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Cage fish farming for the livelihood improvement of the local people in Kulekhani, Nepal

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Master's thesis in International Fisheries Management…FSK-3910…May 2022

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ACRONYMS AND ABBREVIATIONS

IDRC	International Development Research Centre
FAO	Food and Agriculture Organization
DFID	Department for International Development
DoFD	Directorate of Fisheries Development
DLF	Directorate of Livestock and Fisheries
CFPCC	Central Fisheries Promotion and Conservation Centre
FDC	Fisheries Development Centre
AFU	Agriculture and Forestry University
PU	Purbanchal University
TU	Tribhuvan University
NARC	Nepal Agriculture Research Council
JICA	Japan International Co-operative Agency

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ABSTRACT

In Nepal, cage fish culture in the lake and reservoir has plays important role in the improvement of the livelihood of local people through creating employment, improving incomes, and assuring food security. Cage fish farming in Kulekhani was implemented with the support of the International Development Research Centre, Canada (IDRC) and the Nepal government to improve the livelihood of those people who were displaced by the impoundment of the reservoir. The local people in Kulekhani reservoirs have been practicing semi-intensive fish farming over extensive farming system because of its satisfactory production with low investment cost. This study is conducted to find out how cage fish farming in Kulekhani contributes to the changes in the local people's livelihood. The study also aimed at finding out the social and economic obstacles faced by potential local people for cage fish farming. In Kulekhani, Balami, Majhi, Tamang, and Pode are those ethnic communities who are involved mainly in fishing for their living, and recently they are adopting cage fish farming for better living.

Cage fish culture has helped the displaced people, poor, indigenous, and marginalized communities by providing income, food security, and a healthy community where everyone is living without being discriminated. Nowadays, cage fish culture in Kulekhani reservoir has been observed as valuable to all people from the community, not only to those who were displaced by the impoundment of the reservoir, landless, poor, or untouchable groups. Cage fish culture has gained popularity in Kulekhani but the establishment of more cages in the area is hampered due to various problems. The result shows that the major constraints related to the adoption of cage fish farming are lack of knowledge, lack of capital and discrimination between upper and lower caste, rich and poor people were major.

1. INTRODUCTION

For the past centuries, aquaculture introduced in many parts of developing countries, such as Africa and Asia. The objective is to open opportunities for local rural communities to improve their standard of living and escape from poverty. The promotion of aquaculture for rural development has had a poor record in many developing countries (Edwards, 2000). However, the recent adoption of new technology suggests that, with adequate support, aquaculture has potentially contributed significantly to rural development in countries where it is neither a traditional nor widespread newly established practice (Edwards, 2000). It is believed that aquaculture can be a potential way for poor rural people to earn a living, and to improve the socio-economic situation through improved income, employment and food supply. In addition, exports from aquaculture can also develop into a valuable source of foreign exchange for national development in some countries. (Olaganathan & Kar Mun, 2017). Nepal for example is rich in fresh water sources and has only inland water. This may represent a potentiality for aquaculture developments in Nepal. Hence, aquaculture seems to gain popularity nowadays among local people in Nepal. The common fish cultures used in Nepal are pond culture, cage culture, pen culture, rice cum fish culture, and raceways culture.

Local people have recognized that water resources are not only important for household use and irrigation but can be a source of income generation. The people who live around the natural water bodies quite often belong to so-called "untouchable" ethnic groups. They are landless and amongst the poorest people in the country. Their main livelihood has traditionally been fishing. For the untouchable ethnic groups who live around the water resources, Aquaculture is probably the main employment and the only form of livelihood. The main aim for the development of aquaculture sector agriculture in Nepal is to improve livelihood, and nutrition and to provide opportunities for these rural and marginalized people. But nowadays, aquaculture has become an alternative source of livelihood for other ethnic groups in Nepal. Cage culture is seen as promising aquaculture technology that makes proper use of lakes, rivers, and water reservoirs.

1.1 WHAT IS AQUACULTURE?

Aquaculture is simply known as the farming of aquatic organisms by strengthening the utilization of natural resources and done in a controlled process for human consumption (Khadka & Tiwari, 2020). In the context of Nepal, the farmed aquatic organism is only fish. The Food and Agriculture

Organization (FAO) of the United Nation defines aquaculture as "the farming of aquatic organisms including fish, mollusks, crustaceans, and aquatic plants"((FAO), 2020). Aquaculture includes all the activities from producing aquatic organisms to delivering the products to the consumer. This includes things like hatching, growing, harvesting, marketing, and selling (Parker, 2011). Aquaculture can be warm water aquaculture, cold water aquaculture, and freshwater and marine or saltwater aquaculture (Rath, 2018). It means aquaculture can be done in the oceans, in freshwater bodies, or ponds and tanks on the land. Around the world, aquaculture plays an important role in filling the animal proteins with poor resources, helps in providing various career opportunities, and helps in conserving wild aquatic organisms' population (Olaganathan & Kar Mun, 2017).

Fishing and aquaculture often take place in the same environment. Therefore, it is important to distinguish between fishing and aquaculture. Fishing is the harvesting of already existing populations of fish, exploited by the public as common property resources, and people involved in it are called fishers, but aquaculture includes growing, rearing and then only harvesting by identifiable owner and the people involved in is it called fish farmers (capstone, 2020). Both matured and immature fish are captured randomly in fishing, but only mature fish are captured in aquaculture. Fishing is concerned only with fish, but aquaculture is related to both aquatic plants and animals (capstone, 2020). Since Nepal is landlocked country, we find freshwater aquaculture in Nepal. In Nepal, the history of aquaculture is about 60 years, which is considered comparatively short compared to aquaculture in other developed countries, while fishing from nature is being practiced since ancient time in Nepal (Shrestha, 2018). The fish catches have declined because of overfishing, and strict rules against illegal fishing are introduced. Fishing requires much labor and is time consuming. In addition, there is a movement working for conservation of water resources. Of such reasons, fishing people shifted from traditional fishing to aquaculture on man-made ponds (Khadka & Tiwari, 2020). Pond culture is a very popular, common, old practice and a major contributor of total aquaculture production in Nepal (Kunwar & Adhikari, 2016).

1.2 RESEARCH OBJECTIVES

The objective of this research is to describe the situation of cage fish farmers in selected area of Nepal and to examine the potential of improving the livelihood of the fish farmers community in Kulekhani area by cage fish farming. The study focuses on the marginalized group of community,

who do not have any other source of income and the local people, who are displaced by the impoundment of the reservoirs. To achieve these general objectives, the study will

1. Explore the social and economic obstacles faced by potential local people for cage fish farming.

2. More specifically discuss how cage fish farming in Kulekhani contributes to the changes in the local people's livelihood.

1.3 RESEARCH QUESTIONS

To achieve the objective of the study, the following research questions will have to be answered.

- What are the main challenges faced by local people in communities in relation to cage fish farming?
- How has cage fish farming affected the livelihood of local people in Kulekhani?

1.4 JUSTIFICATION AND RELEVANCE

The purpose of the study is to produce knowledge about the impact on the livelihood status of the local people in the community through cage fish culture. Furthermore, it is interesting to know the problems faced in cage fish farming. Since cage fish culture is a relatively new and underdeveloped farming practice compared to agriculture and animal husbandry in Nepal, hence, it is important to explore the potential contribution of cage fish farming as a rural development strategy.

It is limited amount of research conducted about this in Nepal. The results from this study could motivate other people from different part of the country to practice cage fish farming and get benefits of it through improved food supply, employment, and income generation and ultimately improve the livelihood of the marginalized communities. The study findings will also help governmental offices, fisheries development experts and researchers to provide strategies for encouraging to do research on how it can be improved to uplift the social and economic status of poor people along with sustainable development.

1.5 ORGANIZATION OF THE STUDY

The study is organized in five chapters. Chapter one is the introduction part with background information about aquaculture, objectives of the study, the study research questions and justification and relevance. Chapter two is a literature review including lessons learned from it. Chapter three covers methodology and comprises geographical description, detailed background

information of research area and communities, data sources, criteria for selecting materials used and limitation. The main findings are presented in chapter four. Chapter five is the discussion part of the study and concluded remarks are also presented in this part of the study.

2. AQUACULTURE IN NEPAL – A LITERATURE REVIEW AND KNOWLEDGE STATUS

2.1 DIFFERENT FORMS OF AQUACULTURE

Mainly there are three types of aquacultures culture system adopted by the inland fish farmers around the world and they are extensive fish farming system, semi-intensive fish farming system and intensive fish farming system (see figure 1). Extensive fish farming is the least managed fish farming where capital, labour and care are low. In a developing country like Nepal where many people live below the poverty line with few possibilities to invest, many people prefer to adopt extensive practices of aquaculture. In this type of culture fish depends only on natural food, no supplemental feed or fertilisation is provided. Consequently, the yield is also low with compared to semi-intensive and intensive farming.

The semi-intensive fish farming requires moderate level of labour, capital and feed and certain amount of management is required, which ultimately increases the yield of fish. Like extensive system, main feeding source is natural food, but added with supplemental feeding and fertilisation which helps to increase fish production (Carballo et al., 2008).

Intensive fish farming system is a highly managed form of fish farming where proper management must be done to achieve maximum production. In this system, investment cost is high, and the fishes are fed on artificial food in addition to the natural feed, natural food has minor role (Carballo et al., 2008). Huge salmon farming industry in Norway is intensive farming in salt water. Most of the saltwater fin fish and prawn aquaculture in salt water are intensive systems. Norway's aquaculture sector for salmonids (salmon, trout, etc.) is the largest in the world.(SOFIA, 2021)

The extensive fish farming is a cheaper and environmentally friendly fish farming system, because it does not introduce nutrients into the water body. In the extensive system, fish are stocked in low densities. Mainly plankton feeding fish like silver carp and big head carp are used as main species in cage fish culture. Sometimes, Rohu species are reared in small stocked because they feed on detritus attached to cage mesh which helps to keep cage clean (Shrestha & Pant, 2012). Plankton means minute organisms that are found in water bodies and can be divided into two types as phytoplankton (plant like organisms) and zooplankton (animal like organisms). The productivity of cage fish farming depends on nutrients of the lakes and naturally available plankton. Production input cost is low in cage fish culture so poor people can easily afford this

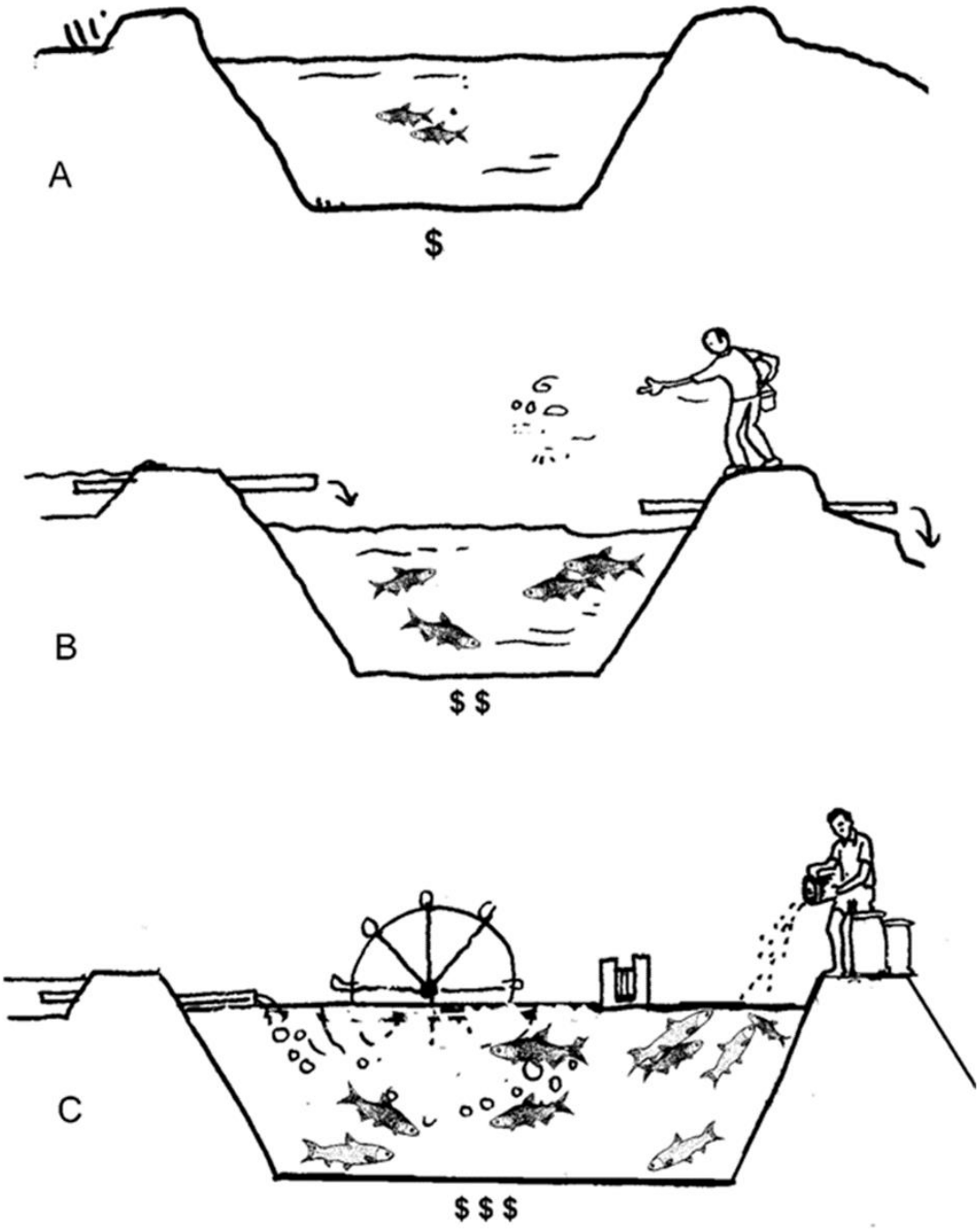

Figure 1: A) Extensive fish farming system, B) Semi-intensive fish farming system and C) Intensive fish farming system. Source: (Carballo et al., 2008)

The establishment of water bodies after the damming of the rivers is called reservoirs. The reservoirs are mainly made for two purposes, hydroelectricity generation and irrigation. However, these reservoirs are suitable for cage aquaculture. Hence, establishment of aquaculture in dams is

gaining popularity (Weimin et al., 2006). Such use of water resources is expected to boost food security and create livelihood for people living around the reservoirs (Weimin et al., 2006). Most of the dams in the world are developed for irrigation (approx. 48 %), hydropower (approx. 20%) and other multipurpose dams include water supply, flood control, recreation, fish farming etc. (Sharma, 2010). Cage fish culture, pen fish culture and polyculture are common fish farming practices done in dams. In dam, water current will be less, so cage landing is safe in cage fish culture. Floating net cage aquaculture can be used as a sustainable and important new means of large-scale population resettlement from hydropower dam construction in developing countries. Fish yields are comparatively better in reservoir cage fish farming compared to other culture-based fisheries and cage culture in dam is appropriate because it is minimally polluting and maintains the ecological health of the reservoir (Das et al., 2009).

2.2 CAGE FISH FARMING AND POTENTIAL FOR BETTER LIVELIHOOD

Many researchers have studied how fishing and aquaculture has influenced the fish farmer's livelihood or how farmers have been impacted by it in different countries (Table 1). However, there are less research conducted about this in Nepal. One study is: "Contribution of small-scale cage fish culture to poverty reduction and sustainable development in Nepal: A socio economic update (Wagle, Shrestha et al. 2012). This paper presented the status and future scope of small-scale fish culture in Nepal. It described how cage fish farmers has experienced low productivity that have influenced their economic status. This also discussed how fish farming can be improved to uplift the social and economic status of poor people. Similar research has also been conducted in Bangladesh "The Sustainable livelihood approach to the development of fish farming in rural Bangladesh" (Ahmed 2009). This research described how fish farmers can achieve livelihood improvement through access to a range of livelihood assets, like financial capital, human capital, physical capital, etc. The research also described the potential of fish farming to provide higher economic returns and social benefits for the fish farming population. In the following sections, I will present some findings from research on cage fish farming around the world.

Livelihood means living a life by securing the necessities of life that is used in everyday life like food, water, shelter and clothing. DFID (1999) defines livelihood as comprising the capabilities, assets (including materials and social resources) and activities required for realizing a means of living. According to (Bhujel, 2009), cage fish culture which is practiced in lakes, reservoirs and

rivers in different parts of the world is very old practice. The advantages of cage culture over other culture systems are its ability to use different types of water resources such as lakes, reservoirs, ponds and rivers, which could be unsuitable for fish farming due to difficulties in harvesting (Kenya, 2009).

According to De Silva and Davy (2010), reservoir-based fisheries and aquaculture have successfully generated food, income, and alternative livelihood opportunities for people. Despite the fact that cage fish culture is an old tradition, it has rather recently developed into a major sector in aquaculture. (Anjejo, 2019) noted that even though Egypt has limited sources of water, these practices have been promoted for providing huge number of job opportunities to the people in areas with water sources as the farms requires technicians and skilled laborers. In addition, beyond job opportunities, cage cultures offer a better fish production technology with minimum work efforts (Anjejo, 2019).

Tilapia cage culture in Thailand and Vietnam and cage fish culture in Phewa, Begnas and Kulekhani in Nepal are good examples in Asia of how cage culture has contributed to improvement in the livelihood of fishers of people. According to Bhujel (2009), people from different marginalized ethnic groups and especially landless people are more attracted towards cage fish farming in unused lakes, reservoirs and swamps and also local fisher communities are converted permanent settlers in cage fishing.

Cage culture can be a livelihood option for displaced peoples due to hydropower dam constructions. It is estimated that a tremendous number of dams are constructed in the coming years (Husen, 2018). While some of the literature showed that cage fish farming can have a few negative impacts on the environment, water bodies, it also can provide economic and social benefits such as employment generation, increase the income and food security. Hence, it may contribute to the improvement of livelihood conditions of the fish farming societies (Ng'Wigulu, 2021). Ng'Wigulu also mentioned that in an area around Lake Victoria women are participating in harvesting, processing and marketing activities based on cage fish farming.

Table 1: Literature review related to benefits of cage fish farming. Source: (Ng'Wigulu, 2021)

Article	Location	Benefits	Observations

(Jacobi, 2013)	Lake Victoria-Kenya	Cage fish farming empowered underprivileged group, women and youth. Improved the living standard of farmers in terms of food, shelter, health, and education.	Most fish farms are small-scale and usually family owned. Many of the farmers were elderly and male, often receiving a pension or having a regular income generating business.
(Anjejo, 2019)	Lake Victoria-Kenya	Cage fish farming contributes to the livelihood of the communities in terms of food security, employment generation like in construction of sinkers and floaters, weaving nets, etc., income generation, assets (Lands and houses) and business-like selling plastics and fish feeders	Most fish farms are owned by foreign investors, locals (men) involve as cage laborers while women involve in the fish trade
(Paudel, 2014)	Phewa lake-Pokhara	Many Indigenous, poor and untouchable people have been able to increase the income through cage fish farming and fish related activities. This has been a great source of income for the poor, marginalized, landless and untouchable groups.	The study focused on poor and untouchable communities who live around the lake: Pode and Jalaris who do not have access to land.

(Natarajan & Joseph, 2020)	Southwest coast of Kerala, India	cage fish farming in the coastal waters of Kerala has potential for enhancing the farmers income and improved the coastal livelihood	The respondents comprised of individual owners, partnerships and self -help group members.
(Phillips & DeSilva, 2004)	Asia	The cage aquaculture sector supports the livelihoods of the people through job creation, poverty reduction, trade, and food supply	The increased benefits to the community are due to improved technology, quality seeds and feed

2.3 STUDIES OF CAGE FISH FARMING IN NEPAL

According to Swar and Pradhan (1992), Fish farming in Phewa Lake and Begnas lake of Pokhara valley has the highest production of fish in comparison to other places of Nepal. Also, water resources have been used for cage fish farming which helps to support the livelihood of fisher family and improved the living standard in Pokhara valley (Swar & Pradhan, 1992).

Swar (2002) has concise that involvement of farmers or fishers in cage fish farming can help to protect important fish species and reduce the mortalities of non-targeted aquatic organisms and small sized fry and fingerlings because the fishers will stop to use destructive fishing gears (Swar, 2002).

Gurung (2014) has stated that cage fish farming increases job opportunities, helps to increase income, and also helps to control migration rate by uplifting living standard of people life. Besides fulfilling basic needs of family, cage fish farming helps in the payment for children's education, health, and other family related needs of the household. Sharma (2008) has concluded that water resources available in Nepal gives an opportunity to the people to uplift their life by the electricity production, irrigation and fish farming. Wagle et, al. (2012) noted that due to cage fish farming Indigenous fish farmer communities in Pokhara near Begnas Lake have been able to send their

children to school, has changed thatched house to concrete or tin roofed house, has got to eat nutritious food and has improved their livings in other different parts (Wagle et al., 2012).

Nepal has caste system and has social discrimination mentioning untouchable to lower caste especially Indigenous fishing tribes based on caste system. According to Poudel (2014) Fish farming has also played an important role in eradicating social discrimination and contributes to women empowerment and gender equality in the country.

2.4 CHALLENGES IN CAGE FISH FARMING

According to (Weimin et al., 2006), fish farmers in China are less passionate in cage fish farming because common species cultured in cages like common carp, grass carp and tilapia produced high yields, but the economic returns are low due to low price. Also, it has high feeding costs and fish farmers are not satisfied with low market value. The reason behind the high feed cost is China import almost all fish meals which automatically makes the feeding cost high. According to him, cage fish farmers are having conflicts with government and environmentalists because government and environmentalists are more worried about the pollution and water quality deterioration caused by cage fish farming in the reservoirs. However, reservoirs are famous for good quality of water but recently some fish diseases have been common in cage fish farming which is another emerging problem for cage fish farmers in China. But in case of Nepal, high production solely dependent on plankton available in the water body and cage cultured species are fed on locally available supplementary feeds like aquatic weeds and byproducts from grain processing and oil extraction (Weimin et al., 2012).

According to Weimin et al. (2012), cage farming has number of problems related with environment like deterioration in water quality which could lead to high risk of occurrence of diseases and treatment of diseases in cage cultured is more difficult compared to other types of culturing. According to him, cage destruction is another problem faced by farmers in Kenya, aquatic animals like hippos, crocodiles can make breakage in net from where fish can escape easily which directly or indirectly impacts on wild fish populations. Another problem is difficulties in removal of fish mortalities and wastes (Kenya, 2009).

According to Bista, J., et al. (2012) there are certain problems faced by cage fish farmers which is quite different from other countries cage fish farmers, and they are poor access to cage net materials because readymade net cages and net materials are imported from abroad and all farmers

do not have access to it. And another is shortage of cage frame materials that is bamboo which is not commercially cultivated so it cannot be found easily in every place. Also, inadequate supply of fish seed has been another major restriction to support the productivity of cage fish culture.

2.5 LESSONS LEARNED

From this short review where I have focused on freshwater, cage fish farming has expanded all over the world. There are some studies about how cage fish farming especially positively affects the livelihood of farmers. In most of the Asian countries focus has been on marginalized fish farmers in deprived communities. A lesson that is learned from this limited literature review is the importance of cage fish farming, in terms of employment opportunities and involvement of Indigenous ethnic groups and women. It also shows that this farming offers an opportunity to improve livelihood for especially fishermen and local people who lives around water bodies mainly rivers and lakes. This shows that nowadays not only fishermen of certain communities are only not involved in cage fish farming, but this has been increasing trends among other people. Hence, this has reduced conflicts between the fishermen and local people living around lakes and other users.

3. METHODOLOGY

The research is based on a literature and document study of texts related to cage fish farming. The methodology helps to provide the answer for the specific research question, also literature review helps to compare the views of different authors and compare past and recent data as well. To answer the research questions, I searched for data in Google Scholar, SAGE Journals, Google, Research Gate and Web of Science. Only articles and publications in English language were selected where I systematically reviewed literature related to cage fish farming, improvement of livelihood of fishermen in Nepal, involvement of ethnic groups in fishing, worldwide aquaculture and aquaculture in Nepal. In this literature I selected, identified, interpreted and critically evaluated whole texts and parts of the texts to answer formulated questions.

3.1 STUDY AREA

The study area Kulekhani was selected, as local people in Kulekhani are more engaged in cage fish farming and availability of Indigenous fishing community are more around the area of Kulekhani reservoir. Fishing and cage fish farming is the main source of income in the communities of Kulekhani. Kulekhani is situated in Makwanpur district approximately 42km from capital city of Nepal, Kathmandu and at 1,430 m above sea level. Kulekhani has first man-made reservoir in the country, in which cage fish farming has been implemented to provide a means of livelihood to the people who were displaced by the construction of the reservoir at first. Economic activities in this are mainly fishing, agriculture and other small business.

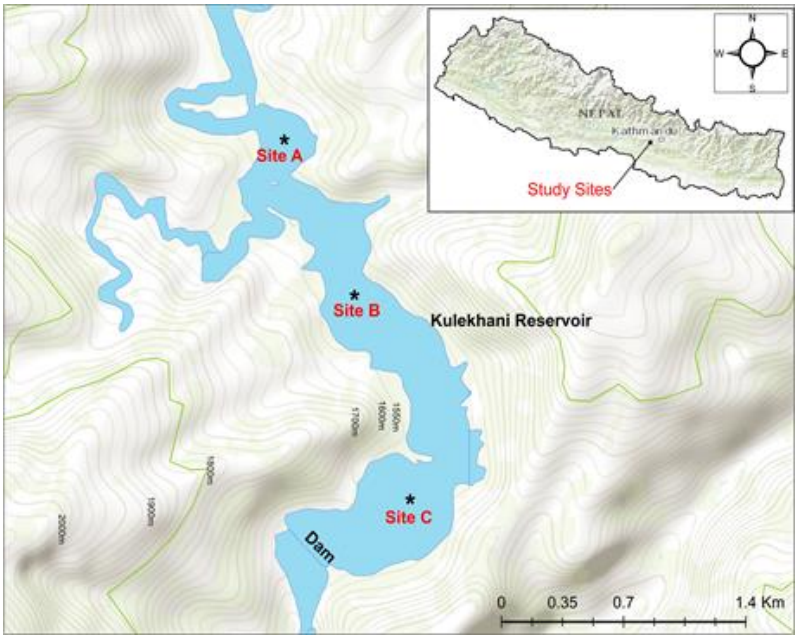

Figure 2: Map of Nepal showing Kulekhani and sites showing area for cage fish farming

Source: (Adhikari et al., 2017)

3.2 DATA SOURCES

Two types of data are used in research primary and secondary data. In this study secondary data are used. I used secondary data from published journals, newspaper articles, books, research papers, document from internet, articles, published thesis from Tribhuvan and Purbanchal University of Nepal and Maps. The sources were collected through either directly searching for topics like them, or through the following citations in these sources.

3.3 CRITERIA FOR SELECTING THE MATERIALS USED

Systematic search was conducted on the Internet using the following keywords: Aquaculture, cage fish farming, importance of cage fish farming, livelihood, problems of cage fish farming, lakes and reservoirs in Nepal, history of fishing and cage fish farming, traditional method of fish farming, National policies in aquaculture, ethnic communities involved, women empowerment, economic benefit from cage fish farming and cage fish farming in Kulekhani. The material that I found from this keyword was systematically reviewed. These keywords were searched for in English language and some in Nepali as well. I also searched for information and data related to the topic in Nepal government websites as well as FAO website. Most of the material was easily accessible. Some of the material was received only after registering and sending a request to the

author, and it took 1-2 days to receive material on the registered email address. I only used material that was open access and could be downloaded or read without payment. Because a very limited amount of material related to my topics was published, I collected the material without any restriction of the publication date.

3.4 LIMITATIONS

The idea behind the thesis is to explore challenges related to cage fish farming and to learn about changes that occur in livelihood for local people in certain communities. For this, I was supposed to do a short field trip to collect data through different methods, but because of COVID 19 restrictions I was unable to do so. Hence, the collection of secondary data was the only choice. This limitation, related to the research conducted, is reflected in the outcome and conclusions. No personal data or sensitive information that can be traced back to individuals are collected and handled in this research.

4. FISHERIES AND AQUACULTURE IN NEPAL

4.1. TRADITIONAL FISHING IN NEPAL

Nepal is a small landlocked mountainous country in South Asia, sharing its border with China in North and India on three other sides. Nepal is one of the least developed countries, and poverty and food insecurity is major problem of rural areas of this country (Joshi et al., 2010). Nepal is rich in water resources with rivers, lakes, ponds, swamps and reservoirs (Swar, 2002). Because of the freshwater resources, Nepal has potential for fisheries and aquaculture and the climatic conditions favor aquaculture cultivation of both warm and cold-water species. These water resources are also used for multiple purposes such as recreation, irrigation, hydropower generation and drinking water supply. The fisheries and aquaculture sector has gained importance in Nepal due to food and nutritional security, employment generation, poverty reduction, biodiversity conservation and livelihood of rural people. Fishing method is old and traditional in Nepal and also some unconventional way of fishing has emerged like using electricity currents, poisons and explosive materials which has been destroying aquatic life. Nepal aims to produce fish by utilizing its water resources through aquaculture (Mishra & Upadhyaya, 2011).

Fishing is the traditional occupation for especially to those who lives around the water resources in Nepal. Water bodies in Nepal are easily accessible to everyone, including, marginalized ethnic groups, marginalized communities and people living around water bodies. Generally, Majhi, Pode, Jalaris, and Tharu people belong to these groups. Many of the communities of these groups are deprived of agricultural land and people lack other skills.

Fishing methods and gears have been traditional in Nepal. cast net, gill net, baskets, bamboo traps, loop and line and hook are some traditional and conventional ways of fishing (Gautam, 2015). In inland capture fisheries, cast nets were the most common gear used for fishing. Cast nets, also known as throw nets and drag nets, are mostly used by people for fishing in lakes and rivers. People are fishing for various purposes, but in case of Nepal, in older days people used to fish for daily livelihood. Nowadays, people are fishing as their hobby, hunting and included as leisure activities in tourist areas like Pokhara. Hence, nowadays, there are three kinds of fishers: recreational fishers, commercial fishers and artisanal fishers. They use different types of techniques of fishing. Commercial fishers use netting, recreational fishers use angling and artisanal fishers use traditional, low technology method. Even people who are familiar with new technology still prefer

to use old traditional methods. In addition, particularly in more recent years, some fishermen use unconventional, non-indigenous and destructive fishing methods like poison, electricity and explosives or blast fishing (Gautam, 2015) . People are using illegal methods to catch more fish and to earn more money. Also, use of gill nets for fishing made up of nylon and plastics is illegal to use, but nowadays different technologies are introduced to improve better production. Despite certain rules and regulations regarding fishing, people are involved in illegal fishing, which directly affects aquatic biodiversity. Rules and regulations are hardly followed by the people. Inland waters in some parts of the country have been seized for hydropower generation and irrigation (De Silva & Davy, 2010), people now have turned to practicing cage fish farming in lakes and reservoirs.

Figure 3: Fisherman making traditional fishing gear (Bamboo trap)

Source: (Bhusal, ,2012)

4.2 GOVERNANCE SYSTEM FOR THE FISHERIES AND AQUACULTURE IN NEPAL

The fisheries and aquaculture sector are one of the priority areas and activities related to these are regulated by Directorate of Fisheries Development (DoFD) which comes under the Ministry of Agriculture and Livestock Development (Figure 4). Some of the government organizations that work for fisheries and aquaculture are Directorate of Livestock and Fisheries (DLF), Central Fisheries Promotion and Conservation Center (CFPCC), and Fisheries Development Center (FDC). Likewise, some of the research institutions that are involved for the development of aquaculture in the country are Agriculture and Forestry University (AFU), Tribhuvan University (TU), Purbanchal University (PU) and Nepal Agriculture Research Council (NARC). There are research centers of NARC working with warm water aquaculture (Tarahara, Parwanipur and Nepalgunj), cold water aquaculture (Trishuli and Dhunche) and lake and reservoirs aquaculture (Pokhara) (Giri et al., 2019). These centers have specific roles in the development of aquaculture and fisheries in Nepal. Also, there are international organization supporting aquaculture development in Nepal, like for example: Japan International Co-operative Agency (JICA), Food and Agriculture organization (FAO), International Development Research Center (IDRC) and Asian Development bank (ADB) (Shrestha & Pant, 2012).

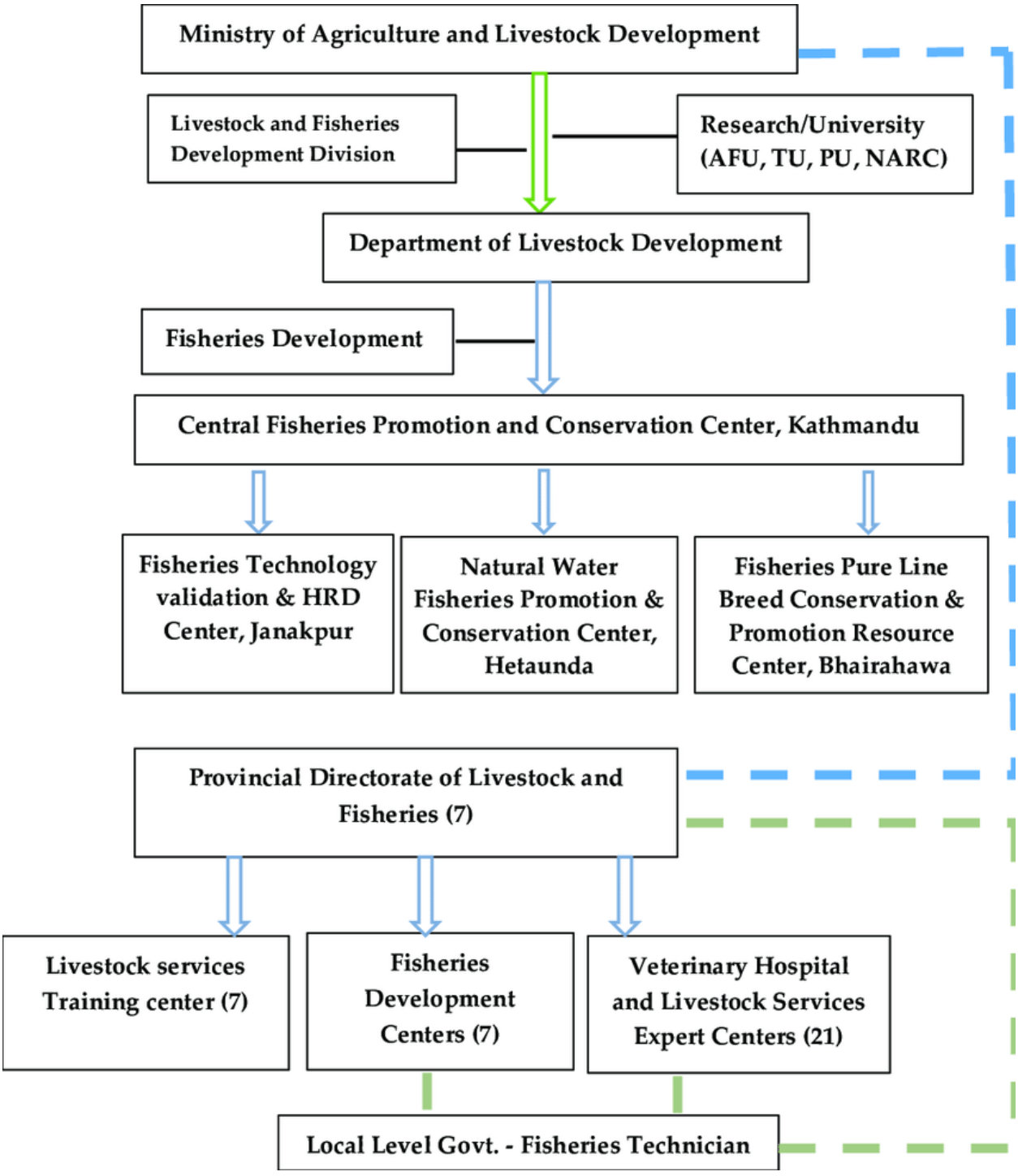

Figure 4: Institutional Frameworks for Fisheries and Aquaculture in Nepal.

Source: (Giri et al., 2019)

Nepal is divided into seven provinces based on geographical resources and there are seven provincial DLF in each of the seven provinces. Under the DLF, there are seven livestock training

centers (one in each province) assigned to capacity development of livestock services and fisheries technicians. There are seven FDCs (one in each province) responsible for fish seed production and laboratory work. Moreover, there are twenty-one veterinary hospitals and livestock services expert centers responsible for extension services (Giri et al., 2019). CFPCC comes under the Department of Livestock Development responsible for making central level planning, policy and supervision. There are three centers of CFPCC: Fisheries Technology Validation and Human Resources Development Center, Janakpur; Natural Water Fisheries Promotion and Conservation Center, Hetauda and Fisheries Pure Line Breed Conservation and Promotion Resource Center, Bhairahawa. However, each department has its own roles and contribution but the common aim of all the institutions in general is to develop aquaculture sector, enhance the capacity of communities and conducting awareness about aquatic diversity. The governmental institutions and international agencies without specific policies are not successful in the implementation of the aquaculture activities.

4.3 OVERVIEW OF AQUACULTURE IN NEPAL

Aquaculture is highly accepted activities in Nepal which was first initiated as a strategy to alleviate the poverty in 1940s with pond culture of Indian Major Carps and after that cage fish culture was initiated in 1970s. Different type aquaculture practiced in Nepal are pond culture, cage culture, pen culture, rice cum fish culture and raceways culture. Pond aquaculture has been categorized into extensive, semi-intensive and intensive farming. It is more popular in terai region of Nepal. Rice cum fish culture is another aquaculture in which fish is grown in irrigated paddy fields to obtain an added production of fish with rice. Rice fields can be used for duck rearing and fish production. Rainbow trout in raceways culture is also gaining popularity due to high market value of trout in Nepal. It is an expensive fish species compared to other species reared in Nepal because of its great taste and nutritional value. There are trout farms-integrated with restaurants in Rasuwa, Nuwakot, and Kaski. This practice has been successful practice in Nepal, which help to sustain small scale farmers business (Gurung et al., 2012), Cage fish farming in Nepal was started with the extensive system where external feed is not supplied, but the past few years semi-intensive has gained some popularity. From the past few years aquaculture production system in Nepal has been changed from extensive to semi-intensive farming system (Husen, 2018). The contribution of various aquaculture practices to total aquaculture production is shown below as below:

Table 2: Contribution of various aquaculture practices to total aquaculture production.

Source: (Subedi & Shrestha, 2015)

Aquaculture practices	**Production (mt. tones)**
Pond culture	58,433
Rice cum fish culture	15
Ghol culture	6390
Enclosure culture	65
Cage culture	302.38
Rainbow trout farms (Raceway culture)	320
Government farm	18.8
Total	**65,544**

The table 2 shows that an aquaculture practices that contributed to fish productions in Nepal are pond culture (major contributor), rice cum fish culture, ghol culture, enclosure culture, pen culture, rainbow trout culture and government farm center.

The fish farming was targeted to marginalised group Majhi, Pode, Jalaris and Tharu in initial phase of aquaculture development. An extensive system of cage fish culture was practiced using planktivorous fish that depends on natural food available in the water. After cage fish culture become popular in Phewa, Rupa and Begnas lakes of Pokhara valley and Kulekhani reservoir, cage culture became popular in different parts of the country. The fish farming system has been changed from extensive to semi-intensive with modern production technology. The local people in Kulekhani reservoirs have been practicing semi-intensive fish farming with natural productivity and supplemental feeds. The reason behind adopting semi-intensive cage culture by local people of Kulekhani is because of its satisfactory production with low investment cost and comparatively cleaner system as compared to extensive culture systems. Now, the main aim of local people for adopting cage fish culture is to increase the fish yields and get benefit from it. The cage fish culture with common carp in extensive system did not meet the expectation of the people so they changed

the farming system. The past study proved that cage culture with semi-intensive system also helped to improve ecosystem of yields 1.5 times more compared to extensive system (Prasad, 2012). In extensive and semi-intensive system, stocking density in cage depends on the natural productivity of the water bodies. Fry are raises in the nursery cage with 5-15mm mesh size (20-100 fish per meter cube) and once fingerlings reach 20-30g body weight then they are transferred to production cages and it takes 12 months to reach a marketable size with 700g (Giri et al., 2019).

Nepal is an agricultural country where more than 50% of population are engaged in farming for their income, to alleviate poverty and uplift the living standard of Nepalese people. But nowadays agricultural lands are plotted for housing construction which directly affect the livelihood of agriculture-based farmers. So, from few years ago people are engaged in aquaculture by adopting new technology which showed better production compared to seasonal crops and improvement in livelihood of farmers in the country. According to Rai and Wagle (2007), the available land area for agricultural production in Kulekhani is decreasing due to increasing in human population in the area, so, cage fish farming will be the best alternative source for supporting livelihoods of people living near the Kulekhani Reservoir. According to Shrestha et. al. (2012) the government of Nepal has been promoting aquaculture like cage fish farming as they believed that it can fight with household malnutrition and low economy opportunity.

4.4 CAGE FISH FARMING IN NEPAL

4.4.1 Types and species

Fish species that are suitable for cage culture vary considerably in their feeding habit, temperature water quality, pH and other characteristics (Bista et al., 2012) . In most cases, cage fish culture is practiced with intensive feeding and high stocking rates for high economic benefit (Bostock et al., 2010), but in the context of Nepal the commonly used method in this type of fish farming is the extensive type, where the fish is fed on naturally available plankton and the semi-intensive type where supplemental feed is supplied.

In the initial days, the most used method in this type of fish farming was extensive, with Silver and bighead carps (feeding on plankton) as the main species (see figure 6). More recently the development of semi-intensive aquaculture is based on Grass carps (feeding on aquatic grass with supplementary) (Bista et al., 2012).

Figure 5: Fish species for cage fish farming.

Source:(Internet)

4.4.2 Technology and material

The fish cages that are in Nepal are generally made up of bamboo, sal wood, iron wire mesh cage, nylon, etc. in which plastic drum, oil drums are used for floating the cage. Today, floating cage system of nylon cages with bamboo frame is popular among the farmers (Figure 7) (Prasad, 2012). To keep the cage in position, mounted on iron pipes and iron anchors or concrete block are used. Bamboo has been more important in cage farming compared to sal wood because of its natural buoyancy characteristics. It is also cheaper than sal wood. Both bamboo and sal wood are locally available materials and uses of sal wood for making cages are under study (Husen, 2019). In the starting phase of cage fish farming, different types of readymade cages were imported from abroad, but nowadays local people are making their own cages. Most of the cages that are used in Nepal from the initial days are 50-meter cube as they are easy for handling, but there are some cages with 150-meter cube. The use of larger cage sizes is challenging both for grading fish and net changing (Prasad, 2012).

Figure 6: Fish culture in bamboo floating nylon cages.

Source: (Husen, 2019)

4.4.3 General impacts of cage fish farming

Cage fish farming seems to have improved the socioeconomic conditions of the families involved. Cage fish farming in Nepal have helped the poor and marginalized communities to improve their livelihood by providing income and food security. The cage fish culture is profitable in compared to other cultures, so it has been expanded enormously all over Nepal in recent years. This has been expanded for commercial use as well (Gurung et al., 2010).

The plankton-based cage fish culture in Nepal was initiated in lakes of the Pokhara Valley for the benefit of the landless and deprived community for livelihood enhancement with the support of UNDP/FAO (Gurung & Bista, 2003). As this cage fish farming practice was successful, it was thought that cage fish farming could improve the livelihood of local people in Kulekhani Reservoir (Shrestha & Pant, 2012). Cage fish farming was implemented in Kulekhani reservoirs with the support of the International Development Research Center (IDRC). More recently, Fish farming in lakes, reservoir and river, using cage culture technique is gaining importance in Nepal and this culture is highly depends on potential water bodies (Figure 8). It has been shown that reservoir-

based fisheries and aquaculture have successfully generated food, income, and alternative livelihood opportunities (De Silva & Davy, 2010)

Figure 7: Cage fish farming in Kulekhani reservoir

Source: (Internet)

4.5 AQUACULTURE IN KULEKHANI

Kulekhani reservoir, which is also known as Indrasarobar located in Markhu, Makwanpur is the first and largest man-made reservoir of Nepal with 220 ha of water bodies. Markhu river basin has turned into Kulekhani reservoir and people who lived there were displaced because of the reservoir construction. The reservoir was constructed with the purpose of producing electricity. After successful implementation of cage fish farming in Pokhara, this practice was introduced in Indrasarobar in 1984 with the help of Nepal government and International Development Research Centre, IDRC, Canada, to provide a source of income and livelihood for those who have been displaced because of the reservoir's construction. In the initial development of cage fish farming in the reservoir, the development mainly focused on Indigenous ethnic groups, those who were landless, the marginalized groups and communities displaced by impoundment of reservoir. More recently, it has become a source of income for others as well. but in recent times it has become source of income for besides those communities and ethnic groups.

Government and non-government groups have encouraged cage fish farming in Kulekhani to improve the livelihoods of poor communities. Nowadays, Kulekhani is popular for fish, fishing and cage fish farming in reservoir which has changed the livelihood of communities in positive way (Gurung et al., 2010). Farmers accept that among the set of different livelihood options proposed, cage fish farming directly improves food security and income for the family (Gurung et al., 2005). In past years, even though cage fish farming was a primary source of income in the study area, it did not provide full-time employment. This seems to have changed, because of a high interest in starting cage fish farming (Husen, 2019).

4.6 SOCIO-ECONOMIC CONDITION IN FISH FARMING COMMUNITIES IN KULEKHANI

The total population of the Indrasarobar municipality in Kulekhani was 13,891 in 2011 with 6591 male and 7300 female. Among them, 500 families or approximately 2,100 people were affected during the construction of the hydro-dam in Kulekhani and around 60% of the population was classified as poor in that area (Gurung et al., 2010). Nepal has as mentioned a diverse religion and culture system with two different caste system, upper and lower caste system. Lower caste communities are categorized according to their profession for example Kami for Iron smith, Sunar for gold smith, Majhi for fishermen or who lives near water bodies. In Kulekhani, Balami, Majhi, Tamang and Pode are those ethnic communities who are involved mainly in fishing for their living and recently they are adopting cage fish farming for better living. Most of the families living around water resources and those displaced by impoundment of reservoir have either very little or no land. They are primarily dependent on fishing and are employed as farm laborers. For these people fish farming may be an opportunity.

4.6.1 Caste System in Nepal

Nepal follows Hindu caste system and classifies as Brahmin, Kshatriya, Vaishya and Shudra. The caste system is generally divided into three categories: Tagadhari (twice born) which includes Brahmin, Kshatriya and Thakuri also recognize as highest castes in Nepal; Matwali (liquor drinking) which includes Tibeto-Burman and Indo-European tribal groups and Pani nachalne (untouchables or Dalits) which is called as lower caste or untouchable caste groups, have their own traditional occupations and are exploited economically and socially humiliated (Cox, 1988).

Higher caste people are economically, politically and socially strong. Higher caste people are rich who have power, lands, business and also are assigned with high income job like officer, teacher,

mayor of village, priest, etc. but Dalits are poor and landless and assigned to low-income jobs like blacksmiths, goldsmiths, tailors, shoemakers and fish farmers. Indigenous fishing tribal groups like Pode and Jalaris belongs to lower caste whereas Majhi and Tharu are not from untouchable groups, but they are involved in fishing for their livelihood and landless, respectively.

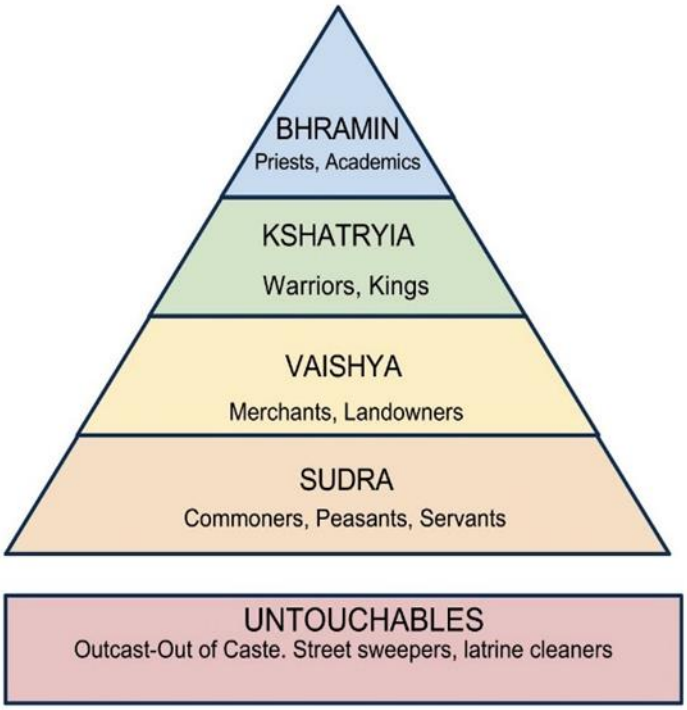

Figure 8: Hindu caste system. Source:(Paudel, 2014)

According to Bista, J., et al. (2012) Cage fish farming has improved the livelihood of poor, deprived and some marginalized ethnic groups, which depend on fishing. Jalaris, Pode, Bhote, Kumal, and Majhi living around lakes in Pokhara, and communities displaced by Kulekhani hydropower project. Among different Indigenous fishing tribes, Pode and Jalaris lives around lakes and rivers of Pokhara and Majhi and Mushar around Kulekhani reservoir. They travel and live around water resources like rivers, lakes, streams and wetlands with their families for their living. Their main source of income and occupation is fishing, and water related occupations such as boating and making fishing nets. Development of cage fish farming was especially targeted for those who are landless, for groups who do not have any other sources of income and poor people who could not afford large production input. He has concluded that these practices do not only have economic importance but are also advantageous from the ecological and social point of view.

Khadka (2020) stated that being Indigenous people, they are deprived from newly started fish farming, deprived of traditional agricultural land and lacked other skills, and have limited access to resources in comparison to other ethnic groups. Because of this all reason they are facing problems to run their family expenses. Hence, these groups were forced to go to neighboring countries for employment because of low income from fishing but recently they are choosing cage fish culture over foreign employment. Also, they were attracted from the successful implementation of cage fish farming done in Pokhara and Kulekhani and believed that they could run their livelihood through cage fish farming. Nowadays, not only Indigenous fishing communities, but also communities from upper caste have understand the importance and potential of cage fish farming and are attracted toward it.

In Kulekhani reservoir, about 31% Tamang, 29 % Magar, 21% Brahmin and Chhetri, 17% Newar, and 1% Kami, Damai and Pode (Dalit or untouchable group) are involved in cage fish culture and most of them had been displaced during the impoundment (Bista et al., 2012) (Figure 9). The main income source for this community is cage fish farming in Kulekhani. There are fewer untouchable groups in this area, because during the impoundment of Kulekhani reservoir they migrated to Pokhara in search of work and new fishing places.

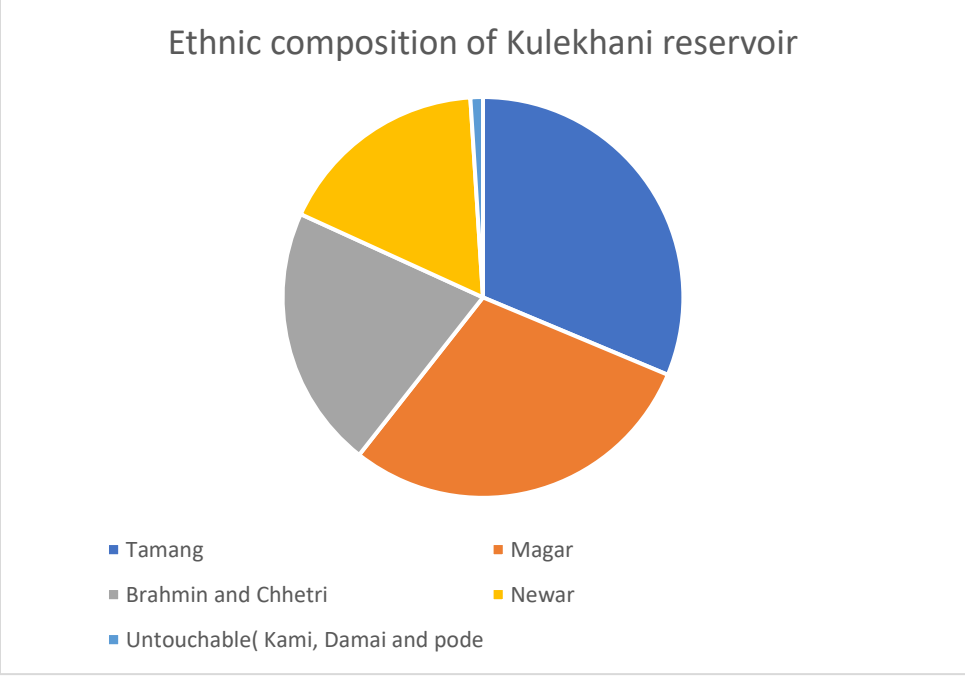

Figure 9: Ethnic composition of the communities involved in cage fish culture in Kulekhani reservoir.

4.7 REASONS FOR ADOPTING CAGE FISH FARMING

Firstly, the implementation of cage fish farming with the assistance the Food and Agriculture Organization (FAO), the United Nations Development Program (UNDP) and Ministry of Agriculture, Government of Nepal was successful to fulfill the objective for the program: cage fish farming as an option for alternative livelihood. Secondly, this farming helped to provide affordable animal protein to the communities. After this, local people were convinced that cage fish farming offered better income and better life. As fish are grown in natural waters, the market price of caged fish is comparatively high. Resources like lakes and reservoirs have multipurpose usage esp. suitable for cage fish farming, also for electricity generation, recreation and irrigation. In case of Nepal, cage fish farming is best for those groups of people who are fishers by their profession, who are poor, marginalized ethnic communities and landless. In short, cage culture utilizes the resources, has low investment cost as cage farming is semi-intensive type in Nepal and gives good returns to the investment. Table 3 shows that the communities were able to earn net profit of NPR 2120000 from cage fish production (30 t) over a period of five years (Prasad, 2012).

Table 3: The production and profitability of cage fish farming in Kulekhani reservoir over period of five years (2012/13 -2016/17). Source: (Prasad, 2012)

S. N	Activities	Unit	Quantity Rate	Amount (NPR)	Operational cost
	A) Operational cost				
1	Production cage cost	No	150	1000	1500000
2	Fingerlings m	No	1000001		100000
3	Labor cost	No	4	12000	576000
4	A) Total cost (1st year)	NPR			2176000
	B) Total cost (2nd year) labor + seed	NPR	676000	4	2704000
	C) Total cost (5years) A+B	NPR			4480000
5	D) Fish Production (5 years)	T	30	220000	6600000
6	Net profit (C-D)	NPR			2120000

5. DISCUSSION

This chapter continues the discussion of the social and economic problems faced by the local people of the communities during cage fish farming and aims towards answers to the research questions.

5.1 EXPERIENCED OBSTACLES IN CAGE FISH FARMING

The cage farming practices tends to have benefited the local people, who are also facing difficulties adapting to this technology and that needs to be solved to secure the food security and the livelihood of those local people. The problems can be related to technical issues, social, environmental and economic. Some of the obstacles that hinders cage fish farming in general are lack of cage materials, high cost for net, lack of aquaculture policy, shortage of fingerlings, marketing problem and so on, which directly impact on the productivity and production of the fishes (Wagle et al., 2007).

In Kulekhani, local people are increasingly interested in cage fish culture because they witnessed the improvement in the livelihood of the people who were displaced by the impoundment with the help of these practices. But this technology is not accessible to all the people who are interested in it because of several reasons. Technical constraints that are commonly faced by local people in the study area are lack of trained and skilled persons due to which they lack proper knowledge about this culture among local people. Before starting this culture, one should know about types of cage material that should be selected, location and topography of sites, limnology of lake, types of species which are suitable for such cultures, and about feeding process and components (Shrestha & Pant, 2012). If they do not get proper knowledge about these things, then it directly affects in the productivity of the species. The major problems faced by farmers of Kulekhani are mentioned below (Table 4) with specific problems in each category (Shrestha & Pant, 2012).

Table 4: Problem types and specific problems faced by farmers in Kulekhani

Problems Type	**Specific problem stated**
Technical	Lack of skilled and qualified managers and manpower
Economics	Lack of Capital
Environmental	Deterioration of water quality

Social	Conflict between displaced communities and other communities
Institutional	Lack of technical knowledge

5.1.1 Social Problems

Due to impoundment of the reservoir, people have been displaced by it and displaced communities are helped to uplift their livelihood by cage fish farming with the help of government and international organization. As only displaced communities were offered with cage fish farming schemes, conflicts were raised among displaced communities and remaining other people of same communities (Gurung et al., 2010). As Kulekhani has set an example for successful implementation of cage fish farming after Pokhara valley, people migrated from different districts to study sites which has created conflicts between migrated people and originally resided people. Gurung (2010) described that there was a conflict between fish farmers and Nepal Electricity Authority (NEA) (Gurung et al., 2010).

In Kulekhani, population has almost equal number of male and female (Shrestha et al., 2012). In initial development stage of cage fish farming, only men used to involve in all activities of this practices. Due to inequality between men and women and social exclusion, women were bounded with household chores only. But from few years ago, both men and women are equally and actively involved in this culture (Gurung et al., 2010). Women from Pokhara valley and Kulekhani reservoir has set an example who participated in cage fish farming as well as household chores (Wagle et al., 2007). One of the studies claims that this cage farming has played an important role in eradicating social discrimination and gender inequality in society (Paudel, 2014). However, there is involvement of women in fishing activities they have only traditional knowledge related to this, due to this reason they are engaged in limited activities only. The study also reveals the fact that another problem of social discrimination and gender inequality have decreased, but women have limited activities to involved in. In addition to this all, cage farming in Kulekhani has experienced security problems like stealing of fishing gears and fish from cages because of poverty and also due to conflicts (Wagle et al., 2007).

Also, there is competition among local people from one cage farm to another cage farm. Some of the local people claim false fish sale in the market, which hampers the other people from another

cage farm. According to the news published in The Rising Nepal on 18th August 2021, the Jalaris (Local marginalized ethnic group) are facing in the decrement in the caged fish sale which directly affect their income. The reason behind decrement in the sale is, people secretly import fish from India or Terai region and sell it to the hotels saying it is caged fish (Adhikari, 2021). The price of imported fish is cheaper than the local caged fish, so hotels prefer to buy the fish from those who import it, rather than from the local people cage farm. Youth are migrated abroad for further study or to earn money, so most of the family has kids and old people at home. Even though cage culture is profitable business, youth are not involved in this business. So, new technology is adopted by only a few farmers. Karikari (2016) concluded that fish farmers depend on the experience from previous cage fish farms which does not encourage innovative practices but continues the old tradition.

Also, youth are not promoted by administration and local government. Study reveals that the facilities provided by government and private organizations were not sufficient. The findings show that governmental subsidies have been misused in study area in power of different political parties, so poor were deprived of their rights of getting subsidies and allotted budgets. This study suggests that cage fish farming can be expanded much more in this region, if the existing problems regarding cage fish farming are solved.

5.1.2 Economic Problems

Setting up any business, either small or big required capital. Cage fish farming is an emerging business in the study area. Money is required for cage materials, fingerlings, and feed in cage fish farming. Prices for net materials, made up of nylon and polythene imported from Japan and Britain is high (Gurung et al., 2010). The high price makes it difficult for local people to purchase it without loans or subsidies. In more years, it has been imported from China and prices are comparatively low but with low life expectancy. Study showed another major problem in adoption of cage culture is limited access to financial capital or loans from banks and cooperatives to those who are poor, landless and untouchable or in general socially deprived people. In Kulekhani, marginalized groups belong to lower income family and displaced communities, who were poor with limited or no fund to start up the cage fish farming. In developed countries farmers can get sufficient loans from private, governmental banks and financial institutions but in the case of my study area, local people are unable to get sufficient loans from banks and micro finance. According

to Karikari (2016) access to financial capital is a potential barrier to practice cage fish farming (Karikari et al., 2016). Even though some banks and microfinance provide loans in Kulekhani they have high interest rates (Gurung et al., 2010). There is a provision of subsidies and government budget in the study area, but it is accessible to those who are politically and socially active in society and also rich. Government brought subsidies and allocated the budget with the intention to help those who are unable to get bank loans and are poor people who could not afford to start up cage fish farming by their own, but the advantage of those subsidies was taken by other groups. To stop such misleading governmental budget and subsidies, government bodies should pay more attention and information regarding governmental, loans, credits, and subsidies should be circulated to everyone.

The total number of people involved in cage culture decreased from 500 to 307 in 2010 and 2011 (Prasad, 2012). The data given below in table 5 showed, even the number of people was not increased, the number of cages was increased, and 27900 m^3 volume cages was used for table fish production producing 26.8 MT fish in 2011.

Table 5: Status of household engaged in cage culture at Kulekhani Reservoir.

Source: (Prasad, 2012)

Kulekhani reservoir	2010	2011
Number of households	307	307
Number of cages	288	588
Volume (m3)	14400	27900
Production (mt)	13.4	26.8

But due to the various problems faced by local people in cage fish farming, the cage numbers have decreased to 62% in 2015 as compared to 2011. Similarly, the number of cage and cage volume for production and nursery has increased in 2011 but reduced in 2015 (figure 10) (Husen, 2019)

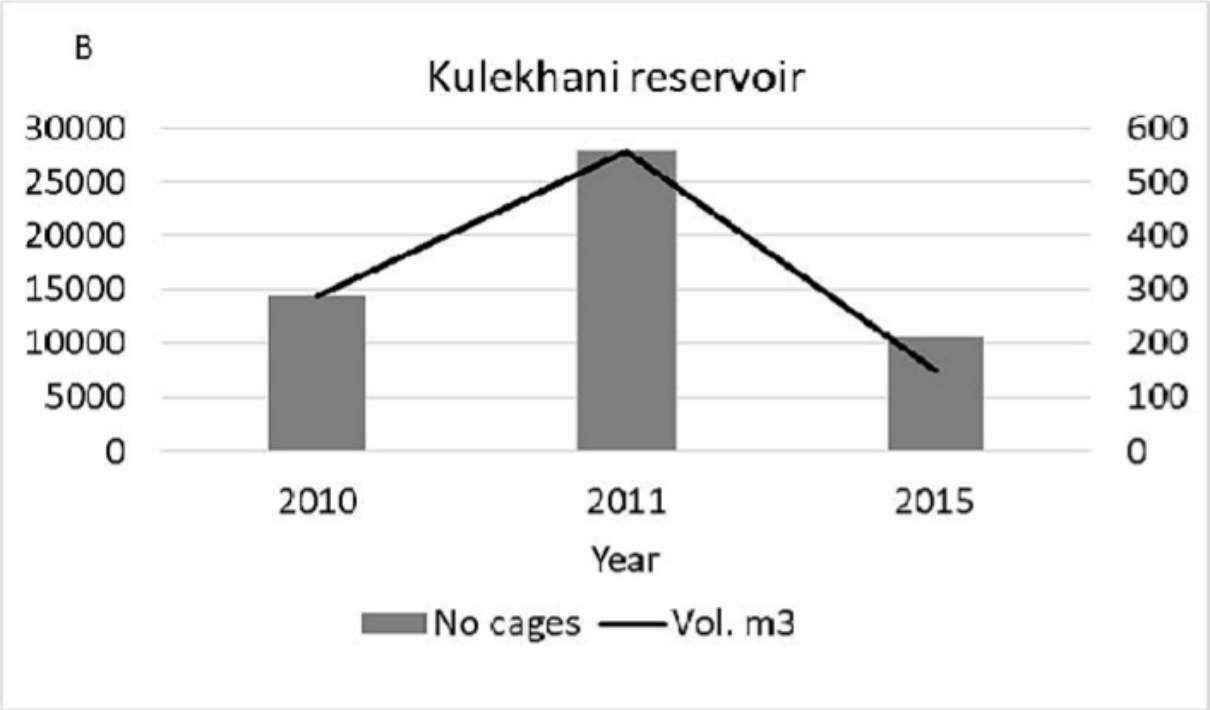

Figure 10: Cage number and volume (m3) in Kulekhani reservoir.

Source: (Husen, 2019)

5.2 POTENTIAL IMPACTS

When Kulekhani dam was constructed in Kulekhani river, around 500 families were affected from this and people who were displaced during the impoundment adopted cage fish culture as their livelihood (Gurung et al., 2010). However, the primary purpose of this reservoir was hydroelectric power generation but considering the displaced people condition government allows it for cage fish culture as well. The ethnic communities who were displaced and involved in cage fish culture were Tamang, Magar, Brahmin, Chettri, Newar, Kami Damai and Pode. Some of them migrated to other places near the water sources for example: large number of Pode ethnic group migrated to Begnas lake of Pokhara valley. Many Indigenous, poor and untouchable people have been able to increase the income through fish farming and fish related activities. Cage fish farming in Kulekhani reservoir for displaced communities had become a source for their livelihood and had been a suitable culture which can easily be adopted by them. Cage fish culture had been suitable practices for livelihood of poor people, landless and marginalized ethnic groups in Kulekhani. People from every community, either upper castes or lower castes, are engaged in cage fish culture. For example: in Pokhara Valley lakes, a landless traditional ethnic community near Phewa, Rupa

and Begnas lake has successfully adopted the technology of cage fish farming as a source of their livelihood (Gurung et al., 2010). Nowadays, Kulekhani has become a tourist hub because of Kulekhani reservoir, the reservoir is the main attraction of foreign as well as domestic tourists. This has added additional income to their main incomes. This increase in income has positively influenced the livelihood of local people and has brought food security. Their families are getting better food, better shelter and they are also able to give their children a better education. The income derived from cage fish farming was used for running the livelihood of the family and remaining savings were invested in adding more cages in the farm.

This study found that people living around lakes and reservoirs are more engaged in cage fish farming and that is because of lack of flat land for agriculture near the water resources. Nawaraj Poudel (2014) revealed that more people are engaged in cage culture, because of increasing fish prices and good internal market opportunities (Paudel, 2014). Since it has been more than 20years that people have adopted cage fish farming and involvement of displaced communities in this new technology has increased noticeably. Some studies found that the number of cages has increased because its declaration of employment, income and food security. Much has been written about the potential role of technologies in how it helps to improve livelihood, reduce food insecurity and to bring positive changes in society as well as the fact that hinders adopting cage fish cultures. Empirical evidence shows that cage fish farming is one of the several aquaculture practices which helps in income generating activities to poor people and plays an important role in the social and economic lives of the people. The study also reveals that, initially construction of hydropower has negative impacts in the life of people living around water resources but nowadays more dams' construction has been an opportunity for more cage farm which has brought positive changes in the livelihood of people. Having cage culture in the reservoir does not affect power generation but helps in increasing the income of the people.

5.2.1 Changes in livelihood of the communities

The people who are landless or have limited land and the communities displaced in study area are dependent upon cage fish farming for their livelihood. In addition to cage fish farming some are engaged in other labor work. Mostly they are engaged in cage fish farming because it has assured them food security and income security throughout the year. Initially it provided limited earnings for the community, but later income increased after the installation of more cages. Income

generation has increased by selling fish produced in cages, nutrition status has been accomplished in human body as fish provides large amounts of protein. This culture usually helps to control illegal fishing in lakes. Fish from lakes and rivers have high market values and prices. According to Gurung (2007), most families in communities are now able to send their children to school, some have access to media like Television, computer and importantly have gas for cooking, before this practices farmer used to cook food using fuel wood and kerosene (Wagle, Gurung et al. 2007). He mentioned that cage culture has improved livelihood of landless, deprived and displaced communities and remaining other people of communities has added this source as an alternative source of income (Gurung and Bista 2003). Olaganathan mentioned that with the help of cage farming income has increased, due to this the people have better access to housing, education, health and communication facilities that significantly improved people living standards in Bangladesh (Olaganathan and Kar Mun 2017).

Research done in Kulekhani by (Gurung, Mulmi et al. 2010) has illustrates that Cage fish farming has been a suitable technology which is easily adopted by people. He also mentioned that people from study area reported that they are living better life, able to eat nutritious food, generate employment in field of marketing, transporting, making cages, etc. It helped to creates job opportunities for women as well as to increase income for their household and contributed to strengthening women's empowerment. Also, some of them are able to buy land to grow vegetables which has become an additional source of income (Gurung, Mulmi et al. 2010).

A case study of those who were displaced by impoundment of reservoir at Kulekhani showed this cage farming has brought prosperity to their life and they are happy with it. One of the local people mentioned that he used to go to Kathmandu and Hetauda for labor work before doing cage farming, but later, after starting cage farming, they spend their whole time on it and gain Rs 300,000 annually by selling fish produced in cages. (Source: JAPANESE SUPPORT Energy Development | New Spotlight Magazine (spotlightnepal.com))

Similarly, one of the local people from study area said that he initiated this culture with the help of government at first from which he gains little earnings, later he added more cages due to which he was able to make annual income approximately 0.2 million and he used this amount to build house in capital city. Also, he opened a hotel in Kulekhani which helped to improve his livelihood. (Gurung, Mulmi et al. 2010).

5.2.2 Contribution to social and gender empowerment

There was social discrimination between male and female, poor and rich and touchable and untouchable caste in whole Nepal but some positive changes occurred due cage fish farming with the support of government strict rules. It is believed that for the successful execution of any work related to the family, job, business, social related work or politics, male and female plays an equal role. But in Nepal, females are far behind then males. Female are deprived of the facilities that male gets from the time of their birth, for example: if son is born, it is celebrated by sacrificing an animal like goat, buffalo or hen and if it is a daughter, there is no celebration at all. Female in general lag male in access to education, money and property and they are limited within household chores. But these days the participation of women in other activities beside then household chores and agriculture are rapidly increasing. Cage fish culture in Kulekhani has contributed to support women's empowerment. Different sectors are involved to promote the role of women in overall aquaculture field which helps them to empower socially and economically.

Male dominant society accepted that women are also equally important for the family and to make small or large business successful and women are supporting their family by earning money by themselves. Some ethnic groups which are mainly engaged in fishing involves women in cage fish farming like feeding the fish and cleaning the cages, but recently they are involved in decision making, meetings, workshops, excursions and aquaculture related activities. Gurung (2003) concluded that cage fish culture has strengthen women's empowerment, as women are active in activities like attending meetings, making decisions, boating, harvesting, marketing and even in transportation. Gurung (2003) study reported that cage fish farming has allowed women to move ahead from household activities and are now involved in capacity enhancement activities that can be helpful in the family as well as society also. Kapapa (2003) study documented that woman are engaged in cage fish farming. They are engaged in fish processing and farming activities but not in fish harvesting in Tanzania (Kapapa, 2003). Now, they are confident to perform any activities related to aquaculture. With the equal involvement of women in cage farming in Kulekhani, there is a significant increase in participation of local people in cage farming and also a greater number of cages has been observed (Gurung et al., 2010). Cage culture had played an important role in eradicating social discrimination. Like my results, one of the studies showed that women are empowered due fish farming besides then household chores and economic improvement played a vital role in transforming the standard of living (Gurung, 2006). Upper caste or touchable groups

and rich people are attracted toward this farming because of good market price of fish cultured in cages, which has contributed to the social development as well. Such kinds of changes surely help the whole nation's development.

Figure 11: Involvement of cage fish farming in Kulekhani reservoir

Source: (Bista et al., 2012)

5.3 TECHNOLOGY

My study shows that local people in Kulekhani used local materials like bamboo and sal wood, as it is cheap and requires small capital investment like bamboo and sal wood. Net and irons were imported from nearby country like China and India. Making a frame and mounting the iron is done by local people, which also reduces the cost. According to Bista, (2012) cage fish culture requires small capital investments and gives rapid returns to investments, which is a suitable option for resource-poor fish farmer(Bista et al., 2012). My study reveals that farmers prefer smaller sized cages as larger sized cage fish farmers faced problems in changing net, cleaning and grading. This study suggests that cage mounted by iron pipes and anchored by iron at the bottom are more economical compared to floating nylon cage with bamboo frames. The study recommends using

appropriate technical advice and adopting better management for cage fish farmers. This study demonstrated that illegal and destructive fishing practices have been reduced due to the strict rules made by the government and engaging in cage culture.

5.4 ECONOMY

Study shows that cage fish culture with semi extensive type of farming with planktivorous species was found to be more economical, where some supplemental feeding is done in addition to natural food. The study found that semi-intensive cage farming is preferable compared to extensive type because of better production and cleaner systems which help to improve ecosystem. This has improved the living standard of the people and get access to social facilities. Wagle (2007) claims that extensive cage fish culture with planktivorous carps was found to be more economical because there is no cost involvement beside the nylon cage, fingerling purchase, and minimal labor (Wagle et al., 2007).

5.5 CONCLUDING REMARKS

The objective of this study was to present changes brought in livelihood by cage fish farming and the problems faced by farmers in cage fish farming. The study sets out to find the ways in which people are changing their livelihood activities, the problems they are facing and how they are coping with this. However, there are different views regarding the importance and problems regarding cage fish farming, it helped to understand the national context and international context about cage fish farming. The study claims that this culture helped to improve the livelihood of local people living around the Kulekhani reservoir by generating income, employment and food security. Nowadays, besides the various potentiality of this farming the establishment of more cages in Kulekhani is hindered due to the various problems faced by them, which results in a decrease in production from this sector. Among the constraints found to adoption of cage fish farming, lack of knowledge, lack of capital and discrimination between upper and lower caste, rich and poor people were major. Cage farming in Kulekhani reservoir has been observed valuable to the community who were displaced by the impoundment of this reservoir.

It is noticed from the study that the displaced community of Kulekhani are dependent on cage fish farming for their livelihood activities. They were initially dependent on government or other donors for the adoption of this technology, but in recent years they are adopting this at their own expense. An increased interest of farmers participation in this farming shows that this farming is

gaining popularity because of high profits and income from low production cost. After the successful implementation of cage fish farming in Pokhara, the people have understood the importance and potentiality of cage fish farming in Kulekhani as well. The study noticed that nowadays people from all communities are engaged in this farming, not only people who were displaced', landless, poor or untouchable group. But government policies need to be in holistic approach which includes poor, deprived and Indigenous ethnic communities so that entire community can be benefited. The study observed that cage fish culture activities in Kulekhani have been successful in allowing women to involved in this technology, which enhance women empowerment and involved in other activities beside then household chores. This study will help to the fish farming researchers, scientists, farmers, fishermen, planners, students, and individual person who are interested in cage fish farming in Nepal. Also, this study helps to improve the socio-economic condition of people because this study focused on income status, employment, problems, and solutions faced by farmers in cage fish farming in Kulekhani.

REFERENCES

(FAO), F. a. A. O. o. U. N. (2020). *The State of World Fisheries and Aquaculture 2020*. https://www.fao.org/state-of-fisheries-aquaculture

Adhikari, P. L., Shrestha, S., Bam, W., Xie, L., & Perschbacher, P. (2017). Evaluation of spatial-temporal variations of water quality and plankton assemblages and its relationship to water use in Kulekhani Multipurpose Reservoir, Nepal. *Journal of Environmental Protection*, *8*(11), 1270.

Adhikari, S. (2021). *Local Fishermen Worry About False Claim In Fish Sale*. https://risingnepaldaily.com/business/local-fishermen-worry-about-false-claim-in-fish-sale

Anjejo, K. O. (2019). *Cage Fish Farming and Its Effects on Livelihoods of Fisherfolk Within Anyanga Beach, Siaya County, Kenya* University of Nairobi].

Bhujel, R. C. (2009). Promotion of Sustainable Aquaculture for Livelihood Improvement.

Bhusal, D. (,2012). Traditional fishing gears and fish collection utensils in nepal. *Fish Consulting Group*

https://fishconsult.org/?p=2547,

Bista, J., Gurung, T., Wagle, S., Shrestha, M., Prasad, S., Dhakal, R., & KC, K. (2012). Contribution of small-scale cage fish culture to poverty reduction and sustainable development in Nepal. *Small-scale Aquaculture for Rural Livelihoods*, 87.

Bostock, J., McAndrew, B., Richards, R., Jauncey, K., Telfer, T., Lorenzen, K., Little, D., Ross, L., Handisyde, N., & Gatward, I. (2010). Aquaculture: global status and trends. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1554), 2897-2912.

capstone, F. (2020). *What's the difference between fishing and aquaculture?* https://feliciacapstone2020.wordpress.ncsu.edu/difference-between-fishing-and-aquaculture/

Carballo, E., Eer, A. v., Chie, T. v., & Hilbrands, A. (2008). *Small-scale freshwater fish farming*. Agromisa/CTA.

Cox, T. (1988). The current socioeconomic status of untouchables in Nepal.

Das, A., Vass, K., Shrivastava, N., & Katiha, P. (2009). *Cage culture in reservoirs in India (a handbook)*. WorldFish.

De Silva, S. S., & Davy, F. B. (2010). *Success stories in Asian aquaculture*. Springer.

Edwards, P. (2000). *Aquaculture, poverty impacts and livelihoods*. Overseas Development Institute.

Gautam, N. (2015). Challenges of freshwater fisheries in Nepal: a short overview. *International Journal of Applied Sciences and Biotechnology*, *3*(4), 579-583.

Giri, S. S., Bokhtiar, S. M., Sahoo, S. K., Paul, B. N., & Mohanty, S. (2019). Aquaculture of commercially important finfishes in south Asia. *SAARC Agriculture Centre, SAARC, Dhaka, Bangladesh*.

Gurung, M. (2006). *WOMEN IN FISHERIES: A STUDY ON WOMEN'S COPING STRATEGIES IN FISHISHG COMMUNITIES IN LAKE BEGNAS, NEPAL* Citeseer].

Gurung, T., Basnet, S., Thapa, A., Raymajhi, A., & Pradhan, N. (2012). Small-scale aquaculture in Nepal: Principles and practices. *Small-scale Aquaculture for Rural Livelihoods*, 25.

Gurung, T. B., Mulmi, R. M., Kalyan, K., Wagle, G., Pradhan, G. B., Upadhayaya, K., & Rai, A. K. (2010). Cage fish culture: an alternative livelihood option for communities displaced by reservoir impoundment in Kulekhani, Nepal. In *Success stories in Asian aquaculture* (pp. 85-102). Springer.

Gurung, T. B., Wagle, S. K., Bista, J. D., Joshi, P. L., Batajoo, R., Adhikari, P., & Rai, A. K. (2005). Participatory fisheries management for livelihood improvement of fishers in Phewa Lake, Pokhara, Nepal. *Himalayan Journal of Sciences*, *3*(5), 47-52.

Husen, M. A. (2019). Cage and Pen Fish Farming in the Lakes to Obtain Income and Employment for Landless Fisher Community. *Diversification in Aquaculture*, 137.

Husen, M. A., et al.,. (2018). Cage fish farming in lakes and reservoirs of Nepal: a mini review and update.

Internet. https://www.google.no/url?sa=i&url=https%3A%2F%2Ftwitter.com%2Fgreatlakesprgm%2Fstatus%2F1364204076351840260&psig=AOvVaw31EBeM5y2ozihTze4baT6m&ust=1647368300619000&source=images&cd=vfe&ved=0CAsQjRxqFwoTCMj29aebxvYCFQAAAAAdAAAAABAO

Jacobi, N. (2013). *Examining the Potential of Fish Farming to Improve the Livelihoods of Farmers in the Lake Victoria Region, Kenya: assessing Impacts of Governmental Support* University of Akureyri].

Joshi, N. P., Maharjan, K. L., & Piya, L. (2010). Poverty and food insecurity in Nepal a review.

Kapapa, L. S. (2003). *The importance of artisanal fisheries of Lake Tanganyika to the livelihood of the fishers in Kigoma region-Tanzania:(a socio-economic case study of the" Dagaa" fishery (Limnothrissa miodon and Stolothrissa tanganyicae)* Universitetet i Tromsø].

Karikari, A., Asmah, R., Ofori, J., Agbo, N., & Amisah, S. (2016). Characteristics of cage aquaculture in Ghana-A case study of Lake Volta at Asuogyaman District.

Kenya, C. (2009). Low-input cage culture: towards food security and livelihood improvement in rural Kenya.

Khadka, R. K., & Tiwari, S. R. (2020). Improved Aquaculture for Sustainable Livelihood in Majhi Community: A case from Bhimtar, Sindupalchowk.

Kunwar, P. S., & Adhikari, B. (2016). Status and development trend of aquaculture and fisheries in Nepal. *Nepalese Journal of Aquaculture and Fisheries*, *3*, 1-11.

Mishra, R., & Upadhyaya, K. K. (2011). Opportunities, challenges and research needs in fisheries and Aquaculture. Proceedings of the 8th National Workshop on Livestock and Fisheries Research, Nepal Agricultural Research Council,

Natarajan, A., & Joseph, I. (2020). Adoption of small scale coastal cage fish farming in the southwest coast of India: opportunities and challenges. *Israeli Journal of Aquaculture-Bamidgeh*, *72*, 1-9.

Ng'Wigulu, K. L. (2021). Cage fish farming in Lake Victoria, Tanzania: a recently rising food production area and its effects on the environment and community.

Olaganathan, R., & Kar Mun, A. T. (2017). Impact of aquaculture on the livelihoods and food security of rural communities. *International Journal of Fisheries and Aquatic Studies*, *5*(2), 278.

Parker, R. (2011). *Aquaculture science*. Cengage learning.

Paudel, N. (2014). *Socio-economic impact of fish farming in indigenous communities, Phewa Lake, Pokhara, Nepal* UiT The Arctic University of Norway].

Phillips, M., & DeSilva, S. (2004). Finfish cage culture in Asia: an overview of status, lessons learned and future developments. *Cage Culture in Africa*, 49.

Prasad, S. (2012). Technological Advancement of Cage Fish Farming in Nepal: Prospect for Aquaculture in Large Water Bodies. *Proceeding of the fourth SAS-N convection*, 4-6.

Rath, R. K. (2018). *Freshwater aquaculture*. Scientific publishers.

Sharma, C. M. (2010). *Biological impacts and local perceptions of Tinau River Dam, Nepal*. Citeseer.

Shrestha, M. (2018). Aquaculture development in Nepal and current needs. *Retrieved August*, *31*, 2020.

Shrestha, M., Pandit, N., Bista, J., Wagle, S., Dahal, S., & Kc, K. (2012). Water quality pattern and natural food-based cage aquaculture in Kulekhani Reservoir. *Small-scale Aquaculture for Rural Livelihoods*, 118.

Shrestha, M. K., & Pant, J. (2012). *Small-scale aquaculture for rural livelihoods: Proceedings of the Symposium on Small-scale aquaculture for increasing resilience of Rural Livelihoods in Nepal. 5-6 Feb 2009. Kathmandu, Nepal*. WorldFish.

SOFIA, S. o. W. F. a. A. (2021). *State of World Fisheries and Aquaculture SOFIA* https://eurofish.dk/project/state-of-world-fisheries-and-aquaculture-sofia-2022/

Subedi, B., & Shrestha, A. (2015). Overview of pond aquaculture in Nepal. *International Journal of Environment, Agriculture and Biotechnology*, *5*.

Swar, D. (2002). The status of coldwater fish and fisheries in Nepal and prospects of their utilisation for poverty reduction. *FAO fisheries technical paper*, 79-96.

Swar, D., & Pradhan, B. (1992). Cage fish culture in lakes of Pokhara Valley, Nepal, and its impact on local fishers. *Asian Fisheries Science*, *5*, 1-13.

Wagle, S., Shrestha, H., Bista, J., Gurung, T., & Prasad, S. (2012). Cage fish culture and capture fishery as dominant livelihood sources for fisher community in Pokhara Valley, Nepal: A socio-economic update. *Small-scale Aquaculture for Rural Livelihoods*, 132.

Wagle, S. K., Gurung, T. B., Bista, J. D., & Rai, A. K. (2007). Cage fish culture and fisheries for food security and livelihoods in mid hill lakes of Pokhara Valley, Nepal: post community-based management adoption. *Aquaculture Asia*, *12*(3), 21.

Weimin, M., Clausen, J., & Funge-Smith, S. (2012). Development of small-scale aquaculture in highland and remote areas: An opportunity for aquaculture development in Nepal. Small-Scale Aquaculture for Rural Livelihoods: Proceedings of the National Symposium on Small-Scale Aquaculture for Increasing Resilience of Rural Livelihoods in Nepal,

Weimin, M., Liu, J., Li, Z., Xie, S., Vass, K., Sugunan, V., Pradhan, G. B., Amarasinghe, U. S., Weerakoon, D., & Jutagate, T. (2006). Status of Reservoir Fisheries in Five Asian Countries. In: Bangkok: Network of Aquaculture Centres in Asia-Pacific.