop, voices of participants were audio-recorded and later transcribed. I spoke to more than 100 people- formally and informally. Annex-1 shows the list formally interviewed people. The data obtained with these methods discussed above were examined, analyzed, interpreted and evaluated to meet the research objectives. The overall methodology is illustrated in the figure 3.

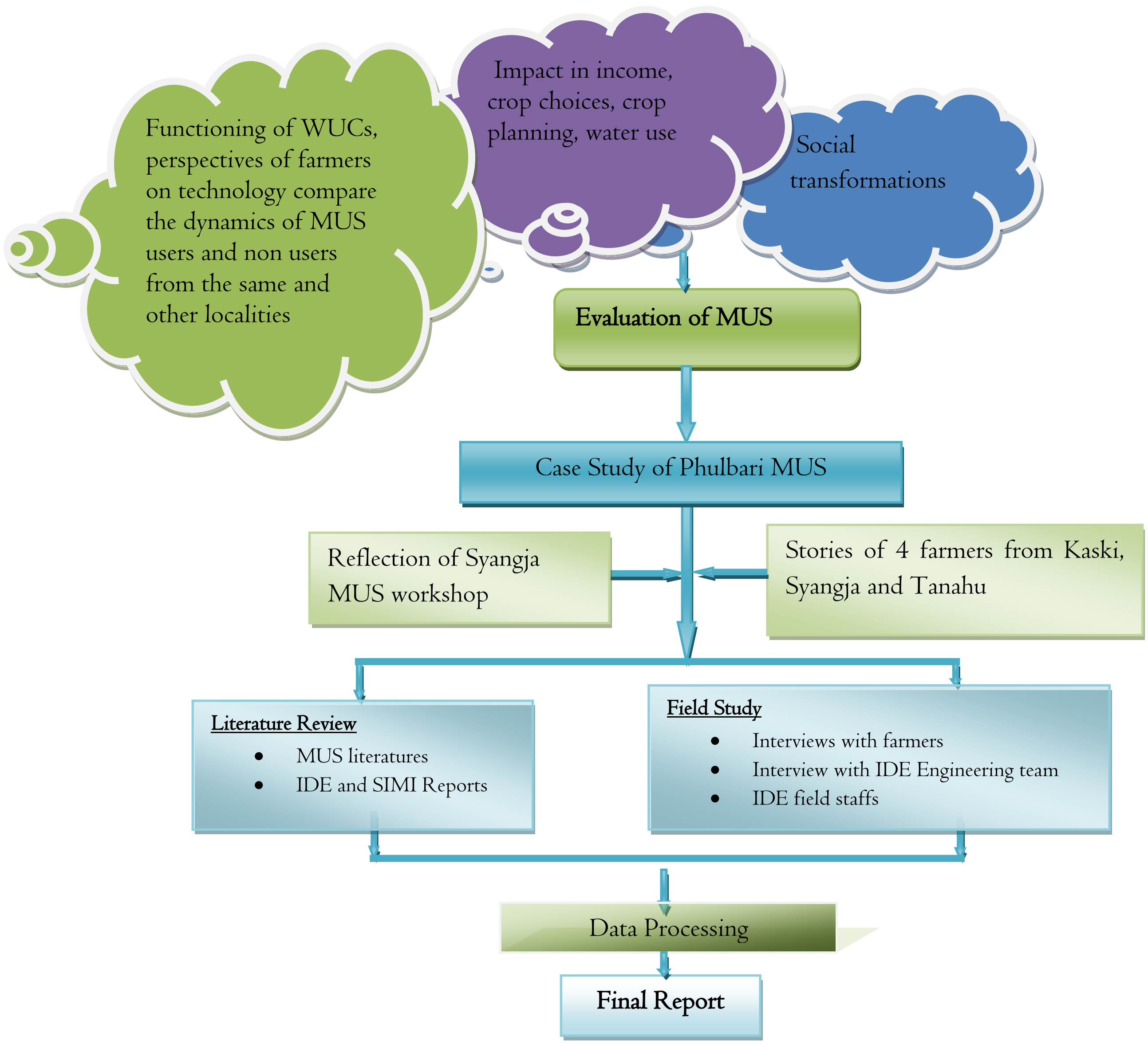

Figure 3 Overall Research Methodology

3.4 Redefining Research Focus

My draft research plan, as developed in Wageningen did not include the interest of IDE/N. I reviewed the proposal when I discussed with Er. Sharma. My research emphasis shifted slightly since it was not logical to compare those two situations- MUS site and Non-MUS site as originally planned. So, we decided to make a constant focus on Phulbari MUS to obtain data in terms of ***Prior to MUS implementation*** (in place of Non-MUS site)**'** and ***After the MUS implementation***, as both situation yield similar meaning when evaluating MUS. So, I finally combined the idea of my draft proposal, IDE/N TOR and ideas of EPD Shamra to arrive at a common aim of the research. All in all, I experienced that working with other is also a compromise, for which I made a compromise in the pre-formulated content of study (proposal) in Wageningen. This was the result that I was not working independently. All in all, I learnt that defining a problem from the desk is never accurate and while redefining it has been a learning to accept and integrate other's ideas emerged through discussion.

3.5 Lessons Learned in the Field

Initially, I had planned two field visits of each one week, but it extended to four weeks, as the interviews were longer than planned. Before moving to the field, I was thinking that interviewing would be an easy. Later I found that farmers understand the same question differently and interpret it in their own way. At the same time, putting them in a constant focus around the question was further challenging because they often had a tendency to explain their own issues. I also noticed the doubt of people who really did not like to respond the inquiries correctly or at all. I experienced that interviewing is really a tough job. After the significant questions had been formulated, I revisited the questions to make them more practical. Those are the reasons why I extended my field visit almost double than planned in order to have a good preparation to effectively deal with the farmers in the remaining interviews. Those lessons led me to conclude that interviewing is really a smart job.The quality of interviews did not go well during the first week. However, I was successful to generate useful informations as expected in the following weeks. Out of the four weeks, I spent two weeks in Syangja and Kaski and rest of the time in Syangja. At the final stage of my internship which was to produce a scientific research report, I realized that putting field work findings into paper was a challenge- especially in translation processes from the mind and then putting systematically and meaningfully. Last but never the least, I practically experienced that rural villages are the source of knowledge and ideas.

Box 2 Reflection Box

Generally, personal and academic interests would seem to be dominant in most of the research. Nevertheless, my case is slightly different. I had to satisfy three fold interests –academic (university), personal (my own) and organizational (IDE/N). As such, I had to prepare a scientific report by addressing these interests. Obviously, it was really challenging to address IDE' interests with the academic frame, in which IDE interests could have been dominant. It was also my responsibility to address their interests when I was also working for them. This led me to experience that it was a 'give and take process'. I learnt that some compromises (in research matter) had to be made because it was the situation where I was not working independently. Nevertheless, as an ex-employee of IDE/N, there would emerge an obvious question on the neutrality of my research. However, I think this is not a problem, as long as I was aware of it, and built my research on arguments, which others can verify and check. All in all, IDE/N has been a learning space that offered me a good opportunity to explore my acquired skills and recognize a power of working in an organizational environment as an independent researcher. I believe that IDE/N will access and apply the insights and recommendations that resulted from my research to its imminent related projects.

4. RESULT & DISCUSSION

Various results, in light of the research objectives are examined and discussed in this chapter. The chapter is divided into sub-chapters to grasp the in-depth content of study and for systematic presentation.

4.1 An Assessment of Water Resources in Phulbari

As a student of water resources management, obviously I was interested to know more about the water resources across the area. The rich water resources in the village really fascinated me. The people in the study area were really resourceful in terms of water resources, but the reality was that the multiple potentials of many sources have never been explored and never been the source of income in the past, because they were unaware about the ongoing development, and left behind by it. The main water resources in the area are as follows-

1. *Bhute Khola Mul*[10]
2. *Andhi Khola*[11]
3. *Bishmure Mul* (Thulo Mul/Chiso Paani)

Bhute Khola Mul is the nearest source (about 700 m) from Phulbari and the MUS system was developed from the same source. The average yield of the source was 0.35 ltr /sec. However, during the driest time of the year the delivery of the spring is reduced and the storage tank does not fill up completely. At these times there is only enough water to use the taps for few hours per day. To address problems of shortage in the dry season, water supply is regulated through a 'management system' developed by the local WUC (refer 4.3 for detail).

Both *Andhi Khola* (round walking distance of 45-50 minutes) and *Bishmure Mul* (round walking distance of 20-30 minutes) are situated down the village. People normally do not drink water from *Kholas* (Rivers). Pumping is required to transfer water from the Bishmure *Mul*, which is generally expensive. So, *Bhute Khola Mul* was considered by IDE/N technically and economically the best option for developing into MUS, even though water from *Bishmure Mul* was considered by local households, of good quality, as the water is cold and clean, because it is located in a community forest. The past generations used to drink water from this source, but at present the source is not used so frequently.

One of the respondents of the village reported that *Bhute Khola Mul* was becoming dryer and dirtier because of deforestation and new settlements above the village, which has been a relevant source of drinking water for years before (hence, not so 'safe' after all). Similarly, local people reported that water quantity in the *Andhi Khola* has reduced over the years. One of the local women told me that the water amount in the river has reduced, as the river bed could be seen exposed. She reasoned that it was not the case before, and argued that the bed would be full of water in the same season, but she did not have any reason for this.

[10] Mul means spring water
[11] Khola means River

4.2 Phulbari MUS: System Construction

In 2005 staffs of IDE/N were looking for a potential site in Syangja district to develop a MUS system as a part of SIMI program. In the mean time, SIMI staffs learned from their colleagues about the Phulbari village. Soon SIMI staffs (District Manager and Irrigation Technician) approached a local person, Mr. Gupta Bahadur Sunar (commonly known as 'Kaka'), and a discussion took place about water needs in the village. After the first meeting with Mr. Kaka, he was advised to organize a meeting with one representative from each household for a formal discussion. He was then put in contact with SIMI team. They had *bari* land near their houses which IDE/N considered suitable for vegetable cultivation, and the source was appraised feasible both socially and technically (refer annex 9 for MUS selection criteria). After a few days, a meeting was held between local people and the SIMI team, at which they elected seven committee executive members by voice vote, three of them were women (refer 4.3 for detail). This was done as part of project requirements of IDE/N. In the next meeting, SIMI explained their water situation to determine what type of system might work best for them and a verbal agreement was reached with the users to start MUS construction at the earliest possible time. Upon signing of the agreements, as stipulated by SIMI, a detailed engineering survey was carried out by SIMI technical supervisor to decide for the best design. After all the assessments, a double tank, two-line distribution system was built considering the moderate water source (refer annex 2 for detail). Moreover, such a system would provide domestic water needs and also enable the expansion of MIT use and save water collection time. At the same time, according to Water Resources Act, 2049, the allocated water should meet domestic water needs first (annex 3), and this was accommodated in the design. Acknowledging all these arguments, the system was designed in such a way that once the domestic storage tank is full, additional water is directed through an overflow pipe directly into the distribution system[12]. It also enabled the reuse of the existing old tank as an irrigation tank. None of the components of the old system were good enough to use for the system except the old existing tank after repairs.

Box 3 Smart Technology to Reduce Conflict?

Shortly after the system construction was finished, two thapas (local people who are residing at the bottom of the village) requested to provide them with water from the new system. SIMI proposed with the WUC to allow them to use the nearby multi use tap, as they were excluded because of their lack of interest in the system building . Finally, a compromise was made to share a tap. For this, they had to buy the water rights equivalent the cost of community contribution of their share. Besides this, implementation of the system have successfully avoided conflict in delivering water as the system ensured that water resources are shared equitably and fairly among and within communities in a sustainable manner for multiple needs. In the dry season, WUC rotate drinking water supply (5AM to 8 AM) and 4PM to 7AM). In order to save water for irrigation, the fixed time allocation of drinking water during the lean season has been established. The absence of disputes is due to the design of technology and working rules set well in practice (Detail in 5.3). While the ample water situation requires less concern for allocation rules and management effort to match distribution to the planned use, the underplaying principle of all MUS built by the IDE/Winrock team is that all households have equal access to water for both productive as well as domestic needs (Yoder *et.al* ,2008).

[12] 239 m long HDPE pipe carries water from the higher elevation spring source (intake) to MTJ of 1000 ltr and overflow is supplied to the FCL tank of 6000 ltr. The length of pipe line from the MTJ to tap stands is 165m and the length of pipe line from FCL tank to irrigation off takes is 261 m.

SIMI staff estimated the domestic and productive water demand for a 10 years projected population of 137 people, using 45 liters/capita/day for domestic purpose and 600 liters/household/day for irrigation (drip irrigation).Four ‘multi use taps’ and five ‘irrigation off – takes’, each serving the nearby households were built (refer figure 4 for detail). As the design was done in consultation with the households, there were no conflicts about the number and the location of taps (refer box 2 for detail).

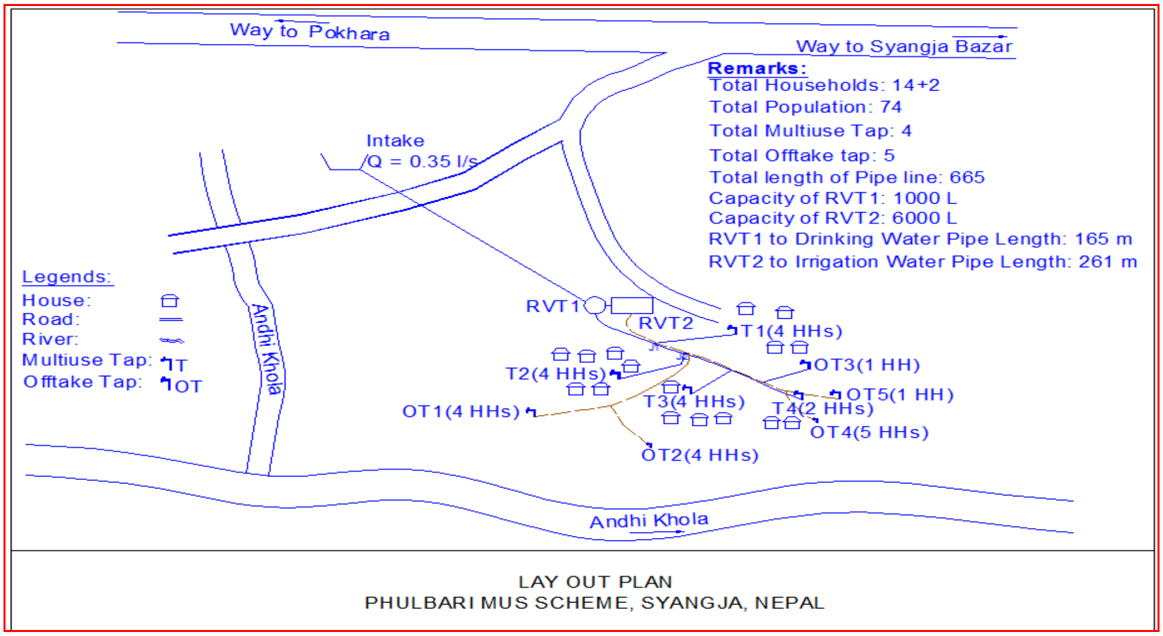

Figure 4 Layout Map of Phulbari MUS

For the system construction, SIMI provided support in the form of external materials and skilled labor[13] while participating households contributed unskilled labor and locally available materials. The system was completed with Rs. 91,890 (approx. €918) including community contribution, of which SIMI provided Rs. 30,000 (33%); other organizations such as District Soil Conservation Office and NGOs contributed with Rs. 31,931.32 (35%) and the community contribution reached the sum of Rs. 29,959 (32%).So, the per capita cost for the system is Rs. 5743 (Aprox €57.43: including community contribution of unskilled labor and locally available materials).

All households contributed throughout the construction period. Both men and women actively participated; men were involved in decision making, arrangement of external materials from Syangja district and organizing labor and women provided the labor in local resources mobilization. Each household provided labor for collection of sand, aggregates and stones from Andhi Khola. IDE/N believes that local contribution in terms of the unskilled labor and local material is necessary to establish the ownership of the project to the community, ensuring the sustainability of the project. In the development sector of Nepal, it is widely accepted that the community contribution (interms of local materials and unskilled labor) assists for the sustainability of the project and the utilization of local resources. The results revealed that process of system construction was interactive and participatory. Hence, the system avoided any conflicts concerning to the allocation and distribution of water.

[13] SIMI trained mistries provided skilled labor.

4.3 System Management through WUC

In Phulbari, a construction committee was formed (from a formal discussion, and on the consensuses of the all the 16 HHs) when the scheme was appraised feasible. All the beneficiaries of all the households were represented as members of the WUC, of which an executive[14] committee of 7 members was formed (with 33% women). The construction committee was created for various tasks that included site selection, selection of pipe route, and selection of sites for constructing multi-use tap stands, off takes, tanks and procurement of materials etc (as discussed in 4.2). Upon the completion of the system, the construction committee transformed into the Phulbari WUC, maintaining the same structure and committee composition in the form of executive committee. With the WUC in place, the system was handed over to the community. Formally, WUCs took over the system in presence of all beneficiates.

In general the executive WUCs are responsible for –

- Operation and maintenance
- Setting allocations rules
- Conflict resolution
- Receive assistance from agencies such as DoI, DoA, VDC and local NGOs for its MUS system.

Early in the process of working with communities, it is necessary to identify and address potential disputes over the use of water sources (according to the MUS intervention criteria of IDE/N). The registration of water source is responsibility of the WUC, but this was not the case in Phulbari because the system was developed from the existing source which they have been using for many years. So, SIMI team felt registration was not necessary.MUS section criteria of IDE/N mentioned that water sources should not be free from water right problem (refer annex 9). In most of the schemes - a provision of collecting Rs. 10 from every household has been established for the maintenance of the system. Concerning to the collection of operation and maintenance (O&M) fund in Phulbari MUS, a written report was prepared and signed by the WUCs executive agreeing to the following-

- Collect Rs.10/month.
- Extra Rs. 2 will be charged for the delay of 1 week.
- For the delay of 1 month, extra Rs. 15 will be added.
- An additional charge of Rs.25 for more 1 week late
- Final warning

If the WUC fails to collect the money even after the final warning, water supply system will then be cut off. In Phulbari, they have established a system of regulating the water supply (5AM to 8 AM and 4PM to 7AM) for drinking water which is voluntarily done by the president of WUA (Kaka), especially in dry season when the system receives less water. But, no rule exists for the irrigation. With the sufficient water availability in the monsoon, all get full supply without any regulation. Members of WUC claimed that they have been following set rules as such. The result shows that this technological design fits with the water management practices.

[14] Representatives of all user households are included in WUC whereas executive committeeWUC is formed in smaller size from the selected households.

Mr. Kaka told me (who is also the president of WUC) that Phulbari WUA normally discussed MUS issues once in a month. But it was not found as such. MTJ had received some cracks few months before, and it started leaking. Asking Mr. Kaka, about the meeting minutes regarding the MTJ problem and its repair plan, he told that they have not discussed the issue yet. Rather, they discussed the problem with IDE project staffs. This shows that the functioning of WUC was very weak and informal. It also seemed that they rush to the project office when problems encountered. The establishment of WUC was aimed to settle such problems.

Training to the local for the operation and maintenance of the scheme is considered an important component of MUS intervention by IDE/N. In general, the maintenance training at present has been provided to men. I learnt from the SIMI staffs that projects lacks shortage of such skilled labor across the region. With the certificate of training provided by IDE/N, it has been easier for men to go to Gulf countries. Hence, once technically trained users opt for better opportunities, and leave the village. Given this reality, it may be more useful to provide trainings to female members of the household, because they tend to stay in the village, so they could do the necessary work while the maintenance technician is away from the village. To this end, it can be concluded that users follow most of the rules set for the system management, but they did not have regular meetings to discuss problems and solve them then and there. Eventually, they rushed to project office when the system breakdown. This clearly showed the weak functioning of WUC.

4.4 Post Project Dynamics

Prior to the MUS construction, farmers in Phulbari were primarily dependent on rainfall for their crops. Soon after the project completion and when farmers received agricultural trainings and with the purchase of MIT, all the households started growing vegetable both on season and off-season. None of the household grew vegetables for sale in commercial markets prior to the system. So, they had no income at all from the vegetables. The farmers used to grow millet and maize in their *bari* land that requires no irrigation or rain fed irritation would be sufficient. They used to grow very limited traditional leafy vegetables, potato, onion, chilli, and garlic in small patches for home consumption. More than 50% households even had to buy vegetables from the nearby markets and that cost about Rs. 300 in a month. Now nobody has to buy vegetables, but sometimes for a new taste they buy in small quantity. After the project, all the households have maintained MUS plot of less than one fourth of a *ropani* i.e 4 *ana* (0.0125 ha) close to their houses. Since MUS is designed to provide year round water supply, all users are growing vegetables in all three seasons (refer annex 6). A wide range of HVC such as tomato, cucumber, cabbage and cauliflower including the climber plants are the newly introduced crops in MUS plot which are mainly for market purposes. Farmers reported that crop yield increased from 30 to 60% as compared to crops grown prior to MUS. 100% of the participating households reported to have increased income (with no income before) from vegetable selling.

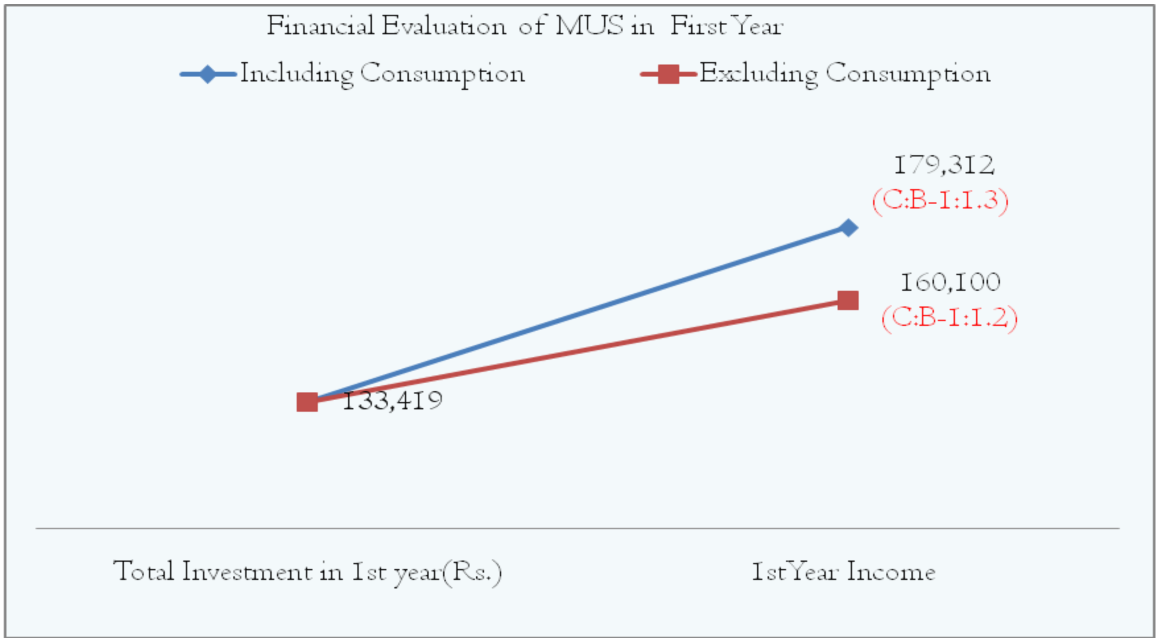

Figure 6 Total Income of Phulbari Households in 1st Year

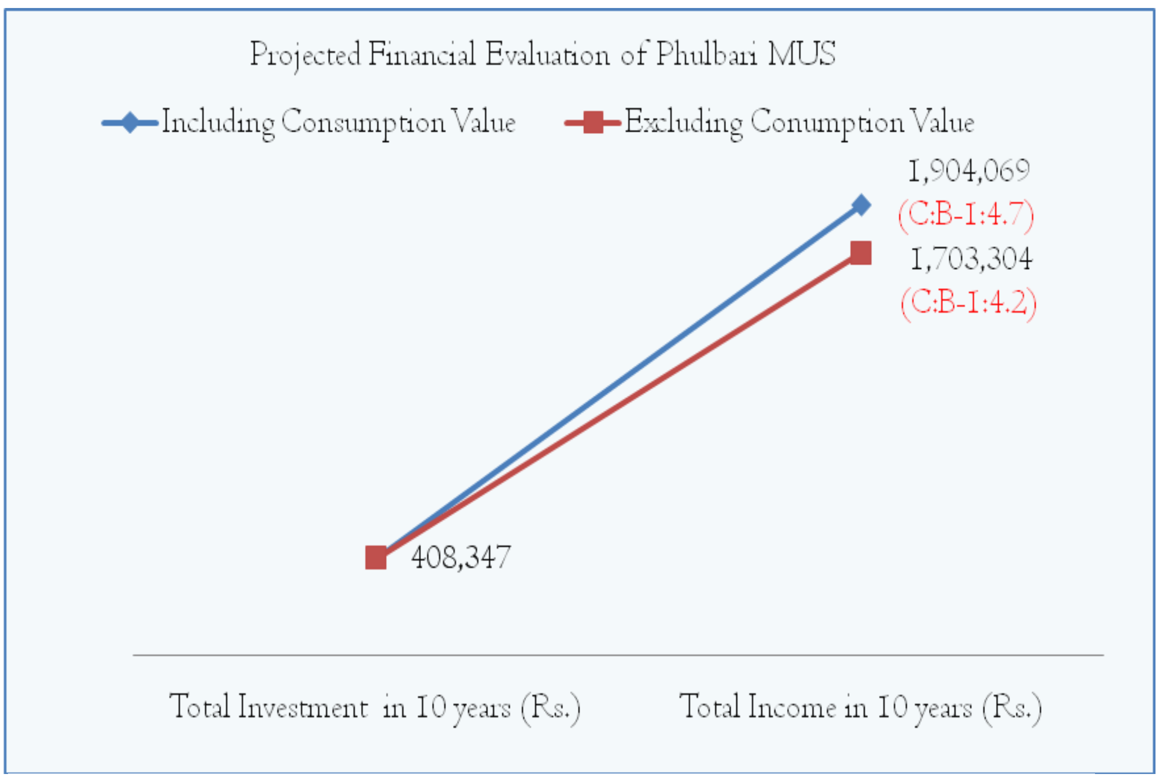

Figure 6 Projected Cost Benefit of Phulbari MUS

Taking into account the total investment (MUS, Drip and Inputs) attributed to each of the household,it is estimated that farmers not only got their investment returned in the MUS installed year, but also they enjoyed a minimum profit . The analysis demonstrated that farmers received the cost - benefit of 1:1.3 (including the consumption value) in the first year as shown in figure 5. According to IDE/N technical reports, MUS can last for 10 years with minor repairs in MTJ and FCL tanks. An assessment of potential benefits and associated costs showed that MUS is expected to produce an average benefit of 1: 4.7 over the projected life of MUS as shown in figure 6 (refer annex 5 for detail calculations).

The annual average gross income of per household increased from Rs. 56779 (approx. €568) to Rs. 68,214 (approx. €683) with an increase of annual cash income of Rs.11436 (€115) from HVC, which is 17% increase in annual income of per household in average. Still the major source of household income was from off- farm employment (83%) because they had very less land for expanding the cultivation area. Despite the very marginal land, it had already been a good initiation that two farmers started to lease farming. But it was not possible to get the land in lease for rest of the farmers (irrigable by MUS) because of lack of land across the village. Out of the 16 households who were growing vegetables, one of the farmers was heading towards a very good production (professional farming) with an annual average income of Rs. 40,000 (refer story 1). Three households hardly sell vegetables equal to Rs. 5000. Basically those households who had less than 2 *ana* of land and earning average Rs 5000/year, were less interested in cultivation telling that they had further no way of improving income from their limited land. Others had average income of about Rs.9, 000 (approx. €90). It is also important to consider the economic value of the vegetables consumed, which averaged Rs. 4000 (approx. €40) per household per year that led them to spend for other purposes. In a rough estimate, 15-20% of the vegetables grown are consumed. They did not have marketing problems, and their produce could easily be sold in Syangja Bazar.

Farmers reported that good quality product is sold and left over inferior quality is consumed. Now they even sell the small quantities of vegetables which they would not have done otherwise. MUS users have observed that their economic standards increased based on market-oriented vegetable production. With the increased income, they purchased more inputs, which further improved the yield and thereby leading to improved income. Most farmers have similar soil types and use fertilizer, pesticides, manure and compost as inputs for their crops. Roughly, 15 % of the total income was invested for agricultural inputs.

Story 1 My Social Image has been Improved: Kaka, Model Farmer, Syangja

Mr. Kaka, a 45 years old farmer of Phulbari has been a model farmer (IDE staffs in Syangja believe so) in his village. He is a mason and supported his family with this income. Prior to MUS, he was completely unknown about HVC and he used to grow the millets and maize. In the MUS installed year, he earned cash income of Rs. 25,000 (approx. € 250) by selling tomato and cucumber from his limited plot of 3 ana and he was pleased with the result. Since then, he has been involved in HVC. After one season of vegetable production, he has had minor success and gain confidence in vegetable production. He has expended irrigated area from 3 ana to 1 ropani by renting a land. He tells, "*It's my good luck that I got the land in rent, because everybody in the cluster has very limited land*". Even it was left barren prior to MUS, I have understood the value of the small plots now."In an average he is earning Rs. 40,000 (approx. € 400).

Access to water alone was not the reason why Mr. Kaka engaged in HVC production, the techniques he learnt has been a source of motivation. He expresses his pleasure that everybody knows him around and even the people from government and other agencies. In 2007, he received the best farmer award from SIMI representing Syangja district. Others villages are also closely observing his progress and seem impressed with him. When I met a people at Ganeshpur village close to Phulbari, he took Kaka's name as one of the laborious and successful farmer. Kaka tells confidently, "*I gained popularity even if I am not a leader and my image has been improved*". He further added that selling vegetables is a subject of social pride. As we were walking around the village, he pointed out the nearby plots left open, "*We just harvested tomato, and all of the plots will be full of beans after two weeks*". Now his dream is to have some bank balance. I found him worried about the leaking of FCL tank. He wanted the tank repaired, but looks like he was looking for financial support from IDE project in Syangja. In this connection, I oriented my question: don't you have R& M fund with your group to get the tank repaired? He replied that they wanted some support from the project and spent some amount of their own fund.

Now he is allocating his time for vegetable cultivation and assisting his family to construct plastic houses, filling drip tank and other support if necessary. Most of the vegetable production works are undertaken by his wife. Prior to MUS, his wife used to undertake unskilled labor work. He mentioned that SIMI staffs provided various kinds of agriculture trainings namely: nursery raising, drip installation, transplantation, plant protection etc, has helped him a lot to achieve this success. He is impressed with the women in his cluster who can speak with people from outside without any hesitation. He says, "*For the dalits like us, especially the women, it was one of the most difficult tasks*" This became possible because they were involved in most of the activities of MUS, he reasoned. Lots of people like you frequently come to their village to ask questions about the MUS, he told. All in all, increasing agricultural productivity in the available land is his utmost priority. I would not have come this far without MUS, Kaka told.

4.4.1 Crop Choices and Crop Planning

Water availability is one of the major factor influencing crop choices. Mostly rain fed *Bari* where millet, maize and mustard were the dominant crops that required no artificial irrigation prior to MUS. This cropping pattern was due to the unavailability of irrigation facility. Because of availability of constant source of water, farmers (now) choose range of crops like tomato, cucumber chillies, radish, coriander, climber plants etc. Tomato and cucumber were the main crops of farmer' preference because of little risks associated with it, and had better market and the price did not fluctuate so much as compared to other crops. The cropping pattern also included Colocasia and other climber plant. Coriander was found to be intercropped with HVC. Farmers projected their priorities for those crops which could easily be produced that gives more production from small area and had a better market demand. Among them, farmer's priority in crop choices is largely influenced by the market trend. For example, farmers follow the same crop if they receive better prices in preceding year. Finally they leave the crop next year if they were not happy with the price of previous year. This was widely practiced trend in the mid hills including Phulbari (Pant *et.al*, 2005).

After MUS, majority of MUS users have changed seed varieties from local to hybrid. When SIMI linked farmers with local traders (SIMI linked the MUS users to the local traders as a part of the MUS project), the farmers could purchase improved seeds from the nearby market. Farmers started growing seedlings in a common plot, and they shared it at the time of transplantation. Farmer's attitude towards this crop planning process indicates that they were motivated towards group approaches rather than individual planning. This encouraged them to be more competitive and using their resources efficiently. This way, farmers started to use different approaches in crop planning like observation of market trends and market information from radio. These findings in (SIMI, 2004) suggested that the project has created awareness and its effect is clearly observed in the adoption of their learning in crop planning. About 45% farmers reported that they have received more production also from their *khet* land, as they used experience gained in MUS plot in their distance *khet* land.

After the intervention of MUS, farmers became 'technically aware' because of number of training (hybrid farming, marketing techniques, off-seasonal vegetable production etc.) they received from project. With this, majority of the farmers learned to grow hybrid seed varieties of tomato and cucumber including the climber plants with techniques of vegetable cultivation. They immediately consult the agriculture technician of the project or district agriculture office if disease appears in crops. In sum, they seemed aware of practices related to crop diseases, crop choices, crop planning and inter-cropping for increasing income.

4.4.2 Consumption – Health- Sanitation

Average frequency of fresh vegetable intake per week increased in all households of Phulbari. Prior to MUS, the average consumption of fresh vegetables in a week was about 2-3 kg, and this had to be purchased in most times of the year. This consumption figure increased to 7-8 kg per week after MUS. Nevertheless, 90% farmers in Phulbari reported that they did not see any changes in the health after the MUS. However, it is widely being reported that the consumption of fresh vegetables improves the health of families. Such increase in vegetable consumption is desirable from nutrition and food security point of view (Gurung, 2000). Since vegetable production has increased farmer' normal vegetable consumption, it has positive impact on their health in Patneri (refer story 2).

In Phulbari, only two households have constructed toilets after the MUS. About 64% respondents reported that they did not like to construct toilets because it would attract flies. Optimum use of toilet and its frequent flushing even in the constructed toilets were not seen. The availability of the drinking water near to the households has contributed to improve hygiene of the household members, as 98% respondents reported that they developed a timely cleaning habit, for instance washing hands and taking baths.

Story 2 MUS and Health are Synonymous in Our Cluster: Moti Lal Subedi, Kaski

Patneri has gone through a change in their health and sanitation after the MUS project initiated by Nepal SIMI in 2006.Prior to the project,diarrhea and vomiting were common around the year and most frequent in the rainy season. Consumption habit has changed after the project leading to improvement in dietary habits. Subedi tells, "*We have seasonal vegetables and consume up to 2-3 kg per day, before the project consumption of the fresh vegetables was very less and had to buy in most times of the year*." Moreover, availability of water at the home- yard has made enable the use of toilet and its frequent flushing with a bucket of water placed in each toilet. The trend has improved the hygiene and sanitation situation. Open defecation has been discouraged after the project. In an informal talk, he told that most of families were maintaining good sanitation and cleanliness the home yard and around. He reported that water use practice has been changed for cooking from about 2-3 gallon (1 gallon- 5 ltr) to 5-6 gallon after the project. Awareness in sanitation was the biggest achievement in the village , people started constructing toilet. According to Subedi, prior to the project it was even difficult to wash cloths, bath and keep the children clean, now most children can be seen cleanly maintained. Public health, as a whole, is in satisfactory level now.

According to him, besides health and hygiene improvement farmer's income has increased.Last year, he earned about Rs. 40,000 (approx. € 400) from vegetables after consumption (Bitterguard- 9,000, Tomato- 12,000 and Cucumber- 10,000 and Chillies, Squash, Sponge guard, Cauli, cabbage-9000) in a total input of Rs. 3600. Before the project, he used to grow 4-5 climber plants which was just sufficient for home consumption. Prior to MUS, millet and soybean were dominant crops. He has expanded irrigated area from 2 *ana* to 1 *ropani* and mostly covered with cucumber and tomato. Local traders come to on home yard to buy the vegetables and farmers do not have to bargain so much for a reasonable price. With the income from vegetable production, he made a new kitchen investing Rs. 20,000 (aprox. € 200). He memorized the difficulty of water prior to MUS that he was compelled to pay Rs. 170/day for the construction of house wall in his home because of labor required for transportation of water from Seti river. He further added that the scarcity of water was very high and the place was just like a desert.

Since the project implementation, farmers in his cluster are getting support from local NGOs and DADO in hybrid seed and organic farming, as the agencies knew their village because of MUS. According to Subedi, he is saving one hour of time per day with the application of drip (he also applies fertilizer with drip) and utilizes the time in other activities like working in field, meetings and socialization. He has received several trainings offered by different organizations such as tomato grafting nursery raising , pesticide application ,marketing and seed raising etc. With the knowledge, he was not only applying in his MUS plot, but also coached to his neighbours. He says, even I am 60 years old , the kitchen garden has been my friend where I move around and take care of vegetables. "It has been a new life for me", he added. Finally, he expressed his feeling that, " *all the difficulties faced with water scarcity remain a memory of past.*"

4.4.3 Irrigated Area

All the households in Phulbari mentioned that the use of MUS resulted into increase in cultivated area. About 40% of land in the cluster was left barren after the harvest of maize and millet. Now the barren land has been covered with HVC - mostly with tomato and cucumber. Additionally, two farmers have started lease farming. One has rented a piece of land from a neighbour of upper Phulbari, for which she has to share the crops produced from the land. Another lease farmer who rented a land increased his irrigated area from 4 *ana* to 1 *ropani*. For the rest of the household, they have utilized the available land. According to 79% of the farmers, their willingness to produce more vegetable has not been materialized because of lack of land across the cluster. However, a secured year round supply of water enabled them utilizing the 100% of their available land with HVC (refer story 3).

Story 3 My Hope Increased When I Got My Land Irrigated: Sunita B.K., Tanahu

Sunita B.K, 34 years old farmer of Dulegaunda-2, Tanahu district has a great hope after the MUS project in her village.The Okhelkuna MUS was completed with a total investment of Rs. 88, 754 (approx. €888) at the beginning of 2009 (completed just last 6 month before when I was there for the research). From the system, 16 *dalit* hosueholds have been benefiting. Prior to MUS, she had to fetch water from a distance of 30 minutes to walk for a round trip. She is utilizing the saved time for weeding, picking up extra leafs etc. According to her, it was easier to feed water to her livestock. The use of water from irrigation has dramatically changed from 15-20 liters per day to 400-500 ltr per day. From the access of water close to home yard, timely bathing and washing clothes has improved.

As IDE suggested local people should involve in HVC production, she has started doing the same in her nearby plot. As such, she had harvested one cycle of monsoon vegetables including cucumber, and tomato was ongoing at the time of research. Pointing to the tomatos in her plot, she told that she was expecting to earn Rs. 20,000 (approx. €200) from the tomato, last year at the same time she had earned just Rs. 5,000 (approx. €50) by selling tomato (no access of water last year). She is planning to increase the number of plants. In addition to cucumber and tomato, she prefers growing cauliflower, garlic, radish, bitter guard, sponge guard and potato. This year, she had a bad harvest of cucumber due to diseases. However, she has not lost her hope. She suspects the quality of soil was deteriorated. Despite the bad harvest, she sold cucumber of Rs.7, 000 (approx. € 70) planted in an area of 40 sq.m (tunnel of 8m x 5 m), for which she invested the input (seeds and fertilizer) of Rs. 5, 00- 7, 00 (€ 5 -7). She worked herself in assistance of her family members. This way, money for labor is saved. Prior to MUS, she was earning about Rs. 10,000-12,000 (approx. € 100 -120) in a year. After the MUS, she was expecting to earn at the range of Rs.40000-50000 (approx. € 400 – 500). She has also increased the number of climber plants such as Sponge guard from 3 plants to 10 plants and Squash from 1 plant to 5 plants. In the same period last year, she used to work in others, but this year she has no time for this, she told.

When she did not have irrigation facilitates, she used to apply more fertilizer. After receiving training from IDE/N, she applies right amount of fertilizer in right time. She is planning to put income of vegetable back into the agriculture. She is willing to cultivate vegetables for the whole 1 *ropani* of her Bari with plastic houses. She told that if she makes a plastic house, her income would further increase because tomato will be protected from monsoon rain. She will then invest increased income for sending her children in a private English school at Dulegaunda.At the end of the interview, she told, "*I leave no stone unturned to effectively utilize the water and grow crops in all the three seasons*". Lastly, Ms. BK tells '*I then can stand on my own feet and do not have to extend my hands for support with others*"

4.4.4 Water Use and Time Saving

Water access previous to MUS implementation was not reliable and did not include the design for irrigation. Prior to MUS, all households used to share a single tap. With the implementation of the MUS, water has been supplied with 4 'multi use taps' and 5 'irrigation taps' near to their homestead. The use of MUS has demonstrated increase in water use by 50% (aprox.) for household use and 95 % for irrigation. Similarly, water use within the households has increased tremendously because of increase in water consumption in activities like cattle, washing and cleaning, vegetable production. About 35% reported that water availability for livestock has increased. As informed by the farmers and the staffs, approx. 350-400 lt. per day of water have been used by the farmers to meet their water requirements. Eventually, the water availability has increased for most of the activities and even in lean season (march-june) after MUS. In dry season when water was not sufficient, farmers were compelled to bring water from the sources at distance. Women reported that they did not compromise in using drinking water like before, as it was so near that their husband and children bring water when she remains busy in cooking. They did not store water in utensils as before. Other activities like dish washing, bathing adult and children, and vegetable cleaning have also increased. Before MUS, only 60% of households were washing clothes within the household and after project this figure reached to 100%.

Clearly, water use activity inside or outside household is affected by the availability of water close to the household. Prior to MUS, they normally had to spend 5-10 minutes walking and sometimes even up to 30 minutes when they used to go to the *Bishmure* or *Chisapani Mul*. Sometimes they used to go *Andhi Khola* for washing clothes. One of the major changes in the community is the time saved in water fetching. Time saving is one of the important contributions of the drinking water system under MUS. In average, time saved was about 10 minutes for round trip fetching of water by households. The time saved is depended upon the size of family and the distance to the old tap. If a household made three trips a day, it was estimated for a year it is 22.8 working days[15], which is direct benefit for users. Extra time saved have been used for rest and regular household activities, taking good care of their children, socializing , taking rest, caring for livestock, attending training and group meetings and cleaning the courtyard (58 % households). Rest 42% households reported that the saved time has been used for growing vegetables, for which they require 30-45 minutes each day in the farm.

[15] 8 working hours

4.4.5 Social Transformation

In Phulbari, there has been a considerable change in household's activities after the intervention of MUS. It is evident that rural women are one of the disadvantaged groups in communities to benefit from new technology. Eventually, when the use of technology started generating income, income was often controlled by men, whether it is from new enterprises or from a newly introduced profitable crop (Pant *et.al*, 2005). Similarly, women were often absent in decision making (system construction, crop planning etc.) due to their busy time in household activities, child caring, livestock etc. After the project, women were basically responsible for vegetable production and marketing. As such, the income first goes to women's hand. This has increased the women's role in decision making. However, final decisions for utilizing the money were made based on the consensus of both. Generally, male farmers were more actively engaged in making plastic houses, structures and filling drip tanks after MUS. In many cases, storage, handling, stocking, marketing and processing were the full responsibility of man; which have been a mixed responsibility now, whenever who is free performed it. 79% respondents in the village reported that men have started cooperating with women to perform household tasks particularly in fetching water and managing livestock. This established and gave a space for women, which had never been the case before.

In Phulbari, women from the village went together to sell their produce. They also worked in group for undertaking a varity of works in relation to MUS and production - formally in WUC and Phulbari Krisak Samaha (Phulbari Farmer Group).With this practice, social harmony and communal feeling has been improved. When asked about the use of income generated from vegetable selling, 45% spent for education and 55% spent for food and clothes. Because they were marginal landholders, extra income has been predominately used for food by majority of users.

Further, women in the village have built up their confidence to deal with people from outside of their village.Sita Sunar, an active women farmer of Phulbari told that, "I could not speak with people from outside, and even I hardly could say Namaste, but now I'm talking to you so easily. This kind of empowerment has been seen with other *dalit* women as well (refer story 4). The change was a clear indicator of empowerment.

Farmers had a tendency to borrow vegetables. Now they have developed a sense that they have to produce for themselves. Farmers usually used to offer vegetables to their neighbors when new crops were harvested. Also they often used to offer their produce to staffs at field visits. Now the farmers have been trained in such a way that they have to earn money.Getting better price has been heir major concern. Now staffs have to buy vegetables from farmers in a market rate. (*Dil Bahadur Basnet, marketing supervisor of rural prosperity initiative(RPI project) Kaski, shared with me that the farmer' tendency has been changed a lot: he experienced this as one of the major change in his seven years of working with the farmers in the region*). Those dynamics were similar to the other MUS cases of mid-hills. It can be concluded that those social transformations (discussed throughout the section) are the social assets of the community. In the mid hills, the result of Eco-Tech Consult (2004) showed that there has been improved in habit of people who normally play caramboard and cards and they utilize the time for helping in household work after MUS intervention. Sharma (2009) reported that there has been slight decrease in the number of wage earning women (by working in others and undertaking unskilled labor) and those involved in marketing of vegetables after the project.

Story 4 Now I have Something to Say to My Husband: Maya B.K ,Kaski

Maya B.K. is one of the poorest farmers across Kunathar , and holds 3 ropani of land including *Khet* and *Bari* (50-50%). She purchased the land from the income of her husband who works in Saudi Arab. She grows cereal crops in half of the land (1.5 ropani) that support for just 2-3 months food. On the rest, she grows HVC. Prior to MUS, millet and rice were the dominant crops in all 3 ropani land.Recalling her past days of working as an unskilled labor, she told that she was upset by the words hit to her while working in other's. She further added, "*When I realized this burden, I'm cultivating vegetables in all three seasons and getting better return from it after the MUS was launched in our village in 2007*." Before MUS, she used to grow very limited climber plants for consumption. Now, she is earning about Rs. 45,000-50,000 (€450-500) from wide varieties of HVC cultivated in an area of 1.5 ropani with an investment of Rs. 3000-3500. While undertaking unskilled labor work, she could hardly earn Rs. 3000 -3500 (€ 30- 35) per month.But, this year she could not get better income because of disease in cucumber. With the increased income, she spends Rs. 2500/month for the education of her children and she got her house plastered . She is confident that she will be able to make plastic tunnel by next year.

When I was interviewing her, her husband was also sitting aside me (he returned home just few weeks before from Saudi Arab). She openly expressed with a smile looking at her husband that it is not necessary for him to go to Arab again. Reacting to it, her husband told that he never knew such an amazing results produced by selling vegetables. She further adds, "*Situation has changed a lot. He helps me in fetching water and spends some time in taking care of the vegetable. Otherwise, he would have gone somewhere with his friends*." For her, too, the tendency of spending time in chatting with neighours was quite normal prior to MUS. At the mean time, she tells, "*We both have our own source of income and I do not have to live on his income, so now I have something to say to my husband too*".

I was really surprised when she told that something was out of my mind. Prior to MUS, if she had to communicate to somebody from out of the village, she could not do it face to face and used to put her head down. She reasoned that her confidence has been built because of her involvement in activities of MUS such as attend group meetings, interacting with project people and receiving training. Finally, she expressed her interest in vegetable production telling that, "*even if RPI project is discontinued, it already has taught me a lot, and I can continue myself* ."

4.5 MUS Users and Non –Users: A Comparison from Same Locality of Phulbari

Upper Phulbari is a non-MUS village. It is close to Phulbari: just above the village and has 12 households. The upper households all belong to Chhetri (Thapa) and financially strong as compared to the down communities and majority of them are employed in Government job. There were few reasons why they were deprived of MUS. On one hand, they never requested any agencies /any projects for irrigation facilities. On the other hand, while developing the MUS, IDE/N was basically interested in '*dalits*' and disadvantaged communities and the project did not have much interest in the upper cluster.

It is to be noted that the '*Sunar families*' of lower cluster always repeated that they did not have land for agriculture extension. At the same time, farmers in the upper clusters were not able to produce even having the suitable land. Apparently, in a MUS site the availability of water near the household may have contributed to increased water use in the household and more interest in HVC production. In upper Phulbari (non- MUS), farmers have limited access to water, and they had to carry water from the nearby sources for irrigation. But, this was not only the case that they might not seem interested in vegetable production. The upper Phulbari people had sufficient *Bari* land suitable for HVC. However, they grew traditional crops like millet, maize and the land remains uncultivated for half of the year. This is clearly a case of pre-MUS situation of lower Phulbari. As such, the availability of water influenced the production behavior. Eventually, it was found that they lack interest in vegetable production, as they have not realized multiple benefits of technology. Further, they had another source of income and took agriculture as profession of grief; I came to know shortly talking with few *Thapa* households.

In addition, two households of Phulbari MUS who were later included in MUS group never seemed interested in vegetable production. Few reasons can explain their disinterest; first they did not have provision for planned irrigation facility (They were just sharing multi use tap, but not irrigation off take) because they showed interested in drinking water facility. This way, they were not present from the beginning of the project and lack the idea of improved cultivation. As such, they were less interested in vegetable production.

4.6 Perspectives on Technology from Syangja, Kaski and Tanahu (Mid-hills)

In the sections below, I collected a few but significant suggestions from users and staffs of Syangja, Kaski and Tanahu districts how they have perceived MUS technology as a whole and its challenges and benefits.

Pant *et.al* (2005) showed that users did not foresee the income generation in the beginning of MUS interventions as they expected drinking water. They based their argument that a secure drinking water supply was the highest priority for water use at the household level. Contrary to it, irrigation was most wanted priority for majority of male farmers. In the farmers view, large volume of water is required for irrigating plants, which is almost impossible to transport from distance sources, but drinking water is not required in such a large volume which is easier for women to fetch.

While talking with farmers of varying localities of MUS, they have found these systems a good investment given their limited means and limited water supply. According to them, MUS functions quite-well and has created opportunities for them to improve their agricultural productivity and living standards. Acknowledging fully all the benefits, they also seemed very satisfied with their efforts and consequent success. This showed that MUS scheme has been able in meeting users' (both male and female) expectations. Most of the farmers were interested in viewing MUS from 'single use approach' vs. 'multi use approach'. Farmers also expressed that a reliable irrigation removes the risk of water stress which is essential to motivate farmer towards adopting improved farming and growth of HVC. In most of the schemes, shortly after SIMI began working with communities, other neighbouring communities showed interest in MUS. IDE staffs also received lot of demands for MUS construction from communities.

As reported by farmers, they have been using the technology without any major problems; expect few cases of cracking in MTJ. It is assumed that a MUS system would serve for a ten-year projected population, but majority of interviewed did not believe that the system will work so long. This raises questions about the sustainability of MUS systems. In few MUS systems, farmers complained about flooding: other farmer keep the taps left open for many hours. In this case, the proper functioning of WUA can be questioned. In light of the above discussion, it can be argued that the farmers had positive feedback on the technology and they were happy on using it. However, they doubt on its structural stability to work effectively for its whole design period (10 years).

4.6.1 Sustainability of Drip without MUS: Hidden Truth or Reality?

Generally in the mid-hills, IDE/N field staffs had the responsibility to meet given project target of drip numbers and other MIT and generate *match fund* for MUS construction from like minded organizations and line agencies. The districts team should be able to promote the allocated number of drip - is a part of many projects of IDE/N under its marketing strategy for improving access to water for HVC. It was easier to generate match funds for MUS construction from the supporting agencies such as DADO, VDCs and I/NGOs as compared to single drip program. In the same way, farmers purchased MIT without any hesitation when MUS was constructed in their village. But if there was no project for MUS, farmers usually sought subsidy to purchase drip. In this case, it was really a big challenge for field staff to meet the given project target of drip, because they had problem convincing the farmers. This shows that farmers were not comfortable in using drip unless MUS was implemented. According to IDE MUS selection criteria (refer annex 9 for basic criteria of MUS development), more than 75 % of the users should be willing to adopt MIT (drip or sprinkler system).I found that the farmers were willing to buy drip kits, because they liked the MUS system.

In Gairathock of Syangja (non-MUS MIT farmers) , majority of farmers had already dropped MIT because the system was too small for their plots because they had already switched their cultivation to a bigger scale. They reported that drip was mainly an entry point for them. But, IDE had the systems to suit their plots even up to 1 *ropani* and they are also informed about the system, nobody has purchased it.In light of both of the above discussions, it can be concluded that the sustainability of drip is questionable if used without MUS.

4.7 A Glance of MUS in Syangja: Challenges and Opportunities

As an Intern, IDE provided me an opportunity to participate in district level MUS workshop in Syangja (on Dec 18, 2009) organized by ASHA Program/Montview foundation. This provided me an opportunity to directly participate in discussions and talk to representative farmers of 18 MUS systems of Syangja.

Out of 18 MUS implemented in Syangja (refer annex 7), Malewabasne MUS showed the best impact on production. Maize and millet were the main crops usually to be grown by Malewabasne farmers (because of lack of water for irrigation) and those crops were replaced with the HVC (tomato, cucumber, cauli and cabbage) after the implementation of MUS leading to increase in annual income from Rs. 1,500-2,000 to 35,000 -150,000.The farmers expanded irrigated area from 1-2 *ana* to 1-2 *ropani*. Besides Malewabasne MUS, another three MUS have shown almost that level of impact. In rest of the majority MUS, farmers earned about Rs. 5,000-12,000 in the first year (MUS implemented year) cultivated in an average 1/2 *ropani* of land. As explained by the them (in the later case), the production did not improve beyond that, rather it went down because of their lack of interest in agriculture (and more interest in off-farm activities and foreign jobs). From the farmers' presentation, I understood that few of them were limited to produce for self consumption. It seemed that farmers of four MUS were heading towards the professional production and marketing. In those MUS, the management (functioning of WUC) was strong and the set rules and regulations were also functioning well. According to the representative of the Malewabasne MUS, people in their cluster were interested in agriculture because a significant amount of remittance has been coming in. However, farmers were more concerned with the lack of certainty or guarantee until crops were harvested, as they suffered from hailstone, climatic extremities (lack of timely rainfall, fertilizer and seeds).Farmers reported that it was easier to get loan (as compared to agriculture loan) if somebody wants to go foreign country for work.

Eventually, most of the participants pointed out that there have been lot of social transformations after the implementation of MUS; awareness in HVC production and marketing has raised, leadership has developed, social cohesion among members MUS user households has improved, inclusion of minorities, *dalits* and women has increased. Some participants mentioned that after the SIMI marketing interventions (such as marketing tranings and establishment of vegetable collection centres), farmers came to know that they were being paid less than market value from the vegetable traders. Pant *et.al* (2005) reported that the market in Syangja has been transformed to supplier dominated. This became possible because of a number of trainings delivered by SIMI. Majority of the participants mentioned that they were trained in hybrid seeds, seed raising, marketing, exposure visits and had opportunity to interact with a number of foreigner and local development workers.

About 50% of the representatives mentioned that the collection of R&M fund and meetings of WUC was not regular leading to weak management of the system. One of the farmers mentioned that they were hardly able to get together for a meeting just 1 week before after 18 months because of lack of coordination among the WUC members. This shows an informal and weak functioning of WUC. Three participants reported the leakage in FCL tank.

Participants from the two MUS mentioned that they were facing water scarcity in dry season enough to irrigate their plots, as the water sources were drying up.According to a participant, the existing water source was getting polluted by the increased settlements and deforestation around the source. This way, they do not like to put their health at risk and want a new source (near by the existing source) developed in support of IDE project in Syangja. In a set of questions passed out among the MUS representatives, I received responses from 100% that they all have increased income from HVC production and agricultural practices have been improved. 100% of them also mentioned that they purchased MIT when they were assured of MUS development, and about 60-70% reported that they were using drip effectively.

In sum, it can be concluded that functioning of WUC and the success from the MUS are strongly related. As such, the MUS clusters, where WUCs were functioning well farmers received better return from MUS and vice –versa. Few cases, such as farmers receiving good harvest in the first year and second year (of MUS implementation) have been limited in self consumption indicate that the farmers keep on losing their interest in MUS when there was a gap in contact between the communities and the project in the later years. Nevertheless, farmers have enjoyed multiple benefits as discussed.

Box 4 When Water, Production, Gender, Health and Sanitation Collide: My Impression

The discussions (including the stories) showed the multiple benefits of MUS that includes increase in extension of vegetable growing, financial profits, health and sanitation, build up of confidence of farmers. I'm really impressed with motives of Sunita BK (Story 3) when she told me that she would leave no stone unturned in discharging her duty to fully utilize the MUS. The scheme (used by her) was only recently introduced, it was too early to make full hope for recovery of the costs incurred and additional benefits. But, still she was quite hopeful. She was not only the single farmer motivated for HVC production, but also farmers from Kaski and Syangja showed similar interests. This has demonstrated that farmers were motivated to draw a full value from MUS. In Phulbari, prior to the intervention of MUS, women used to put their head down if they had to talk with somebody from out of their village. Now they can really speak up for themselves. Those motivations and transformations have been in fact the vital effects produced by the technology. By and large, the diverse results from the three districts of the mid-hills and the focused case of the Phulbari demonstrated that single MUS produced multiple benefits and the benefits largely overlap in different MUS.

5. CONCLUSION AND RECOMMENDATIONS

The study showed the evaluation of MUS in the mid-hills of Nepal with special reference to the particular socio-economic context of Phulbari MUS. This study confirmed that IDE/N developed MUS system in the mid-hills of Nepal are cost friendly and has provided a wide range of direct and indirect benefits to its users. Firstly, MUS has increased accessibility of water for irrigating small plots (and access to drinking water) from the scarce source of water enabling them to expand diversities of crop production and generate more income. Secondly, those benefits have led to poverty reduction through water-based livelihoods. As such, technology prepared the ground for social transformation such as change in intra household roles, increase women's role in decision making, strengthening local capacities, improve empowerment, promote social awareness and increase equity. Such impacts have produced as a result of reality of smallholders has been reflected in the technology design and users have accepted it. These technologies proved to be an effective and appropriate to the rural poor, normally returning investment costs within one growing season. Farmers also perceived the technology effective and appropriate. This study also revealed that farmers who have not enjoyed the multiple benefits of technology, they did not involve in improved cultivation practices. As such, technology became an entry point.

All in all , keeping the socio-technical approach and IDE approach to technology promotion as conceptual basis, I conclude that technology has proven aware of the need of rural poor and oppressed together with considering socio-economic setting of the place where dissemination of the technologies took place. Local capacities have emerged to let their skills detect and experience of benefits through the package of interventions - social mobilization, agricultural trainings and by means of farmer's friendly technology to let those impacts happen. Concluding, IDE approach to technology promotion has been quite successful in establishing a MUS technology as socio-technical innovation. It created multiple opportunities for smallholders meeting an ultimate purpose of introduction of MUS that aimed to enhance land and water productivity, improve rural livelihoods and promote gender equity. In sum, it can be concluded that one development opportunity has led to another and other multiple opportunities provided that the technology has been accepted by the farmers.

Nevertheless, sustainability of MUS is questionable, because its beneficiaries relied on IDE/N support and external assistance when there was a system breakdown.This shows that they were relying on the project. Further, the function of WUC was found weak.This is contrary to IDE/N belief, that formation of WUC to be an effective water user organization that had a full responsibility for operating it and regularly collecting fees from users.

1. Linked to the IDE expectations, IDE has aimed to increase the income of farmers more than 1 dollar per day through the development of MUS and promotion of MIT for vegetable production has not been met in particular socio-economic setting of Phulbari. Two important points can be drawn from the foregoing discussion. Firstly, although MUS initiated the impressive vegetable cultivation practices at Phulbari, it is evident that the communities with marginal land will not survive due to marginal benefit of 13% generated by MUS. Since they have very limited land and lack an opportunity for expansion of irrigated area, farmers are dependent on off-farm opportunities.

Arguably, these poor might require other opportunities for secured income generation. Secondly, despite those circumstances of limited land and socially and economically deprived community, MUS showed great promise for raising the land and water productivity, water efficiency, and incomes of poor smallholders in Phulbari. This way, MUS has provided them with an opportunity to understand the value of their small landholdings, more importantly a breakthrough in social transformation in such a socially and economically backward community.

2. The study of Phulbari and other stories of farmers from Kaski and Tanahu have demonstrated that the impact of MUS largely overlaps (economic benefits and the social transformations as indicated in the previous sections) in the region; expect the Phulbari users have limited income because of marginal land.WUC has lacked institutional processes and question of sustainability has emerged. For those systems where WUC has organized and worked on an institutional basis, farmers have drawn the full value from MUS and vice-versa. Since it has been well established that water management is not only technical issue; it is mostly caused by the lack of managment, institutional processes and lack of ownership. Although communities have taken over the projects, WUC needs strengthening in order to keep the organization healthy and smooth in operation for the sustainability of MUS. Arguably, the integration of different actors with different perception and getting them to agree on a common approach and implementing it in a coordinated way is a greater management challenge. With this in mind, the implementing agency or project should be able to supply enough ingenuity at the right place and time.

3. Although both women and men were found to be equally encouraged to participate in the decision making process right from the planning stage to implementation of the system, women have not been involved in the operation and maintenance (training) of the system. Dublin principle (as discussed in 1.5.1) has recognized women as a central player in the provision, management and safeguarding of water. Further, women are permanent residents in the village as compared to men, because men usually go to foreign countries to undertake unskilled labor work. In line to these reasoning, it can be recommended that women's' involvement in the O & M of the system would be an added advantage for ensuring the sustainability of the system.

4. Availability of water in the home- yard has naturally improved the hygiene and sanitation situation in case of Kaski. But, farmer's lack of interest in Phulbari for sanitation (toilet) showed that sanitation component should be attached with the MUS promotion, especially in '*dalit*' and '*oppressed*' communities like Phulbari.

5. The non- MUS farmers who were primarily using drips have dropped it using, even the cost involved in investing on drip systems were not expensive to them. Drip irrigation was found effective in areas where MUS have been introduced. Arguably, this might be because of easier access to water for drip. Access to water alone is not a single reason behind dropping of drip by farmers. Apparently, promotion of drip without MUS is questionable. So, it would be logical to have a detail study to explore the ways of developing sustainable market for drips.

6. As indicated by some of the participants in the Syangja MUS workshop, the small water resources are increasingly drying up in recent times. Definitely, this might be a big challenge in the coming days for ensuring the sustainable use of small water resources across the region. Water resources professionals doubt that the Government's unplanned development interventions might be one of the causes for this situation. As such, protection and management of these water resources has to be given priority and most importantly should be the common responsibility of the users and relevant actors and sectors.

7. IDE MUS interventions is inspired by PRISM value chain approach that includes the key elements - water control technology, social mobilization and output market development to create opportunities for small farmers to increase their income.Among these key entities, social mobilization seemed weak in MUS. Since social mobilization is the overall process of change to strengthen community participation and enable them for taking a full ownership of MUS to ensure its sustainability. Further, MUS is a management system (as explained in 4.3). In this case, WUCs are the lives of MUS system. As such, addressing its week functioning, strengthening of WUCs should have a priority. For the implemented MUS, social mobilization backstopping is required. Otherwise, there is imminent danger of ending up the true sense of management system as discussed in 5.3.In sum, for a greater degree of success especially for the sustainability of MUS, a regular monitoring and follow up programs might be vital until self –reliance in the community appears and greater attention is required while implementing new MUS.

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ANNEXES

Annex 2 List of People Interviewd

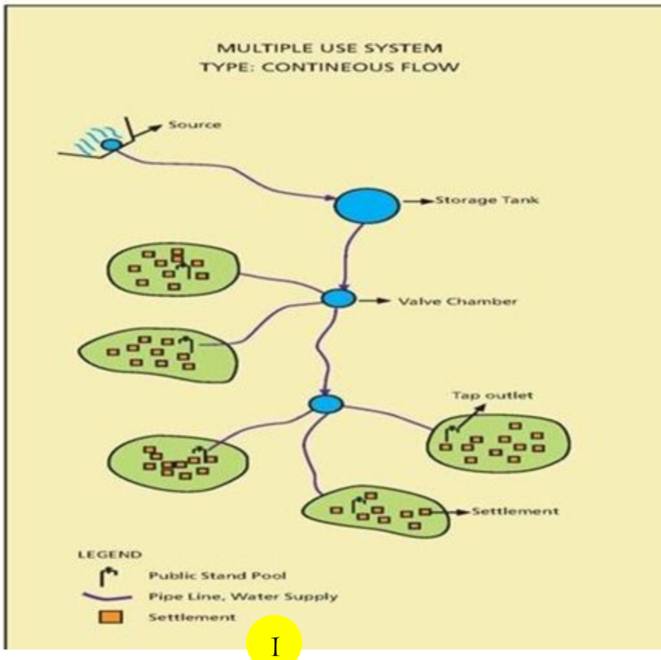
I.List of Farmers

S.N	Date	Name	Scheme Name	Location
1	31.08.2009	Som Bdr. Pulami	Okhelkuna MUS scheme	Dulegaunda -2 ,Tanahu
2	01.09.2009	Sunita B.K	Okhelkuna MUS scheme	Dulegaunda-2, Tanahu
3	04.09.2009	Sher Bahadur Gautam	Simle MUS (Simle) Scheme	Bhalum-7, Kunathar,Kaski
4	05.09.2009	Moti Lal Subedi	Odharae MUS scheme	Patnari, Kaski
5	04.09.2009	Maya B.K.	Kunathar (Simle) MUS scheme	Bhalum-1,Kunathar,Kaski
6	04.09.2009	Kalpana Basnet	Without MIT	Bhalaum-1, Majhtole,Kaski
7	08.09.2009	Focul group	Phulbari MUS	Putalibazar-6, shyangja
8	08.09.2009	Dilli Raj Koirala	Gairathock MIT	Gairathock,Syangja
9	17.10.2009	Padam Pani Regmi	Gairathock MIT	Gairathock,Syangja
10	17.10.2009	Khem Bdr.Koirala	Gairathock MIT	Gairathock,Syangja
11	17.10.2009	Sova Poudel	Gairathock MIT	Gairathock,Syangja
12	17.10.2009	Sumita Poudel	Gairathock MIT	Gairathock,Syangja
13	17.10.2009	Lilimber Koirala	Gairathock MIT	Gairathock,Syangja
14	17.10.2009	Gopi Chandra Regmi	Gairathock MIT	Gairathock,Syangja
15	14.10.2009	Gupta Bdr.Sunar "Kaka"	Phulbari MUS	Putalinazar-6,Shyangja
16	14.10.2009	Durga Sunar	Phulbari MUS	Putalinazar-6,Shyangja
17	14.10.2009	Basna Sunar	Phulbari MUS	Putalinazar-6,Shyangja
18	14.10.2009	Meena Sunar	Phulbari MUS	Putalinazar-6,Shyangja
19	15.10.2009	Manu Sunar	Phulbari MUS	Putalinazar-6,Shyangja
20	15.10.2009	Santa Sunar	Phulbari MUS	Putalinazar-6,Shyangja
21	15.102009	Dhansari Ka	Phulbari MUS	Putalinazar-6,Shyangja
22	16.10.2009	Dhansari Kha	Phulbari MUS	Putalinazar-6,Shyangja
23	16.10.2009	Sunna Sunar	Phulbari MUS	Putalinazar-6,Shyangja
24	16.10.2009	Mithu Sunar	Phulbari MUS	Putalinazar-6,Shyangja
25	18.12.2009	Ramesh Sunar	Phulbari MUS	Putalinazar-6,Shyangja
26	18.12.2009	Nanda Ram Nepali	MUS Workshop	Syangja
27	17.12.2009	Radha Krishna Aryal	Easy Drip Installation Trip	Syangja
28	18.12.2009	Tara pati Regmi	MUS Workshop,Shyangja	Syangja
29	18.12.2009	Tulusi Ram Regmi	MUS Workshop	Syangja
30	18.12.2009	Danda Pani	MUS Workshop	Syangja
31	18.12.2009	Hom Nath Lamsal	MUS Workshop	Syangja
32	18.12.2009	Rajehndra Bdr.	MUS Workshop	Syangja

2. List of Staffs

S.N	Date	Staff Name	Project	Position	Station
1	23.07.2009	Kailash Shamra	RPI/SIMI	Director of Engineering	Central offoice
2	24.07.2009	Binod Dhakal	RPI	Technical Supervisor	Lalitpur District
3	01.09.2009	Dil Bdr. Khatri	RPI	Marketing Supervisor	Pokhara
4	01.09.2009	Phalman Gurung	RPI	Program Officer	Pokhara
5	02.09.2009	Lalan Shah	Asha Program	Technical supervisor	Shyangja
6	08.09.2009	Kalpana Dhital	Asha Program	District Manager	Syangja
7	06.10.2009	Kamal Bahadur Sapkota	SIMI	Technical Supervisor	Syangja
8	07.09.2009	Arjun Chaulagain	Asha Program	Agriculture Technican	Syangja
9	05.10.2009	Sabin Regmi	SIMI	Technical Supervisor	Syangja (Ex-TS)

Annex 3 Types of MUS Design
(IDE/N, 2007)



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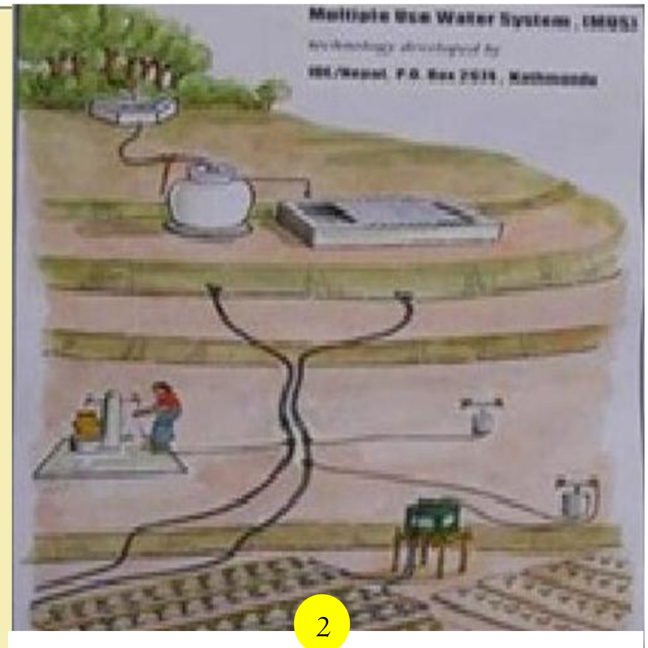


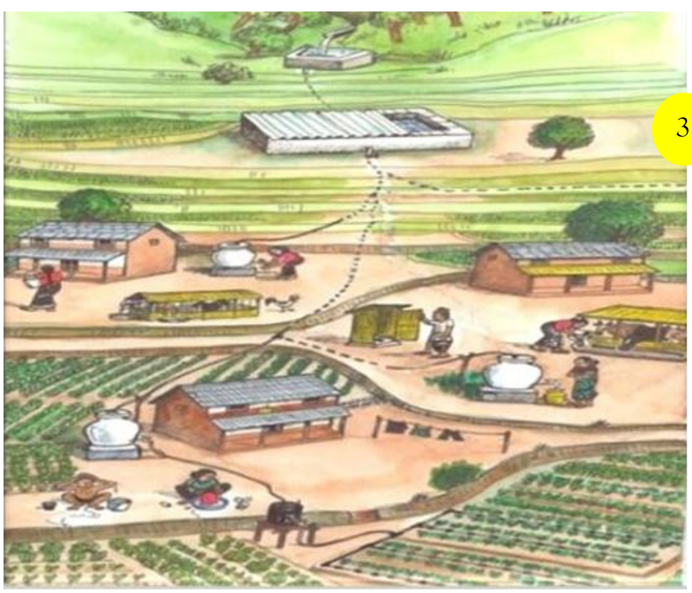
2

Continuous Flow System

- Designed if safe discharge is more than 1.5 times the projected water demand.
- No regulation is required throughout the season
- Not recommended if household number exceeds 40 or the pipe network is more than 4 km long.

Seasonally Controlled System

- Designed if the flow of the water source is not adequate to meet the design demand throughout the year.
- Provision of separate water tanks – one for domestic and one for productive uses.
- Once 1st tank (MTJ) is filled, the surplus water is directed to 2nd tank (FCL).



3

Year- Round Controlled System

- Designed if the water source is just enough to meet the design demand.
- Provision of storage tank in each households
- Households tanks are filled on a turn-by-turn basis

Annex 4 Water Rights Priority Order

The Water Resources Act, 2049 of Nepal instructs for the rational utilization, conservation, management and development of water resources that are available to the country in whatsoever form. As per this Act, following priority order shall be followed while utilizing water resources-

1. Drinking water and domestic uses
2. Irrigation
3. Agricultural uses such as animal husbandry and Fisheries;
4. Hydroelectricity
5. Cottage industry, industrial enterprises and mining uses
6. Navigation
7. Recreational uses and
8. Other use.

Annex 5 Design Criteria for Technology/Product

(i) **Low-cost**: The products have to be affordable to the smallholder farmers.

(ii) **Time Saving**: The product should decrease the load of the smallholder farmers and save time for production.

(iii) **Adoptable:** The product should be able to adopt as per the demand of the consumers such as the plot of smallholder farmers may be different in *hilly* area as compare to *terai* land.

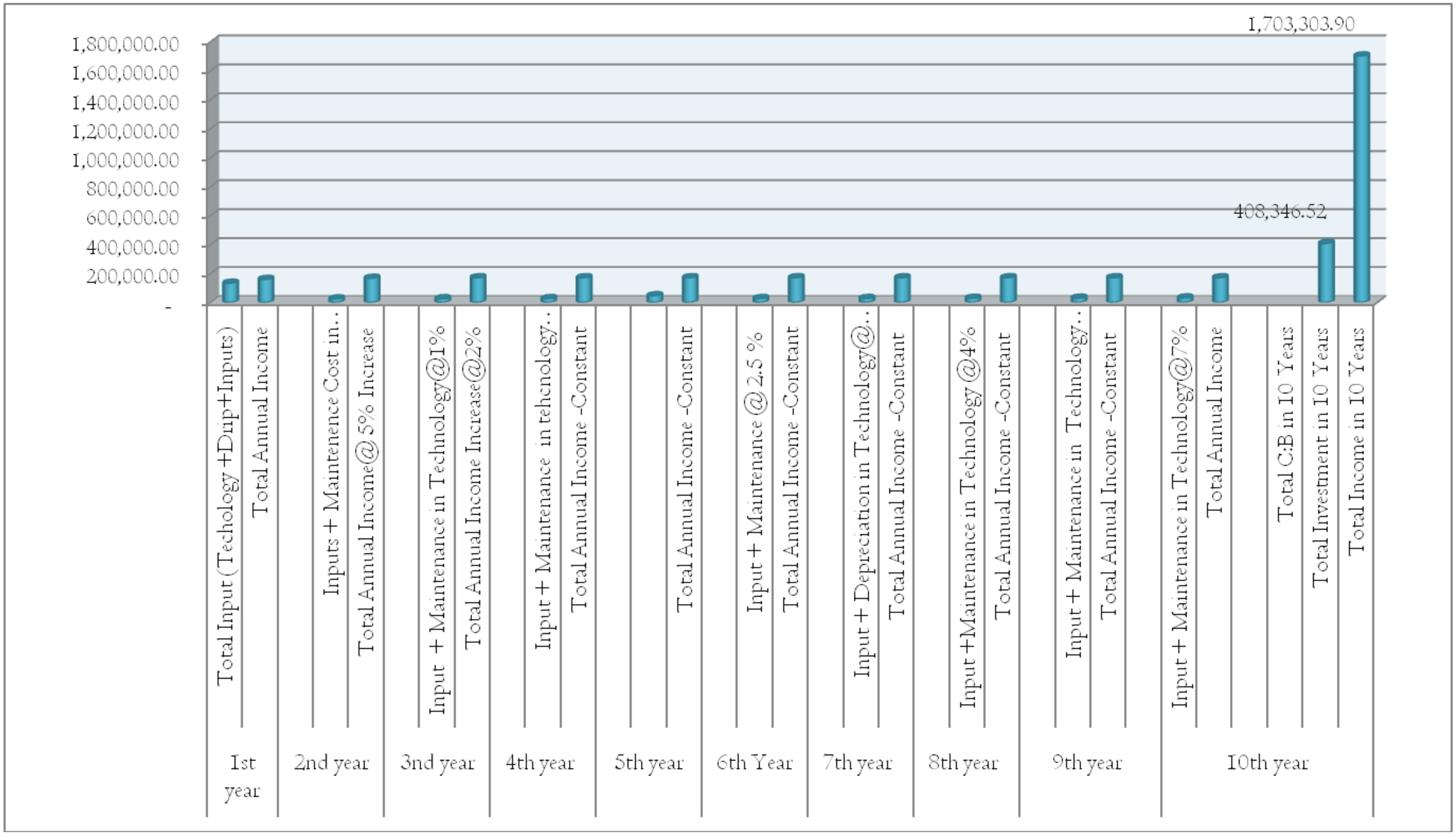
(iv) **Reliability:** The product operation and maintenance needed to be low and manageable at the farm level, with little training required.

(v) **Marketability:** The greater the potential for "off-the-shelf" packages in kit form requiring little design and customization would increase sales volumes and ensure availability and affordability through decentralized marketing networks.

(vi) **Replicability:** Identifying low-cost components and materials available locally could stimulate decentralized production of the technology in-country and worldwide.

(Adopted from: Nepali and Shrestha, 2008)

Annex 6 Projected Financial Evaluation of Phulbari MUS



Annex 7 Crop Season and Crop Calendar for Main Crops

1. Season

Monsoon season:	Mid June – mid October	(Ashad-Ashoj)
Winter season:	Mid November – mid February	(Kartik-Magh)
Summer season:	Mid March – mid June	(Chaitra-Jestha)

2. Crop calendar

Types of Crop	Seedling Preparation	Planting	Harvesting
Tomato	February-March	February-April	April-July
	April-June	May-July	July-November
Chilli	December-February	January-February	March-May
Cauliflower	July-October	August -November	November -February
	September- December	October-January	January -April
Cabbage	July-October	August -November	November-February
Cucumber	December-February	January-March	March -June
Sponge Guard	December-February	January-March	April-August
Bitter guard	December-February	January-March	April-August

Annex 8 List of MUS Implemented in Syangja

S.N.	Name of MUS	Location	HH Served	Contribution (Rs.)			Total
				Project	Community	Support Organizations	
1	Malewabasne MUS	Sworek-7, Toridanda	21	65,620.18	46055.79	24,214	1,35,889.97
2	Rangethati MUS/MI Scheme	Setidobhan-5, Rangethati	36	70,158.09	45,285.45		1,15,443.54
3	Senapuk MUS	Pelakot-9, Senapuk	36	1,21,255.33	1,17,289.50		2,38,544.83
4	Simle Water harvesting(MUS)	Sworek-9, Simle	18	57,480.61	51,825.25		1,09,305.86
5	Jugle/Betenee MUS (Pipe support)	Setidobhan-9 & 2, Betenee	24	-	-	-	-
6	Bhandrakhola MUS/MI	Phendikhola-2, Bhandarkhola	38	32,982.37	82,119.19	99,365.76	2,14,467.32
7	Kumalgaun MUS	Putalibazar Munucipality-5, Kumalgaun	51 and 1 school	45,000	1,35,976.14	1,79,399.7	3,60,375.84
8	Syanuthumka MUS	Pelakot-9, Syanuthumka	32	50,000	61,095.36	74,383.02	1,85,478.38
9	Phulbari MUS	Putalibazar Munucipality-6, Phulbari	16	30,000	29,959	31,931.32	91,890.32
10	Junelidanda MUS	Kalikakot-5, Junelidanda	25	30,000	1,79,717.48	85,088	2,94,805.48
11	Kataunje MUS	Pelakot-5, Kataunje	25	30,000	1,20,846.37	60,000	2,10,846.37
12	Ganeshpur MUS	Putalibazar Munucipality-6, Ganeshpur	17	40,000	32,557.71	32,636.65	1,05,194.36
13	Mulibas MUS	Pelakot-9, Mulibas	33	40,000	1,19,073	1,43,792	3,02,865
14	Danda Kharka MUS	Sirsikot – 1,Dandakharka	86	42,000	1,08,201.43	1,1 6585.59	2,66,787.02
15	Pitlek MUS	Jagatbhnajyang – 2, Pitlek	34 (1 school)	63,000	98,613.45	89,177.94	2,50,791.39
16	Akala devi MUS	Sirsikot – 2,Dandakharka	39	63,000	83,066.72	49,795.35	1,95,862.08
	Total		533	7,80,496.58	13,11,681.84	9,86,369.33	30,78,547.75

Annex 9 PRISM Value Chain Approach in Action

(Adopted from: www.ideorg.org)

Annex 10 Rough Criteria for MUS Development

i) **Location**: Rural or peri-urban. At least 2 km from the local town
ii) **Water Right**: Water source to be free from water right problem.
iii) **Water Source:** Preference will be given to the spring source.
iv) **Water discharge**: Enough to meet at least 600 liters of water per household per day for the projected population of 10 years.
v) **Elevation of the water source**: Water source to be located at a sufficiently higher elevation from the village so the water can be supplied by gravity.
vi) **Distance between village and the water source**: To be less than 3 k.m.
vii) **Alignment:** To be suitable with minimum number of crossings, hard rock and without sharp U-profile alignment.
viii) **Water Quality** : To be drinkable
ix) **Hardship in water collection:** At least more than ½ hour for the round trip during two months of the year.
x) **Willingness to Community contribution:** Strong commitment to provide voluntary labor for non-cash components of the construction.
xi) **O&M Cost :** All households ready to deposit Rs. 50 as an initial deposit for the O&M cost. Also willing to pay the regular water tariff.
xii) **Adoption of microirrigation technology:** More than 75 % of the beneficiaries willing to adopt MIT (Drip or sprinkler system).
xiii) **Community Contribution** : Commitment on
  - Providing land at free of cost for constructing tank and other structures
  - Voluntary contribution for collection/ transportation of materials, and unskilled labor.
  - No obstruction in laying the pipes for transmission and distribution

XV) No potential conflict in water distribution.

(Source: IDE Nepal)

Annex 11 Field Photographs

Plate 1: Interviewing with Maya B.K, Kaski

Plate 2: Interviewing with Som Bahadur Pulami, Tanahu

Plate 3: Interviewing with Moti Lal Subedi, Kaski

Plate 4: Interviewing with Sher Bahadur Gautam, Kaski

Plate 5: Double Tank MUS System

Plate 6: Moti Lal Subedi showing water flowing in Multi Use Tap

Plate 7: Farmer's field being irrigated with Drip

Plate 8: A Farmer filling his Drip Tank

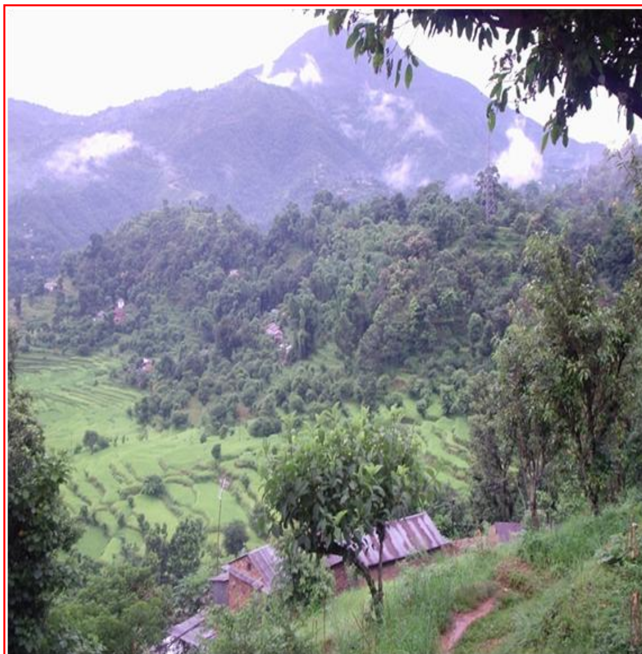


Plate: 9 Landscape of Phulbari, Syangja

Plate: 10 A Women harvesting Tomato

Plate: 11 MUS Workshop, Syangja

Plate: 12 MUS Workshop, Syangja