

Chapter - One

INTRODUCTION

1.1 Background

Rural areas cover about three fourths of the area of Nepal. The rural areas face common problems, like sanitation, population growth, degraded environment, depleting resources and short supply of needs. Among all these problems, sanitation is one of the great problems in rural areas. For this, ECOSAN is one of the alternatives to reduce sanitation problem in rural areas.

Nepal is a poor, agriculture dominant country. Agriculture has been intensified in some areas by increasing use of chemical fertilizer and pesticides. We have to import chemical fertilizers and pesticides from other countries, which lead environment degradation as well as economic loss.

Human excreta is full of resources for agricultural purposes, despite of millions of microorganisms inhabiting in them. If these can be ecologically managed and recycled or reused, we are two steps closer to the environment conservation and economic progress. First, it reduces the impact of pollution that we face and second, it provides necessary nutrient elements to the growing crops if used for agricultural purposes. This will reduce the volume of waste water and cost on its treatment. It helps to save capital from purchasing tons of chemical fertilizer, which consume tones of natural resources and depleting of mineral sources.

Ecological sanitation has all these features and more. This environment friendly sustainable sanitation system, which regard human waste as resource for agriculture purpose and food security, serves all criteria listed here:

- a) Prevent diseases
- b) Protects environmental degradation
- c) Simple process
- d) Affordable
- e) Acceptable

Many ethnic farming communities had practice of applying human excreta and night soil to their fields to grow crops. Even though this has become obsolete, the ECOSAN system would once

again revive the tradition in more appropriate way. The new system would embrace the old concept in better ecological, economical and sustainable terms in rural development.

Figure 1: Map of Lalitpur



Source: Central Bureau of Statistics

Figure 2: Map of Siddhipur



Source: AutoCAD Drawing

1.2 Rationale for the Study

Nepal is poor and agriculture dominant country. Being a poor country, we have to import chemical fertilizer, pesticides from other countries. Use of this fertilizer, pesticides leads soil degradation which in turn leads to low production and two steps backwards to poverty.

Beside that, except core areas of metropolitan and sub metropolitan cities there are no sewerage system. So, the main problem is how to use human waste properly. Only one sewerage treatment plant is working in Pashupathi area and other sewerage are directly discharged into near by watercourses. Everybody knows the blockage, breakage and spillage of sewer line causing nuisance in the different part of the valley. Some of the household use simple pit, pour flush latrine, septic tank etc. and practice of open defecation place very common among the rest.

In such country the concept of ECOSAN toilets may be one of the appropriate options. Both the direct discharge into the watercourse and open defecation are seriously contaminating the surface and ground water causing the water related diseases like diarrhea, dysentery, cholera, jaundice etc. The main water source for drinking purpose in hill area is stream where as shallow well (Dug well and tube well) is the main source of Terai.

PhD scholar Mr. Steven A. Esrey states in his paper “Human excreta are resources, not waste. There is no such thing as a waste in nature; it is only in our minds. Waste is nothing more than resource in wrong place.” According to this statement, human excreta are resources, not waste. If we manage human excreta properly it helps to grow our crops, preserve natural resources, health, and environment and so on. Waste not want not drive should be followed to tackle the environment problem, social problem, sanitation problem and economic problem.

If human excreta can be ecologically managed and recycled for reuse we are two steps closer to the environment conservation; economic progress and social progress, which leads sustainable development.

1.3 Objectives Of the Study

The general objective of the study is to find out how the ECOSAN toilet helps in the process of sustainable development. The specific objectives are the following:

1. To find out how ECOSAN toilet functions.
2. To assess the advantages of ECOSAN over traditional sanitation system.
3. To measure the impact of ECOSAN on the settlement of Siddhipur.
4. To find out the social acceptance of ECOSAN by the communities.

1.4 Research questions

The ecological sanitation toilet can be promoted as a sustainable alternative. It is not only beneficial from the point of view of the excreta management and sanitation but also from the point of view of nutrient recycling which is being lost as a waste. So, the ecological sanitation might be properly adopted by the agro based communities because once again revive the traditional in more appropriate way which embrace the old concept in better ecological, economical, social and sustainable terms.

Research questions are:

- 1) How ECOSAN toilets help in sustainable development?
- 2) How has sanitation status improved in Siddhipur after installing ECOSAN?
- 3) How does community respond to ECOSAN?

1.5 Limitation of the Study

Limitations of the study are:

- 1) Biological
- 2) Technological

1.6 Organization of the Study

The first chapter is about Introduction which contains Background, Rationale for the Study, Objectives of the Study, Research Questions, and Limitations of the Study and Organization of

Study. The second chapter deals with the Literature Review related to Sustainable Development, Natural Resources, Sanitation, and Ecosan Toilet, Human Excreta as a Resource, Ecological Sanitation System, Ecosan Waterless Toilet, Fertilizer and waste. The third chapter presents Research Methodology. Research Methodology includes Selection of the Study Area, Research Design, Nature and Sources of Data, Universe, Tools and technique of Data Collection and Classification and Editing of Data. Tools and Techniques of Data Collection comprise of Observation, Household survey, Questionnaire for Ecosan Users as well as Field Staff and Representative of Local Institution Involved in Ecosan Toilet Development.

The fourth chapter includes Examination of Ecosan and Traditional Sanitation System. It explains about Introduction of Ecosan, How Does it Works and Traditional Sanitation Systems. Traditional Sanitation System includes *Nauga*, *Saga*, *Khikhamoga*, its Advantages and Drawbacks. The fifth chapter presents Data Analysis and Interpretation related to Total Population, Income Sources, Agricultural Land, Investment in Agriculture, Use of Human Excreta as Fertilizer, Harvesting, Sources of Drinking Water, Houses having Toilet before using Ecosan, Traditional method for making Ash before Ecosan, Effect of Open Defecation Place, Enpho's Support, Difficulties to Use toilet, Cleanness of Toilet, Suggestion for Toilet. The sixth chapter contains Summary, Recommendation for Improvement and Recommendation for Further Study.

Chapter - Two

LITERATURE REVIEW

2.1 Sustainable Development

World Commission on Environment and Development (1987) in its book “Our Common Future” defines sustainable development as:

“Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs” (p: 8)

Economic, environmental and cultural resources must be adopting three pronged for truly sustainable development. (Sustainability, 'The Lasting Fuel, 2003:6)

According to Robert Gilam, President of context institute “Sustainability refers to the ability of a society, ecosystem, or any such ongoing system to continue functioning into the indefinite future without being forced into decline through exhaustion ...of key resources.” (Sustainability, 'The Lasting Fuel, 2003:6)

2.2 Natural Resources

Natural resources or resource is usually defined as anything that can be obtained from the physical environment to fulfill human beings' needs. The resources available in the surface of the natural environment can be easily used. Some natural resources can be used without further processing and some can be used as further processing. Different factors determine the utility of natural resources. On the basis of these factors natural resources can be classified into perpetual, renewable and non-renewable.

a) Perpetual resources:

The sources of perpetual resources are inexhaustible. They will be available at certain rate from the nature.

b) Renewable resources:

Renewable resources are those natural resources recover themselves through natural process there will not be any depletion.

c) Non renewable resources:

Non renewable resources are available in a fixed amount in various places of the earth's crust. These are limited resources. If they are used continuously, the store will be empty. Once they are completely exploited natural processes will not replenish them. If it replenishes it is slower than the rate of use.

So we should be careful while using such resources. We should be reducing their use. The other ways of the reduction of their use are re-used and re-cycle. (Ranjit, 2061:82-84)

2.3 Sanitation

WHO defines sanitation, as "Health is a state of complete physical, mental and social well being of and not merely the absence of diseases of infirmity." (Thapa, 2004:15)

According to Oxford Advanced Learner's Dictionary, 7th edition sanitation means the equipment and systems that keep places clean, especially by removing human waste.

2.4 ECOSAN Toilet

The ECOSAN toilet is a urine separating or non mixing system that enables the separate storage of urine and faeces. The urine is led through a pipe into a special container. The faeces, also collected in a separate container, and then mixed with ashes, soil, leaves, grass, sawdust or any other suitable materials available. By not mixing the urine- "the natural fertilizer "-with faeces, which contains most of the pathogens, the bad smell from the latrines is very much reduced. (Shrestha, 2003:3)

2.5 Human Excreta as a Resource

Human excreta are resource not waste; there is no such thing as waste in nature. It is only in our minds. Waste is nothing more than a resource in a wrong place. (Thapa, 2004:4)

2.6 Ecological Sanitation Closes the Loop between Sanitation and agriculture

The concept behind ecological sanitation (ECOSAN) is that sanitation problems could be solved more sustainably and efficiently if the resources contained in excreta and wastewater were recovered and used rather than discharged into the water bodies and the surrounding environment.

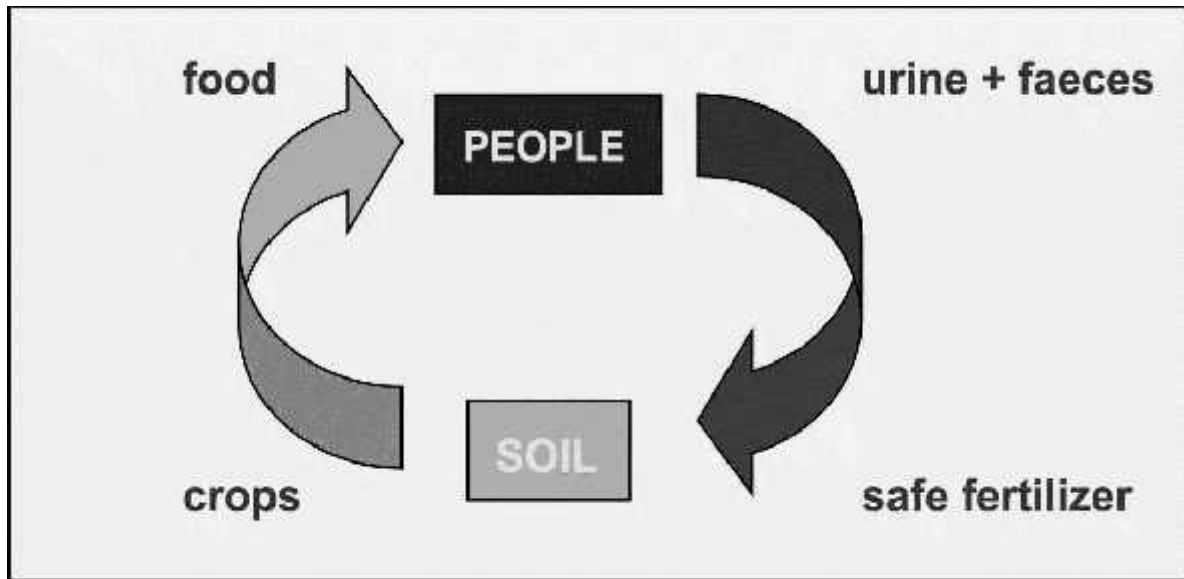
The end-of-pipe sanitary systems that are used today are based on the modern misconception that human excreta are simply wastes with no useful purpose and must be disposed of.

Ecological sanitation is a new paradigm in sanitation that recognizes human excreta and water from households not as a waste but as resources that can be recovered, treated where necessary and safely used again.



Ideally, ecological sanitation systems enable a complete recovery of nutrients in household wastewater and their reuse in agriculture. In this way, they help preserve soil fertility and safeguard long-term food security, whilst minimizing the consumption and pollution of water resources. (<http://www.gtz.de/en/themen/umwelt-infrastruktur/wasser/8524.htm>)

Figure 3: State of the Art of Ecological Sanitation



Source: <http://www.gtz.de/en/themen/umwelt-infrastruktur/wasser/8524.htm>

Figure 4: Closing the Loop on sanitation

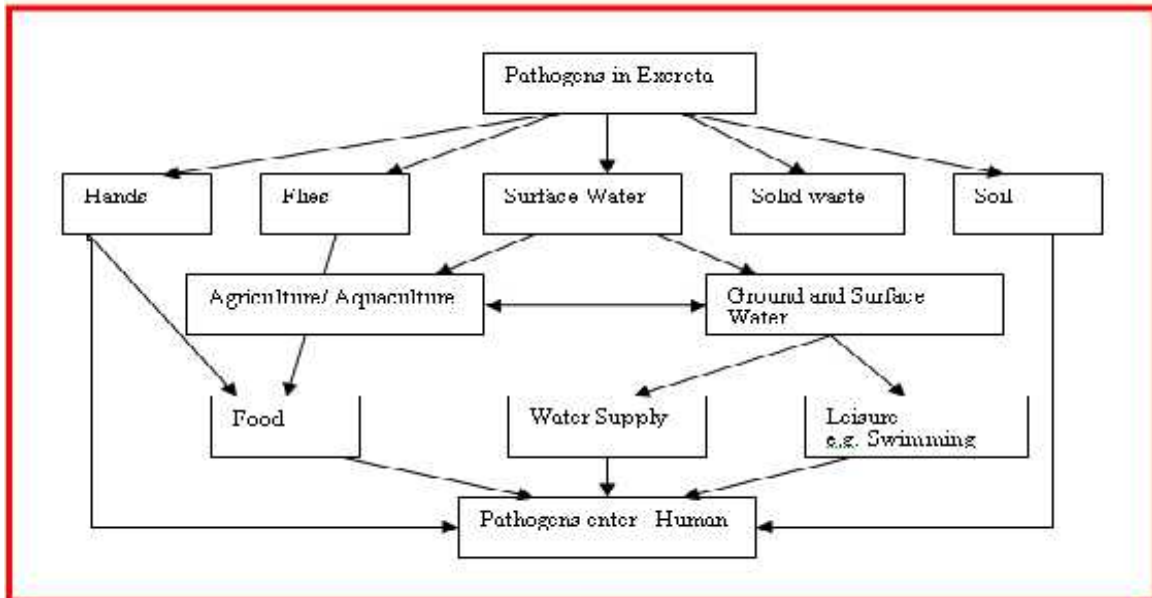
ECOSAN (Ecological Sanitation)

- Closing the loop in waste water management and sanitation
- sanitation sustainable and environmentally friendly sanitation



Source: Shrestha, P., et al, Sept 7, 2005

Figure 5: Infectious Routes of Pathogens



Source: Shrestha, P., et al, 2005

ECOSAN is a on sanitation that not only helps in managing the human excreta at the source but it also helps in refurbishing the agriculture practices at the present era and future. It blends the historical sanitation and agriculture custom in scientific ways to

-) Respect ecological integrity
-) Conserve the freshwater
-) Promote dignified and healthy living
-) Recycle nutrients from human excreta for use in agriculture. (ENPHO, 2004:57)

ECOSAN is an ecosystem approach to excreta disposal. ECOSAN recognize:

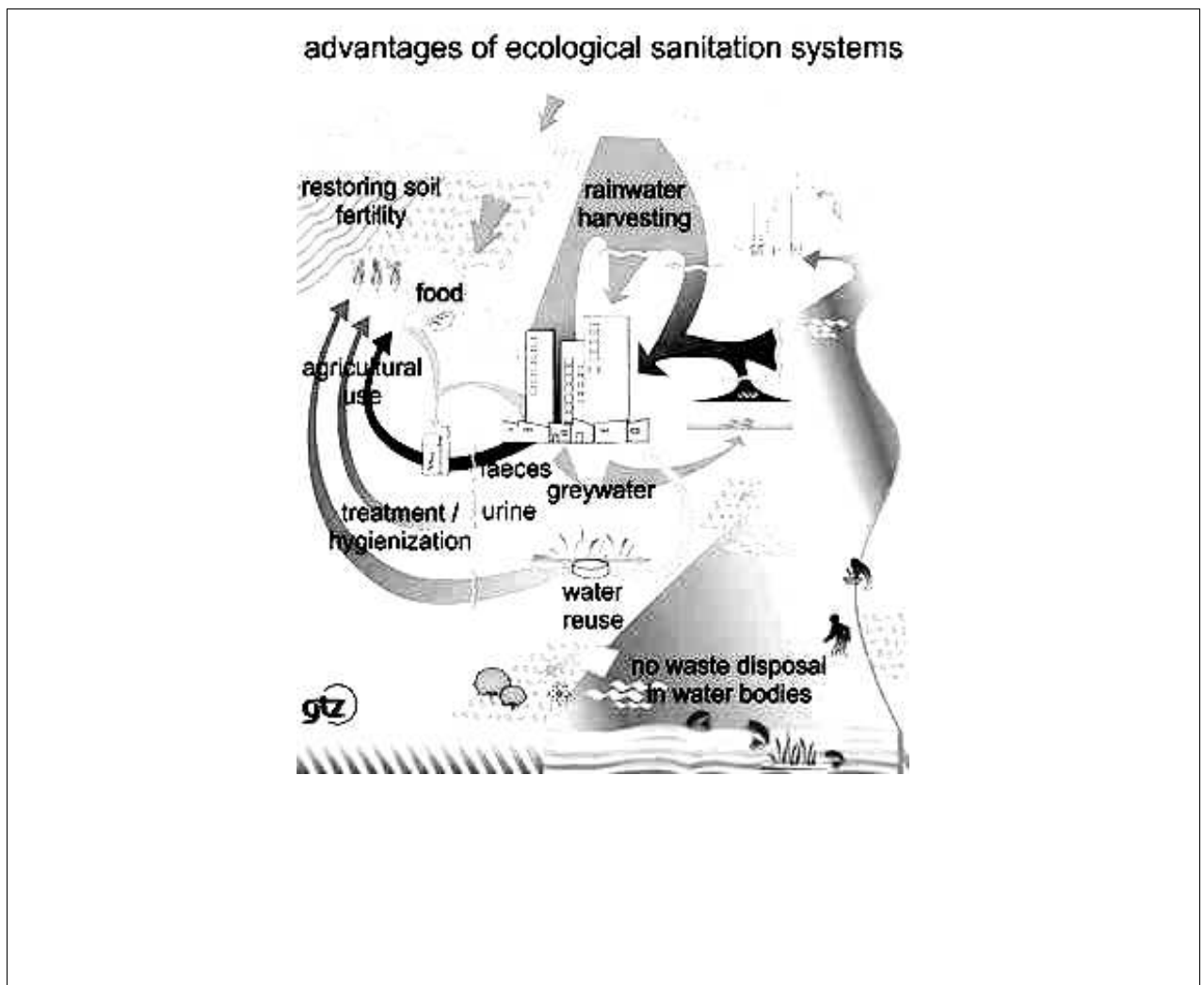
-) Human excreta as a resource, not a waste
-) Water is precious resource that should not be used to transport excreta
-) Excreta should be managed as close as possible to its resources.

2.7 Ecological Sanitation Systems

Ecological sanitation systems are designed to avoid the discharge of domestic wastewater into the environment and to enable the reuse of the nutrients, organics, water and energy contained in excreta and wastewater.

A wide range of technologies can be applied in ECOSAN systems. Decentralized systems, waste separation and minimization of dilution are the main features of many ECOSAN systems but mixing and centralized systems (e.g. wastewater irrigation) are also possible.

Figure 6: Advantages of Ecological Sanitation Systems



Source: <http://www.gtz.de/en/themen/umwelt-infrastruktur/wasser/8802.htm>

-) improvement of health by minimizing the introduction of pathogens from human excrement into the water cycle
-) promotion of recycling by safe, hygienic recovery and use of nutrients, organics, trace elements, water and energy
-) conservation of resources, through lower water consumption, substitution of chemical fertilizers and minimization of water pollution
-) preference for modular, decentralized partial-flow systems for more appropriate cost-efficient solutions
-) possibility to integrate on-plot systems into houses, increasing user comfort, and security for women and girls
-) contribution to the preservation of soil fertility
-) improvement of agricultural productivity and hence contributes to food security

Promotion of a holistic, interdisciplinary approach: hygiene, water supply and sanitation, resource conservation, environmental protection, urban planning, agriculture, irrigation, food security, small-business promotion. (<http://www.gtz.de/en/themen/umwelt-infrastruktur/wasser/8802.htm>)

2.8 ECOSAN Waterless Toilet

What is a waterless / water free toilet system?

It is a sanitation system that does not require any water. Not only does it save on water use, but it is entirely isolated from the surrounding environment and cannot contaminate underground water resources.

How can sanitation work without water?

The system utilizes a natural biological process to break down human waste into a dehydrated odorless compost-like material.

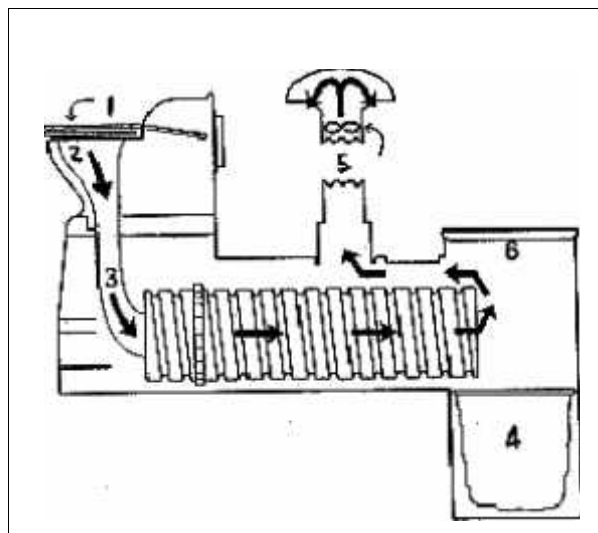
How does it work?

We receive many questions about the toilets, of which “How does it work “is the most frequently asked. The following is a brief description of the ECOSAN toilet concept as well as its main features.

The human excrement falls down a vertical chute (2) and into one end of a specially designed helical screw conveyor (3). Every time the toilet lid (1) is lifted, a mechanism rotates the conveyor. With each rotation the human excrement slowly moves along, taking approximately twenty five days before falling into a reusable collection bag (4). It takes six months for the bag to fill with dry and odorless waste.

Through the uniquely designed ventilation pipe (5), adequate airflow is provided for the dehydration / evaporation, deodorizing process. Human excrement consists of roughly 95% moisture. As the solids dry in the conveyor the urine and moisture is vented into the atmosphere. The solid waste then dries into a compost-like material, roughly 5 - 10% of its original mass.

Figure 7: How does Waterless Toilet Work



.....Source: http://myweb.absa.co.za/ernstt/product_info.html

The dry waste is manageable and can be processed in the following ways.

-) Use it in the making of compost
-) Dispose of it by using municipal waste services
-) Use it as a source of fuel

Large objects like beverage cans, disposable nappies or other objects accidentally dropped down the chute will not block the system, It is however not advisable to do this

Features

-) No plumbing required
-) No drains
-) No pipes
-) Water free
-) Odorless
-) Chemical free

Relatively light and easy to install (http://myweb.absa.co.za/ernstt/product_info.html)

2.9 Fertilizer

Fertilizer use is nutrient runoff. This is seen as serious problem in Europe, where fertilizer use has declined somewhat in recent years, and in the United States, where fertilizer nutrients flowing down the Mississippi River and into the Gulf of Mexico are leading to explosions of algae. When these algae concentrations die, they absorb the free oxygen in the water, leading to death of all marine life in that area, including various types of seafood. In effect, efforts to expand the harvest from the land are reducing the harvest from the oceans. (Lekhak, 2003, 86.)

The agricultural system in Nepal has been intensified in some areas by increasing use of chemical fertilizer and pesticides. The average use of chemical fertilizers, such as nitrogen, phosphorus, and potassium per hectare has increase tremendously in the country from 7.6 kg in 1975 to 26.6 in 1998. In the agriculturally prosperous area of eastern Chitwan district, the use of fertilizer is estimated to be 420 kg/ ha. However, the present level of use is still the lowest in South Asia (Basnyat 1999). However, the concentration of nutrients is within the permissible level for river water quality. (ICIMOD, 2001:127.)

Altogether 250 types of pesticides are used in Nepal. The average use of pesticide was 0.17 Kg/ha in 1986 (CBS 1998) and 0.142 kg/ha in 1995 (Palikhe 1999). All these pesticide are organochlorides and organophosphates. Organochlorides are persistent organic pesticides, which pass through the food chain through the process of bioaccumulation and biomagnification, and thus are hazardous to health. (ICIMOD, 2001:127.)

2.10 Waste

About 93% pollution load is from domestic sewerage and the remaining 7% from industrial effluents. In Nepal, water related diseases have the highest share of the total OPD visits, of which diarrhea and skin diseases constitute 10% and 42% respectively none of the water from ground such as dug wells, deep tube wells, stone pots, ponds and piped water in valleys, is guaranteed free from faecal contamination. (State of the Environment, 2001:142.).

Economic activities and use of waste disposal can have an adverse impact on the aquatic flora and fauna of streams, ponds, and lakes; for instance, biodiversity is measured in terms of abundance and type of fauna and flora and both have declined sharply in the polluted section of Bagmati Rivers and its tributaries. (Lekhak,, 2003,:248.)

In Nepal, water bodies like rivers, lakes, ponds, and spring sources (Kund) are considered to be sacred to be sacred places for performing religious activities. However, aesthetic values of water bodies have been greatly affected by haphazard construction of urban houses, encroaching on the river bank, dumping and discharging of households waste and sewerage, discharge of industrial effluents into rivers, and quarrying of sand and stone. These activities, which are associated mostly with urban development, are considered injurious to the preservation of the aesthetic value of water bodies. They are not beneficial from an ecological perspective either. (Lekhak, 2003,: 248.)

Chapter - Three

RESEARCH METHODOLOGY

3.1 Selection of the Study Area

There are limited areas within Kathmandu valley practicing the ECOSAN toilets. Tignee and Bode are located in Maddyapur Thimi municipality of Bhaktapur district to eastern, Simthalee of Lubhu VDC; Siddhipur in Silddhipur VDC; Ochhu of Imadol VDC lies in Lalitpur district to the southern and Khokana village in Khokana VDC is situated due south from center of the city except Sankhamul. Except Sankhumul all communities are 6 to 10 km away from the center of the capital city Kathmandu at least linking with graveled road facility.

Within them, Siddhipur VDC is selected for the study. Silddhipur is traditional farmer's village located around 10 km south east of Kathmandu in Lalitpur district. It has 1193 household with 5566 population among which, 2647male and 2919 female. People are farming as an occupation, low rate of literacy, low level of income, poor sanitary condition, lack of sanitary facilities, lack of drinking facilities etc. Some of sanitary practices are: *Naugal*, *Saaga*, and *Khikhamoga*. More than 50% of the people use *Nauga*, *saga* and *Khikhamoga* still now. Use of ECOSAN is seen to cover up more hygienically the function of *Nauga* and *Khikhamoga*. The user of *Naugal* reported the collected ash with urine works as good nutrient to resist diseases for the plants. The user including children never use to defecate in *Naugal* because they believe its location under the stair case, is one of the god to come in. The *Saaga* is pit to make the manure from the solid waste. The children use to defecate in the *Saaga* without hesitation digested manure with solid waste. *Khikhamoga* is open defecation place as well as common toilet.

Being a student, I selected Siddhipur which is near by my location. No language problem for data collection. Water and sanitation is one of the most serious problems of this village where 52 public stand posts supply untreated water to entire village where more than half of the households do not have proper toilets.

3.2 Research Design

There are only 59 ECOSAN toilets implemented, 28 are under construction and targeted toilets are 100.

Only 59% toilets are implemented so I take universe implemented ECOSAN toilets.

3.3 Nature and Sources of Data

The information from primary and secondary sources were collected and used in the analysis. The sources of information are given separately below.

3.3.1 Primary Source of Data

3.3.1.1 Household survey of ECOSAN users

Major of the primary information in the study were the respondents selected from each ECOSAN users household. The information collected from this source was as per household questionnaire.

3.3.1.2 Questionnaire for field staff and representative of local institution involved in ECOSAN

Primary information in the study was the respondents selected from staff involved in ECOSAN toilet.

3.3.1.3 Observation

The study area was visited observed before and during household survey. Mainly the practice of the householders based on questionnaire observed. The information collected from the observation was used for the verification of data collected through questionnaires. These data were also used to converse the quantitative and qualitative result from in the analysis.

3.3.2 Secondary Source of Data

The following documents were reviewed as the secondary source of information in the study

Theories related to the ecological sanitation.

Earlier theses

ECOSAN journals and websites

Papers of workshop and seminars

The collected secondary information's were used for comparison with the findings of the study.

3.4 Universe

There are only 59 ECOSAN users, therefore sampling is not necessary. Universe study was done.

3.5 Tools and Techniques of Data Collection

The following data collection instruments are used in study

3.5.1 Observation

Out of two observation method, because of time and resource limitation, direct observation method was used in the study. For the validity and the reliability of the information, the observations were done simultaneously with interview and separately for the verification of collected information.

3.5.2 Household Survey of ECOSAN Users

For the validity and the reliability of the information, the household survey of ECOSAN toilet users were done simultaneously with interview.

3.5.3 Questionnaire

3.5.3.1 Household Questionnaire of ECOSAN users

The schedule was used for collection of information at household level. The household were interviewed talking time of at least 45 minutes about ECOSAN toilet's impact on sustainable

development. It contains environmental impact, economical impact, agricultural impact, social impact, health and sanitation impact and suggestion for further improvement. Interviews were conducted asking fifty two structured questions in each ECOSAN users.

3.5.3 2. Questionnaire for Field Staff and Representative of Local Institution Involved in ECOSAN Toilet

The schedule was used for collection information from staff. The ECOSAN staffs were interviewed talking time of at least 30 minutes about ECOSAN toilet's impact on sustainable development and benefited by society. It contains general information, cause of toilet use, selected this area, fertilizer use, impact on health and sanitation, suggestion for further improvement, and benefited the society, agricultural change, construction cost, what type of awareness before launching ECOSAN? and further improvement. Interviews were conducting asking twelve structured questions.

3.6. Classification and Editing of Data

Data were classified according to quantitative and qualitative data. Unnecessary data were removed.

Chapter - Four

EXAMINATION OF ECOSAN AND TRADITIONAL SANITATION SYSTEM

4.1 Introduction to ECOSAN

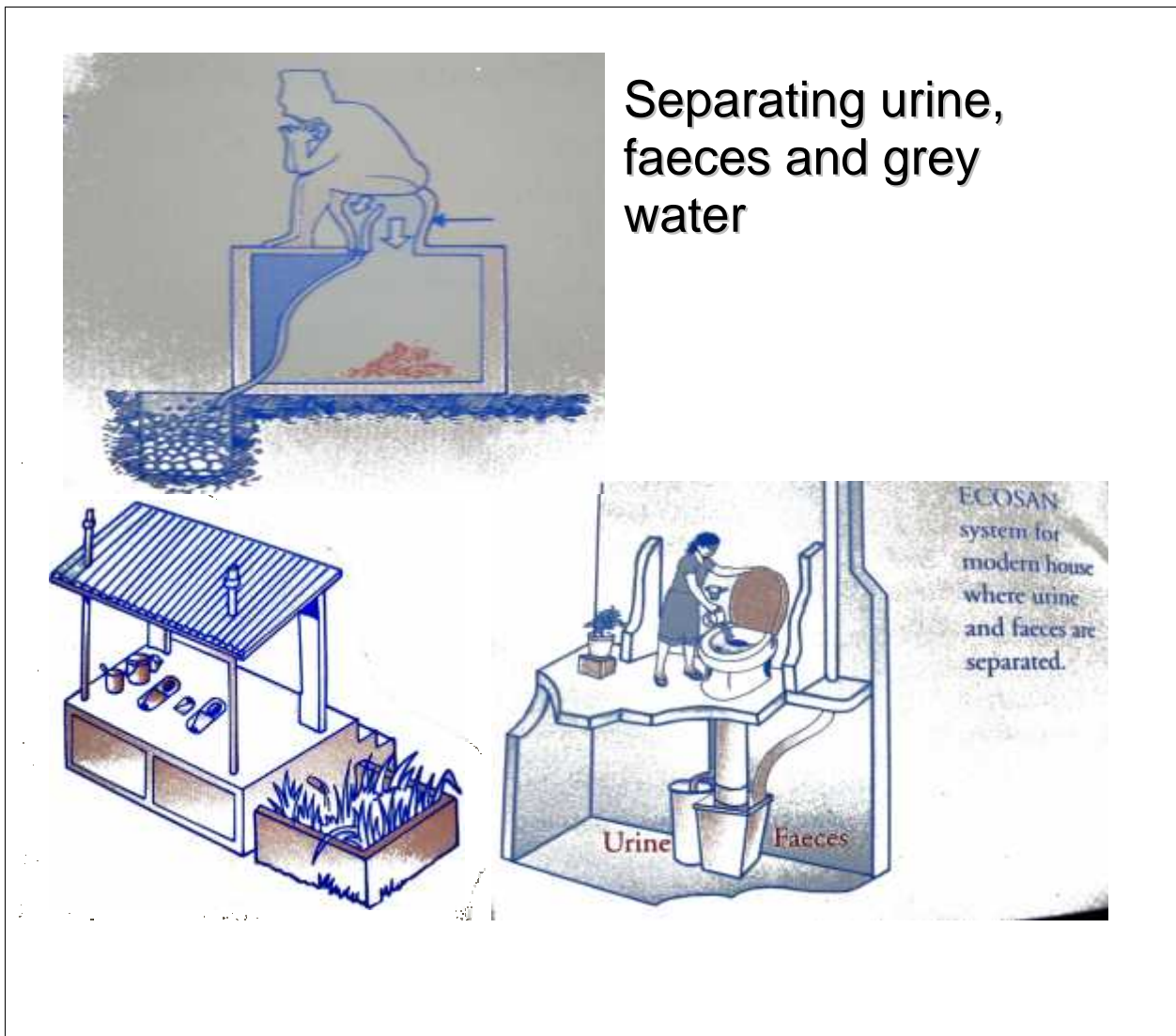
ECOSAN (ecological Sanitation) means closing the “loop” in wastewater management and sanitation. It means moving from only sanitation (left) to sustainable and environmentally friendly sanitation (right).

In fact, ECOSAN is a holistic and safe new concept for:

- ☐☐ Effective wastewater management and sanitation;
- ☐☐ Closing material cycles;
- ☐☐ Recovering and utilizing plant nutrients;
- ☐☐ Reducing the consumption of freshwater;
- ☐☐ Minimizing health risks;
- ☐☐ Minimizing environmental pollution; and
- ☐☐ Reducing energy consumption rates/better utilizing energy contents.

ECOSAN is not a specific technology, but a new philosophy based on an overall view of material flows, of dealing with what is presently regarded as waste and wastewater for disposal. Ecological sanitation is different to water supply and is not equal to sewerage. It needs different solutions in different places. At the moment ECOSAN has its own informal institution, but this urgently needs to be formalized and institutionalized. ECOSAN has to be built on culture and has to be prioritized so to be able to positively contribute to combating the world water and sanitation crisis. ECOSAN options must be provided.

Figure 8: Basic Concept of ECOSAN



Source: Shrestha, P., et al, Sept 7, 2005.

4.2 How does ECOSAN Work?

Containment and sanitization: ECOSAN systems are designed in such a way that provides two ways to render safe disposal of human excreta through dehydration and decomposition.

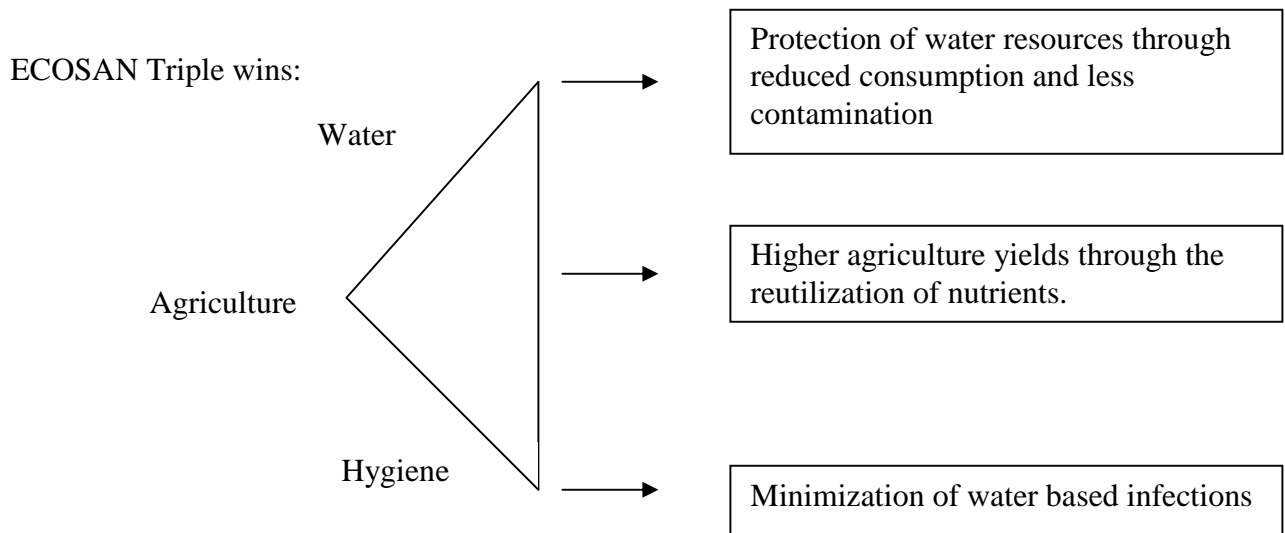
Dehydration is the chemical process of destroying pathogens by eliminating moisture. Some drying materials like wood, ash and lime increase pH which acts as an additional toxic factor to

pathogens if the pH can be raised to over 9.5. To minimize the moisture content in faeces, urine is diverted.

ECOSAN toilet pan consists of slab built over two vaults. The slab has a hole over each vault for the faeces to drop in and a funnel like device to collect the urine. It takes an average family six months to fill one of the vaults. Then second vault is used. The vault is emptied following an additional six months of sanitization and the material is taken to soil compost. Urine is never mixed in this system which is collected separately and can be applied as a fertilizer by diluting with water as necessary.

Recycling: Recycling of nutrients in urine and faeces is one of the key benefits of ECOSAN Urine sconsists of all kind of nutrients (nitrogen, potassium and phosphorus required for the plat growth and it is mostly sterile. Whereas faeces contain large amount of diseases causing pathogens for example: 1 gram of faeces consists of 100 parasite eggs, 1000 parasite cysts, 1,000,000 bacteria, and 10,000,000 virus. Such pathogens will be destroyed after 4 to 6 months of period due to rising of pH and removal of moisture. Finally faeces are converted into composted product “humus”, which is an excellent soil conditioner.

Therefore, ECOSAN toilet serves two purposes: it saves water and generates resource from the waste. It uses human excreta as a resource, not as waste. Thus, the sacred water is never used to transport human excreta.



Using process:

-) Prior to use toilet, a layer of straw should be put on the bottom of faecal tank.
-) Faecal tank should be used for collecting faeces only.
-) After stooling, about one *mana* of ash should be put.
-) Faecal tank should be free from urine and water.
-) If water happens in to be in faecal tank, a little more ash should be added before.
-) Faecal tank should be shacked with stick at least twice a month.
-) Faecal tank should be left closed.

-) Reed should be plant on the way of outlet of toilet water.
-) Another faecal tank should be used after it is filled.
-) Compost should be taken after full another tank.
-) Urine tank should be closed properly.
-) Urine tank should be examined properly from time to time.
-) Protect urine from waste; urine should be properly used in agriculture or storage.
-) While using water or cleaning toilet, water should go into faecal hole.
-) Everyone, who uses toilet, should be well informed about the toilet.
-) We should wash our hands with soap after defecation.

4.3 Traditional Sanitation System:

The ECOSAN concept is reviving the traditional yet forgotten art of applying night soil to agricultural fields in scientific and hygienic way.

Moreover, acceptability was found higher in agro-based settlements due to its manure value and also suitable in low land settlements, because of its water tightness of collection tank and construction above the ground. It was improved approach over their traditional unhygienic practice of '*Nauga*' (pit for disposal ash urination under the staircase), '*Saaga*' (pit for disposal ash and other household waste located outside the house.) and '*Khikhamoga*' (open public toilets for women).

4.3.1 *Nauga*

Nauga is a pit for disposal ash from the cooking fire and for urinating under the stair on the ground floor in rectangle shape. In newari '*nau*' means ash and '*ga*' means hole. It uses to accumulate ash for making fertilizer. *Nauga*, in the most of the *Jyappu* community, is usually cleaned out every two or three months.

Figure 10: *Nauga* Under Staircase in Siddhipur



Source: Field Survey 2006

Advantages of *Nauga* are:

- a) Pit for disposal ash from the cooking fire and urination under the stair on the ground floor which is easy to dispose ash.
- b) To accumulate ash for making fertilizer
- c) Combination of ash and urine is used as one of the best fertilizers for agriculture. Ash kills microbes contains with urine.
- d) Urine contains useful chemical for fertilizer.
- e) Help to clean environment if cleaned from time to time.
- f) Protect tradition and culture.

Disadvantages of *Nauga* are:

- a) Unhygienic way to make fertilizer.

- b) Less contamination of essential chemicals for fertilizer due to open pit.

4.3.2 *Saaga*

Saaga is a pit for disposal ash and other watery household waste located outside the house. It is mostly located at the back of the house. In Newari, *Sa* means compost and *ga* means hole.

Figure 11: *Saaga* located at the Back of the House in Siddhipur.



Source: Field Survey 2006

Advantages of *Saaga* are:

- a) Pit for disposal ash and other watery household waste located outside the house.
- b) To accumulate ash for making fertilizer

- c) Combination of ash and urine is used is best fertilizer for agriculture. Ash kills microbes along with urine and other watery household waste.
- d) Household waste is used as fertilizer.
- e) Urine contains useful chemical for fertilizer.
- f) Help to clean environment if cleaned time
- g) Protect tradition and culture.

Disadvantages of *saaga* are:

- a) Unhygienic way to make fertilizer.
- b) Less contamination of essential chemical for fertilizer due to open pit.

4.3.3 *Khikhamoga*:

Khikhamoga is a public toilet or open defecation place for women. Especially *Khikhamoga* is used as reed covered place. Reed controls bad smell. But in Siddhipur, it is not in a reed covered place. They use a ditch as a place for *Khikhamoga*.

Figure 12: Public Toilet for Women in Siddhipur.



Source: Field Survey 2006

Advantages of open defecation place:

- a) To remove defecation place problem.
- b) It helps to control defecation everywhere.

Disadvantages of open defecation place:

- a) Unhygienic way for defecation.
- b) Poor sanitation.
- c) Difficult to live its surrounding.

The traditional system of disposing household waste is still practiced by the most of the people. *Nauga*, which is dug under the staircase, is used for accumulating ash. It is also used as urinals. *Saga* which is bigger than *Nauga* is often located at the back of the house. In the *saga* all types of liquid, household waste are thrown. The traditional system of defecation place is practiced by the most of the people.

To remove unhygienic system, ECOSAN toilets could be appropriate options because it is a means of sustainable non-polluting system based on recycling

4.3.4 Drawbacks of traditional system:

Advantages and drawbacks of traditional system are:

Table 1: Advantages and Drawbacks of Traditional System

Drawbacks	Advantages
Unhygienic way to accumulate ash for making fertilizer.	To accumulate ash for making fertilizer.
Unscientific way to use urine and faeces as fertilizer.	Way to use urine and faeces as fertilizer.
Spreads bad smell.	Reed covered area is used as <i>Khikhamoga</i> to control bad smell.
Less contaminations of essential chemical to fertilizer.	Manure is useful to agriculture.
Unscientific and unhygienic technology.	Indigenous technology.
Open and polluting system.	Easy and convenience system.
Can't be free from flies and mosquito.	

Chapter - Five

DATA ANALYSIS AND INTERPREATION

This chapter incorporates the analysis and interpretation of data collected from the respondents. Total 59 (fifty nine) HHs survey was conducted. The questionnaire contains general information, social information, economic information, environmental information, agricultural information, human waste disposal information, health and sanitation information and other related information. Please see the attached sample questionnaire. For easy understanding the analyzed data are presented in graphical forms.

5.1 Total Population:

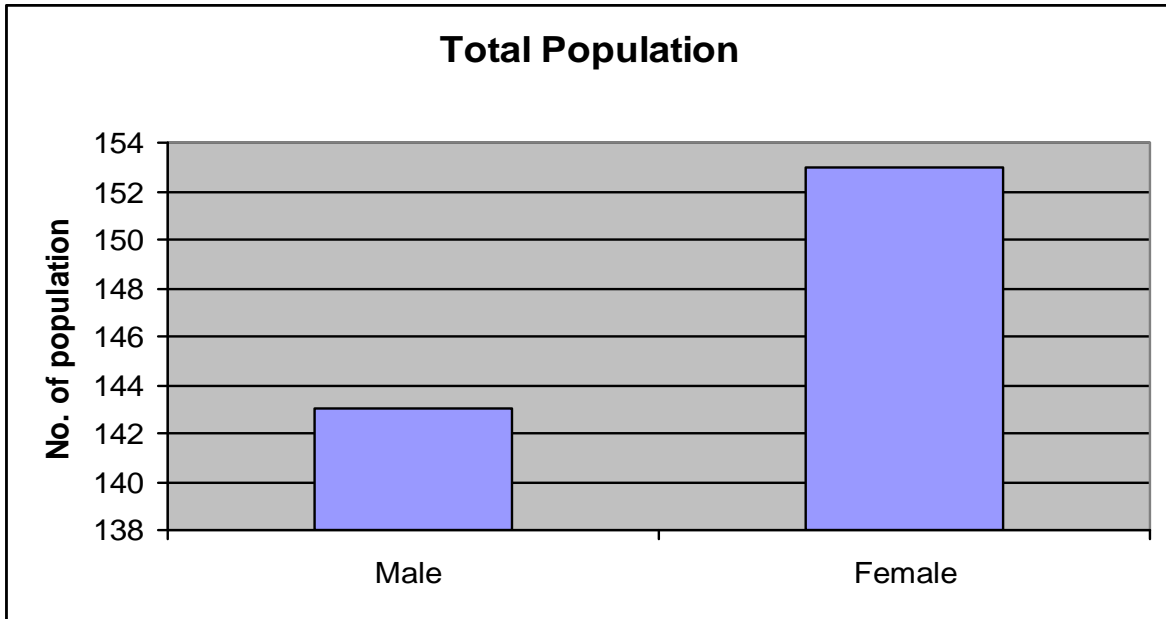
There are 59 ECOSAN users HHs during survey period. The distribution of male and female population is shown in Table 2 below.

Table 2: Total Population

Total Population	Male	Female
296	143	153

Source: ENPHO 2061/62

Figure 13: Total Population



Source: ENPHO 2061/62

The analysis showed that 59 HHs altogether 296 population of which 153 female and 143 male.

5.2 Income Sources:

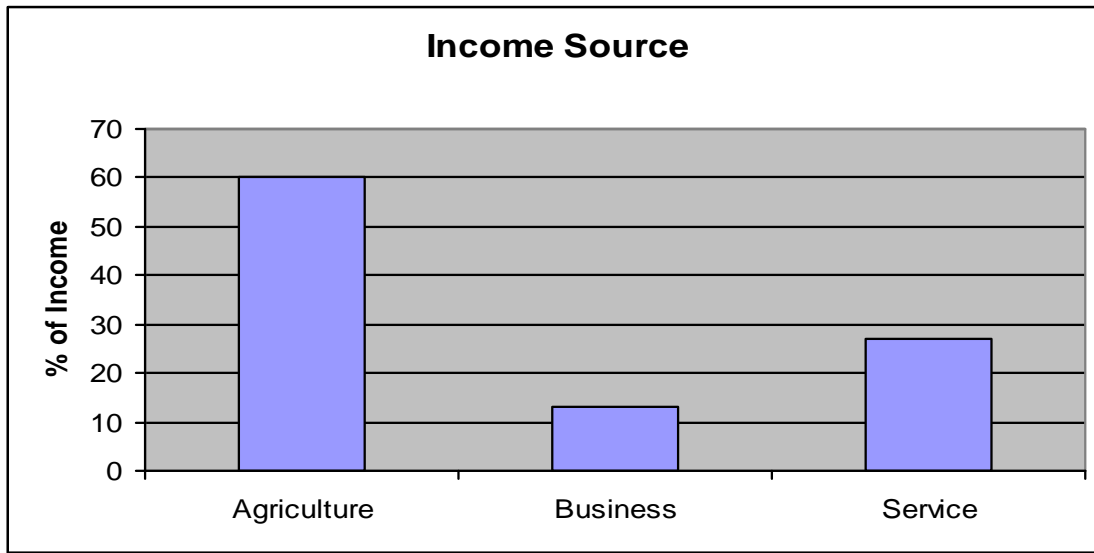
Agricultural is the first main occupation of each HH. The people are opting some other profession during off farm period. However they are in micro scale. All HHs have agriculture as prime profession where as 40% each; of the HHs have service and business as traditional profession respectively. The distribution of income source is shown in Table 3 below.

Table 3: Percentage of Income Source

Agriculture	Business	Service
60%	13%	27%

Source: Field Survey, 2006.

Figure 14: Income Source



Source: Field Survey, 2006.

The main income source is agriculture 60%, service 27% and business 13%.

5.3 Agricultural Land:

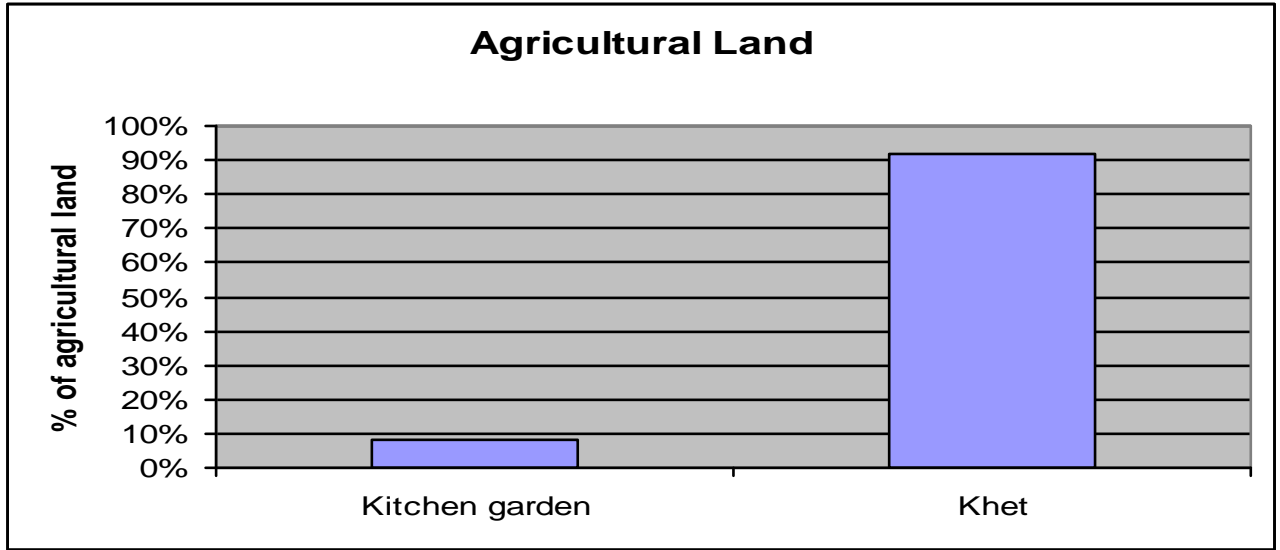
Two types of agricultural land are found *Khet* is 92% and kitchen garden is 8%. The distribution of percentage of agricultural land is shown in Table 4 below.

Table 4: Percentage of Agricultural Land

Types of Land	Ropanies	Percentage
Khet	134.5	92
Bari	11.8	8

Source: Field Survey, 2006.

Figure 15: Agricultural Land



Source: Field Survey, 2006.

The cultivated land is around 147.5 ropanies. These households have around 134.5 ropanies of *khet* and 11.8 ropanies of kitchen garden. They have been practicing agricultural traditionally. About 90% household know about organic manure.

5.4 Investment in Agricultural:

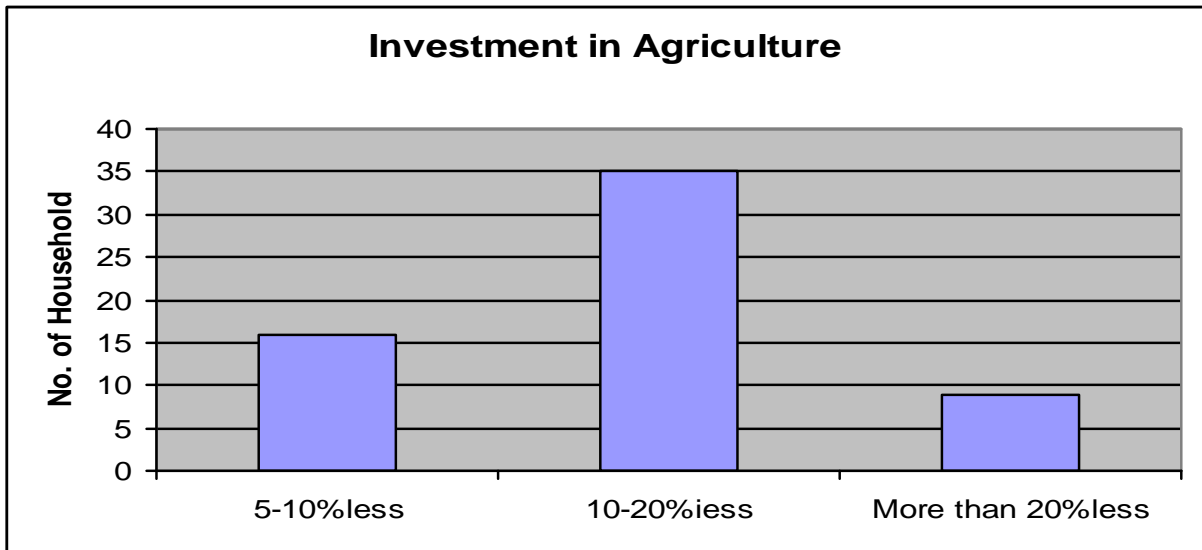
After using ECOSAN toilets, investment in chemical fertilizer had been lowered. According to survey, 17 HHs said 5 to 10% less in agriculture investment, 35 HHs said 10 to 20% less in agriculture investment and 7 HHs said that more than 20% less in agriculture investment. The distribution of decreasing percentage of investment in agricultural is shown in Table 5 below.

Table 5: Decreasing in Agricultural Investment

Decreasing % in investment	5 to 10%	10 to 11%	More than 20%
No. of Households	17	35	7

Source: Field Survey, 2006.

Figure 16: Investment in Agriculture



Source: Field Survey, 2006.

Not only change in fertilizer investment; change also in production and taste. All most all users told little increase in agricultural production. They know appropriate use of chemical fertilizer by the organization's training. A little few told that less in agricultural production due lack of appropriate use of chemical fertilizer.

5.5 Use human excreta as fertilizer:

Whole toilet users use human excreta as fertilizer. Before ECOSAN toilet, half of the total HHs doesn't use human excreta as manure and rest halves do so.

Response to application of human excreta as manure: All most all users said that it helps in money saving, increase in production. Some of them said that the use of fertilizer makes good tasty in agricultural production.

5.6 Harvesting:

All of them harvest twice in a year.

5.7 Source of Drinking Water:

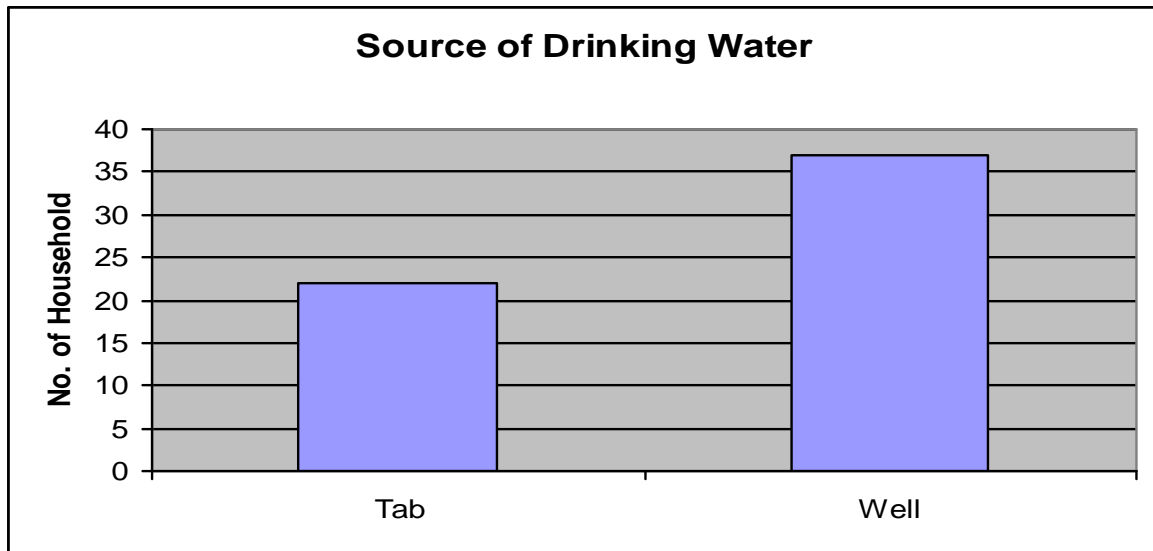
Sources of drinking water are tap and well. 22 HHs use tap and rest of 37 HHs use well for drinking water. The distribution of sources of drinking water is shown in Table 6 below.

Table 6: Sources of Drinking Water

Source of Drinking Water	N0. of household	Percentage
Tab	22	37.288
Well	37	62.711

Source: Field Survey, 2006.

Figure 17: Source of Drinking Water



Source: Field Survey, 2006.

22 HHs use tap and rest of them use well.

5.8 House having toilet before using ECOSAN:

Only few household have toilet before ECOSAN toilet. Although they have toilet; toilet is not in good sanitation. So, they use open place for defecation. About 32 household's female use

Khikhamoga and rest of the HH's use *Khet*, stream bank and other places; male use stream bank, *Khet* and other places and children use *saga* and other places where they like.

5.9 Defecation Place for Women

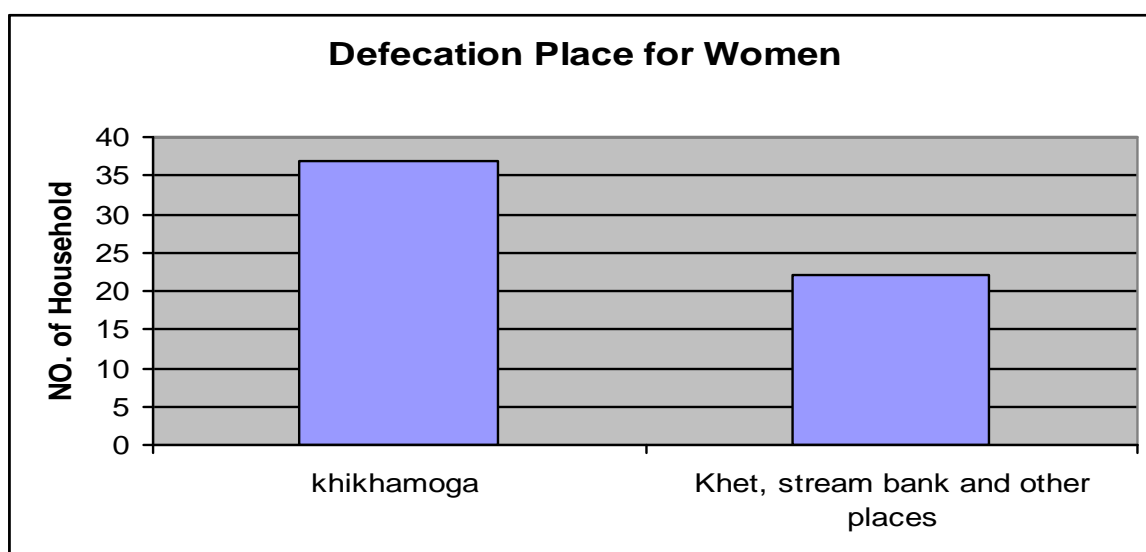
Only few household have toilet before ECOSAN toilet. So, they use open place for defecation. About 32 household's female use *Khikhamoga* and rest of the HH's use *Khet*, stream bank and other places. Male use stream bank, *Khet* and other places and children use *saaga* and other places where they like. The distribution of defecation place for women is shown in Table 7 below.

Table 6: Defecation Place for Women

Defecation Place for Women	No. of Household	Percentage
<i>Khikhamoga</i>	32	54.237
Stream Bank, <i>Khet</i> and Other Places	27	45.763

Source: Field Survey, 2006.

Figure 18: Defecation Place for Women



Source: Field Survey, 2006.

There is about 4 *Khikhamoga* in different tole. Most HH needs less than 15 minutes one way to go defecation place. Few HH needs 15 to 30 minutes for one way defecation place.

5.10 Traditional method for making ash before ECOSAN:

All most all users' HH have *Nauga* or *Saaga* in their houses. Mostly they cleaned out two times in a year as their culture. They cleaned *Nauga* and *saga* in especial days ie, *Sithi Nakaha* and *Lokh Mahadev puja*.

5.11 Effect of open defecation place:

All of them know that open defecation place effect neighbors or the people near to the open defecation place. Well, they use open defecation place due to lack of toilet in their houses.

5.12 ENPHO's support:

Most of them are unable to invest in toilet construction due to their economic condition. Total cost per toilet need around 16,000.00 (Sixteen thousand); ENPHO contribute around 9,500.00 (Nine thousand five hundred) or up to pan level. Beside that ENPHO giving awareness about use of human excreta, traditional unhygienic manure making process, health and sanitation etc. so, they start to use ECOSAN toilet.

5.13 Difficult to use toilet:

Most of them told that guest doesn't know about the proper use of toilet. Lack of proper knowledge, guests make toilet dirty. So it is difficult to use when new guest come to their house.

5.14 Cleanness of toilet:

90% ECOSAN toilet remain in clean condition. Beside that some toilet are not clean and some are very dirty.

5.15 Suggestion for toilet:

Size of ENPHO constructed toilet is 4 ft. 2 inch/ 6ft. 10 inch. Some of few users suggested that it will be to enlarge slightly.

The above simple bar diagrams and percentage bar diagram shows that ECOSAN toilets help in economic development, social development, environment development, water protection, and health and sanitation improvement.

Chapter - Six

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The following conclusions are drawn based on the result of present study.

-) The study concludes that urine separating or non mixing system toilets are found accepted by communities because of their manure value especially in farmers communities whose income in the middle income level. Key factors of acceptance are practice of human excreta use as manure, environmental benefit, improvement of traditional method, economic benefit as well as social benefit.
-) Using human excreta as manure reduce investment in chemical fertilizer. At the same time increases in production with good taste. Long term use of chemical fertilizer reduces soil fertility. Long term use of human excreta improves soil fertility rate in sustainable way.
-) Growing cities like Kathmandu is at verge of water and sanitation facilities. Authorized organization are nor able to produce good water to meet the demands. Of the total supplied water to the consumer, 37% of the total water is lost as leakage. The facility of the sewer lines to convey public waste water to appropriate disposal sites and their treatment is essential. The major implementation to tackle such problems in the past failed. The treatment before disposal is essential to environment. Nowadays rivers are nothing than an open sewer canals. ECOSAN helps to protect water source from the contamination of human waste.
-) It helps reviving the traditional yet forgotten art of applying night soil to agricultural fields in scientific and hygienic way which means socio-cultural improvement.
-) All users use human excreta as manure properly. Some toilets have leakage problem in urine tank. Beside leakage of urine, almost all toilets function well.
-) ECOSAN is hygienic and scientific way to accumulate urine, faeces and ash for making fertilizer. It contains high value of essential chemical for fertilizer. It controls bad smell due to closed system. So we can say that it is best than traditional sanitation system.
-) Seventy percent have toilet. Rest use *Khikhamoga*, stream bank, *Khet*, *Bari* etc. Among 70%, 10% people have toilets with septic tank. Rests of them don't have hygienic toilets. ECOSAN toilet has good impact due to lack of sanitation toilet.

-) Advantage of ECOSAN are smell less, protect water from contamination, use less quantity of water and produce essential chemical contaminated fertilizer for agriculture. Beside its advantages, it is difficult to use. Chance misuse by guest due to lack of knowledge, information and training.

6.2 Recommendations

6.2.1 Recommendation for Improvement

The following areas need to carry out for improvement:

-) Awareness, information, knowledge, training are necessary for toilet users as well as non users which protect chances from misuse.
-) Continuous monitoring and follow up are required at least for one complete cycle for correction of the knowingly and unknowingly made mistake by the users, to make benefit visible and thus works as driving force to sustain the unit forever.
-) Leak test of the structure, tightness and gradient tests of pipe need to be assure carefully before commissioning the units.

6.2.2 Recommendation for Future Study

The following areas need to carry out for further study:

-) The availability of ash is not always possible. Alternatives of easily available like rice husk saw dust, soil and mixing them with lime in a certain ratio is also an area for future improvement.
-) The crops verities its yields and health risk against the dose and way of application may be one of the areas for further study.

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Appendix

Impact of Ecological Sanitation Toilets on Sustainable Development

Eco San toilet is a little bit different between our usual toilets. In this toilet not discharge human excreta into river. Urine and night soil collect in different boxes in order to use as fertilizer.

Questionnaire used for field staff and representative of local institution

1) General Information:

- a) Respondent no. :
- b) Name of respondent :
- c) Date of interview :
- d) Post :

2) Why are Eco san toilets used?

- a) Fertilizer
- b) To protect environment
- c) To protect water from pollution
- d) All

3) Does Eco San's fertilizer use consumer properly?

- a) Yes
- b) No
- c) Don't
- d) Little bit

4) Why this area is selected for Eco San toilets?

- a) Main occupation is agriculture
- b) Near to Kathmandu valley
- c) Transportation facility is good
- d) Lack of toilet

5) How do you compare the impact of Eco San toilet on health and sanitation?

- a) More
- b) Little

c) No

6) How does Eco San benefit the society as a whole?

a) Economically

b) Environmentally

c) Socially

d) All above

7) Have you experienced any change in agriculture before and after Eco San toilet?

a) Yes

b) No

c) Little

d) Don't know

8) Do you have any suggestion for further improvement?

a) Yes

b) No

If yes how?

.....
.....

9) How do Eco San users feel about Eco San toilets?

a) Best

b) Good

c) Not good

10) How much was for construction of Eco San toilets?

a) Organization

b) Consumer

11) Before launching this programme what type of awareness is given?

.....
.....

12) The number of Eco San users increased day by day according to consumer's choice or organization choice

.....
.....

Questionnaire used for consumer interviews

A) General information

- 1) Respondent no:
- 2) Date of Interview :
- 3) Ward no. :
- 4) Name of tole :

B) Social Information :

- 1) Respondent's name :
- 2) Age :
- 3) Gender : a)Male b)Female
- 4) Occupation : a)Housewife b)Farmer c)Businessman
d)Student e)Service holder
- 5) Education : a)Literate b)Illiterate
If literate up to a) Primary b) Secondary c) Higher
- 6) Number of family members: a) Male b) Female.....
- 7) How does the Eco San benefit the society as a whole?

C) Economic Information:

- 1) How much land do you have?
 - a) Kitchen gardenropani.
 - b) Khetropani.
 - c) Bariropani.
- 2) How much is your yearly income?
 - a) Salary
 - b) Business
 - c) Agriculture
 - d) Others
- 3) How much did you use to invest in chemical fertilizer before Eco San?
- 4) How much has your investment in chemical fertilizer been lowered after using Eco San?
.....

5) What changes have you observed before and after agriculture production?

- a) More
- b) Little change
- c) No change

6) How far is farm land from your house?

- a) Less than 50 m
- b) Up to 500 m
- c) Up to 1000 m
- d) Up to 1500 m
- e) More than 1500 m

D) Environmental Information:

1) To what extent the water source has been protected?

- a) More
- b) Little
- c) No
- d) Don't know

2) Does it help to keep cleanliness of surroundings?

- a) Yes
- b) No
- c) Don't know

3) How much distance between Eco San and water source?

- a) Less than 5 m.
- b) Up to 50 m.
- c) Up to 100 m.
- d) Up to 150 m.
- e) More than 150 m.

4) Do you think that Eco San has lowered air pollution?

- a) Yes
- b) No
- c) Don't know

E) Agricultural Information:

- 1) How much did you use to invest in chemical fertilizer before Eco San?
- 2) How much has your investment in chemical fertilizer been lowered after using Eco San?.....
- 3) What changes have you observed before and after agriculture production?
 - a) More
 - b) Little change
 - c) No change
- 4) What changes do you observed before and after taste in agricultural production?
 - a) More
 - b) Little change
 - c) No change
- 5) Do you use Eco San by- product in agriculture as fertilizer properly?
 - a) Yes
 - b) No
- 6) What type of fertilizer had been used before Eco San?
 - a) Organic
 - b) Inorganic
- 7) How many times is the land harvested once a year?
 - a) One
 - b) Two
 - c) Three
 - d) More than three

F) Health and Sanitation Information:

- 1) Main source of drinking water
 - a) Tap
 - b) Well
 - c) Tube well

d) Other sources

2) Do you have toilet in your home before Eco San toilet?

If no, which place is used for toileting?

- a) Stream bank
- b) Khitamoga or open place
- c) Anywhere

2) i. Where do the adult family members go for defecation?

- a) Defecation place for male
- b) Defecation place for female

2) ii. Where do the children go for defecating?

.....

2) iii. Way of cleaning after defecation.....

3) Which place is used for rainy season?.....

4) How much time does it take you to commute for defecation?

- a) Less than 15 minutes.
- b) 15 to 30 minutes.
- c) More than 30 minutes.

5) If yes, where do you dispose the by-product?

- a) Open place
- b) Agricultural land
- c) Poode
- d) Anywhere

6) Do you ever treat the by-product before disposing?

- a) Yes
- b) No

If yes, how?.....

7) Does open defecation effect neighbors or the people near to the open defecation place?

- a) Yes
- b) No
- c) Don't know

8) Do your children ever suffer from any diseases?

If yes, which disease?

9) Do you have naugal in your house before Eco San?

a) Yes

b) No

9) i. If yes where is it?

.....

9) ii. Use of naugal

a) Urinating

b) Defecation by children

c) Throw ash

e) Other (Specific)

9) iii. Do you think, naugal is good?

a) Yes

b) No

c) Don't know

9) iv. How often do you clean the naugal?

a) Once in three month

b) Once in six month

c) Four times in month

d) Occasionally

9) v. Who cleans it?

.....

.....

10) Do you have a saaga?

a) Yes

b) No

If yes.

a) Own.....

b) Common to two household.....

- c) Common to three household.....
- D) Common more than three household.....

If no,

10) i. Where do you throw waste?

10) ii. Use of Sagga

- a) Urinating
- b) Defecation by children
- c) Throw ash
- e) Other (Specific)

10) iii. How often do you clean the saga?

- a) Once in three month
- b) Once in six month
- c) Four times in month
- d) Occasionally

10) iv. Who cleans it?

.....
.....

11) Does guest properly use the toilet?

.....
.....

12) How do you compare the impact of on health and sanitation before and after Eco San?

.....
.....

13) Do you have any suggestions for further improvement?

.....
.....