ISSN-2091-2323

# PROCEEDINGS OF THE 7TH NATIONAL ANIMAL SCIENCE CONVENTION

## 23-24 CHAITRA, 2070 (6-7 APRIL, 2014)

## "CLIMATE SMART LIVESTOCK PRODUCTION FOR FOOD AND NUTRITION SECURITY"

# Editors

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**Nepal Animal Science Association**

**December, 2015**

# 7th NASA Convention

| | |
|---|---|
| Organizer: | Nepal Animal Science Association |
| Theme: | Climate Smart Livestock Production for Food and Nutrition Security |
| Venue: | Nepal Adminstrative Staff College, Jawalakhel, Lalitpur |
| Date: | 23-24 Chaitra, 2070 (6-7 April, 2014) |



ISSN: 2091-2323

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# FOREWORD

Livestock and Fisheries are important components in Nepalese farming system contributing significantly in the national economy. Their contribution in food and nutrition security is immense. Improving livestock and fisheries productivity in the context of changing climate and livestock being constantly blamed as major contributor of green house gases is the challenge ahead to the professionals working in the sector. On the other hand livestock and fisheries are also being affected directly or indirectly by changing climate. Adaptation and mitigation measures to climate change in the livestock and fisheries sector is thus of prime importance.

The seventh National Animal Science Convention was organized at Nepal Administrative College, Lalitpur from 23-24 Chaitra, 2070 (6-7 April, 2014) with the major theme of "Climate Smart Livestock Production for Food and Nutrition Security". The convention provided forum for the livestock professionals and entrepreneurs to share the issues and research outputs/ technologies for the livestock and fisheries sector development at large. The convention brought the animal scientist, development experts, educationists, extensionist, entrepreneurs and farmers together for interacting on the pertaining livestock and fisheries related issues. A total of 25 papers in different discipline of livestock and fisheries sector including few key note speech in the convention theme were presented in the workshop. NASA is pleased to present the presented papers in the form of Proceedings with the hope that it will serve as an invaluable resources for the farmers, development workers, researchers, and educationists working in livestock and fisheries field and also to the policy makers for sectoral development.

I would like to thank all those who contributed in making the convention successful. I sincerely appreciate and cordially thank to the past executive committee for successfully organizing the 7th National Convention. I would also like to sincerely acknowledge the editorial board for upbringing the proceedings in this form. Lastly, the financial contribution of different livestock entrepreneurs and institutions are gratefully acknowledged.

Devendra Prasad Yadav

President, NASA

# CONTENTS

# GLOBAL LIVESTOCK TREND AND NATIONAL SCENARIO OF LIVESTOCK PRODUCTION WITH RESPECT TO FOOD AND NUTRITIONAL SECURITY IN NEPAL

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## ABSTRACT

*Livestock plays a pivotal role not only in food and nutritional security but also in economic growth of most of the countries of the world. Though, the production and productivity of livestock is found to have increased substantially in last decades it is still not enough to fulfill the demand of the ever growing population. Livestock is valued about 1.5 trillion US$ in monitory term and provides employment to 1.3 billion people which is a significant contribution in the context of ever growing under-employment and disguised employment in the world. Livestock is still perceived as the pride of society in most of the developing countries. It has not only been the way of life but also a means of livelihood and economic development. Unprecedented increase in the demand of livestock commodity will continue over the coming five decades. Big changes have been expected among the small holders with greater opportunities to the small scale mixed crop livestock farmers by virtue of big potentiality for preventing disease outbreaks, closing yield gaps and reducing greenhouse gases (GHG). It has been projected that livestock production will be increased by 92% in 2030 compared to 2000. Eggs and mono-gastric meat (pigs and poultry) will be increased by 106% where as that of ruminant meat and milk production will be increased by 88 and 85%, respectively in the same period. The milk revolution in India, booming pig industry in Vietnam, dairying in small holders in Kenya, cheapest milk production in Uganda and dairy industry mechanization in Europe and America are few of the noticeable progresses achieved during the past decades. It has also been estimated that Africa and Middle East countries consume 60% lesser livestock products than the European countries but the scenario will be reversed in 2050 resulting in highest consumption in Africa and Middle East. Livestock is also heavily charged for its contribution in GHG emission, skyrocketing prices of livestock products, cause of deadly diseases leading to increased poverty, hunger and malnutrition. Hotspots, 2012 pointed out that a deadly dozen zoonotic diseases kill 2.2 million people and sicken 2.4 billion people each year. In these perspectives, broadly 2 scenarios, namely, (1) technical, such as improved efficiency of livestock production through better feeding, genetics and health; and (2) Institutional, such as policy intervention in production and marketing to consumption including packaging, delivery, market response differ significantly in the period of half century (2000-2050).*

*Livestock is an integral part of agricultural farming system in Nepal. It contributes about 26% and 12% to the Agricultural Gross Domestic Production (AGDP) and Gross Domestic Production (GDP), respectively. Livestock is perceived as the live-bank and the main source of food and nutritional security in Nepal. Despite great efforts from Department of Livestock Services (DLS), Nepal Agricultural Research Council (NARC) and other stakeholders, the per capita consumption of milk, meat and eggs is still far below the FAO and WHO recommendation. Though, DLS has the very good networking up to the grass-root level, it has been facing several challenges in achieving the international standard in livestock production, productivity and livestock products consumption. Allocation of very limited budget in livestock sector, lack of sufficient manpower, insufficient high yielding seeds and breeds, limited commercialization, very limited*

*research works in livestock enterprises, lack of resource centers for the high yielding breeds, lack of soft loans and incentives, etc. are some of the important challenges in the livestock sector development in Nepal. In this paper, global trend of livestock production and its scenario in Nepalese conditions with respect to the food and nutritional security has been dealt with in detail.*

**Key words**: *DLS, food and nutritional security, GHG, livestock, production and productivity*

## BACKGROUND

### Role of livestock in global context

Livestock is taken as the very important enterprise that plays pivotal role not only in food and nutritional security but also in economic growth of most of the countries of the world. Livestock in most of the countries is associated with livelihood and the social prestige of the people. In most of the developing countries of the world, livestock is an integral part of the farming system. This enterprise is also taken as a buffering agent that has the direct connection with food balance in many countries of the world. In some of the countries livestock has a direct link with gender issues as well because of more than 70% of the livestock related works are carried out by women. Livestock enterprises, in most of the developing countries are taken as the live bank that can help during the time of social and economic crises.

In spite of several positive roles that have been played by livestock sector, some of the activists against the livestock enterprise raise the issues and blame that livestock farming is directly responsible for global warming and climate change and create favorable environment for the zoonotic diseases and their transmission from one species to the others. As none of the enterprises would be absolutely positive to all the aspects of the environment, it is the responsibility of livestock professionals to advocate about the very positive roles of livestock enterprise and to work in the areas of mitigation of the negative effects, if any, on economic, social, religious, cultural, traditional as well as sustainability aspects of the livestock enterprise in the face of the millennium development goals of the United Nations.

The total global population of all of the livestock species, except sheep, ashes, mules and horses is at increasing trend (table 1). FAO, 2004 has reported that the total population of cattle reached to 1.4 billion where as that of buffalo, sheep, goat and pig was 171, 1024, 768 and 956 million, respectively in the year 2003. The total number of chicken in the year 2003 was found 16 billion in the world. Among the livestock species, more than 95% of the total number of buffaloes in the world is found in Asia and hence it is known as the Asian animal. (http://www.fao.org/docrep/004/ad452e/ad452e2v.htm#TopOfPage).

The trend shows that highest population growth (57.1%) was found in the case of duck followed by poultry, goat and buffalo in the year 1993-2003 (table 2). In the same way, the highest decrease was found with the mules (14.67%) followed by sheep and horses.

Table 1: Trend in the world livestock population from 1993-2003. (FAO, 2013).

| Animal | Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2201 | 2002 | 2003 |
| Cattle | 1307.6 | 1319.5 | 1331 | 1327.1 | 1320.3 | 1322.5 | 1329.8 | 1336.9 | 1349.5 | 1355.9 | 1371.1 |
| Buffalo | 154.3 | 156.8 | 159.3 | 160.9 | 161 | 160.8 | 162.2 | 164.3 | 165.5 | 167.4 | 170.7 |
| Sheep | 1121.7 | 1110.4 | 1074 | 1059.4 | 1041.5 | 1043.6 | 1048.5 | 1049.5 | 1031.1 | 1025.6 | 1024 |
| Goats | 604.7 | 630.5 | 660.5 | 688.9 | 677 | 692.6 | 707.5 | 722.2 | 737.4 | 751.1 | 767.9 |
| Pigs | 876.5 | 881.8 | 898.6 | 859 | 832.5 | 871.1 | 900.5 | 906.1 | 921.2 | 943.4 | 956 |
| Horses | 58.4 | 58.4 | 59 | 58.5 | 57.1 | 56.8 | 56.8 | 56.7 | 56.3 | 55.2 | 55.5 |
| Mules | 15 | 14.9 | 14.6 | 13.8 | 13.2 | 13.2 | 13.2 | 13.2 | 13.1 | 12.9 | 12.8 |
| Asses | 41.5 | 41.7 | 42.1 | 41.2 | 40.2 | 39.8 | 40.7 | 40.6 | 40.8 | 40.4 | 40.3 |
| Camels | 17.4 | 17.7 | 17.9 | 17.8 | 18 | 18.4 | 19 | 18.9 | 19.2 | 19.2 | 19.1 |
| Chicken | 11.9 | 12.6 | 13 | 13.6 | 14.2 | 13.3 | 13.9 | 14.8 | 15.5 | 16.4 | 16.6 |
| Ducks | 0.7 | 0.8 | 0.8 | 0.9 | 0.9 | 0.8 | 0.9 | 1 | 1 | 1.1 | 1.1 |

Table 2: Changes in the World Livestock Population (1993-2003)

| Animals | Year | | Change (%) |
|---|---|---|---|
| | 1993 | 2003 | |
| Cattle | 1307.6 | 1371.1 | 4.86 |
| Buffaloes | 154.3 | 170.7 | 10.63 |
| Sheep | 1121.7 | 1024 | -8.71 |
| Goats | 604.7 | 767.9 | 26.99 |
| Pigs | 876.5 | 956 | 9.07 |
| Horses | 58.4 | 55.5 | -4.97 |
| Mules | 15 | 12.8 | -14.67 |
| Asses | 41.5 | 40.3 | -2.89 |
| Camels | 17.4 | 19.1 | 9.77 |
| Chickens (billion) | 11.9 | 16.6 | 39.5 |
| Ducks (billion) | 0.7 | 1.1 | 57.1 |

**Livestock and food supply**

Livestock contributes about 12.9% of global calories and 27.9% protein to the ever growing population. Animal protein with wide range of Amino acids (AAs) matches the human needs. It is possible to live without eating animal proteins but they provide nutritional benefit, particularly, through micronutrients from the animal foods. Livestock also provides bio-available micronutrients such as iron, zinc, Vit A, Vit $B_{12}$ and Calcium in which many malnourished people are deficit. Livestock also contributes to crop production through the provision of draft power and manure. The change in the livestock products in last 40 years (1967 to 2007) has been shown in table 3.

Table 3: Trend in the global livestock production from 1967 to 2007 (*World Livestock 2011, FAOSTAT)*

| Item | Production (million tons) | | Change |
|---|---|---|---|
| | 1967 | 2007 | |
| Pig meat | 33.86 | 99.53 | 294% |
| Beef and buffalo meat | 36.50 | 65.61 | 180% |
| Eggs, primary | 18.16 | 64.03 | 353% |
| Milk, total | 381.81 | 680.66 | 178% |
| Poultry meat | 12.39 | 88.02 | 711% |
| Sheep and goat meat | 6.49 | 13.11 | 202% |

Table 3 shows that there has been tremendous change in poultry meat production followed by eggs, pork and sheep and goat meat during the period of 1967 to 2007. Though there is a substantial increase in livestock products, this production may not be enough to fulfill the ever increasing demand. Figure 1 shows the anticipated change in global demand for livestock products during the period of 2000 to 2050. The figure clearly shows that there has to be an increase of 170% in poultry meat, about 100% in milk production, 85% in mutton production and 65-70% in egg production to meet the ever increasing global demand for the livestock products.

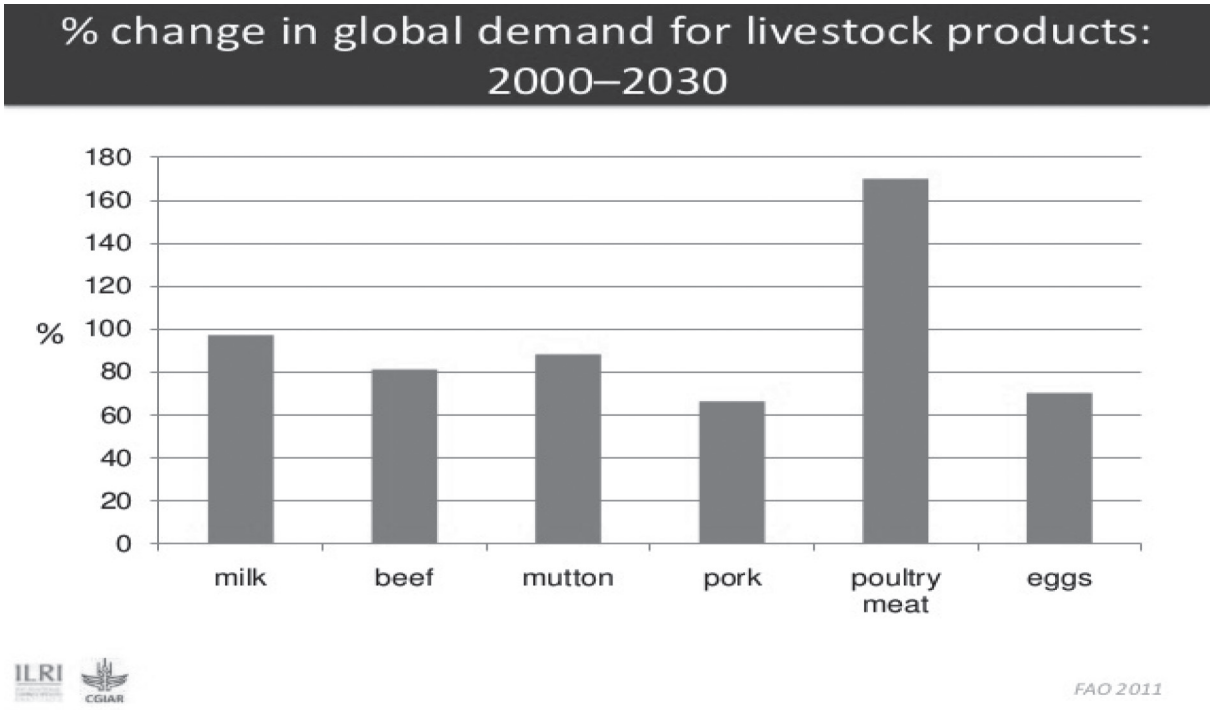



Figure 1: Anticipated change in the demand of livestock products from 2000 to 2030 (*FAOSTAT, 2011)*

For the production of livestock products, India, China, Brazil, Russia, Sub-Saharan Africa (SSA) and high income countries will have noticeable change in between 2000 to 2030.

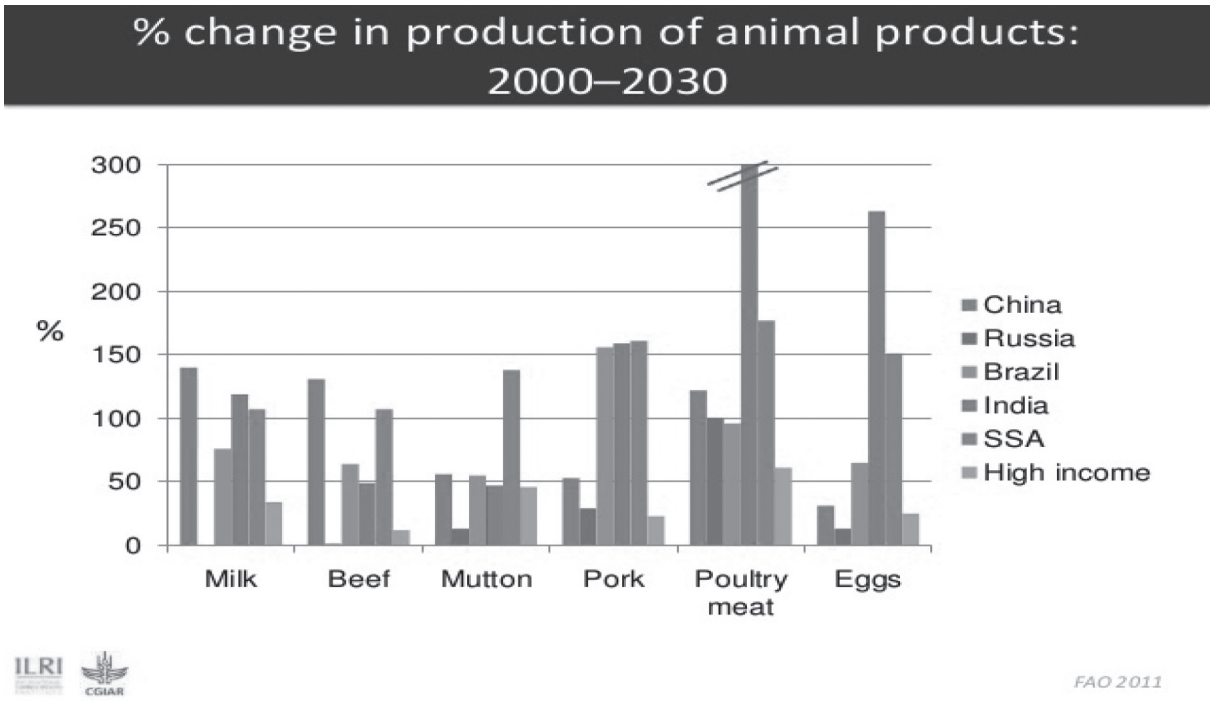



Figure 2: Anticipated change in the production of livestock products among the potential countries and the regions from 2000 to 2030 (*FAOSTAT, 2011)*

In milk production, China will have the highest change followed by India, SSA and Brazil whereas the poultry meat India will have the highest change followed by SSA, China and Russia. In pork production, Brazil, India and SSA will have almost equal change whereas in egg production India will surpass other countries. In mutton production, SSA will have the highest change followed by China, Brazil and India (Figure 2). In beef production, China will have the highest change followed by SSA, Brazil and India. These figures indicate that highly populated countries will have higher change in the livestock product production which can be taken as the obvious need to fulfill their demand. These are the good indication for the policy makers to plan, adjust and implement the livestock related programs to fulfill the national demand and to forecast and plan the project anticipating the import-export potentialities of the nations and the regions as well.

**Consumption of livestock products**

Keatig et al, 2014 reported that in 2050 global overall increase in per capita daily consumption of livestock products will be of 37% compared to 2000. However, livestock commodities differ, e.g., there will be 2% decrease in global per capita meat consumption whereas there will be a 61% increase in global per capita milk consumption in 2050. Similarly, the consumption differs according to the region. e.g., in 2000, Africa and Middle East consumed (in total calorie consumption) 60% fewer livestock foods than the European Community (EC) but in 2050, this will be reversed: highest livestock consumption will be in Africa & Middle East, lowest in

the EC. Figure 3 shows the change in the consumption of meat between the developing and developed countries of the world. Up to 1990, consumption of meat in developed countries was higher than in the developing countries whereas consumption of meat in developing countries surpasses that of the developed countries after 1990. This change is because of the already saturated situation in developed countries where as the increase of consumption in developing countries is because of the change in food habit, consciousness of the people towards food and nutritional security and positive change in the income level of people.

Table 4 also shows the projected consumption of livestock products in between 2010 to 2050. It can be observed from the table that there would be the highest change (225%) in the consumption of poultry meat followed by ovine and bovine meat. There would also be great change (158%) in the consumption of dairy products during the period (2010-2050). The consumption of pig meat was highest (102.3 million ton) among all types of meat in 2010 which will be surpassed by poultry meat (193.3 million ton) in 2050.

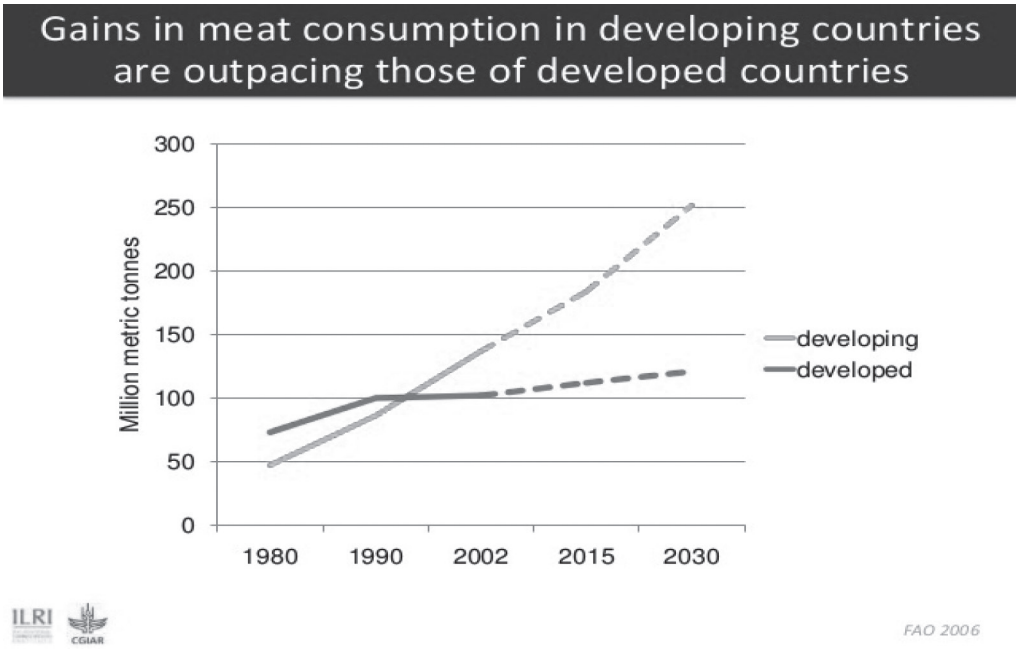



Figure 3: Gain in meat consumption in developing and developed countries between1980 to 2030.

Table 4: Projected consumption of Meat and Dairy Products (million MT)

| Item | Consumption (million tons) | | Change |
|---|---|---|---|
| | 2010 | 2050 | |
| All meat | 268.7 | 463.8 | 173% |
| Bovine meat | 67.3 | 106.3 | 158% |
| Ovine meat | 13.2 | 23.5 | 178% |
| Pig meat | 102.3 | 140.7 | 137% |
| Poultry meat | 85.9 | 193.3 | 225% |
| Dairy not butter | 657.3 | 1038.4 | 158% |

(World Livestock 2011, FAOSTAT )

All these are the positive symptoms for the producers involved in the livestock sector in the global level whereas it could be a challenge to the policy makers, development workers and in general to the concerned governments to generate the technologies, production package and infra-structure to meet the growing demand of consumers.

It is imperative to note that out of the five highest value global agricultural commodities four are the livestock products. In the global level, rice is at the top followed by cattle milk, cattle meat, pig meat and chicken meat. Wheat comes at the 6th level followed by soybeans, tomatoes, maize and sugar cane ranking 7th, 8th, 9th and 10th position in the global level (figure 4).

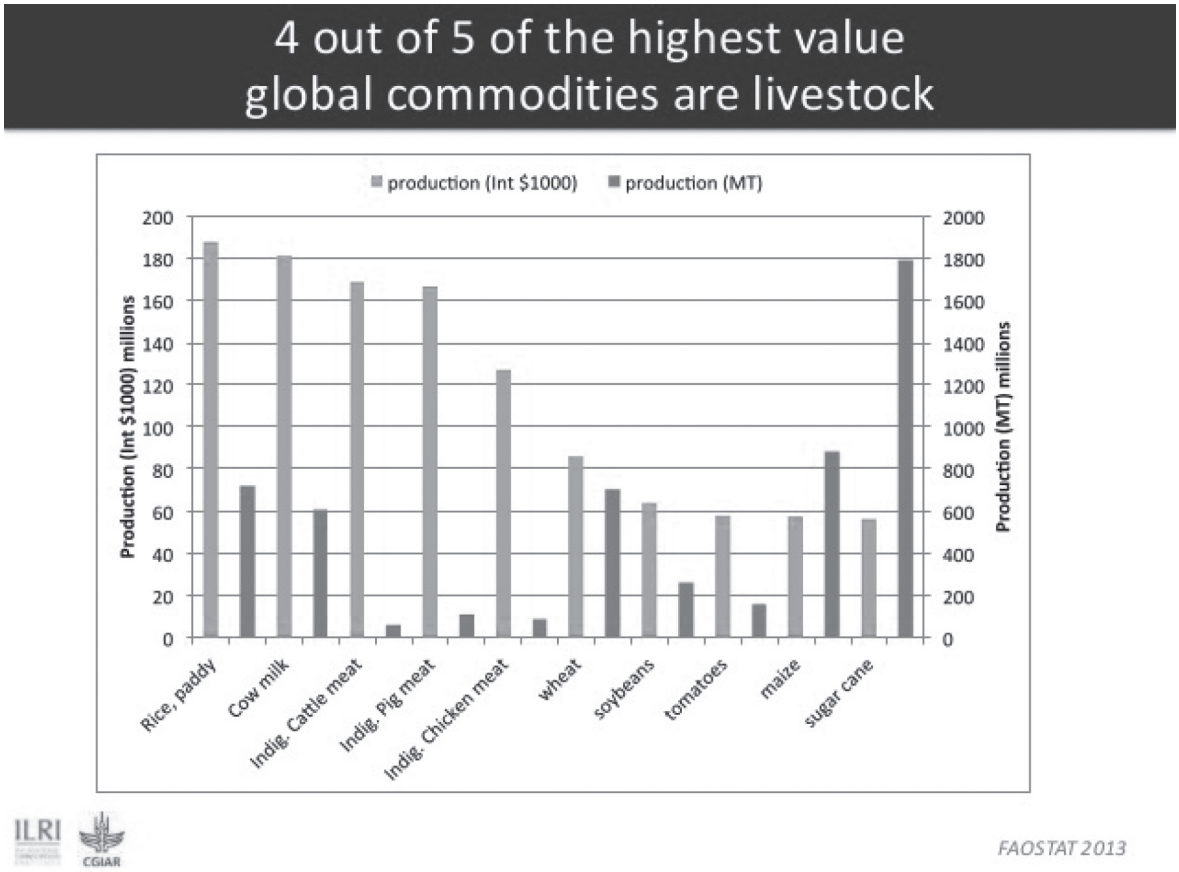



Figure 4: Ten highest value global agricultural commodities (FAO, 2013).

**Growth potentiality of livestock (trajectory of growth)**

**Growth pathes in livestock production:**

Though livestock enterprise is still at the growing phase in almost all the countries but there are differences in the trajectories of growth in different countries and the regions. Following are the main three groth trajectories of livestock enterprise at global level:

**Fragile growth**: This growth is taking place where remoteness, marginal land resources or agro-climatic vulnerability restrict intensification. The production system of buffalo farming in the remote areas of Nepal and even the urban and peri-urban livestock farming can be taken as fragile growth in livestock sector. It is called fragile because it can continue with supportive

environment or collapse at any stage of production if some negative changes take place in the due course of time (figure 5.a and 5.b).

Figure 5.a: Peri-urban buffalo farming in Nepal 5.b: Mixed livestock farming in the village,

**Strong growth**: This is the growth of livestock farming under the intensifying and market oriented production system. Since it is based upon the market, this kind of growth can be taken as sustainable, commercial and strong. Figure 6 shows the commercial cattle farms in Mukundapur of Nawalparasi and Bhaktapur. These farms are well commercialized, market oriented and sustainable depicting the strong growth.


Figure 6: Commercial cattle farms, examples of strong growth, in Mukundapur and Bhaktapur, Nepal

**High growth with externalities (Industrial):** In these types of livestock farms animals are reared under the intensified livestock system with diverse challenges on environment and human health. Here, almost all the farm activities are mechanized (industrialized) and limited use of human labors and the production at different steps of value chains are considered to achieve the maximum benefit per unit of input. These types of growth may pose challenges to the environment and the human health. Figure 7 shows Robert milking system in cattle farms in USA where a cow may produce up to 40 liters of milk per day. The cows in these farms may come to the Robert whenever they feel to let down their milk.

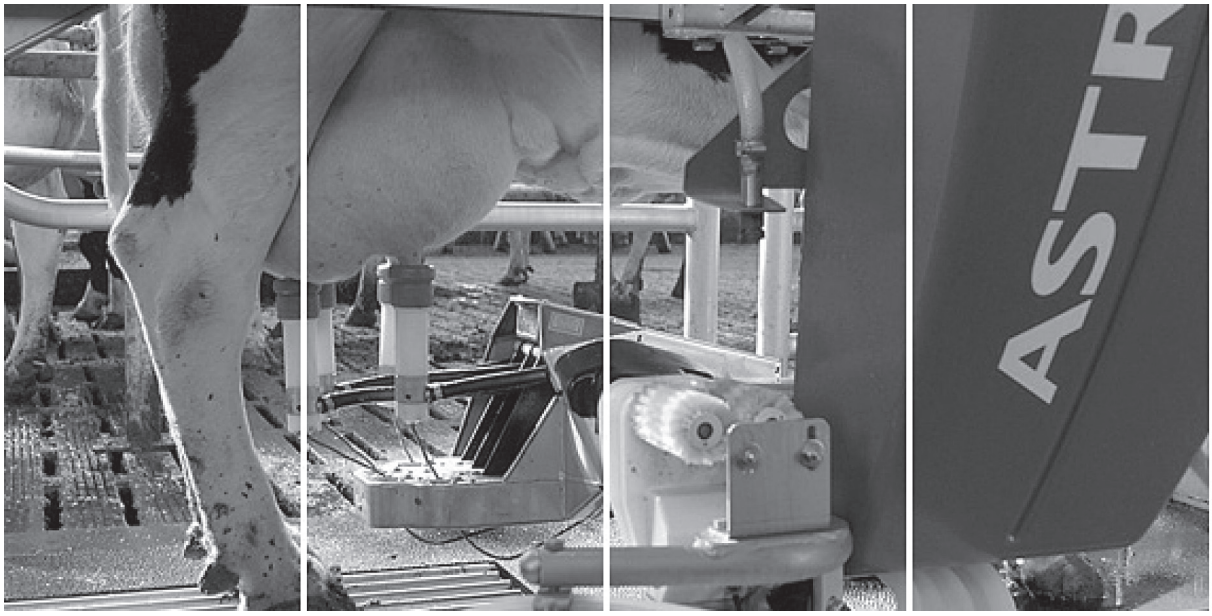



Figure 7: Robert milking under the high growth with externalities production system in USA

**Charges to Livestock**

Though livestock is very important not only from the GDP point of view but also for food and nutritional security, environmental management and cultural and religious point view, livestock enterprise and livestock professionals sometime face negative charge from anti-livestock personalities. Some of the common charges on livestock farming are as follows:

a. Livestock significantly contribute to emission of Green House Gases (GHG).

b. Skyrocketing prices of livestock products that may be out of the approach of the pro-poor.

c. Livestock are the causes of deadly diseases: Hotspots, 2012 pointed out that a dozen deadly zoonotic diseases kill 2.2 million people and sicken 2.4 billion people each year in the world!

d. Livestock create huge demand of grains and other concentrates to feed them. Hence, livestock competes with the human feeds.

e. Livestock are directly or indirectly responsible for environmental degradation, pollution and global warming.

However, following Good Livestock Practices/ Good Veterinary Practices (GLPs/GVPs) and judicious farming mitigate almost all of the above charges on livestock enterprises.

**Livestock and Food and Nutritional Security in Nepal**

**Livestock share in the national GDP of Nepal:**

From the global perspective, if we narrow down to observe the national scenario especially with the domestic livestock production systems of Nepal, we find that livestock plays a pivotal role to lead the national economy. It is further supported by

the following points:

a. Share of agriculture in National GDP –32%

b. Livestock contribution to AGDP – 27%

   I. Dairy Contribution to livestock – 63%

   II. Meat Contribution to livestock – 32%

   III. Eggs Contribution to livestock – 5%

c. Potentialities to increase 45% contribution to AGDP by the year 2014/15 (APP, 1995)

d. 65.7% population are engaged in subsistence oriented agriculture based on integrated crop-livestock farming system

e. Highest livestock population per capita and per unit of cultivated land in Asia.

f. Livestock and its products account for 11% and 6% of total agricultural exports and imports, respectively.

**Livestock population and production statistics of Nepal:**

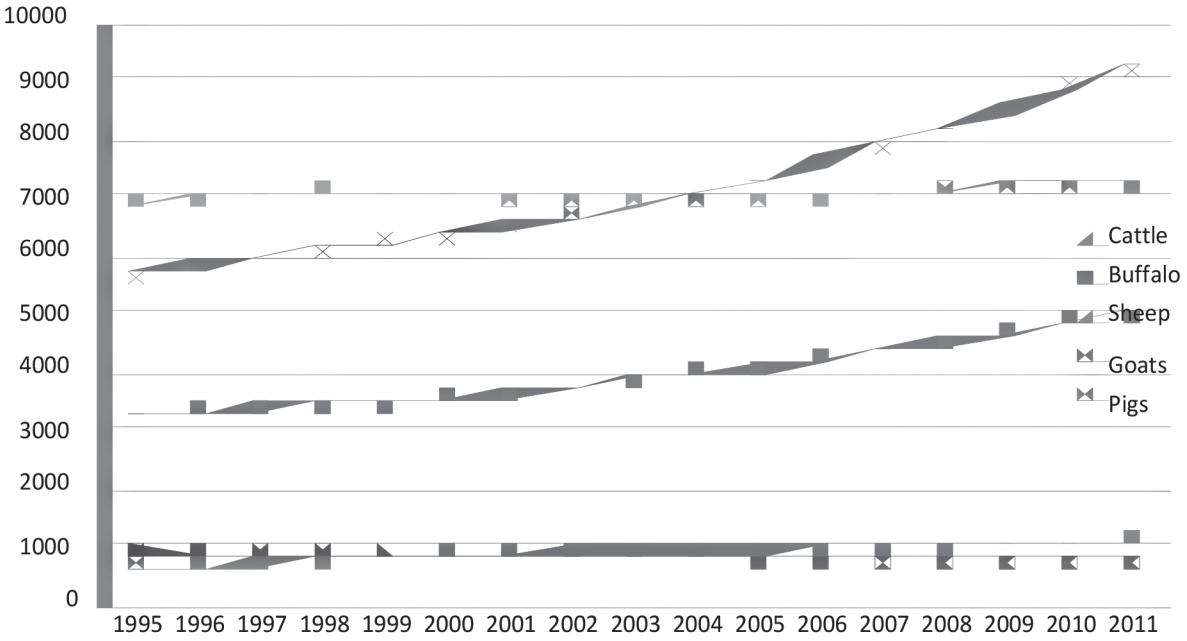



Figure 8: Trend of livestock population in Nepal

Source: Livestock statistics ('000) of Nepal from 1995 to 2011 (AICC, 1996-2012)

Figure 7 shows that the population of cattle for the last 17 years is almost stagnant whereas that of buffalo and goat has increased during the same period (1995 to 2011). The population of pig has increased slightly where as that of sheep decreased. Milk production statistics shows that there has been increase in the milk production by around 3.8% in the period of 2007 to 2011 (figure 8). The data also show that buffalo milk production has been increased by about 4% where as that of cattle is increased by 3.4%. Out of the total milk production of the country, about 71% comes from buffalo and only 29% comes from cattle.

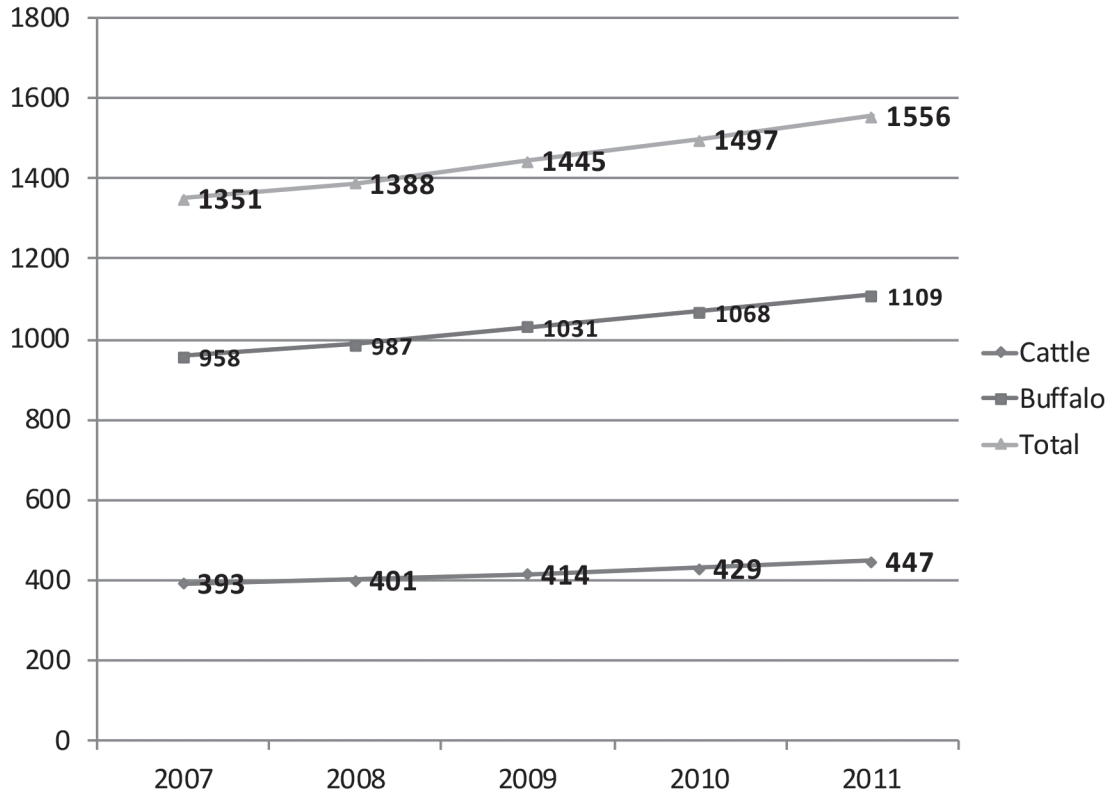



Figure 9: Milk Production ('000 mt/year) from 2007 to 2011 (AICC, 2008-2012)

Figure 9 shows the meat production statistics of Nepal during the period of 2007 to 2011. In the year 2011 out of the total meat production of 2,78,000 mt, buffalo contributed about 1,68,000 mt which was about 60% of the total meat production in the country. The contribution of goat to the total meat production comes after buffalo followed by chicken and swine. Therefore, buffalo is taken as the very important commodity in the livestock sector in Nepal. It is said that none of the part of the production of buffaloes goes wasted during their active lives, retired lives and even after their death.

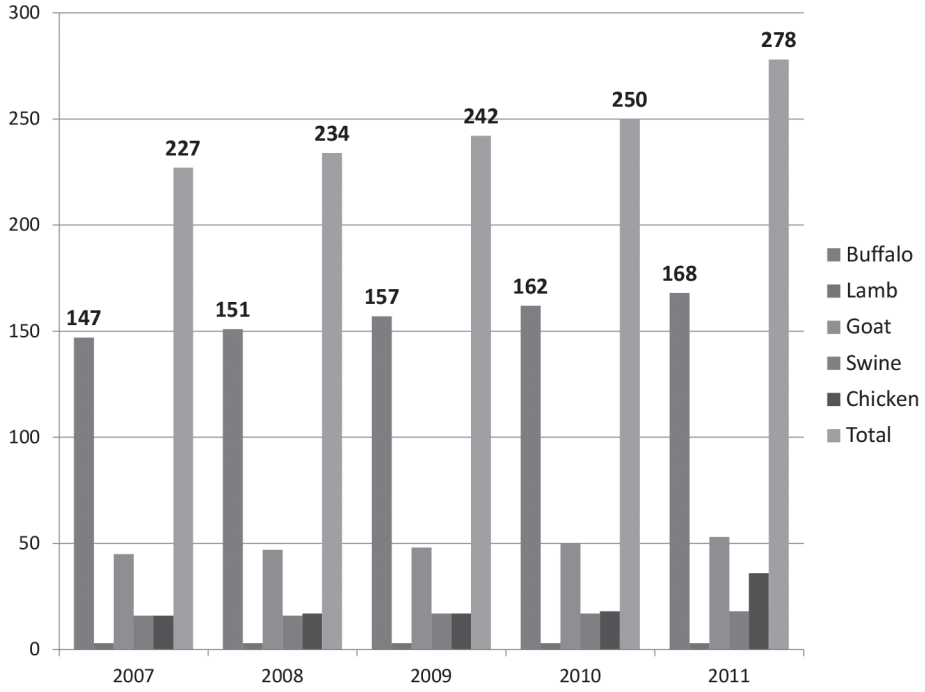
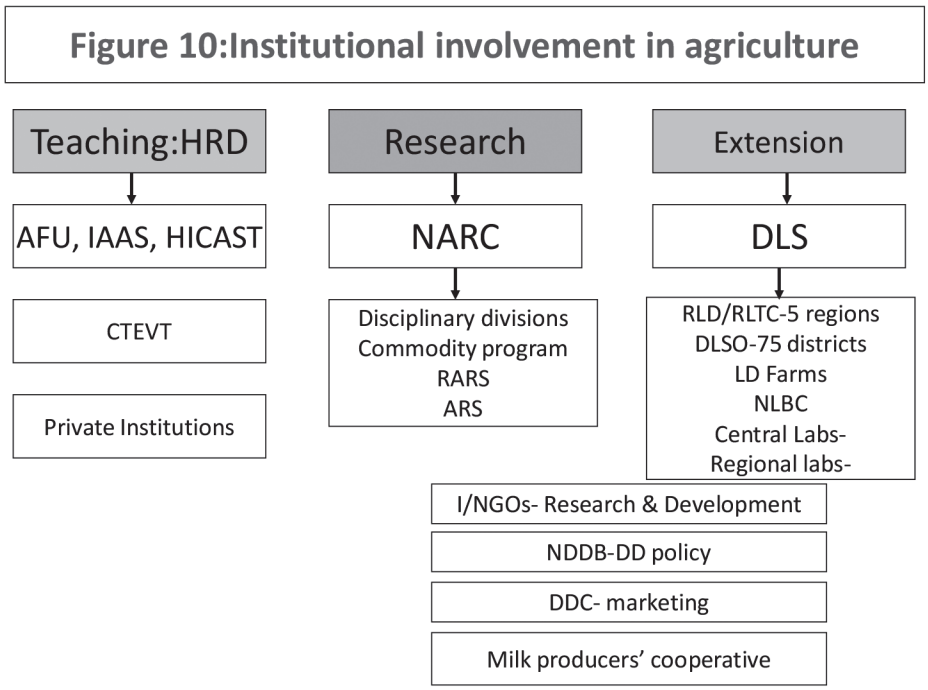



Figure 10: Meat production statistics of Nepal

**Institutions involved in livestock sector development in Nepal:**

Following chart shows the institutional involvement for agricultural development in Nepal. Basically, Agriculture and Forestry University (AFU), Tribhuwan University (TU, IAAS), Purwanchal University (PU, HICAST) and some of the vocational training institutions and private institutions are responsible for the production of human resources.



Nepal agricultural research council (NARC) through its different disciplinary divisions and commodities programs is responsible to generate the appropriate technologies in the fields of agriculture and livestock whereas Department of Livestock Services (DLS) through its program directorates, regional directorates, district level offices and service centers are responsible for the extension of technologies up to the grass root level. A present, there are 2,260 technical and 1,790 administrative staff in the DLS who are engaged for the extension of the livestock technologies throughout the country.

**Food and nutrition security**

There are four pillars of food and nutritional security as follows:

a. Food availability: The availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports.
b. Food access: Access by individuals to adequate resources (entitlements) for acquiring appropriate foods for a nutritious diet.
c. Stability: Access to adequate food at all times.
d. Utilization: Utilization of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met.

If all the above pillars are met, then only we can say that a country or a community is food secured. When we observe the food and nutritional security in Nepal, we find very bitter truth. It seems that we in Nepal are not even at the stage of food security where the nutritional security is still a dream for us! National recommendation for milk, meat and eggs was 57 liter, 14 kg and 48 numbers per person per year, respectively but we have only achieved the national target of milk till now. The data show that national availability of milk, meat and egg is 57 liter, 11 kg and 27 numbers per person per year in 2013 (AICC, 2014). In milk too, we are far behind the recommendation of the Food and Agriculture Organization (FAO) which is 91 liter/person/year.

**Constraints of livestock development in Nepal**

Some of the crucial constraints in the development of livestock sector in Nepal are listed below:

a. Large number of unproductive animals
b. High cost of production
c. No/negligible incentives in livestock farming
d. Limited research on practical problems related to livestock farming (very low priority to research)
e. Limited technical manpower (one JT/JTA should work upto 4-7 VDCs)
f. Very less resources in capacity building
g. Low priority given by universities in livestock related programs (HRD)
    I. BSc Dairy Science curriculum approved but no intake in AFU!
    II. Suspended BSc Animal Science course in TU/IAAS
    III. No more animal science elective course in TU/IAAS

h. Limited budget allocation in livestock sector!

i. Limited marketing network.

Above constraints can be justified from the facts and figures on contribution of livestock to the GDP and budget allocation for the livestock sector in Nepal that are given below:

**Contribution to GDP and budget allocation**

- Contribution of Agriculture to GDP: 34.33%
- Contribution of Livestock to GDP: 12%
- Contribution of Livestock to AGDP: 27% **(APP envisaged 45% in 2015)**
- Weights of different commodities in AGDP: 3 out of 6 commodities are livestock!
    1. Rice: 20.75
    2. Milk: 12.36
    3. Ruminant Meat: 7.66
    4. Wheat: 7.16
    5. Maize: 6.88
    6. Non-ruminant meat and others: 5.67
- Loan investment by ADB:
    1. Crop and crop services: 18.5%
    2. Livestock: 19.5% (ABPSD, 2013)
- Budget to Agricultural sector: 4.14% of the total national budget
    1. Allocation to livestock sector: 0.81% of total and 19.6% of the agriculture sector budget
    2. Budget projection for DoAH and DoLP for the FY 2071/72 as compared to FY 2070/71 is less by 29% and 34%, respectively!

**CONCLUSION**

Following conclusion can be drawn for the trend, potentiality and reality of the livestock sector the food and nutritional security in the global and national perspectives:

a. Livestock in the past, present and future should be considered as an integral part of agricultural system.

b. Unprecedented rising demand for livestock commodities will continue over the coming 5 decades.

c. As the human population keeps growing, the total livestock production should be doubled from 2000 to 2050.

d. More attention should be paid for liberal financing, friendly policies, regulations and standards in livestock sector in Nepal.

e. Priority should be given to livestock teaching, research and extension for the suitable technology generation and dissemination to meet the present as well as future demand of food and nutritional security in Nepal.

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# IMPACTS OF CLIMATE CHANGE ON LIVESTOCK-BASED LIVELIHOODS AND APPROPRIATE ADAPTATION MEASURES IN NEPAL

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## ABSTRACT

*Climate change as evidenced by increased climate variability such as more erratic rainfall, extreme events and increased temperature, is affecting the livelihoods of people dependent on livestock for their livelihoods. Livestock will have a role in relation to climate change, both in mitigation, and adaptation. Attempts are made to outline some of the likely effects of climate change on livestock production, and then discuss some adaptation plans and measures that are applied by the communities and those needed to develop and establish for mitigating the adverse effects of climate change. The key gaps and way forward to address the climate change issues in relation to livelihoods are discussed.*

## BACKGROUND

Climate change is defined as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UNFCCC, 1997). In simple word, climate change refers to any significant change in measures of climate; such as temperature, precipitation or wind- lasting for an extended period (decades or longer). During the past few decades, the world has been experiencing significant increase in global temperature resulting into climate change. Most of the warming in recent decades is very likely the result of human activities (IPCC, 2007) whereas climate change is now not just an environmental phenomenon, but also an economic, social and political issues in the world. Nepal is one of the most vulnerable countries in the world in terms of climate change and its consequences. However, the level of understanding and awareness on the issue is limited. Both crops and livestock are sensitive domain that could affect in production and sustainable attributes due, mainly, to climate change and its possible hazards.

Livestock play an important role in the Nepalese farming system and provide a major source of animal protein and household cash income, and thus have a significant place in the national economy. They contribute a significant proportion to the total gross domestic product (GDP) in Nepal. Livestock production is an integral part of the mixed-farming system where agriculture sector alone accounts for about three-quarters of employment and around one-third of Gross Domestic Product (GDP) in the country (MOAD, 2013). The livestock sector contributes about 13 percent to the national GDP and 27 percent to agricultural GDP. However, land use changes, deforestation, declining agricultural productivity, dwindling water resources, and the prevalence of diseases and parasites in recent years have resulted in a deterioration of these systems. In addition, climate change effects- such as rising temperatures, droughts, floods, emerging new diseases, and forest degradation, have threatened the existence of livestock production systems in the country. Livestock sector, which plays a key role in the economy of Nepal, can't keep as such without being affected by climate change. Findings from elsewhere suggested that livestock production has been affected to a great extent by climate change

(Morgan *et al*., 2007; Thornton *et al*., 2007; Thornton *et al*., 2009). Reflecting to the Nepalese context, studies are limited on this endeavor.

The impact of climate change is expected to heighten the vulnerability of livestock systems and reinforce existing factors that are affecting livestock production systems, overall economy of farmers, rising demand for food (including livestock) and products, conflict over resources (land, tenure, water, and biofuels, etc.) and ultimately cause decrease household economy.

Livestock will have a role in relation to climate change, both in mitigation, and adaptation. Mitigation measures on livestock could include technical and management options to reduce greenhouse gas emission (GHG) from livestock as well as the integration of livestock into broader environmental service approaches. These mitigation issues are not discussed in the paper. Attempts are, indeed, made to outline some of the likely effects of climate change on livestock production, and then discuss some adaptation plans and measures that are applied by the communities and those needed to develop/establish for mitigating the adverse effect of climate change. The key gaps and way forward to address the climate change issue in relation to livelihoods are also discussed.

**Perceived and Observed Climate Change**

The major climatic changes reported include increase in temperature, water scarcity, change in precipitation pattern, soil erosion and finally the climatic variability, which makes difficult and unpredictable situation. As a result of these, effects have been observed on livestock production and productivity and also on the epidemiology of the diseases that could have its direct link to the climate change issues (Devkota, 2010; NAPA, 2010; Singh, 2010).

There are several empirical studies carried out in relation to the climate change and its impact, but are largely confined to the perceived feeling and thought. Several of such feelings could be well reflected in the perused information too. For example, the transect appraisal exercise conducted in Karnali, Gandaki and Koshi river basin as a part of NAPA in 2009 (NAPA, 2010) showed the nature of change, kind of impact as a result of climate change and people response to such changes and institutions involved for livestock. In addition the knowledge available on science of the changes was found correlated with perceived climate change effects.

Due to change in climatic variability (for example, increase temperature especially in mid and high hills) there is considerable effect on breeding pattern of livestock species. It has been reported that breeding season and time of livestock species especially cattle and buffaloes could have been changed (references?). There is more infertility and sterility and repeat breeding cases observed under such scenario. Calving season has also been affected due to the rise in temperature. This may have big implication on livestock production. Similarly, there is a high prevalence of parasitic diseases such as liver fluke and other internal parasites and external parasites as well. Moreover, more new skin diseases have been reported by the farmers and livestock personnel. Due to high temperature, there is heat stress, especially in lactating cattle and buffaloes and also in poultry birds, which significantly reduces milk, meat and egg production (NAPA, 2010).

Similarly, change in rainfall pattern such as high precipitation, erratic rainfall are believed to have major effects on fodder and pasture production at all the altitudes, especially in high hills. Long drought causes decline in the emergence of pasture and fodder species, which further reduces forage production for livestock and thus there is high chance of nutritional deficiency

diseases and leading to decrease in milk and meat production. In addition, it has been reported that number of livestock species is decreasing due to shortage of feed. Moreover, available grasses emerged during drought periods may have some toxic substances and anti-nutrient factors, which further lower down the digestibility of the forage by the animals. It has been reported by the farmers in some specific sites that forage produced in drought periods could cause sterility and infertility and also upset the digestion in the ruminant species. The causes and the consequences about toxic chemical substance are not well understood. But the cases are reported sporadic. For example, similar observation on the toxic plants was found in Mustang rangelands (Personal observation by the authors in 2011 and 2012). Toxic plants reported from rangeland has been causing adverse effect on animal health, particularly sheep and goats (Neopane, 2012)

**Impacts of Climate Change on Livelihoods**

Climate change as evidenced by increased climatic variability such as more erratic rainfall and extreme events and increased temperature, is affecting the livelihoods of rural poor and marginal farmers in Nepal (NAPA, 2010; WFP, 2009). The ability to adapt to the impacts of climate change and variability is extremely important for Nepalese farmers to reduce its negative impacts. Very few attempts are, however, made so far in these endeavors.

Climate change continues to be a threat to the lives and livelihoods of small farmers of Nepal dependent on the integrated crop-livestock systems. Given the strategic importance of Nepal's agriculture to the nation's economy, potential impacts of climate variability and change on national food security is a cause of concern. In recent years, evidence of changing climate, such as, general warming, receding snowline, prolonged drought, and unpredictable rainfall patterns has been well documented in the region (MOE, 2010). Specifically, such cases are being identified as most peculiar and site specific one. Ghimire (2011) reported effect of climate change related drought on the livestock production in the hills of Nepal, where the farmers having low land holding and no access to irrigation were the most affected and vulnerable to cope with climate change. Some authors (Khanal *et al*., 2011; Pathak *et al*., 2011; Thakur, 2011) have reported about the effect of climate change on the livestock diseases.

The major climate change variables reported in the country are drought, erratic rainfall, winds and storms and diseases and pest with regard to agriculture (Table 1). These variables appear to have effects on production and household income and eventually on livelihood.

Table 1: Climate Change Variables and Effects

| Variables | Effects |
|---|---|
| Drought | Production decline, water sources affected, biodiversity affected, rangeland affected etc. |
| Erratic Rainfall/Flood | Infrastructure affected, agriculture land eroded, landslides, forage affected |
| Winds and storms | Infrastructure, agriculture crops and livestock affected |
| Disease and pest | Production decline, environment affected |

*Sources: NAPA (2010); Neopane and Thakur (2010); Neopane, et al. (2011); Singh (2010)*

**Animal Feed and Fodder**

Animal feeds and availability of fodders are critical from production perspectives of the animal. There could be several of such relations obtained while considering availability and production issues. A study carried out in Solukhumbhu, Humla and Mustang districts in 2010 and 2011(Neopane, 2012) showed climate change and feed and fodder availability relationship where rangelands including grazing lands were found affected with less rainfall, snow fall timing and amount, and drought. Drought could affect both emergence and growth of forage. Inadequate moisture (due to less rainfall, drought and snow fall) has affected forage growth and production. Number of harvesting frequency and biomass yield were also affected because of the changes in the climatic attributes.

Moreover, climate change can be expected to have several impacts on feed crops and grazing systems. The impact may be on the herbage growth brought about by changes in atmospheric carbon di-oxide ($CO_2$)concentrations and temperature, changes in composition of pasture (Devkota, 2010), such as changes in ratio of the grasses to legumes, changes in herbage quality with changing concentration of water soluble carbohydrates and Nitrogen (N) at given dry matter (DM) yields, greater incidences of drought which may offset any DM yield increase and greater intensity of rainfall which may increase N leaching in certain systems (IFAD, 2009). Consequences of such changes should be addressed for their accountability to the production related parameters.

Sherpa and Kayastha (2009) reported slow emergence of new grass and poor quality grass on pasture/rangeland of Khumbu region of Nepal. Effects would depend significantly on location-system and species. In C4 species- a rise in temperature to 30–35$^0$C may increase the productivity of crops, fodder and pasture. In C3 plants, rising temperature has a similar effect, but increase in $CO_2$ level could have a positive impact on the productivity of these crops (IFAD, 2009). Such probable positive contribution should be cautiously taken as it should be supported by the scientific and concrete research (Devkota, 2010) whereas continued efforts in this line could help in generating reliable scientific information.

Several authors have reported about the pros and cons of climate change and about their attributes causing consequences. Singh (2010) reported river bank cuttings, grassland covered by debris and sands caused soil erosion, loss of green herbage and community pasture land which has led to shortage of feeds for ruminants in terai (Siraha and Kapilvastu) and hill districts (Udaypur and Arghakhanchi). Delayed rainfalls (monsoon) and prolonged drought conditions resulted in delayed planting of rice with a decreased crop yield, drying of tree fodders, and delayed emergence of local grasses by which availability of green fodder was adversely affected resulting in lower body condition and decline in animal productivity. In Udaypur district community pasture land located across the river could not be utilized due to stronger flood water current during monsoon.

**Animal Health**

There are limited studies and findings available about climate change and animal health. However, available information is very relevant to address the issues. A study carried out in Solukhumbhu, Humla and Mustang districts in 2010 and 2011(Neopane, 2012) showed climate change and animal health relationship showing occurrence of new diseases; PPR in Mustang

(which was not seen before), TAS, a lung shrunk and dry condition in goats in Humla; ticks and mites in all three districts. High prevalence of diseases (Red water and HS) and parasites (liver fluke) was reported from these districts. The most affected species were ruminants.

The impact of changes in ecosystems on infectious disease depend on the ecosystem affected, the type of land and use change, disease specific transmission dynamics and susceptibility of the population at risk. Thornton *et al.* (2008) suggested that vector borne diseases could be affected by the expansion of vector populations into cooler areas and changes in rainfall pattern during wetter years, which could also lead to expanding vector population and large scale outbreak of disease. Likewise Helminth infections are greatly influenced by changes in temperature and humidity. Example from Africa revealed that climate change may affect trypano tolerance in sub-humid zones of West Africa that could lead to loss of this adaptive trait that has developed over millennia and greater disease risk in the future (Thornton *et al.,* 2008). Several of such related findings could contribute well to the science.

Besides indirect effects, the direct effect of climate change will include- change to the high temperature, weather and changing rainfall pattern, which could, for example translate into the increased spread of existing vector borne diseases and macro parasites accompanied by the emergence and circulation of new diseases and transmission models as well. For example Sherpa and Kayastha (2009) in their study found increasing prevalence of black flies and similar other pests in yak and *Chauries* in the Khumbu region of Nepal. Similarly Neopane (2012) reported infestation of external parasites in Mustang, Humla and Solukhumbu districts in cattle, sheep and goats but these were not reported in the districts earlier. Several investigations (Khanal *et al.*, 2011; NAPA, 2010; Thakur, 2011) reported new diseases including parasites in the hills of Nepal, which were not seen earlier in those areas. Singh (2010) working in terai and hill district of Nepal reported high prevalence of parasitic diseases (liver fluke, and nematodes), ecto-parasite infestation and new skin diseases in animals due to rise in temperatures in some terai and hill districts. Incidence of ruminants' parasites and animal diseases has been increased in changing environment such as Liver fluke and helminthes infestation which has caused poor health, higher mortality rates and production losses. Similarly other contagious diseases (HS, FMD) have appeared and the morbidity and mortality were found higher than the past. Helminthes infections are significantly influenced by changes in temperature and humidity. Farmers of project sites have quoted ecto-parasitic infestations at increasing trend than previous years. These findings are critical in addressing climate related facts in relation to the livestock diseases.

Several authors have reported about climatic variability and diseases related to the livestock elsewhere. For example, Hoffman (2010) reported that there could be a visible impact of climate change such as change in temperature, humidity and extremities to the animal health and reproduction. In deed climate change can make direct impact to the physiological status of animal that are also linked to the reproductive health. . In addition to the physiological effects of higher temperatures on individual animals, the consequences of climate change are likely to include increased risk that geographically restricted rare breed populations will be badly affected by disturbances. Indirect effects may be felt via ecosystem changes that alter the distribution of animal diseases or affect the supply of feed. Breeding goals may have to be adjusted to account for higher temperatures, lower quality diets and greater disease challenge. Species and breeds that are well adapted to such conditions may become more widely used (Hoffman, 2010; Laczka, 2010). These responses and processes are found well related to the climatic parameters.

**Animal Performance**

A study from terai and hills (Siraha, Udaypur, Kaplivastu, and Arghakhanchi) by Singh (2010) for FAO TCP showed the impact of climate change on animal performance. Farmers of project districts expressed their views on climate change/variability and its impact on agriculture and animal production. The farmers in Siraha and Udaypur expressed change in agricultural practices over the period of last ten years due to climate change/variability.

Farmers have felt the temperature increase during both summer and winter months. The risen temperature in winter might have a few positive impacts on young animals' survivability, lower feed requirement and stress due to extreme cold may be lessened but the winter crop yields has been adversely affected. High temperatures in summer caused both ruminants and the herders suffering by heat load during grazing hours in pasture. This will lead to poor performance of the animals. Studies from elsewhere support this, For example, Rowlinson (2008) reported that heat stress suffered by animals mainly will reduce the rate of animal feed intake and results in their poor growth performance.

Due to increase in temperature especially in mid and high hills breeding pattern of cattle and buffaloes has been changed and hence calving seasons have been affected. The cases of infertility, sterility and repeat breeding in cows and buffaloes have been increased.

**Adaptation Measures**

Climate adaptation refers to the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damage, to take advantage of opportunities, or to cope with consequences. The IPCC (2007) defines adaptation as the “adjustment in natural or human systems to a new or changing environment”. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptations can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

Climate mitigation refers as any action taken to permanently eliminate or reduce the long term risk and hazards of climate change to human life and property. IPCC (2007) defines mitigation as “an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases”

Several studies in the country (NAPA, 2010; Neopane, 2012; Neopane and Thakur, 2010; Singh, 2010) showed that the community has been applying their own strategies to cope with climate change effects. The major strategies are as follows;

- Replace shallow tube by deep tube well-an example to cope with water shortage
- Switching to alternative livelihood (diversifying options for livelihoods)
- Encourage insurance for animals-as of more susceptible enterprise
- Seeking technical advice
- Use of veterinary drugs to control diseases and parasites

- Increase awareness on animal diseases
- Increase cultivation of fodder grasses
- Plantation around farm lands and water sources
- Restricted grazing
- Rain water harvesting
- Reduce use of water at home and farm
- Promote non-timber plantation to increase food and fodder supply
- Promote to using compost to increase farm productivity in line with coping to the probable worse scenario or worst soil fertility
- Change in fodder species in different ecological belts as fits to them
- Forest plantation

These strategies have to be validated with science and scaled and promoted (if the community strategies and science match) for increasing adaptive capacity of the community. In order to do this, studies have to be done on this endeavor. However, preliminary findings from some of the studies in the country (Devkota *et al.*, 2011; Ghimire, 2011) revealed that strategies based on indigenous knowledge match with sciences. Comprehensive studies on the aspects are very much needed whereas continued efforts would yield relevant scientific facts into practice.

**Some Suggested Important Climate Change Adaptation Strategies**

**Animal Feed and Fodder**

The climatic hazards or disasters will have severe impacts on the livestock feed availability; therefore, main emphasis should be given to improve feed and fodder supply for ruminants. Awareness of rotational grazing and stall feeding should be disseminated in the communities through trainings, observation tours and demonstrations. A demonstration of stall feeding of ruminants might be an inspiring activity, which will lower parasitic burdens on animals, protect environment and an extra manure will be available for crops and vegetable production. This will also reduce emission of GHG and promote sustainable grazing system in the days to come.

The multipurpose fodder trees play important role in conserving the tree fodder for dry season. These trees will also support soil conservation, provide timber, firewood and litter materials. Therefore, wherever propagation is practicable, the plantation work should be carried out in a wider scale. Demonstration of silvipasture management should be carried out in private or community land to produce ample green matter for ruminant livestock. The native species of fodder trees should be promoted to help safeguard protection of native species that are more adaptable to the niche specific context.

There are many promising species of grasses and legumes available which are suitable for Terai and hill region of the country. The seeds and planting materials were imported by various projects and the government farms. These should be planted in bari land, terrace risers, bunds and community land/forests to produce more green forage for dairy cattle, buffaloes and goats.

Most of these species are found vigorous, yield more green matter, tolerant to droughts, floods, shade and grazing.

Shed floors should be clean and hygienic to maintain the health of animals. Proper cleaning of shed floors is possible when the surface is hard, have slope towards the gutter. Many sheds in the country are lacking adequate ventilation, sanitation and comfort to animals. With the frequent climatic hazards animals are severely affected. Therefore, the shed should have adequate floor, roofing, ventilation, gutters to collect urine and dung.

There should be compost pits, roof water collection tanks, etc. and provision of shade trees around the shed to reduce impact of extreme hot weather conditions. Awareness raising of the farmers in improvement of shed management can be carried out with a demonstration, training, and farmers tours. Farmers field school (FFS) can play significant roles in this regard.

**Animal Health**

Vaccination against contagious animal diseases should be done on regular basis so as to protect the animals from the climatic hazards. Similarly, deworming against internal parasites should be done.

Shed floors should be clean and hygienic to maintain the health of animals. Sheds should have adequate floor, roofing, ventilation, gutters to collect urine and dung for adapting climatic hazards. There should be compost pits, roof water collection tanks etc. and provision of shade trees around the shed to reduce impact of extreme hot weather conditions. Awareness raising of farmers in the improvement for shed management is required.

**Animal Performance**

Native breeds are already adapted to their harsh environment. Due to this fact generally they are superior compared to exotic breeds. However, many Indian buffalo and goat breeds are successfully adapted to Terai to mid-hill region of the country. In Terai as well as at mid hills, the Indian Murrah buffaloes have survived and reproduced successfully, and have shown higher production potentials compared to native breeds. In order to cope with the adverse climatic impacts and for the purpose of food security cross breeding with Indian breeds in native buffaloes and Terai goats can be continued. In the mid hill region native Khari breed has been found superior to crossbreds with Indian breeds. The performance of crossbreds with Boer goats and recommendation by NARC is anticipated. Regarding cattle, Jersey crossbreds will be better adaptive to warmer climatic conditions compared to Holstein Friesians. The Indian cattle breeds are suitable for bullock production for carting and land tilling purposes. These examples could be fortified to match with the specific context.

Appropriate shed and other husbandry practices should be promoted for having comforts to the animals so that they can perform well.

**Key Gaps and Way Forward**

Based on available knowledge and experiences from the country on the effect of climate change for livestock and livelihoods, the following major gaps and way forward are suggested.

- Despite of the role of livestock to play in coping with risk and providing livelihood options, there is only limited knowledge about the interaction of climate with other drivers of change in livestock based system on a broader trends. These facts must be addressed scientifically in the days to come.
- Adaptation options need to be tested in more extreme environments
- Research can't contribute with full extent to improving adaptation capacity without a comprehensive understanding of the context in which decisions about adaptation are made. Therefore research has to be very strongly established and strengthened.
- Use and promotion of indigenous species and breeds of livestock and poultry at local levels.
- Use and promotion of indigenous and local species and varieties of forages at local level.
- Diversification of income sources through livestock farming. Diversification could be at species level or breed level whereas increased in the percentage of diversification would entrust in creating safest livelihood option.
- In depth study on impact assessment and adaptation plan.
- Further investigation on the impact of climate change.
- Understanding the strategies in more depth and promote these practices.
- Make appropriate interventions in increasing their adaptive capacity
- Make an integrated approach to cope with the possible climate change effects on livestock farming.

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# CLIMATE CHANGE IMPACT ON AQUACULTURE: MITIGATION BY CLIMATE SMART MANAGEMENT?

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## ABSTRACT

*Climate change impact mitigation is one of the major thrust given for food and nutrition security in Nepal. However, comparing to major food production sectors, climate change impact over aquaculture and fisheries has not been adequately covered. Therefore, the main aim of present work is elucidate the climate change impact mitigation measures by climate smart management for resilience to small scale fishers and farming communities in Nepal. Climate smart management may describe as participatory approaches using recent meteorological, weather forecast, and adaptive technological information for sustainable fish production. Inland fishery and aquaculture plays important role in rural food and nutrition security especially to women, deprived communities and commercial farmers in Nepal. Nearly 0.7 million people are known to depend directly or indirectly in fisheries and aquaculture. Aquaculture is one of the fastest growing sectors with an average growth rate of approximately 9% per annum. Still there remains huge aquaculture production potentiality from perspectives of abundant inland water resources. In Nepal, fisheries and aquaculture may distinctively separate into three agro-fisheries zones, as cold, cool and warm water. The cold water aquaculture which most predominantly represented by Shizothorax spp fishery and rainbow trout aquaculture; cool water in mid hills best represented by Mahaseer, and Acrossocheilus and Labeo dero fishery, and warm water by Wallago attu, Clarias, Puntius spp, Channa fishery and Labeo, Cirrhinus etc. Increasing variability in precipitation and resulting flood and drought extremes would be the most significant drivers of change in inland aquaculture. Associate events of land slide and turbid water are also likely to impact cold water aquaculture. The fisheries and aquaculture in plains, hills and high hills might be impacted by increasing temperature and erratic rainfall. There could be invasion of warm water fish, invertebrates and invasive aquatic plants towards mid hills. Due to climatic extremities, weak capacity to preparedness, Nepal has been rated as one of the most vulnerable countries of climate change impact in the world. Several glacial lakes situated at high Himalaya have been forecasted to be burst due to melting leading to flood and landslides causing loss of aquaculture infrastructures and human casualties. To mitigate the major climate change impact aquatic life friendly storage reservoirs, irrigational networks, agriculture practices, embankment in rivers and streams may be useful. To mitigate the climate change impact, major strategies would be the generation, improvement and adoption of diversified aquaculture technologies as a part of the climate smart aquaculture would be most pragmatic solution.*

**Key words:** *Climate change, climate smart aquaculture management, flood and inundation*

## INTRODUCTION

Climate is the average weather at a given point and time of year for a long period of 30 years, while whether is expect to change from day to day but climate remain relatively constant, if remain constant over typically 30 years of long period, it is the climate change (Wikipedia 2015). Climate change has characterized to have erratic rainfall and occasion drought. Since aquaculture is farming of fish in water and land mass 3-dimensional system, thus excess in heavy rain might harm the aquaculture by means of inundation, flood while or limited rain causes drought. The most visible impacts of climate change could be widespread of many protozoan, viral, and infectious diseases and parasites to fish due to increasing water temperature.

Aquaculture is one of the fastest growing food industry (Sena 2010), therefore the concern of climate change to aquaculture becomes substantial (Wagle *et al.* 2011). Fisheries are one of the primitive professions of Nepal since tradition and culture, however, the art of aquaculture has relatively short history and within a short period the aquaculture has been expanded substantially with greater potentiality in future. The fisheries and aquaculture contributes 0.9% in total Gross Domestic Production (GDP), but it is socially important because of higher involvement of women, socially deprived communities and playing important role in food and nutrition to the society. However, the aquaculture now is becoming more productive, commercial, and beginning to take industrial shape. Therefore, the present work aims to elucidate some of the basic highlights on climate impact over fisheries and aquaculture in Nepal.

Climate change adaptation, preparedness and mitigation are the major thrust areas for the country because Nepal is the 4th most vulnerable countries of the world while its contribution in Green House Gas emission has been rated only 0.025% (Gurung *et al.* 2011). Although many such studies related to vulnerability, adaptation, preparedness in agricultural sector especially in crop, horticulture and livestock sector have been initiated (Agarwal 2007). The concept of forming 'climate smart village' has also been put forwarded with achievements in areas of weather forecasting using the mobile phone and meteorological services (Taneja *et al.* 2014, CCAFS 2015). However, in-lieu, aquaculture & fisheries nevertheless are the most vulnerable practices since such facilities are mostly located close to rivers, lakes, wet- and lowlands vulnerable to flood and drought. Therefore, the primary aim of this paper is to elucidate effects of climate change and propose climate smart management for adaptation and policies to mitigate the threats and building resilience for 'Climate Smart Nepal'.


Figure 1. Location of Nepal in between India and China

**Climate change and the fisheries sector in Nepal and regional countries**

Nepal has one of the fastest growing inland fisheries and aquaculture sectors. The growth rate is estimated above 8-9% per year. The aquaculture is growing at fastest rate in central and eastern terai region for carp aquaculture, while for rainbow trout the central, eastern and western regions are the areas rapidly coming up. It is very much generic that fish farms and aquaculture production spots will be located nearby water bodies, such as river, lake and reservoir. Since the climate change is known to provide erratic rainfall which might cause flooding as well as drought. In both conditions the aquaculture sector has to be impacted the most. There could be several consequences on fisheries from fish disease, parasites, eutrophication, spreading of tropical fish diseases towards hills and mountains, scarcity of water supply, flooding and landslide could affect the growth potentialities of aquaculture. Therefore, in such perspective the climate change impact might bring serious consequences to aquaculture practices of the country. Being mountainous, Nepal has also been rated highly vulnerable due to land slide, snow melt episodes, hailstone, wild fire etc. These all might cause direct and indirect impact over aquaculture and fisheries.

**Climate change direct and indirect consequences and adaptive measures in fisheries**

Climate change has overarching impact of erratic rain and increasing water temperature and nutrients dynamics on plankton species, quality and quantity on fish species distribution, growth and reproduction (Table 1 and 2). The impact of climate change could be direct as well as indirect. The direct impact is clear drought might cause unfavorable conditions for existence of specific fish species. The flooding also causes to sweep out the fish, the flooding and landslide causing the high turbidity might negatively affect the reproduction and breeding activities. There are several examples that in monsoon hundreds of hectares of fish ponds are inundated causing loss of millions in southern terai due to over active monsoon rain and flood. There has also been example when drought conditions delays on the filling of water in fish ponds and impacting over the production. In mountain side aquaculture land slide, flash flood has been the causative factors for loss of cold water aquaculture raceways.

Table 1: Climate change consequences due to temperature rise on environment and fish habitats with possible adaptive measures

| Change | Consequences | Impact | Adaptive Measures |
|---|---|---|---|
| Glacier melting | High altitude glacier burst | Flash flood disaster | Awareness, forecast, early warning system |
| Drying lakes & wetlands | Swamp formation | Poor cage & lake fishery | Restoration measures, low DO tolerant or air breathing species dominance |
| Low water tables in rivers | Low water supply | Poor water availability | Watershed management |

Table : 2 Climate change consequences on fish physiology, flood, fish diseases, post harvest measures and possible adaptive measures

| Change | Consequences | Impact | Adaptive measures |
|---|---|---|---|
| Early maturity | Undersize offspring | Low market value | Genetic improvement for alternative breeds |
| High flood | Submerged farms | Loss of production | Integration with hydro dam or irrigation system |
| DO depletion in ponds | Poor productivity | Poor benefits | Measures to increase DO |
| Fish diseases and parasites | Poor productivity | Poor benefits, low quality products | Species selection, high sanitation, good management practices |
| Post harvest | Fast decay | Poor benefits | Ice factory, cooling vehicle, value addition |

The present scenario of aquaculture species distribution in Nepal has been illustrated in Fig. 2. The southern terai, below Siwalik is generally the belt for carp, tilapia and tropical catfish production areas, while the deeper above Siwalik hills and mountains are the areas for cold water species such as Sahar known as Mahaseer (*Tor* spp.), Katle (*Neolissochilus hexagonolepis*), Asala (*Shizothorax* spp) and also trout areas in general. But, in high mountain areas in general belongs to Asala and trout. The high mountain and Himalaya are not very well known for fisheries. It is speculated that probably these high altitude rivers and streams could be best utilized for rearing Arctic charr (*Salvelinus alpines*) successfully, which prefer water temperature ranging 1-2 $^{0}$C for aquaculture (Bjorn *et al* ). It is likely that with climate change and global warming the southerly located fish species would shift deeper towards the hills and Himalayas due to increasing water temperature. Some visible evidences of climate change related to aquaculture have been enlisted in Box 1.

**Some evidences of climate change episodes ?**

- Flood in terai fish ponds loss of resources
- Land slide causing the loss of rainbow trout farms
- Tilapia farming gradually adapting
- African catfish in hilly districts invaded.
- Water hyacinth invaded mid hill lakes since 1996.
- Degradation of mid hill lakes
- Glacier melting
- Disappearance of wetlands or swampification

Box 1: Some visible episodes of climate change in aquaculture sector in Nepal

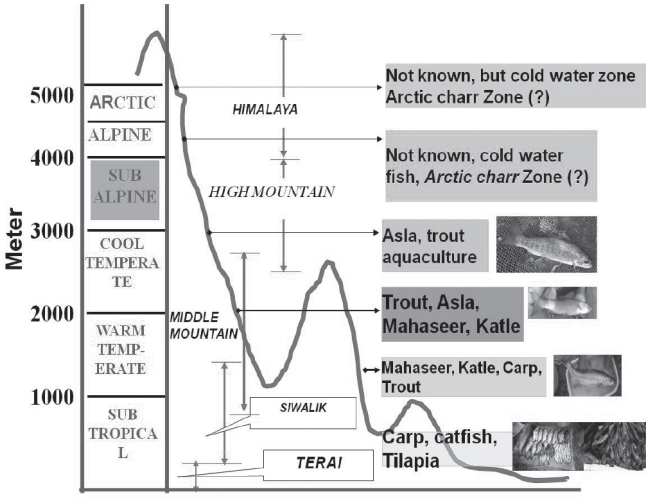


Figure 2. Fisheries zoning with some prediction in different agro-ecological altitudes of Nepal

**What is climate smart aquaculture management?**

In broad sense, climate smart aquaculture management is the same approaches applied to other sectors of agriculture which aims to address the challenges of food, nutrition security and climate change perspective to increase sustainably increasing aquaculture productivity, adapting and building resilience of food security systems to climate change at multiple levels; and reducing greenhouse gas emissions from fisheries (CCAFS 2015). The aquaculture smart management can be achieved by strengthening catchment areas, aquatic life and aquaculture friendly storage reservoir, irrigational network, strengthening embankments in rivers and streams, generation and adoption of water management diversified technologies etc. Climate smart fisheries management may describe as participatory approaches using recent meteorological, weather forecast, and adaptive technological information to identify climate change challenges facing by communities (Agarwal 2007, Taneja *et al.* 2014, CCAFS 2015). Increasing variability in precipitation and resulting flood and drought extremes would be the most significant drivers of change in inland aquaculture (Handisyde *et al*. 2006, SPC 2008, Cochrane *et al*. 2009). Associate events of land slide and turbid water are also likely to impact cold water aquaculture.

## CONCLUSION

Increased invasion of tropical fishes like Tilapia and African catfish in hills and mountains, some native fishes might be endangered and vulnerable, participatory climate smart fisheries would be the best option to build a climate smart Nepal.

## ACKNOWLEDGEMENTS

We express our gratitude to Nepal Animal Science Association for suggestions and discussion on the paper. Thanks to Ministry of Agricultural Development and Nepal Agricultural Research Council for providing support to the present study.

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# GOAT MANAGEMENT AND PRODUCTION BY PRO-POOR: AN EXPERIENCE OF LEASEHOLD FORESTRY AND LIVESTOCK PROGRAMME

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## ABSTRACT

*Leasehold Forestry and Livestock Programme (LFLP) is being implemented in 22 mid-hill districts. Its goal is to reduce the poverty of 44,300 household in mid-hills through the increase production of forest and livestock products. Under livestock development component, the program is designed to cover goat/forage production and development, livestock trainings & services and livestock implementation support. This program provides appropriate seed and planting materials of Stylo, Molasses, Napier, Brachiaria and Amriso, to help develop the lease hold plots and increase the availability of green forage. Availability of forage has reduced the drudgery of women for the collection of fodder from the forest and other community land. Supplied fodder and grass seeds to the leasehold forestry groups, resulted in increased green coverage of the leasehold forestry plots. The vegetative ground cover in new sites is on an average only 32 percent, which increases to 50 percent after one full growing season and gradually expands to an almost full coverage of 90 percent in seven years old sites. The degree of satisfaction by both female and male is high on grasses and fodder seeds and Napier slip distribution. Farmers have saved the time up to max. of 9 hrs in fodder/grass collection and 8 hrs in fuelwood collection. To use the fodder to boost the income of the leasehold groups and to reduce poverty, the program provides all eligible member households with two mature vaccinated and drenched female goats. The Programme has distributed 65880 she goats and 3493 bucks as against the programme appraisal target of 74,250 she-goats and 3,136 bucks. Since 2006/07, goats are being distributed and household flock size has increased. Similarly, 462 breeding does and 20 breeding bucks are provided to the LFUGs of Palpa and Nawalparasi where TA-LFLP has been piloting the LFLP. LFLP trained 146 Village Livestock Assistants (VLA) and 139 Village Animal Health Workers (VAHWs). About 74% of leasehold households were raising goats before the program period. It now has been increased to 93 percent with the project support. Average number of goats per household differs significantly from before program (0.82 AU/HH) to after program (1.54 AU/HH) and the quality of goats has been improved over time. The increment in goat no. is by 90 percentage. The average household income of households in the LFUGs increased by 71% from before the project.* The poverty gap for the average household was reduced from 55.4% to 74.8%, a 35.0% improvement in the poverty situation. *It has been observed that secured access to degraded forestland, combined with training and input assistance, increases the habit of forage cultivation, shifting from free grazing to stall feeding and changes the composition of livestock from local to improved.*

## INTRODUCTION

Leasehold Forestry and Livestock Programme (LFLP) is being implemented by the Government of Nepal, specifically the Department of Forests (DoF) and the Department of Livestock Services (DLS) with financial support from International Fund for Agriculture Development (IFAD) in 22 districts of Nepal since FY 2062/063 (2004/-005). Accordingly, the concerned district level offices: District Forest Office and District Livestock Office are the main implementing agencies at grass root level. However, ECARDS-Nepal, a national NGO, has been entrusted with providing

social mobilization service to the programme. The Leasehold Forestry Section of the DoF is the office of the National Programme Coordinator (NPC) for the overall programme coordination and management.

Goat farming an integral component of Nepalese agriculture is mainly for meat production in the mid-hills. Goat farming has been a technical entry point of programmes on poverty alleviation and income generation of rural farmers for several years in the past. Department of Livestock Services and many other development institutions and agencies are implementing goat distribution as a predominant activity of poverty reduction. Despite various efforts in the past, goat productivity has not increased, though increase in meat production associated with increase in goat population appears evident.

In total, the Programme has distributed 65880 she goats and 3493 bucks as against the programme appraisal target of 74,250 she-goats and 3,136 bucks (NPAFC, 2011). Since 2006/07, goats are being distributed and household flock size has increased.

LFLP trained 146 Village Livestock Assistants (VLA) and 139 Village Animal Health Workers (VAHWs), which are respectively 81% and 158% of appraisal. Some Village Animal Health Workers (VAHWs) received loan to buy veterinary medicines from the DLSO veterinary revolving fund, which ranged from Rs15,000 to Rs18,000. However, the number of active VAHWs is small.

The programme also dispensed a total of 185,635 doses of vaccines to immunize the goats against PPR (Peste Des Petit Ruminants) and 253,941 goats drenched against internal parasites.

The programme made a good progress in seeds and planting materials supply. By July 2011, a total of 8,281 ha of leasehold lands were sown with 38,330 kg of forage seeds. Species included *stylo*, molasses grass, Napier, amriso, mulato, sumba *setaria* and Guatemala. The achievements ranged between 94 and 99% of the appraisal targets. In addition, 384,000 fodder seedlings were also made available to plant on the leasehold plots.'

**Forage development in Lease land:**

This program provides appropriate seed and planting materials of *Stylos*, Molasses, Napier, *Brachiaria* and Amriso, to help develop the lease hold plots and increase the availability of green forage. At least 40% of allocated lease land is covered by these forages. A total of 8,281 ha of leasehold lands were sown with 38,330 kg of forage seeds. Species included *stylo*, molasses grass, napier grass, amriso, mulato, sumba *setaria* and Guatemala. In addition, a total of 384,000 fodder seedlings were also made available to plant on the leasehold plots.

**The basic concepts adopted for forage cultivation and production are:**

- Production of more quality fodder on Leasehold Forest and farm land itself.
- Improvement of soil fertility level with the use of fodder and crop legumes.
- Promotion of fodder production in the wastelands and degraded lands within the farm and Leasehold lands for the benefit of all community members.
- Availability of quality forage from 2nd year for their livestock/goats and,
- Reduction in the work load of women for the collection of fodder from the forest and other community land areas.

**Initial Assessment of Outcome and Impact:**

Supplied fodder and grass seeds to the leasehold forestry groups, resulted in increased green coverage of the leasehold forestry plots.

This intervention has resulted in:

(i) Substantial reduction in time spent by women for collection of forage;

(ii) Increased time usage for other productive activities;

(iii) Quality forage availability even during the dry season;

(iv) Water availability improvement due to increased green coverage; and

(v) Scarcity of animal feed decreased

According the Pandits report (Pandits, 2009), the highest change was observed in the status of leasehold forestry, area under grasses and fodder trees, number of firewood trees and NTFPs. The most significant changes in Natural capital was observed in fodder and grasses collected from leasehold forest, which has contributed to about 34 percent of the total grass and fodder supply to farm animal. The overall response of the fodder promotion programme is quite encouraging. Basically, the women LFUG members took greater interest in managing fodder production, vegetative and seed production activities.

Pandit has stated that the degree of satisfaction by both female and male is high on grasses and fodder seeds and Napier slip distribution.

Forage development in the leaseland has not only encouraged to the improved livestock farming but also helped in the vegetation ground cover improvement. In most places there is rapid natural regeneration of herbs and grasses, followed at varying speeds by the natural regeneration of trees. In some sites, leasehold forestry groups intensively manage and expand the area of planted fodder grasses and legumes or develop fruit orchards. The vegetative ground cover in new sites is on an average only 32 percent, which increases to 50 percent after one full growing season and gradually expands to an almost full coverage of 90 percent in seven years old sites. This will immediately stimulate natural regeneration of the trees and grasses and will have positive impact on biodiversity

The outcome monitoring report of Technical Assistance to Leasehold Forestry and Livestock Programme (TA-LFLP, 2010) highlighted that farmers have saved the time up to max. of 9 hrs in fodder/grass collection and 8 hrs in fuelwood collection. Moreover, 53% of LFUGs reported that the time for fuelwood collection has reduced while in case of fodder 65% of LFUGs reported their time for collection has reduced. 46% of LFUGs reported there is no change in duration of fuelwood collection while 35% of LFUGs reported there is no change in collection time of fodder/grass.

**Goat Production and Management:**

Goat rearing has been widely accepted by rural poor to raise their household income. Due to easy rearing techniques, availability of feeding materials, this income generating activity has got high importance by development organizations as well. DLSO is responsible for providing materials and services to LFUGs in terms of rearing goats and forage development inside leasehold forest. DLSO distribute two goats to each of LFUG members and a buck (he-goat) to a group.

To use the fodder to boost the income of the leasehold groups and to reduce poverty, the program provides all eligible member households with two mature vaccinated and drenched female goats. The program also supplies one male to each of the qualifying group. Each group member should fulfill all the eligible criteria made to receive the goats. DLSO provides anthelmintic and vaccine to drench and vaccine for all goats of group members by VAHWs/ VLAs. 65880 breeding does and 3493 breeding bucks are already provided to Leasehold Forestry Groups of 22 districts during the 6 years of programme period (NPAFC 2011). Similarly, 462 breeding does and 20 breeding bucks are provided to the LFUGs of Palpa and Nawalparasi where TA-LFLP has been piloting the LFLP (TA-LFLP 2010).

**The basic objectives of the improved livestock management system are to**

- Improve animal health and feed, husbandry, breed improvement and shed management systems basically of the goats to reduce wastage and vulnerability of livestock in the mid-hills and increase the overall productivity.
- Promote stall-feeding of animals by increasing the supply of fodder on farm and community Lease lands.
- Adopt improved livestock management systems synchronized with feed availability and natural resource management system.
- Recognize and retain the best breeding buck for better herd productivity.
- Facilitate to develop the Village Animal Health Workers as a service provider in the community, and
- Support the herd owners for the better management of animals and community resources.

**Initial Assessment of Outcome and Impact**

The availability of forage from the lease land has encouraged the farmers to develop;

- Ownership of cattle & buffalo remained stable but being shifted from unproductive to productive ones.
- Grazing in the forest is being shifted to stall feeding especially in goat.
- Herd size of goat has increased.

According the Pandits report, 2009, of the total sample households about 74% were raising goats before the program period. It now has been increased to 93 percent with the project support. The average animal unit per household differs across groups and project periods. The average AU in project site after project implementation is 4.84 compared to 3.68 before project (Table 1)

Table 1: Animal Unit (AU) by Type of Animals (n – 72)

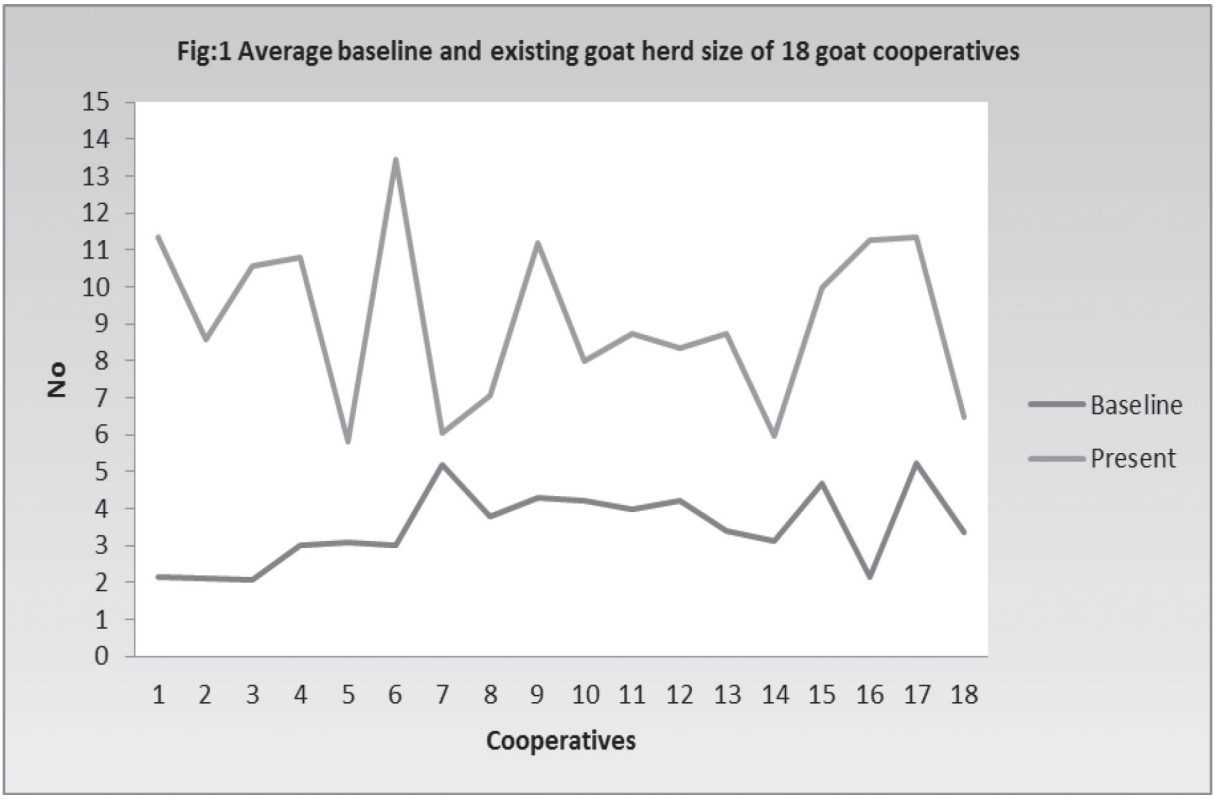
| | Before | | After | |
|---|---|---|---|---|
| Type of Animal | AU/HH | %HH | AU/HH | %HH |
| i. Cattle | 2.02 | 67 | 2.15 | 76 |
| ii. Buffalo | 0.80 | 50 | 1.10 | 73 |
| iii. Goat | 0.82 | 74 | 1.54 | 93 |
| iv. Pig | 0.06 | 17 | 0.06 | 18 |
| Total | 3.68 | | 4.84 | |

Source: Pandit, 2009

Table 1 explained that the average number of goats per household differs significantly from before program (0.82 AU/HH) to after program (1.54 AU/HH). The increment in goat no. is by 90 percentage. Based on the field observations, the quality of goats has been improved over time. The goats in the project site are of better quality, healthier and more productive as compared to before program (FGD meeting). The cattle population is almost the same in both sites, and it does not differ much between periods. We cannot draw any strong conclusion in terms of change in livestock keeping pattern in the study area. However with the increased number of goats, people are slowly moving to buffalo rearing.

An impact study undertaken under FAO TCP demonstrated that the *average* household income of households in the LFUGs increased by 71% from before the project to 2008. The poverty gap for the average household was reduced from 55.4% to 74.8%, a 35.0% improvement in the poverty situation (LFLP, 2012). The increases in household income were the result of strong growth in revenue from goats sales, forest products and labour income.

Outcome monitoring report, 2010 has also reported the encouraging status regarding the goat herd size. The average no. of goats per HH has become 5 in comparison to initial average value of 3. Thus, goat herd size has increased by 2 goats/HH (TA-LFLP, 2010). Similarly, the assessment report of goat resource centers (TA-LFLP, 2011) has also stated that the average herd size of goats in the project VDCs had increased from the level of baseline study (fig 1).




Adopted from TA-LFLP, 2011

**Appropriate goat herd size for Leasehold farmers**

The household survey and focus group discussion done by NASA in 2012, in three leasehold programme districts, revealed that average number of does the leasehold farmers want to rear differed considerably among the farmers of different districts. Response of the farmers in Salyan for appropriate goat herd size (the number of adult doe only) was 6 with the majority of them saying 4 as appropriate (modal herd size) as against 9.0 and 19.0 in Kavre and Tanahun districts (Table 2). This might be the reflection of present low level of income from goats in Tanahun and Kavre districts and their desire to increase it through increasing the number of goats and annual sale. Farmers were of the opinion that labor wouldn't be the constraint for increasing herd size. However, they were unaware of the feeding requirement of goats.

Table 2: Farmers opinion about appropriate goat (adult doe) herd size

| Districts | Preferred Modal Herd Size | Preferred Average herd Size | %age of HH responding to goat herd size | | |
|---|---|---|---|---|---|
| | | | 3-5 | 6-10 | 11-20 or more |
| Salyan | 4.0 | 6.1(2-15) | 56.00 | 40.00 | 4.00 |
| Kavre | 10.0 | 9.0(3-20) | 36.67 | 43.33 | 20.0 |
| Tanahun | 15.0 | 19.1(5-45) | 03.70 | 22.20 | 76.0 |

Adopted from NASA, 2012

NASA has also recommended the appropriate goat herd size for leasehold farmers based on available feeding resources (NASA 2012). This study has recommended the three models of goat herd size according the feeding resource available (Table 3).

Table 3: Recommended effective goat herd size under different model

| Models | Forage/fodder species to be cultivated | Potential Goat Herd Size | | | |
|---|---|---|---|---|---|
| | | Only forage | | Silvi-pasture | |
| | | Only goat | Goat+ One LR | Only goat | Goat+ One LR |
| 0.2 ha LH land | Stylo, Molasses, Napier, Leucaena, Mindula, amriso | 10 (5 doe) | 6 (3 doe) | 12 (6 doe) | 9(5) |
| 0.2ha LH land+ Forest | Stylo, Molasses, Napier, Leucaena, Mindula, amriso | 12 (6 doe) | 8 (4 doe) | 16 (8 doe) | 12(6) |
| 0.2 ha LH land + own land* | Leucaena, Kimbu, Tanki, Dhudhilo, mulato, setaria, napier in farmland | 12 (6 doe) | 8 (4 doe) | 16 (8 doe) | 12 (6 doe) |
| 0.2 ha LH land+ own land+forest | Leucaena, Kimbu, Tanki, Dhudhilo, mulato, setaria, napier in farmland | 14 (7 doe) | 10 (5 doe) | 18 (9 doe) | 14 (7 doe) |

** 8-10 ropani of Pakho land and kharbari and forage from terrace risers and bunds*

LR- Large Ruminants (cattle or buffalo)

*Source: NASA, 2012*

**CONCLUSION**

- Despite excellent contribution of leasehold forest (34 percent) to total fodder and forage supply, the increasing number of unproductive cattle (cows) population (2.2 AU) has created fodder shortage in project households.

- The program focus should be on goat as usual and then to buffalo to increase the household income. The LF members should also be encouraged to plant fast growing fodder trees and legume forage species on the vacant terrace risers.

- In order to increase income from livestock and livestock products, the unproductive cattle population should be replaced by productive buffaloes and goats based on the financial capability of the individual member.

- The quantity of forage seed and cuttings distributed to the leasehold forest users should be extended as per their requirement. Unless farmers have enough fodder resources to feed their animals, they cannot increase the herd size of goats. It was observed in the field that some LFUGs had adequate forage sets/slips already established in their Lease land and farmland. Those forage genetic materials should be exchanged through farmers to farmers approach including the non-LFUG members.

- In-breeding is the common factor to hinder the production of quality goats. Breeding bucks provided by project were not enough for all female goats. To manage the mating for every 30 goats, one buck is required.

- Selection and mating is the key tool for breed improvement. Number of selection of breeding does should be increased and continued. Livestock service center should take ownership of further selection and tagging of qualitative does/bucks after the project. Similarly, record keeping formats and way of record keeping must be provided to the farmers. Concerned DLSOs/LSCs have to provide the record formats and technique of record keeping.

- Interactions with the project field staff and concerned trainees except, 3 days on the spots training for goat management had sown good impact and should be provided to the all LFUGs members as well.

- Selective breeding, control of inbreeding, periodic drenching and vaccination and appropriate feed and forage supply could be managed for making the goat husbandry beneficial.

- Fast growing, multi-cut and nutritious forage/ fodder tree species should be promoted in leasehold land e.g. Ipil, Mulberry, Mulato, Napier, Joint Vetch etc.

- Feeding and breeding management need to be improved for reducing kidding interval and kid mortality.

- Better management will ultimately increase household incomes

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# COMMERCIALIZATION POTENTIAL OF *MORINGA OLEIFERA* IN NEPAL A REVIEW THEME "CLIMATE SMART LIVESTOCK PRODUCTION FOR FOOD AND NUTRITION SECURITY"

Bhoj Bahadur Kshatri (PhD)

## ABSTRACT

*Moringa oleifera L (Moringaceae) has been rediscovered as a versatile multipurpose tree with massive potential of producing natural food, fuel, fertilizer, and medicines including vitamins, proteins, minerals and all essential amino acids. Therefore, moringa serves as a super nutraceutical agent and provides health and financial benefits. Thus, over 140 organizations around the globe including FAO and UNICEF are promoting moringa for elevating poverty and malnutrition emphasizing African Continents. Moringa originated in foothills of Himalayan region, it is the most widely cultivated plant species on Earth. Nutritious products like "Moringa leaf powder", "Green Milk and "Moringa tea" is being sold worldwide. So far in Nepal, Moringa serving as sole source of seasonal vegetable to few Moringa aware people only. It must go for wider production and consumption, which is main aim in this paper.*

*Thirteen years record of Kalimati Fruit and Vegetable Marketing and more than 12 visits of the following districts in Nepal found that moringa growing naturally or planted randomly in about 40 districts including mid-hill district of Dhankuta, Sindhuli, Ramechhap, Kavre, Kaski and Arghakhachi. It indicates that altitude below 1500 m in Nepal is suitable for cultivation of Moringa, however lower the elevation better the productivity. Though moringa favors tropical climate, a rough estimate suggests that about 50% of Nepal's low lying area is suitable for producing moringa that include 20 district of Tarai and about 50% area of 39 mid-hill districts and below 1000 m area of the 16-district in the high hills.*

*Nicaraguan organization called BIOMASA, conducted extensive study using moringa leaves as livestock feed for beef and milk cows, swine, and poultry. When moringa leaves constituted 50% of feed, milk yields for dairy cows and daily weight gains for beef cattle increased by 30%. Whether produced for use as a green manure, for livestock or for human consumption, moringa can be grown intensively with yields of up to 650 metric tons of green matter per hectare per year. Yields of moringa seeds is about 3 tons per hectare per year.*

*To exploit fully the productive potential of Moringa oleifera, altitude based research need to be carried out to understand behavior of Moringa oleifera in various geo-climatic conditions in Nepal. Practical methods of transplanting, growing, pruning, harvesting of seeds and leaves and drying them using various method need to be developed. Economics of producing Moringa leaves in a suitable greenhouse condition will support commercialization and industrialization. Due to global warming higher altitudes are becoming warmer and may be becoming more suitable for better production of Moringa oleifera. Various mass media' can be used for wider dissemination of Moringa technology. Organizations that are concerned with reducing poverty and malnutrition such as Ministry of Agricultural Development (MOAD), Ministry of Health and Population (MOHP), Ministry of Federal Affairs and Local Development (MOFALD) and various National and International Non-governmental Organizations [(I) NGOs] working to support community Development in Nepal also need to coordinate to support Moringa production, processing, marketing and consumption in Nepal.*

## INTRODUCTION

*Moringa oleifera* L (Moringaceae) has been rediscovered as a versatile multipurpose plant that grows as a "perennial-vegetable tree" under intensive cultivation. In a suitable condition, it can grow up to 4m (15ft) a year reaching a height of 15m (50ft) and can live for approximately 20 years. Regular pruning or trimming is recommended to encourage branching and leaf production.

Moringa oleifera, commonly called the 'drumstick tree', is well known for its multi-purpose attributes, wide adaptability, and ease of establishment. Its leaves, pods and flowers are packed with nutrients important to both humans and animals (von Mayde U H.J. 1986. Trees and Shrubs of the Sahel). Moringa has 13 varieties as follows but, sometimes some literature says to have 14 varieties also.

### Varieties of Moringa

- M. arborea
- M. borziana
- M. concanensis
- M. drouhardii
- M. hildebrandtii
- M. longituba
- M. stenopetala
- M. ovalifolia
- M. peregrina
- M. pygmaea
- M. rivae
- M. ruspoliana
- M. stenopetala

With massive natural potential of producing vitamins, proteins, minerals and all essential amino acids condensed mainly in the leaves. Thus, moringa serves as a super nutraceutical agent and provides health, financial, bio-fuel, and green-manure potentials. Originated in foothills of Himalayan region, it is the most widely cultivated plant species on Earth. Nowadays it is widely cultivated in African continents, and its products being sold worldwide.

Regarding publication of Moringa matters, there are over one million web-articles, and 3000 Youtube videos published by international researchers, whereas our responsible researchers like Nepal Agricultural Research Council (NARC), Forest Research Division (FRD), Universities and other private and public Organization seems to be not aware of such publication on Moringa oleifera. Thus, articles in Nepali context are not available in Nepal. Therefore main objective in this article is to inform and share among all interested researcher about existence of highly nutritious plant on Earth is available in our homestead. Traditionally, its pods are being used as vegetable, but leaves which are packed with nutrients and multi-vitamins are wasted with seeds, shoots and roots. In fact moringa need proper research and utilization without delay.

Tarai and midhills of Nepal below 1500 m is suitable domains for cultivation of Moringa in Nepal. Lower the altitude betters the productivity. Rough estimates suggest that about 50%

low lying and dry area of Nepal is suitable for moringa cultivation. It has been found Moringa growing in lower mid-hill district of Dhankuta, Sindhuli, Ramechhap, Kavre, Kaski, Arghakhachi and adjoining districts which has similar agro-climatic situations in Nepal.

BIOMASA conducted extensive trials using moringa leaves as livestock feed for beef and milk cows, swine, and poultry. When moringa leaves constituted 50% of feed, milk yields for dairy cows and daily weight gains for beef cattle increased 30%. "Cattle were fed 15-17 kg of moringa daily

This rapidly-growing tree, have been used by the ancient Romans, Greeks and Egyptians for the treatment and prevention of health ailments, cosmetic and beauty purposes (Announcement of 2nd Global Moringa Meet 2013). Known by the ancient civilizations, the Moringa tree is now being “rediscovered” in many areas of the globe (Moringa meet 2012)

Needless to spend millions of dollars on synthetic medicines with their terrible side effects when God has given us something better? Hippocrates of Cos, the father of Western medicine said: 'Let your food be your medicine, and let your medicine be your food.'

Table 1. Chemical composition of dried leaves of Moringa (*M. oleifera* Lam.)

| Nutritive value | Dry leaf | Standard error |
|---|---|---|
| Moisture (%) | 9.533 | 0.194 |
| Crude protein (%) | 30.29 | 1.480 |
| Fat (%) | 6.50 | 1.042 |
| Ash (%) | 7.64 | 0.433 |
| Neutral detergent fibre (%) | 11.40 | 0.425 |
| Acid detergent fibre (%) | 8.49 | 0.348 |
| Acid detergent lignin (%) | 1.8 | 2.204 |
| Acid detergent cellulose (%) | 4.01 | 0.101 |
| Condensed tannins (mg/g) | 3.12 | 0.104 |
| Total polyphenols (%) | 2.02 | 0.390 |

Busani Moyo1, et al (2011)

Our bodies can synthesize 14 of the 20 or so different amino acids. We cannot make 9 of them. All 9 are called EAAs (Essential Amino Acids) must come from food. Moringa contains all 9 of these EAAs naturally.

1. Leucine **[BRANCH CHAIN AA]**
2. Isoleucine **[BRANCH CHAIN AA]**
3. Valine **[BRANCH CHAIN AA]**
4. Lysine
5. Methionine
6. Phenylalanine
7. Threonine
8. Tryptophan
9. Histidine *[an ESSENTIAL AMINO ACID in infants and may be essential for some adults.]*

Tree of life, a miracle tree revolutionize the use of the plant in Nigeria and thank God, there is an association formed in the university - Moringa Development Association

In Nepal ”Sital-chini” is known by several names. In Tarai, is called Sahijan, Sajana, Sajan in eastern Nepal it is called Munga, in western Nepal including Pokhara it is known as Sitalchini, in Kalimati market is called “Saji-wan”. In African country Senegal, it is called Mother's best friend while in English, it is called “Moringa”, its botanical name is *Moringa oleifera*, benzolive tree, West Indian ben, never die tree, drumstick tree, and horse radish, due to the shape of pod and the design of roots in the seedlings (Pic-1) respectively.

**Products and uses of the M.oleifera tree**

**Seed:** crushed whole seed or press cake remaining after oil extraction as a coagulant for water and waste water treatment

**Vegetable:** green pods as fresh or canned vegetable leaves and flowers used as a relish

**Oil:** seeds contain 40% oil by weight; used for cooking, soap manufacture, as a cosmetic base and to provide illumination

**Other uses:** all plant organs as constituents in traditional medicines; leaves and oil press cake as cattle fodder; grown as live fences and wind breaks; wood from coppicing as a fuel

(Source: J.P. Sutherland at el 1994)

Moringa is planted in the kitchen gardens where its succulent leaves are harvested daily for soups, sauces, or salads (Agro-forestry Species Highlights 1993).

A specially managed high-intensity area of Moringa is under cultivation specifically for this purpose. Green matter yields under this regime are expected to be up to 500 tons per hectare per year - an exceptionally high level of biomass. Part of this leaf crop goes for human or animal consumption but the bulk is composted or mechanically processed before being distributed to the rice growing land. Moringa grows so vigorously that cropped areas re-grow within weeks and can be harvested again (Leone Resources Ltd 2013)

Figure 1. Roots of *Moringa oleifera* seedlings

The green matter is harvested when plants reach a height of 50 cm or more (every 35-40 days). To harvest, cut at a distance of 15-20 cm above the ground. Although losses of seedlings may be 20-30% in the first year, the vigorous re-growth of the remaining seedlings will produce 3 or 5 new shoots after each cutting. Up to nine harvests can be obtained annually. In time (some of BIOMASA's moringa stands are three years old) the 15-20 cm stem will become thick and woody but will continue to send up green shoots.

Moringa produce about 3000 kg of seeds per hectare. "The 650 metric ton yield was obtained in sandy, well-drained soil at 30 meters altitude. Rainfall was 1300 mm annually with irrigation practiced during the dry season. At this level of production, the nutrient requirement per hectare each year is:

| | |
|---|---|
| 1,800 kg Calcium | 0.5 kg Copper |
| 1,400 kg Magnesium | 380 kg Phosphorus |
| 0.6 kg Boron | 280 kg Nitrogen |
| 0.3 kg Zinc | |

BIOMASA conducted extensive trials using moringa leaves as livestock feed for beef and milk cows, swine, and poultry. When moringa leaves constituted 40-50% of feed, milk yields for dairy cows and daily weight gains for beef cattle increased 30%. "Cattle were fed 15-17 kg of moringa daily

Milking should be done at least three hours after feeding to avoid the grassy taste of moringa in the milk." Milk production was 10 liters/day when cows were fed moringa, compared to 7 liters/day without moringa. With moringa feed, daily weight gain of beef cattle was 1,200 grams/day, compared to 900 grams/day without moringa feed."

**Constraints of Commercialization of Moringa**

Several constraints exist for commercialization of Moringa and its products. Some of the problems highlighted hereunder.

i) **Financial** – a product that has, initially, no guarantee of a market.

ii) **Research and development –**

There is a lot of information on how to propagate Moringa but very little on how the tree should be managed. Pruning / pollarding are the obvious management procedures but at what height do you prune?

a. Is Physical oil expression is a much more economical method to extract oil?

b. To generate 'scientific' and 'practical' a significant amount of research and development has to be undertaken prior to recommend practice for producing and selling a product.

iii) **Market awareness** – the introduction of a new product within existing market is one of the most significant constraints to commercial development.

iv) **Regulatory approval** – agencies like NBSM and DFTQC are in place to ensure the quality and safety of products that are being offered for consumers.

v) **Water treatment product** - The fact that a natural water treatment material can be extracted from the seeds (and press cake obtained following oil extraction).

Opportunities do exist for the commercialization of products from the leaves (for human consumption within the 'nutraceutical' market; as an ingredient in animal feed), press-cake (as a fertilizer; an ingredient in animal feed; production of a water treatment material as discussed) and derivatives available from all parts of the tree (e.g. Japanese patent publication exists for a specific iso thiocyanate as an anti-tumour promoter), however, it is clear from the more detailed discussion of the oil and coagulant production that similar constraints to product commercialization will apply.

**Some Discussion on** *Moringa oleifera*

Four year study revealed that *Moringa oleifera* is a highly nutritious plant on Earth. Vegetarians all over the world prefer to take Moringa products. *Moringa oleifera* L (Moringaceae) has been rediscovered as a versatile multipurpose tree with massive potential of producing natural food, fuel, fertilizer, and medicines including vitamins, proteins, minerals and all essential amino acids. Therefore, moringa serves as a super nutraceutical agent and provides health and financial benefits. Thus, over 140 organizations around the globe including FAO and UNICEF are promoting moringa for elevating poverty and malnutrition emphasizing African Continents. Moringa originated in foothills of Himalayan region, it is the most widely cultivated plant species on Earth. Nutritious products like "Moringa leaf powder", "Green Milk and "Moringa tea" is being sold worldwide. In a suitable greenhouse condition it can produce up to 650 ton of fresh leaves per hectare. "Whether produced for use as a green manure, for livestock or for human consumption, moringa can be grown intensively with yields of up to 650 metric tons of green matter per hectare (Price 2007)

Moringa keep away over 300 diseases from human and animals. A nurse in charge of pediatrics at a hospital keeps dried leaf powder on hand to give out to mothers of malnourished children. An administrator at another general hospital is a diabetic. "I have for the past three years been controlling my blood sugar by periodically drinking a tea made from moringa leaves." He decided to plant a thousand trees around the hospital complex. "This way we will always have a ready supply of leaves to treat the cases of malnutrition we receive." Review shows that "One rounded tablespoon (8 g) of leaf powder will satisfy about 14% of the protein, 40% of the calcium, and 23% of the iron and nearly all the vitamin A needs for a child aged 1-3. Six rounded spoonful of leaf powder will satisfy nearly all of a woman's daily iron and calcium needs during pregnancy and breast-feeding. One of the mothers said, "At first, when I tried to nurse my son, I was not producing enough milk. Then I started to eat moringa. After a short while I had enough milk again (Price 2007).

ECHO Technical Note mentioned that, the Moringa first plants grew so well for Gary Shepherd in Nepal that he had us arrange for 1,000 seeds to be shipped. He reports that at five months one was 3.6 m (12 ft) tall and most was 1.8 m (6 ft). Mr. Gary Shepherd was in Nepal for about 20 years between 1969 -1990 as a missionary. Most of the time, he lived with his wife and children in Arkhala at that time eastern Palpa now in Nawalparasi district. I think Gary Shepherd was trying to solve the malnutrition condition of Childrens in Magar communities in eastern Palpa or around by introducing 1000 seeds of Moringa oleifera from United States of America (USA). Location of nursery and list of farmers receiving the seedling of Moring is subject of research. Looking at the size and over 50 years old, some of the Moringa trees in Ramechhap Kavre and Sindhuli, Moringa tree existed in Nepal before Gary Shepherd introduced them. Only green pod of different quality used in Nepal as fresh vegetable, rest other part of the Moringa tree not used. Therefore, there is a need to teach Nepali people that the Moringa leaves are highly nutritious and all other parts of the tree is beneficial for human and livestock. Those who

are aware about importance of Moringa are somehow reluctant to share the knowledge with others. Moringa cures over 300 diseases including AIDS.

In his address at the second Moringa at the Leading Edge (MLE) conference organized by the Moringa Plantation Management Committee of the University of Ilorin, Prof. AbdulGaniyu Ambali, the Vice-Chancellor warned that the product had attracted abuse from unscrupulous agents and quack practitioners, hence the need to tighten the control over the production of herbal products including moringa (AbdulGaniyu Ambali 2013). There is rampant use of mass media for wrong commercial purpose. However, regarding health benefit of Moringa no information found broadcasted or published so far in Nepali mass media. If there are a lot of diseases private hospitals, clinics and medical shops will run profitably. Conversely, eating home grown cheap nutritious Moringa will cure or reduce the more than 300 diseases attaching people, hence adversely affecting the privatized business of health professions. To bribe illiterates, uninformed, hungry malnourished and diseased rural people, corrupt nature of concern people could have stop to produce, process, market, consume and promote of Moringa in Nepal. Otherwise, Moringa is most nutritious plant on Earth and also one of the easiest trees to grow by any lay man in kitchen garden planting a branch.

**Recommendations**

1. Create mass awareness using television, radio and daily newspapers about medicinal, food. Fuel, biodiesel and fodder value and potential *of Moringa oleifera* in Nepal.
2. Promote plantation of *Moringa oleifera for home consumption in each households, and also provide incentives to moringa nursery growers and also encourage people for industrial as well as commercial mass plantation for seed or vegetable production.*
3. *NARC conduct practical and useful research to find up to which elevation is suitable for moringa cultivation, design of moringa trees as what is the right way of training and pruning the trees*
4. *Develop a training manual good for rural remote and illiterate farmers based on practical research, Subject need to include are 1) harvesting of leaves and drying using solar drier, direct sun or oven method 2) harvesting of green pods for seed and vegetable.*
5. *Public offices all over Nepal Plant a Moringa oleifera tree at their premises at least in Tarai and mid-hills.*
6. Profitable means of combating deforestation (http://en.wikipedia.org/wiki/Moringa)

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The second Moringa at the Leading Edge (MLE) conference organised by the Moringa Plantation Management Committee of the University of Ilorin, Prof. AbdulGaniyu Ambali, the Vice-Chancellor

# IDENTIFICATION AND SELECTION OF NATIVE RANGE FORAGE FROM HIGH HILL OF RASUWA DISRICT

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## ABSTRACT

*Pang simali, Lek dolo, Pangkimendo, Dumberchii, Tamrachii, Kang buchii, Dallo pang, Bhui kafal, Marmendo, Kane, Numril, Lek buki and Sindur pang were identified native range forages from high altitude of Rasuwa district. The identified forage cultivated with 3 replication in Chandanbari, Syaphru VDC (3250 masl) to characterize and selection of most promising forages. Out of these identified native range forages, Tamarachhi (Indigofera cylindracea) was only legume. Others identified native forages were Pang Simali (Carex munda Bott, Cyperaceae family), Lek dolo (Potentilla cumutata, Rosaceae family), Pangkimendo (Primula calderiama, Primulaceae family), Dumberchii (Bistorta amplexicaulis, Polygonaceae family), Kang buchhi (Centella asiatica, Umbelliferae family), Dallo pang (Carex remota, Cyperaceae family), Bhui Kaphal (Potentilla nubicola, Rosaceae family), Marmendo (Senecio laetus, Compositae family), Kane (Plantago depressa Willd, Plantaginaceae family), Numril (Kobresia nepalensis, Cyperaceae family), Lek buki (Festuca ovina, Gramineae family) and Sindur pang (Danthoria cumminsii, Gramineae family). Significantly the highest green matter was produced from Danthonia cumminsii (10.8 t/ha) followed by Carex munda (9.6t/ha) and Festuca ovina (8.7 t/ha) and least green matter was produced by Kobresia nepalensis (2.5 t/ha). Indigofera cylindracea, produced 8.4 t/ha green forage. Similarly significantly highest DM (2.4 t/ha) was obtained from Danthonia cumminsii and the lowest (0.45 t/ha) from Kobresia nepalensis.*

**Key words:** *Native range forage*

## INTRODUCTION

Livestock farming is the sole objective at high hill. Major feed source of livestock at high altitude of Rasuwa district is obtained from rangeland. In high altitude Himalayan areas above 2,500 m contribution of rangelands in feed supply is more than 65 percent (LRMP, 1986). Alirol (1979) reported that the quality and quantity of fodder produced in rangelands are very poor, on an average pasture production range from 0.12 Mt DM/ha to 3.2 mt DM/ha. The productivity of rangeland is decreasing day by day due to heavy grazing pressure per unit area thus deterioration of vegetation composition. Observations of fauna suggest that native grasses provide a valuable food source, particularly for grazing fauna, both native and introduced (Gibbs and Gibbs 2001). It was estimated that over 180 species of different species of grasses and legumes are found. Most of these species are grasses; only few species are legumes such as *Astragalus* spp, *Medicago* spp, *Desmodium* spp and others (Livestock Master Plan, 1993). The major species in alpine meadow of Langtang Valley were *Cortia depressa* and *Kobresia* spp (Department of Medicinal Plant, 1976).

Rangeland improvement is the only sole objective to increase the production and productivity of high hill animal. Grass-legume mixtures are always desirable because of their complementary

functions in providing nutritive, succulent and palatable forage. Both exotic and native forage should be cultivated with grass-legume mixture to provide balance diet to animal. The role of native grasses in sustainable agricultural economic production enterprises in Nepal has been recognized recently. Drought and overstocking across pastoral regions caused severe overgrazing of the native grasses, as a result pastures are destabilised as perennial grasses are reduced and bare areas are created which allows for the recruitment of annual grasses (Garden and Bolger, 2001). Introduction of exotic varieties in rangeland is not possible in all sites. Therefore it is necessary to identified suitable native forage varieties. The main objective of this study is to identify and select more productive suitable native range forage from high hill of Rasuwa district.

## MATERIALS AND METHODS

A Survey was conducted to find out the local name of range forage. The identified native forage was collected and herbarium was made in herbarium sheet. The herbarium sample was sent to herbarium lab in Godavari to identify the sample. The identified native forage was collected and cultivated in three replications in 3250 masl, Chandanbari, Rasuwa district. The GM, DM and the plant characteristics was studied. The collected data was analyzed in statistics. Farmers' perception of these native forages was recorded.

## RESULTS AND DISCUSSION

### Identification

Table 1 indicates the identification of native range forage. Out of thirteen identified native forage only one was legume. Proportion of legume forage in high altitude was minimal.

### Taxonomical description

**Pang Simali:** Rhizomes creeping, but usually condensed; stems inserted in a single row. Base of leaf sheaths cream or fawn, bladeless sheaths short. Leaves mainly in elongate, non−flowering rosettes. Inflorescence of 2−6 spikes on long, filiform peduncles, lowest usually single. Glumes pale brown. Flowering/ Fruiting: July to September. Distribution: between 3200−4100 m.

**Lek Dolo:** Perennial rosulate herb. Rhizomes stout, terete, few branched. Stipules of radical leaves with membranous auricles, connected from base to top, apex rounded radical leaves oblanceolate, leaflets villous above, densely sericeous below. Flowering stems from radical leaves, with dense pale brown hairs. Flowers solitary or occasionally in 2 flowered cymes. Petals yellow, oblong to elliptic, apex rounded. Carpels glabrous, ellipsoid, styles sub terminal. Flowering/Fruiting: June to August. Distribution: C Nepal, between 3500−4500m.

**Panki Mendo:** Perennial herbs, heterostylous. Basal bud scales persistent, outer ones purplish brown, lower surface yellowish farinose. Leaves radical, rosulate, 9−26 cm overall at anthesis. Inflorescence simple umbel yellowish farinose. Bracts lanceolate, acuminate. Flowers usually numerous, rarely 3−5, pedicellate; pedicel unequal at anthesis, longest one 2−4 cm. Calyx yellowish farinose, lobes triangular. Corolla yellow. Capsule irregularly torn when mature. Flowering/Fruiting: June to September. Distribution: between 3000−4900m.

**Dambur Chhi:** An erect glabrous herb. Stem about 60 cm high, slender and brown. Stipules 2.5−5 cm long, brown, tips torn. Leaves simple, alternate, lower leaves long petioled upper amplexicaule, ovate, apex acuminate, base cordate, entire. Flowers in long peduncled racemes, 4−5 cm long, red, bracts ovate, brown. Perianth 5. Flowering/Fruiting: March to August. Distribution: between 2100−4800m.

**Tamra Chhi:** Small shrubs, to 1 m, with glabrescent or brownish hairy spreading branches. Leaves 11−15 foliolate; leaflets elliptic−oblong, both surfaces appressed pubescent. Racemes 5−8 cm, bracts subulate, Calyx lobes narrowly ovate. Corolla pink or red. Flowering/Fruiting: July to August. Distribution: between 900−3700m.

**Kangbu Chhi:** Perennial herb, usually woolly−pubescent in young parts. Steam creeping with long stolons, rooting at nodes. Leaves long petioled, with sheath. Petiole up to 13 cm long, roundish cordate to broadly cuneate. Inflorescence axillary simple umbel, peduncle 0.5−0.8 cm long, 2−5 flowered, pedicels very short or obsolete. Flower minute, hermaphrodite, actionomorphic, pink. Calyx teeth obsolete. Fruit about 0.3 cm long, laterally flattened**.** Flowering/Fruiting: March to August. Uses: Medicinal as well as forage. Distribution: between 500−2500m.

**Dallo Pang:** Rhizomes creeping, stems densely tufted. Base of lower sheaths pale brown, strongly ribbed; dark brown, dull, fibrous, bladeless sheaths present at base. Leaves inserted on lower 1/3 of clum, blades shorter than to slightly exceeding clum. Culm 14−33 cm. Inflorescence linear, spike –like, spikes sessile, erect closely appressed to axis, usually overlapping, lower sometimes more distant. Flowering/Fruiting: June to August. Distribution: between 1700−3600m.

**Bhui Kaphal:** Stolons subglabrous or sparsely appressed hairy. Radical leaves trifoliolate, some times bearing 2 additional minor leaflets; leaflets shortly petiolulate or subsessile narrowly to broadly obovate. Flowers 1 or 2. Sepals ovate, glabrescent above, white appressed hairy below. Petals white, broadly obovate to semi orbicular. Fruit subglobose, bright red. Flowering/ Fruiting: April to July. Distribution: between 2000−4000m.

**Marmendo:** Rhizomatous perennial herbs. Stems 20−100 cm tall, often reddish, sparsely pubescent. Radical leaves usually absent at anthesis; lower to middle cauline leaves oblong to oblanceolate, subsessile, coarsely serrated to pinnatisect, apex actute, upper surface glabrous, lower surface sparsely araneous. Upper cauline leaves oblong to lanceolate. Ray florets 10−15, female, marginal, ligule yellow, oblong−lanceolate, apex shallowly 2 or 3 toothed. Flowering/ Fruiting: July to September. Distribution: W, C and E Nepal, between 1400−4000m.

**Kane:** Perennial herbs; roots solitary, vertical, simple or distally branched. Leaves all radical, rosulate, 4−17 cm overall; petiole 1.5−5.8 cm; blade oblong to oblong−oblanceolate. Scapes several, 2.5−34 cm tall, ascending near base, erect distally, pubescent. Inflorescences spike, densely flowered. Bracts ovate, green, margin hyaline, often reddish. Flowers sessile. Capsule conical−ovoid. Flowering/Fruiting: July to September. Distribution: between 2600−4100m.

**Numril:** Cespitose perennial. Culms 10−30 cm, filiform. Leaves about equaling to clum, filiform, involute. Inflorescence consisting of a single spike. Spikes linear, spikelets upper densly arranged or lower partly loosed. Female glume−like bracts greenish to light brown. Prophylls utriculiform, enclosed 1−female flower and 1 sterile rachilla, linear, membranaceous, veinless, open only near apex, 2 keeled, keels ciliate. Stigma 3. Flowering/Fruiting: July to September. Distribution: between 2900−4600m.

**Sindur Pang:** Tufted perennial. Culms 12−39 cm, erected. Leaf blades inrolled, linear or filiform, upper surface glabrous, lower surface hirsute; sheath hirsute, lanuginous at the mouth; a dense fringe of stiff hairs. Inflorescence a raceme or a panicle, 3−5 cm, light green or red purple; branches, ascended. Spikelets 11−21 mm, 3−6 flowered; first glume oblong acute, light green or red purple, usually pilose; second glume 1−2 cm, oblong, acute, light green or red purple, usually pilose; lemma light green, central awn flattened, minutely scabrous on margin; palea membranaceous, hyaline. Flowering/Fruiting: June to September. Distribution: between 2000−4100m.

Table 1: Identification of native range forage

| Local name | Family | Botanical Name |
|---|---|---|
| Pang Simali | Cyperaceae | *Carex munda Bott* |
| Lek Dolo | Rosaceae | *Potentilla cumutata Lehm.* |
| Pangkimendo | Primulaceae | *Primula calderiama* |
| Damburchhi | Polygonaceae | *Bistorta amplexicaulis* |
| Tamrachhi | Leguminosae | *Indigofera cylindracea* |
| Kangbuchhi | Umbelliferae | *Centella asiatica* |
| Dallo Pang | Cyperaceae | *Carex remota L. subsp. rochebrunii* |
| Bhui Kaphal | Rosaceae | *Potentilla nubicola* |
| Marmendo | Compositae | *Senecio laetus Edgens* |
| Kane | Plantaginaceae | *Plantago depressa Willd.* |
| Numril | Cyperaceae | *Kobresia nepalensis* |
| Lek Buki | Gramineae | *Festuca ovina L.* |
| Sindur Pang | Gramineae | *Danthonia cumminsii Hook. f.* |

***Production Performance***

Table 2 indicates the production performance of different native range forages. It was found that significantly the highest green matter (10.8 t/ha) was obtained from Sindur pang followed by Pang simali (9.6 t/ha) and least (2.0t/ha) from Pankimendo. Similarly the highest DM was obtained from Sindur pang (2.4 t/ha) followed by Pang simali (2.3 t/ha) and least from Pankimendo (0.45 t/ha). Low productivity of native forage was supported by Alirol (1979), who reported that fodder produced in rangelands range from 0.12 mt DM/ha to 3.2 mt DM/ha.

Table 2: Production performance

| Forage | GM(t/ha) | DM (t/ha) |
|---|---|---|
| Pang Simali | 9.6 | 2.3 |
| Lek Dolo | 7.1 | 1.6 |
| Pangki Mendo | 2.0 | 0.45 |
| Dambur Chhi | 5.4 | 1.2 |
| Tamra chhi | 8.4 | 1.9 |
| Kangbu Chhi | 3.0 | 0.65 |
| Dallo Pang | 4.3 | 1.6 |
| Bhui Kaphal | 2.9 | 0.75 |
| Marmendo | 6.5 | 1.3 |
| Kane | 3.0 | 0.7 |
| Numril | 2.5 | 0.5 |
| Lek Buki | 8.7 | 1.9 |
| Sindur Pang | 10.8 | 2.4 |
| average | 5.7 | 1.3 |
| F value between treatments | ** | ** |

***Farmers' Perception***

Table 3 indicates the farmers' perception about the identified native forage species. Farmers perceived Numril, Lek buki, Tamrachi and Dale pang were the very good forage species for grazing animals.

Table 3: Farmers' perception

| Farmer perception | Name of forage |
|---|---|
| Very good | Numril, Lek buki, Tamrachii, Dalle pang |
| Good | Pang simali, Sindur pang, Lek dolo |
| Fair | Bhuikafal, Pankimendo, Kangbuchi, Marmendo, Damberchii, Kane |

## CONCLUSION AND RECOMMENDATION

Out of thirteen identified native range forage species Tamrachii (*Indigofera cylindracea*) was only legume. It showed that legume proportion was very less in rangeland. It was found that significantly the highest green matter and dry matter was obtained from Sindur pang and least from Pankimendo.

This finding is usefulness for scientist, planner, students as well as farmers. However, further study is needed before recommended to farmers. There are also many others native range forage whose study is needed.

## ACKNOWLEDGEMENTS

The authors would like to acknowledge all the staff of Agricultural Research Station (Pasture), Dhunche for their support to collect data. I would like special thanks to Mr. Dinesh Pariyar, former executive director, NARC for their continual encouragement as well as valuable comments to prepare this paper in the present form.

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# FODDER YIELD AND CHEMICAL COMPOSITION OF MAJOR FODDER TREE SPECIES OF THE SELECTED DISTRICTS IN THE MID-HILLS OF NEPAL

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## ABSTRACT

*Fodder yield and chemical composition of major fodder tree species in the selected hilly districts of Nepal was determined during June 15th, 2012 to December 20th, 2012 with the objective to access the major nutrient content of the top rank fodder tree species in terms of age variation. The experiment consisted of 9 treatments organized into a 3x3 factorial combination using RCBD. Two factors were: three categories of ages (3-6 years, 7-10 years and 11-14 years) and three fodder species Badahar (Artocarpus lakoocha); Kutmiro (Litsea polyanthus); and Kabro (Ficus lacor). Kabro had significantly (P<0.05) higher biomass yield (31.7 kg DM/tree), followed by Badahar (26.80 kg DM/tree). The biomass production of the selected fodder tree increased with age that was highest (34.2 kg DM/tree) for third age group whereas the biomass production considering age and species was higher for Kabro (38.6 kg DM/tree) with third age group. On the other hand, the energy was significantly (P<0.01) higher in the Kutmiro (4286 kcal/kg fodder) with first age group (3984 kcal/kg).The protein content was significantly (P<0.01) higher in the Badahar with first age group (11.72%). The NDF content (71.9%), ADF content (68.49%) and ADL content (46.9%) was significantly (P<0.01) higher in the Kutmiro as well as the Ca content was significantly (P<0.01) higher for Kutmiro (3.56%). On the other hand, the TA was significantly (P<0.01) higher in the Kabro (11.92%).The Kabro had higher nitrate score (1.33) followed by Kutmiro (1.25) and Badahar (1.19). In conclusion, the study indicates that there is variation in fodder yield, nutrient composition and polyphenolics (lignin, tannin, and nitrate) of fodder tree available in selected hilly districts of Nepal.*

**Keywords:** Fodder yield, chemical composition, fodder tree species, age variation, hilly districts

## INTRODUCTION

Livestock is an important component of crop livestock mixed agricultural farming system in Nepal. There are about 72,44,944 cattle, 51,33,139 buffalo, 95,12,958 goats, 8,07,267 sheep, 4,51,71,185 poultry birds in Nepal that has to sustain by the use of available feed resources (MoAD, 2012). The industry is economically viable as the sector shares about 24 percent of the Agricultural Gross Domestic Products (AGDP) of the country (MoAD, 2012). Among the livestock species in Nepal, ruminants particularly cattle, buffalo, sheep and goats, are important as they contribute to the milk, meat, fiber wool (APP, 1995), and helps in tillage and transport. Further, they are major source of fertilizers (Panday, 1982) to produce crops in the country. They have major contribution in gross domestic products (GDP). Among the inputs required by the animal, feed shares about 60 to 65% of the total cost of milk, meat, fiber and wool production in ruminant animal (Upreti, 2008). The higher feed cost increases the production cost which results the lower net income from the animal.

Livestock diet, at rural context, and both substantial farming, mainly of the ruminants, is usually composed of green grasses, crop residues, crop by-products and tree foliage, with little or no concentrate feed (Upreti and Shrestha, 2006). Over 50% of the total green fodder supply comes from forest resources, both from community forest and private farm land, out of which the share of tree foliage is 15 to 29 percent (Kshatri, 2007). Out of total 1, 47, 18,000 hectare of land, 39.60 % is covered by forest, 12.00 % by pasture land and 7.00 % covered by under non cultivated land in Nepal (MoAD, 2012). About 41% Dry Matter (DM) in animal feed supply comes from the fodder trees (either planted or naturally grown) and tree shrubs (Panday, 1982). Likewise, 47% Total Digestible Nutrients (TDN) comes from the cropland, 30% from the forests, 7% from the shrub land, 5% from the grassland and 11% TDN from the non conventional ingredient (Pariyar, 2004).

In spite of the importance of fodder tree in the livestock raising system in the hills, limited work has been done to estimate and determine the production and productivity of the common fodder tree in Nepal where this situation demanded the need of similar study focusing to the productivity and nutrient composition of major fodder tree in the hills of Nepal, so that appropriate tree management options could be developed for its better utilization by the ruminants.

## MATERIALS AND METHODS

The study consisted two main parts. The first part dealt about socio-economic status of selected farmers based on commonly available fodder trees and their ranking whereas the second part consisted of fodder yield estimation, determination of chemical composition and nitrate content of top ranked and popular fodder trees that were organized into treatments. The study was conducted at Tanahun, Dhading, Dolakha and Sindhupalchok districts from June 15th, 2012 to December 20th, 2012. Three specific sites were selected in each district for detail study. They were Kotre Bazaar, Baniyatar and Chhimkeswari of Tanahun; Khatritar, Dambardanda and Tersepani of Dhading; Vimtar, Harae and Chilaunae of Sindhupalchowk, and Biruwa, Katakuti and Darmedandagaun of Dolakha district. A 3×3 factorial combination of RCBD was used considering age and species of the fodder tree as treatments and the four districts as replication. Accordingly, three categories of ages (3-6 years, 7-10 years and 11-14 years) were combined with three fodder species (Badahar, Kutmiro and Kabro). Fodder species were identified based on findings of socio-economic study and on the basis of identifying top ranked fodder tree species.

Accordingly, the following were the treatments combination:

T1=Badahar age group 3-6 years

T2= Badahar age group 7-10 years

T3= Badahar age group 11-14 years

T4=Kutmiro age group 3-6 years

T5= Kutmiro age group 7-10 years

T6= Kutmiro age group 11-14 years

T7=Kabro age group 3-6 years

T8=Kabro age group 7-10 years

T9=Kabro age group 11-14 years

All the collected data were subjected to statistical analysis. ANOVA was used to test collected data. The data were analyzed by comparing mean of the treatments using LSD (P<0.05). Statistical software Genstat discovery (4) edition was used to analyze the data.

## RESULTS AND DISCUSSION

### *Biomass production*

The biomass production of fodder trees (kg DM/tree) differed significantly (P<0.05) among the fodder species studied by not considering age. Accordingly, Kabro had the higher biomass yield (31.70 kg DM), followed by Badahar (26.80 kg DM/tree) and Kutmiro (23.80 kg DM/tree) (Table 1). The biomass yield (kg DM/tree) recorded in this study is lower than it was reported by (FAO, 2012). Upreti and Shrestha (2006) reported that, the yield differs with the species such as Badahar (31.25 kg DM/tree), Kutmiro (26.69 kg DM/tree) and Kabro (40.98 kg DM/tree). Pande (1994) and Panday (1982) also had reported wider variation in the yield of Badahar as recorded in the same districts of this study. Even with the same site and district the yield could be varied because of the variation in the tree size and with the age of the tree species of the study. This finding supported such variation.

Table 1. Bio mass production of selected fodder tree species regardless of age

| Treatments (Fodder species) | Yield/Tree (kg DM/tree) |
|---|---|
| Badahar | 26.80[a] |
| Kutmiro | 23.80[a] |
| Kabro | 31.70[b] |
| SEM ± | 1.78 |
| P value | 0.009 |
| LSD(0.05 level) | 4.99 |
| CV % | 38.90 |

LSD=Least significant difference, CV=Coefficient of variation, and SEM=Standard error of mean

Table 2. Biomass production (kg DM per tree) of selected fodder tree species by age without considering species

| Treatments (Age) | Yield/tree( kg DM/tree) |
|---|---|
| 1(3-6 years) | 20.80[a] |
| 2(7-10 years) | 27.30[b] |
| 3(11-14 years) | 34.20[c] |
| SEM ± | 1.78 |
| P value | <.001 |
| LSD(0.05 level) | 4.99 |
| CV % | 38.90 |

LSD=Least significant difference, CV=Coefficient of variation, and SEM=Standard error of mean

Table 3. Biomass production (kg DM/tree) of selected fodder tree species by considering species and age

| Treatments | Yield/tree(kg DM/tree) |
|---|---|
| Badahar ×Age1 (3-6years) | 20.30 |
| Badahar ×Age2 (7-10years) | 25.90 |
| Badahar × Age3 (11-14years) | 34.30 |
| Kutmiro × Age1 (3-6years) | 14.60 |
| Kutmiro ×Age2 (7-10years) | 27.10 |
| Kutmiro ×Age3 (11-14years) | 29.70 |
| Kabro ×Age1 (3-6years) | 27.60 |
| Kabro × Age2 (7-10years) | 28.80 |
| Kabro × Age3 (11-14years) | 38.60 |
| SEM ± | 3.08 |
| P value | NS |
| LSD(0.05 level) | 8.65 |
| CV% | 38.90 |

LSD=Least significant difference, CV=Coefficient of variation, SEM=Standard error of mean, and NS=Non significant

**Nutrient composition of selected fodder tree species**

**Energy*:*** The mean energy content of fodder tree differed significantly (P<0.001) among the treatments considering fodder trees species. The energy content ranged from 3830 kcal to 4286 kcal per kg of fodder tree (DM). Accordingly, the Kutmiro had better (4286 kcal/kg) energy content compared to the Kabro (3955 kcal/kg) and Badahar (3830 kcal/kg). Ibrahim *et al.,* (2008) reported that the energy content in Badahar could be 0.82 ME M cal per kg fodder (DM) which is higher than the reported value in this study. Similarly, Kabro recorded a high value of ME of 0.62 ME per kg fodder (DM) than the value recorded in this study (Ibrahim *et al.,* 2008). The study has indicated that the selected fodder trees are good source of energy to the livestock.

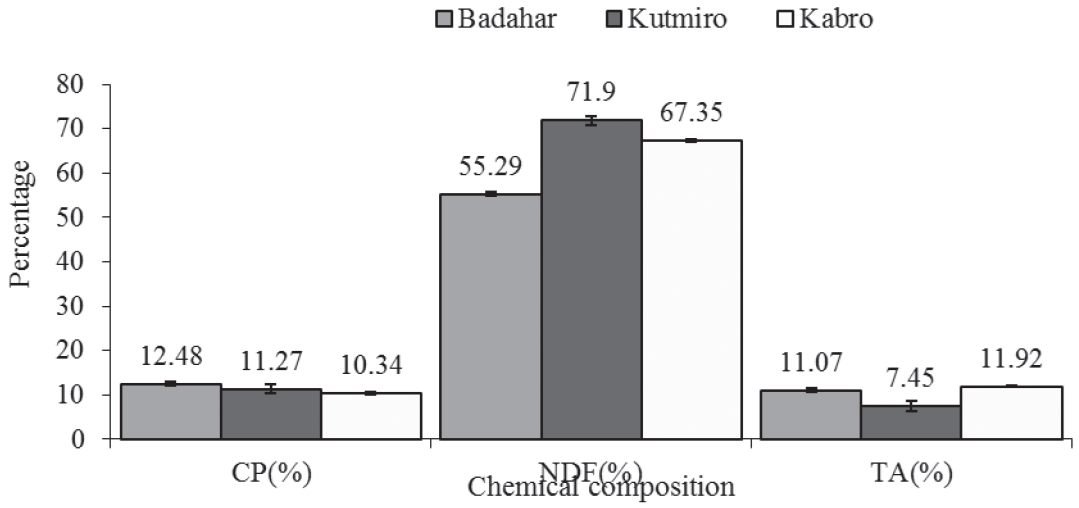


Figure 1. The chemical compositions of selected fodder tree species

**Crude protein (CP):** The protein level in the fodder tree was the next measured parameter for fodder quality assessment thus selected and ranked fodder tree species were assessed against the protein content. The mean protein content of fodder tree differed significantly ($P<0.05$) among the treatments considering fodder trees species. The protein content ranged from 10.34% to 11.27%. Accordingly, Badahar had the higher CP content (12.48%) followed by Kutmiro (11.27%) and Kabro (10.34 %) (Figure 1). The CP content in the selected and ranked fodder tree supported the line of selection index. The CP content of these three fodder trees were higher, Badahar (13.43 %), Kutmiro (15.32 %), and Kabro (12.05 %) as reported by (Upreti and Shrestha, 2006). Subba (1995) reported even higher CP content such as 15.80% for Badahar and 16.8 percent for Kutmiro. Further, Panday (1982) reported higher CP such as 15.67% for Badahar, 16.69% for Kutmiro, and 13.76% for Kabro. Several other study also revealed that the CP content in the fodder trees could greatly varies which may be due to the differences with species, time of lopping, season of lopping etc.( Subba ,1998). The stage of maturity of fodder leaves is different among the selected fodder tree species and that could be the one of the causes to have differing in the CP content.

**Ether extract (EE):** The Ether extract (EE) is the crude fat (CF) content in the feedstuff. The determination of EE in the fodder helps to know the energy level of the particular fodder species. The mean ether extract content of fodder tree differed significantly ($P<0.05$) among the treatments considering fodder trees species. Accordingly, Ether extract ranged from 1.64% to 2.09 % of the selected fodder tree species. Kabro had the highest EE content (2.09%) followed by Kutmiro (1.91%) and Badahar (1.64%). Upreti and Shrestha (2006) had reported higher ether extract in Badahar (1.80%), Kutmiro (2. 031%) and Kabro (2.20%) than the value obtained in the present study. A similar trend was also revealed by (Subba, 1998) where the author had reported ether extract for Kutmiro as 2.7 %, and Kabro 2.6 percent. This also showed that there is a variation in ether extract of the selected and ranked fodder tree species.

**Fiber fraction content of selected fodder tree species**

**Neutral detergent fat (NDF):** The mean NDF content of fodder tree differed significantly ($P<0.001$) among the treatments considering fodder trees species. NDF ranged from 55.29 % to 71.90 % of the selected fodder tree species. Accordingly, Kutmiro had the highest NDF content (71.90%) followed by Kabro (67.35%) and Badahar (55.29%) (Figure 1). Upreti and Shrestha (2006) reported that Badahar, Kutmiro and Kabro could have 44.69 %, 57.32 %, and 51.93 percent respectively. It can be noted that the NDF content in different fodder tree species could thus varied.

**Acid detergent fiber (ADF):** The mean ADF content of fodder tree differed significantly ($P<0.001$) among the treatments considering fodder trees species only. ADF ranged from 49.70% to 68.47 % of the selected fodder tree species. Accordingly, Kutmiro had the highest NDF content (68.47%) followed by Kabro (62.66%) and Badahar (49.70%). Since, the Badahar had the lowest ADF content (49.70%) the selection ranking of Badahar as top fodder species is justified. However, Upreti and Shrestha (2006) reported lower ADF content in all three species than the value presented in this study where the writers had reported 38.92%, 49.69%, and 45.95% ADF to Badahar, Kutmiro and Kabro respectively.

**Acid detergent lignin (ADL):** The mean ADL content of fodder tree differed significantly ($P<0.001$) among the treatments considering fodder trees species only. ADL ranged from 24.76% to 46.94 % of the selected fodder tree species. Accordingly, Kutmiro had the highest ADL content (46.94%) followed by Kabro (32.53%) and Badahar (24.76%). Since, the Badahar had the lowest ADL content (49.70%) the selection ranking of Badahar as top one fodder

species could be well justified. Upreti and Shrestha (2006) had reported lower ADL content in Badahar (17.40%, Kutmiro 28.64%, and Kabro 21.22 percent) that differs slightly compared to the findings of this study. But, in both of these studies the trend of the ADL content was similar. The ADL reduces the digestibility of cell wall carbohydrate (primarily cellulose and hemicelluloses) with which it is bonded (Upreti and Shrestha, 2006). Higher the ADL content in the fodder species indicates lower the quality in terms of fodder utilization.

**Minerals content of selected fodder tree species**

**Calcium:** The mean calcium content of fodder tree differed significantly (P<0.001) among the treatments considering fodder trees species. Calcium ranged from 2.47% to 3.56 % of the selected fodder tree species. Accordingly, Kutmiro had the highest calcium content (3.56%) followed by Kabro (2.60%) and Badahar (2.47%). Upreti and Shrestha (2006) reported 1.96%, 1.66%, and 2.46 percent of calcium in Badahar, Kutmiro, and Kabro respectively. The recorded calcium content in the present study was higher compared to the reported by the authors.

**Phosphorus:** Phosphorus is the structural component for plant which regulates the protein synthesis. A review of phosphorus content of the Badahar, Kutmiro and Kabro revealed that the value could be 0.27%, 0.34%, and 0.25 % respectively as reported by (Upreti and Shrestha, 2006).

**Total ash:** The mean total ash content of fodder tree differed significantly (P<0.001) among the treatments considering fodder trees species. Total ash ranged from 7.45% to 11.07 % of the selected fodder tree species. Accordingly, the ash content of Badahar and Kabro was similar (11.07 % and 11.92 %) whereas the total ash content in Kutmiro was 7.45 percent (Figure 1). Subba (2098) had reported that the total ash content of Kutmiro could be 6.7 % as compared to 9.3% for Kabro. The value presented in this study was higher than the reported by (Subba, 1998).

Table 4. Chemical composition of selected fodder tree species by age without considering species

| Treatments (Age) | Dry matter (%) | Nutrient composition | | | Fiber fraction (%) | | | Mineral Composition (%) | |
|---|---|---|---|---|---|---|---|---|---|
| | | Energy (kcal/kg) | CP% | EE % | NDF | ADF | ADL | TA | Ca |
| 1(3-6 yrs) | 94.21 | 3984 | 11.72 | 1.831 | 64.38 | 59.34 | 34.86 | 10.42 | 2.78 |
| 2(7-10 yrs) | 94.36 | 3772 | 10.74 | 2.009 | 65.02 | 60.78 | 34.98 | 10.08 | 2.83 |
| 3(11-14 yrs) | 94.01 | 3910 | 11.63 | 1.816 | 65.14 | 60.77 | 34.38 | 9.92 | 3.02 |
| SEM ± | 0.41 | 83.70 | 0.52 | 0.12 | 1.02 | 1.15 | 1.22 | 0.26 | 0.17 |
| P value | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| LSD (0.05 level) | 1.16 | 235.00 | 1.46 | 0.34 | 2.87 | 3.25 | 3.44 | 0.72 | 0.47 |
| CV % | 2.70 | 12.50 | 27.60 | 38.60 | 9.50 | 11.50 | 21.20 | 7.40 | 35.50 |

LSD=Least significant difference, CV=Coefficient of variation, SEM=Standard error of mean, and NS=Non significant

Table 5. Chemical composition of selected fodder tree species with total treatment combination

| Treatments | Dry matter (%) | Nutrient composition | | | Fiber fraction (%) | | | Mineral Composition(%) | |
|---|---|---|---|---|---|---|---|---|---|
| | | Energy (kcal/kg) | CP% | EE % | NDF | ADF | ADL | TA | Ca |
| Badahar×Age1 | 93.98 | 3807 | 13.09 | 1.74 | 55.65 | 50.08 | 24.6 | 11.62 | 2.38 |
| Badahar×Age2 | 94.79 | 3910 | 12.86 | 1.52 | 54.46 | 50.25 | 25.1 | 10.89 | 2.64 |
| Badahar×Age3 | 93.89 | 3372 | 11.49 | 1.68 | 55.78 | 48.93 | 24.5 | 10.69 | 2.39 |
| Kutmiro×Age1 | 94.31 | 4372 | 12.07 | 1.92 | 71.59 | 67.42 | 46.2 | 7.38 | 3.48 |
| Kutmiro×Age2 | 93.52 | 4097 | 11.02 | 2.17 | 71.56 | 67.58 | 44.6 | 7.45 | 3.64 |
| Kutmiro×Age3 | 95.11 | 4389 | 10.71 | 1.64 | 72.55 | 70.43 | 50.1 | 7.50 | 3.54 |
| Kabro× Age1 | 94.33 | 3772 | 10.00 | 1.83 | 65.90 | 60.52 | 33.8 | 12.26 | 2.47 |
| Kabro ×Age2 | 93.62 | 3922 | 10.99 | 2.33 | 69.40 | 64.48 | 33.5 | 11.43 | 2.78 |
| Kabro ×Age3 | 94.08 | 4171 | 10.02 | 2.12 | 66.74 | 62.97 | 30.4 | 12.06 | 2.55 |
| SEM ± | 0.72 | 145.00 | 0.90 | 0.21 | 1.77 | 2.00 | 2.12 | 0.45 | 0.29 |
| P value | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| LSD(0.05 level) | 2.02 | 407.10 | 2.54 | 0.59 | 4.97 | 5.63 | 5.96 | 1.26 | 0.82 |
| CV % | 2.70 | 12.50 | 27.60 | 38.60 | 9.50 | 11.50 | 21.20 | 7.40 | 35.50 |

LSD=Least significant difference, CV=Coefficient of variation, SEM=Standard error of mean, and NS=Non significant

**Nitrate content of selected fodder tree species**

Nitrate content in the tree fodder could be a toxic substances to the livestock if fed in large quantities, Nitrate itself is not toxic to livestock but become toxic when reduced to nitrite. Nitrate score of selected fodder tree species remained statistically similar (P>0.05) among the treatments studied considering fodder trees species. Nitrate score ranged from 1.1 (Badahar) to 1.3 (Kabro). The Kabro had higher nitrate score (1.33) followed by Kutmiro(1.25) and Badahar (1.194) (Table 6).The score 1+, 2+ and 3+ containing nitrate level is less than 1 percent. The analyzed records indicated that selected fodder tree species (Badahar, Kutmiro, and Kabro) are very safe for ruminant feeding. Forages containing less than 5000 ppm (0.05%) are generally considered safe for all the classes of livestock, whereas concentration in the 5000 to 10,000 ppm range should not be fed to pregnant cattle. Higher than the 5000 ppm level in the animal feed are potentially deleterious to the health and productivity of ruminant (Knight *et al.,* 2008).

Table 6. Nitrate score of selected fodder tree species

| Treatments (Fodder species) | Nitrate score (1 to 4) |
|---|---|
| Badahar | 1.19 |
| Kutmiro | 1.25 |
| Kabro | 1.33 |
| SEM ± | 0.07 |
| P value | 0.42 |
| LSD(0.05 level) | NS |
| CV % | 36.0 |

LSD=Least significant difference, CV=Coefficient of variation, SEM=Standard error of mean, and NS=Non significant

Table 7. Nitrate score of fodder tree species at different age groups

| Treatments (Age) | Nitrate score (1 to 4) |
|---|---|
| 1(3-6 years) | 1.33 |
| 2(7-10 years) | 1.19 |
| 3(11-14 years) | 1.25 |
| SEM ± | 0.07 |
| P value | NS |
| LSD(0.05 level) | 0.21 |
| CV % | 36.0 |

LSD=Least significant difference, CV=Coefficient of variation, SEM=Standard error of mean, and NS=Non significant

Table 8. Nitrate score of selected fodder tree species with species and age

| Treatments | Nitrate score (1 to 4) |
|---|---|
| Badahar×Age1(3-6 years) | 1.25 |
| Badahar×Age2(7-10 years) | 1.16 |
| Badahar×Age3(11-14 years) | 1.16 |
| Kutmiro×Age1(3-6 years) | 1.33 |
| Kutmiro×Age2(7-10years) | 1.25 |
| Kutmiro×Age3(11-14years) | 1.16 |
| Kabro×Age1(3-6 years) | 1.41 |
| Kabro×Age2(7-10 years) | 1.33 |
| Kabro×Age3(11-14 years) | 1.25 |
| SEM ± | 0.13 |
| P value | NS |
| LSD(0.05 level) | 0.36 |
| CV % | 36.0 |

LSD=Least significant difference, CV=Coefficient of variation, SEM=Standard error of mean, and NS=Non significant

## CONCLUSION

The following are the conclusion drawn based on this study: (a)There is a great variation in fresh herbage mass yield of popular fodder trees in mid hills districts of Nepal whereas Badahar, Kutmiro and the Kabro were the most popular and promising species. Variation among the top ranked fodder tree in biomass indicates scope to explore the best species, (b) Biomass production was positively related with the age of the fodder tree species even in the traditional management system indicating the higher biomass potential of fodder species that could be varied as per species, (c) Whereas the species such as Badahar both with increased age and higher biomass yield potentials suggested the need to consider such potential for better biomass production, (d) Badahar content higher CP but lower energy and Ca indicating that considering only one parameter for feeding animal might cause misleading in nutrient balance. Feeding mixed fodder would thus safe guard the energy and other nutrients requirements as nutrient content of the selected fodder did not differ significantly with respect to the age and species considered, and (e) Findings of this study clearly revealed that commonly grown and popular fodder tree are safe against nitrate toxicity reflecting the need to continue such fodder species in feeding management.

**ACKNOWLEDGEMENTS**

I would like to express my sincere gratitude to Prof. Dr. Naba Raj Devkota, Prof. Dr. Jagat Lal Yadav, and Mr. Bhola Shankhar Shrestha, for there valuable suggestions and guidance. I am thankful to NARC, especially to the Nutrition Division, for providing me the laboratory facilities. Mr. Pulkit Manadal-Division Chief of the Divison and Bashanta Kumar Shrestha, Technical Officer, for their help in laboratory work. I would like to thank all the farmers who generously contributed to this study by providing me the valuable information, and by granting access to the fodder trees in their farm land.

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# FERTILIZER RESPONSE OF COCKSFOOT AND RYEGRASS AT HIGH HILLS OF RASUWA DISTRICT

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## ABSTRACT

*Production performance of cocksfoot and ryegrass was observed separately under six fertilizer regimes: i) NPK@100:60:40 ii) NPK@80:60:40 iii) NPK@ 60:60:40 iv) FYM@ 10 t/ha v) FYM 5 t/ha with NPK@ 80:60:40 and vi) no any fertilizer. There were 3 replications. For cocksfoot 160000 rooted slips/ha were used for the trial. The seed rate for ryegrass was 12 kg/ha. The transplantation/sowing was done at the first week of Ashad. First cutting was obtained after 4 months of establishment of trial and subsequents were done at each 45 days interval. The highest green matter (50.8 t/ha) and dry matter (11.0 t/ha) from cocksfoot was obtained by applying FYM @ 5 t/ha with NPK@ 80:60:40. The least GM and DM (30.3 t/ha and 6.4 t/ha respectively) was obtained without any fertilizer treatment. Plant height of cocksfoot was also highest for the treatment FYM 5 t/ha with NPK@ 80:60:40 i.e. 55.2 cm.*

*The response of ryegrass to fertilizer is in similar pattern as that of cocksfoot. The highest GM (45.1 t/ha) and DM (10 t/ha) were obtained from fertilizer regime NPK@80:60:40 + FYM 5 t/ha. The least GM (25.1 t/ha), DM (5.6 t/ha) and plant height (36.1 cm) were obtained from without any fertilizer application for ryegrass.*

**Key words:** *fertilizer, cocksfoot, ryegrass, green matter, dry matter*

## INTRODUCTION

Cocksfoot (*Dactylis glomerata*) is a perennial grass and well adapted in high hill. The characteristics of this grass are: tolerant of acid soils, persistent under low soil fertility but responds well to fertilizer, contains no anti nutritional compounds, high level of drought tolerance, tolerant of most pests and diseases, highly competitive and persistent.

Perennial ryegrass (*Lolium perene*) is a cool season perennial grass used in cool, temperate climates throughout the world. It has many worthy attributes and is considered the best overall pasture grass for many areas. Ryegrasses, in general, grow best on fertile, well-drained soils but perennial ryegrass can tolerate wet soils better than some other grasses. It also does not generally tolerate drought or extended periods of extreme temperatures well. Perennial ryegrass establishes rapidly, has a long growing season, is high yielding under good environmental conditions and proper fertilization, contains high quality nutrients, recovers well after grazing, tolerates traffic, and is valuable as hay, silage, and pasture.

Fertilizer requirement of grasses depends upon the soil condition and location. Fertilizer is the most important input that not only contributes towards yield and growth of annual cereal forages but also to quality. Higher fodder yield with fertilizer application is due to their favorable effect on plant water relations, higher absorption, crop density, plant height, leaf area and nutrient utilization.

Fodder and pasture is the basic need of ruminant livestock. Daily feeding of green forages is one of the main components of success of a livestock farm. Under the given situation and

limitation of land, the degraded land in high hill of Rasuwa have potentialities for forage yield. At present these lands could be the important land to supply green fodder for large number of livestock. Perennial ryegrass and cocksfoot have been used for range seeding on mid hills and mountains from 1500 - 4000 m in Nepal (Pande, 2007). Cocksfoot, Ryegrass and Tall fescue are the improved perennial pasture grasses in high hill region for green matter production and erosion control. In Nepalese context detail information on fertilizer responses of these grasses has not been available. This research was designed to select appropriate fertilizer scheme for optimum production of cocksfoot and ryegrass.

**Materials and Methods**

Cultivation of cocksfoot and ryegrass was conducted at Dhunche, Rasuwa. The production performance of these two species was observed separately under six fertilizer regimes:

1. NPK@100:60:40
2. NPK@80:60:40
3. NPK@ 60:60:40
4. FYM@ 10 t/ha
5. FYM 5 t/ha with NPK@ 80:60:40 and
6. No any fertilizer

The experiment was designed in RCBD with three replications. The plot size was 2 x 2 $m^2$ each. For Cocksfoot 160000 rooted slips/ha were used for the trial. The seed rate for ryegrass was 12 kg/ha. The transplantation/sowing was done at second week of Ashad (last of June). First cutting was obtained after 4 months of establishment of the trial and subsequent cuttings were done at each 45 days interval. The production data (GM, plant height) were recorded on each cutting. From each plot 100 gm green biomass was taken as sample to find out dry matter content. The collected data were processed and analyzed by using Microsoft Excel and statistical Minitab.

**Results and Discussion**

The production performance of cocksfoot and ryegrass are presented in Table1 and Table 2. The effect of nitrogen was in similar pattern for both species of grasses. Among the treatments with only chemical fertilizer it was found that the GM and DM production was in increasing pattern as nitrogen level increased. Application of FYM@5 t/ha with NPK@80:60:40 produced significantly highest biomass and dry matter. Applying only farm yard manure (FYM) @ 10 t/ha produced 43.7 and 37.2 t/ha green matter from cocksfoot and ryegrass respectively. It was not surprising that the significantly lowest GM and DM production was found for the grasses without the intervention of any fertilizer. Black et al. 2009; Hay & Porter 2006 also reported that an adequate supply of N is essential for the leaf canopy expansion and photosynthesis of grass/clover swards. The photosynthetic capacity of leaves and canopies of pastures and crops is closely linked to the concentration of N in the leaves (Fletcher et al.2013; Peri et al. 2002). Increasing forage yield of mixture under N fertilization have been reported by Al Khateeb (2004). The nitrogen supply to the plant increases the amount of protein, protoplasm and chlorophyll. In turn, this influences cell size and leaf area, and thus photosynthetic activity (Salisbury and Ross 1994). Nitrogen application in excess of 20 lb per acre will stimulate ryegrass development and inhibit legume establishment (Marvin H. Hall, 2014).

Table 1. Green matter and dry matter production of cocksfoot

| S.N | Treatments | Plant height (cm) | GM (t/ha) | DM (t/ha) |
|---|---|---|---|---|
| 1 | No fertilizer | 43.1 | 30.3 | 6.4 |
| 2 | NPK@100:60:40 | 54.4 | 45.5 | 9.8 |
| 3 | NPK@80:60:40 | 51.1 | 42.1 | 9.1 |
| 4 | NPK@60:60:40 | 50.8 | 37.6 | 7.9 |
| 5 | FYM@10 t/ha | 51.6 | 43.7 | 9.2 |
| 6 | NPK@80:60:40 + FYM@ 5t/ha | 55.2 | 50.8 | 11.0 |
| Average | | 51.03 | 41.66 | 8.9 |
| F value between treatments | | NS | * | * |

Table 2. Green matter and dry matter production of ryegrass

| S.N | Treatments | Plant height (cm) | GM(t/ha) |
|---|---|---|---|
| 1 | No fertilizer | 36.1 | 25.2 |
| 2 | NPK@100:60:40 | 45.0 | 40.7 |
| 3 | NPK@80:60:40 | 42.5 | 34.4 |
| 4 | NPK@60:60:40 | 40.2 | 31.5 |
| 5 | FYM@10 t/ha | 43.7 | 37.2 |
| 6 | NPK@80:60:40 + FYM@ 5t/ha | 47.9 | 45.1 |
| Average | | 42.56 | 35.68 |
| F value between treatments | | NS | * |

The N does not change the leaf Emergence rate (LER) of ryegrass; it only increases the size and weight of each leaf (Dairy Australia). The N fertilizer stimulated the growth of the ryegrass which increased its competitiveness towards the white clover, leading to increased total yields (A.D. Black and H.M. Murdoch. V., 2013). H. Davies *et. al*., 2006 found that the interaction of variety and N level was significant in only one case suggesting that all varieties of cocksfoot and ryegrass in each trial responded similarly to increasing levels of N fertilizer. In our study at same level of fertilizer the total biomass production for cocksfoot was found higher than ryegrass. Similar to this study W. C. Weeda (1970) also reported that the total yield of cocksfoot was higher than that of perennial ryegrass as a result of the higher summer yield of cocksfoot.

## CONCLUSION

From this study fertilizer regime NPK@80:60:40 with FYM@5t/ha contributed significantly highest GM and DM production for cocksfoot and ryegrass. Moreover, the response of these grasses at increasing level of nitrogen (>100 kg/ha) can also be assessed for further study. However, in absence of chemical fertilizer application of only FYM@10 t/ha gave good production for cocksfoot and ryegrass at high hill of Rasuwa district.

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# EFFECT OF ALTITUDE ON GROWTH AND REPRODUCTIVE TRAITS OF GOATS IN NAWALPARASI, NEPAL

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## ABSTRACT

Altitude is considered as a potential source of variation among growth and reproductive traits of goats. In this regard, a study was carried out at Deurali VDC, Nawalparasi from June, 2012 to December, 2013 mainly aiming at studying the effect of altitude on the growth and reproductive performance of goats. Altogether 750 adult does and more than 1200 kids were selected for this study. Growth and reproductive traits of the selected kids were recorded monthly. Similarly, past history on reproductive performance of selected does was recorded based on personal interview with the household leader. Data recorded under this study were computerized, coded, and cleaned using MS-Excel. Analysis of data related to growth and reproductive traits was done using least square procedure given by Harvey (1990) software. Results of this study revealed that altitude had significant effect on the weight of kids at pre-weaning ($p<0.01$), six months ($p<0.001$) and nine months ($p<0.001$) age. On the other hand, reproductive traits such as age at first conception ($p<0.001$), age at first kidding ($p<0.001$), kidding interval ($p<0.05$) and post-partum estrus ($p<0.001$) were significantly affected by altitude ($p<0.001$). Most critically, the twinning percentage of local *Khari* goat likely to be deteriorated in recent years as it was recorded 46% whereas majority of the population of does produced single kids (54%) in this study. Similarly, live weight of adult does in this study was significantly influenced ($p<0.001$) by altitude. Thus there is wider scope of enhancing the overall productivity of Nepalese hill goat by considering the non-genetic factor such as altitude with respect to the weight traits of kids and reproductive performance of the does including gestation length, kidding interval, and post-partum estrus. It is also observed that age at first conception could be shortened by 1 month either if they are shifted from lower plain to upper hill. As the productive and reproductive performance significantly influenced by altitude, it is suggested to develop a niche specific breeding program throughout the country to fulfill the meat demand of the country reducing large scale import from neighbors.

**Key Words:** Altitude, growth traits, reproductive efficiency, niche specific breeding

## INTRODUCTION

Goat farming plays a most important role in the upliftment of rural economy and in lucrative employment of rural poor. This is because goats can thrive in hardy weather conditions and can be conveniently reared under unproductive and uncultivable land where dairy farming is least possible. In Nepal, the small and marginal farmers including landless agricultural laborers, predominantly rear goats for sustaining their lives. MoAD (2014) indicated that the population of goat in Nepal increased with an average annual growth rate of 3.25% from 1997 (6.08 million) to 2014 (10.17 million). Goat mainly contributes 18.74% to the total meat production of the nation and ranks in second position followed by buffalo (59.88%) for meat production

(MoAD, 2014).

Nepal consists of altogether four indigenous breeds of goat consisting of Chyangra, Sinhal, Khari and Terai that inhabit in mountain, high hills, mid hills and Terai region of the country respectively (Kharel and Neopane, 1998). Nepalese hill goat (*Khari*) is a well-recognized goat breed across the mid hill region of Nepal from east to west.

Government and Non-government organizations are focusing on small animal promotion program especially in goat production. It shows that the goat keeping program is the main agricultural program for poverty reduction even for landless. Although goat has greater source for generating additional household income among resource poor, but it has been kept on a non-commercial basis or only in subsistence level (Kolachhapati, 2006). Altitude is considered as a potential source of variation among growth and reproductive traits of goats, which in case of Khari goat, was scarcely studied. Thus, present study aims at determining the effect of altitude on growth and reproductive traits of Khari goats in Nawalparasi district of Nepal.

## MATERIALS AND METHODS

This study was carried out at Deurali VDC, Nawalparasi from 14 June, 2012 to 15 December, 2013 mainly aiming at studying the effect of altitude on the growth and reproductive performance of goats. Altogether 750 adult does and more than 1200 kids were selected for this study. Growth and reproductive traits of the selected kids were recorded monthly. Similarly, past history on reproductive performance of selected does was recorded based on personal interview with the household leader. Data recorded under this study were computerized, coded, and cleaned using MS-Excel. Analysis of data related to growth and reproductive traits was done using least square procedure given by Harvey (1990) software. Significantly different means were compared using DMRT computer software.

## RESULTS AND DISCUSSION

### *Growth traits*

According to the results of this study overall mean weight of hill goat kids at birth, pre-weaning, weaning, six months and nine months age was 2.92±0.14 kg 6.91±0.43 kg, 9.82±0.34kg, 14.03±0.56 kg, and 20.49±0.43 kg, respectively. Based on the results of this study, the trend of growth of Nepalese hill goat kids is presented in Figure 1. The mean values of live body weight of hill goat kids at different age closely resemble to the values reported by Kolachhapati (2006), Pandey (2007) and Sapkota (2007). However, Neopane (1997) and Shrestha (2004) reported comparatively lower values of mean weight of hill goat kids at different stages of growth.

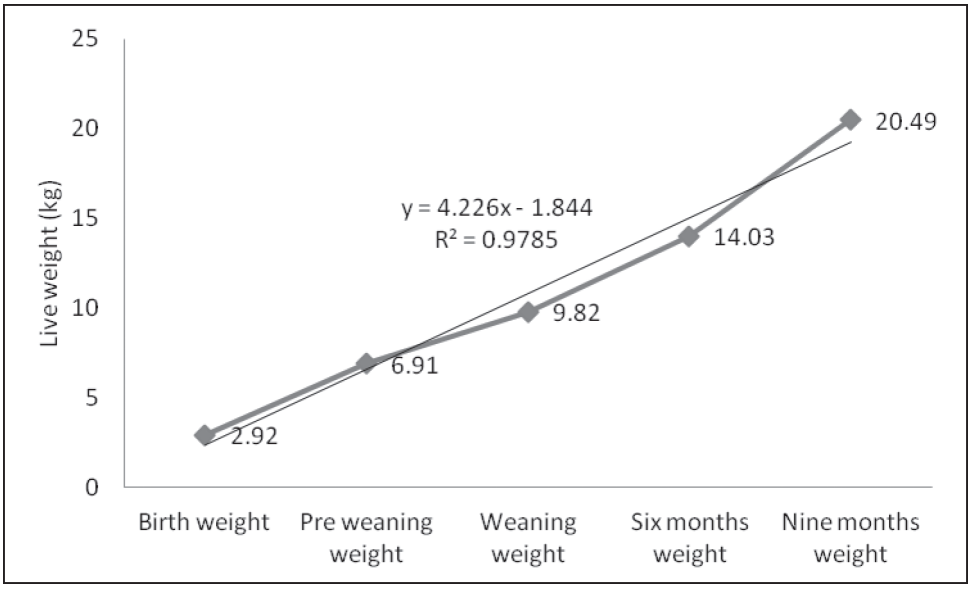


Figure 1. Trend of growth of local goat kids from birth to nine months age

Accordingly, the results have also been indicated that the rate of growth of body weight mostly seems to be increased in increasing rate except at early age, where the rate of growth from birth to weaning age seems to be increased in decreasing rate (Figure 2). This clearly indicates that proper care and management should be concentrated at this stage to enhance the rate of growth of the hill goat kids so as to achieve optimum economic return.

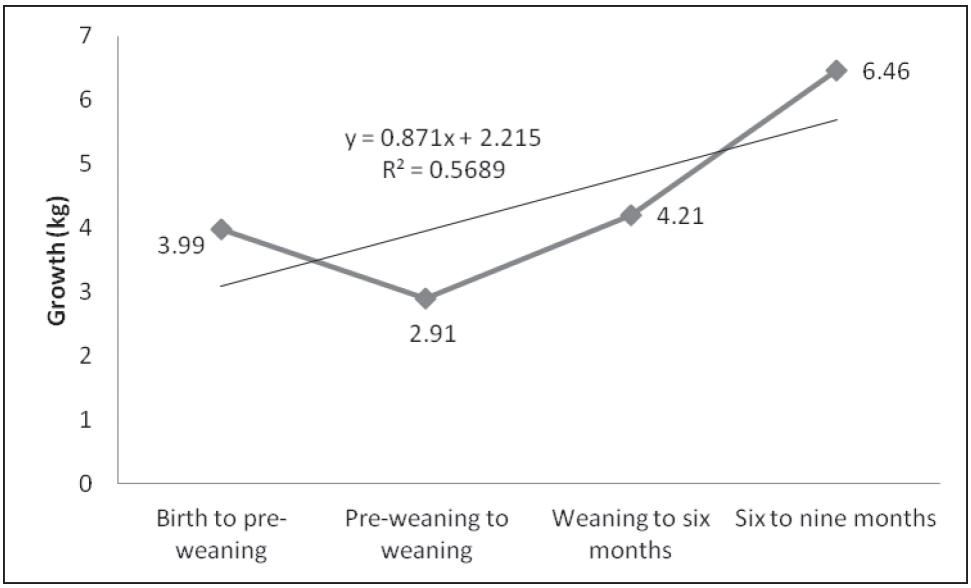


Figure 2. Growth rate of hill goat kids from birth to nine months age showing trend line and linear equation

**Effect of altitude**

Results of this study revealed that altitude was an important source of variation ($p<0.001$) with respect to the weight of kids at pre-weaning, six months and nine months age. However, birth weight and weaning weight was not varied significantly. Though the birth weight of kids

at upper and lower altitude seems to be similar, growth trend of goat kids in two different altitudes indicates that weight of kids at pre-weaning, weaning, six months, and nine months age was significantly higher for those grown in upper altitude as compared to that of lower altitude (Figure 3). Higher body weight of the kids in upper altitude as compared to that in lower might be due to availability of suitable environmental condition, optimum grazing land and nutritious fodder and forage species in communal grazing land as reported by Devendra and Marca (1983).

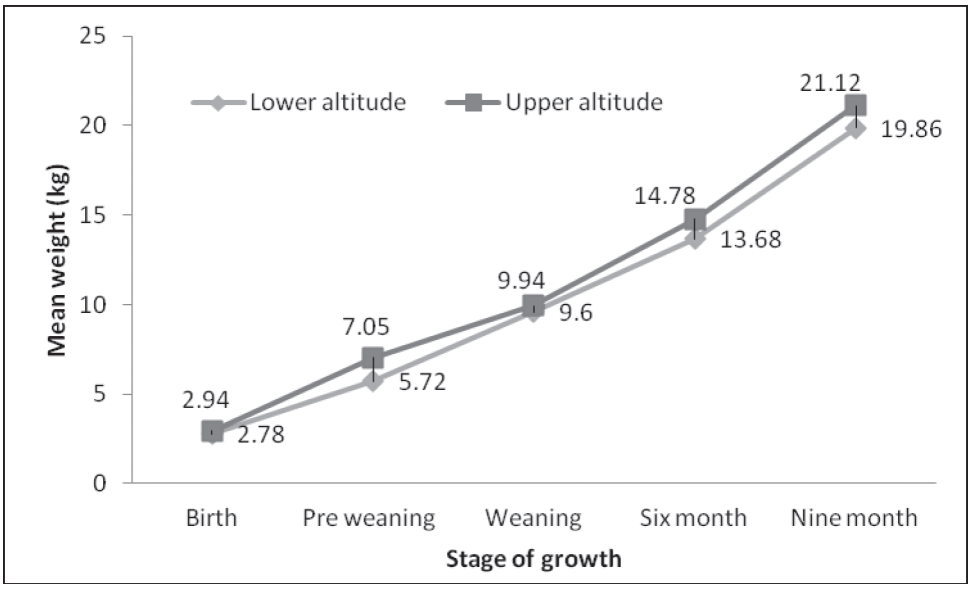


Figure 3. Weight of hill goat kids at different location and different stages of growth

***Age at first conception and kidding***

Findings of present study revealed that the age at first conception and kidding of Khari goats in the research area was determined to be 267.29±6.30 days and 419.83±6.07 days, respectively. (Pandey, 2007) reported comparatively larger values of age at first conception (469.42 days) and age at first kidding (611.30 days) for Khari and its crosses with Indian breeds in Tanahun district.

**Effect of altitude**

Table 1 indicated that altitude had significant effect ($p<0.001$) on age at first conception and kidding. Accordingly, does of upper altitude conceived 14 days earlier and kidded 26 days earlier as compared to those of lower altitude. Sapkota (2007) and Kolachhapati (2006) also reported the significant effect of location/altitude on age at first conception and kidding in their study. The earlier attainment of sexual maturity of the does in upper altitude might be due to availability of nutritious fodder and forage species and early sunshine that may influence the activation of physiological/reproductive system as suggested by Hafez (1989).

Table 1. Effect of altitude on age at first conception and kidding of hill goats in Nawalparasi, Nepal (days)

| Factors | No. of observations | LS Mean±SE | |
|---|---|---|---|
| | | Age at first conception | Age at first kidding |
| Overall | 750 | 267.29±6.30 | 419.83±6.07 |
| **Altitude** | | *** (0.001) | *** (0.001) |
| Lower altitude | 205 | 273.38±6.00[b] | 427.14±6.04[b] |
| Upper altitude | 545 | 259.20±6.10[a] | 401.52±6.15[a] |

Note: LS= Least Square; SE= Standard error; *** = Significant at 0.1% (P<0.001) level, AFC= Age at first conception, AFK= Age at first kidding

**Gestation length, kidding interval and post-partum estrus**

Results of this study revealed that the overall mean gestation length, kidding interval and post-partum estrus of *Khari* goat in Nawalparasi district was 150.65±0.95 days, 201.87±2.30 days and 55.26±0.73 days, respectively (Table 2). Kolachhapati (2006), Bhattarai (2007), Pandey (2007) and Sapkota (2007) reported the similar values of gestation length and higher values of kidding interval and post-partum estrus of Nepalese hill goats.

**Effect of altitude**

Altitude was not an important source of variation with respect to gestation length (Table 2). However, the trait was slightly shorter for the does reared in lower altitude as compared to those of upper altitude (Figure 4). Shorter gestation length of goats in lower altitude might be due to the secretion of reproductive hormones as the influence of warmer climate as compared to that in upper altitude. On the other hand, kidding interval and post-partum estrus were significantly affected by altitudinal variation (p<0.05 and 0.001, respectively). Accordingly, post-partum estrus and kidding interval were about 5 days and 7 days shorter in the does reared in upper altitude as compared to that of lower altitude (Figure 4). Thus, the shorter post-partum estrus and kidding interval of goats reared in upper altitude might be due to the availability of well nutritious fodder and forages and higher light intensities in this region. Besides, this might also be due to the burden of parasites where the goats in lower altitude might have higher parasitic load that needs to be tested.

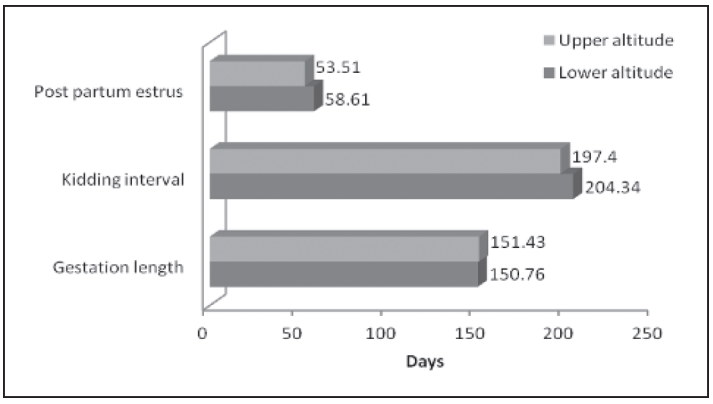


Figure 4. Effect of altitude on post partum estrus, kidding interval and gestation length of Khari goat in Nawalparasi, Nepal

**Twinning percentage**

Findings of this study revealed that out of 750 does, majority of the does (54%) kidded single during the study period whereas only 38% does kidded twins followed by 8% triplet kidding (Figure 5). Kidding percentage was varied significantly with respect to the level of altitude. Accordingly, multiple kidding seemed to be reduced at lower altitude as compared to that of upper altitude. Thus, in almost all cases, kidding was dominated by single kidding followed by twins and triplets.

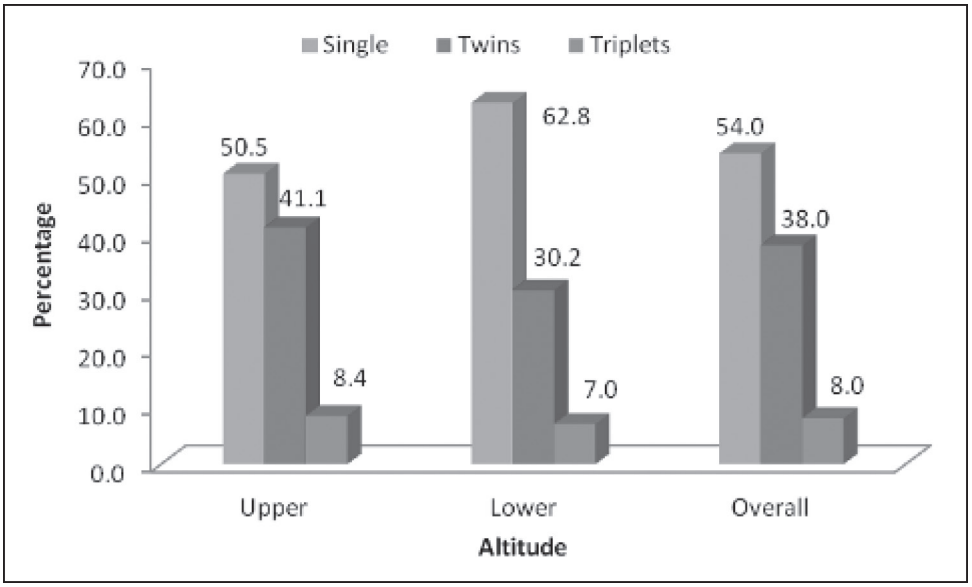


Figure 5. Effect of altitude on kidding percentage

**CONCLUSIONS AND RECOMMENDATIONS**

Since twinning percentage of goats has started to decline even up to alarming rate (<50%), this could be taken as an important area of immediate concern. There is wider scope of enhancing the overall productivity of Nepalese hill goat by considering the non-genetic factors such as altitude with respect to the weight traits of kids, and reproductive performance of the does such as gestation length, kidding interval, and post-partum estrus. It could also be concluded that age at first conception could be shortened by 1 month either if they are shifted from lower plain to upper hill suggesting the scope of spatial arrangement in goat breeding. As suggested by the preliminary findings, productive and reproductive performance could significantly be influenced by altitude that needs thorough investigation to develop a niche specific breeding and commercialization program.

**ACKNOWLEDGEMENTS**

The authors are grateful to Bhola Shankar Shrestha, Chief, Animal Breeding Division, and NASRI/ NARC for his constant encouragement in preparation of this manuscript and publication of present work. Sincere thanks and heartfelt gratitude also goes to University Grant Commission (UGC), Sanothimi, Bhaktapur for the partial funding assistance while conducting present study in the field. Authors are also grateful to the commercial and smallholder farmers of Deurali

VDC of Nawalparasi district. Support from the colleagues and administrative officials from Agriculture and Forestry University, Rampur, Chitwan are highly valued for their continuous cooperation during the study period.

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# STUDY OF SEMEN AND ECONOMIC PARAMETERS OF JERSEY AND ITS CROSSES UNDER FARMERS MANAGED CONDITION AT CENTRAL AND WESTERN NEPAL

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## ABSTRACT

*This study was conducted to assess the quality parameters of Jersey bull semen used for artificial insemination (AI) at National Livestock Breeding Centre (NLBC), Pokhara, to assess the conception rate (CR) of AI and to assess the weight, productive and reproductive performance of different genetic group of Jersey (J)and its crosses (Jersey, Jersey × HF, Local × J., HF × J., HF × J. × J., L. × J. × J. and Jersey >75%) commonly kept by commercial and semi commercial dairy farmers of Kaski, Tanahu, Gorkha, Nawalparasi, Rupandehi, Chitwan and Makawanpur districts of Nepal in 2011/2012. For quality parameters of bull semen over 5 years (2007-2011) semen collection records of NLBC were analysed. The effect of genetic and non genetic factors on weight traits such as birth weight (BWT), weaning weight (WWT), weaning age (WAGE), weight at first service (WFS), reproductive traits such as age at first service (AFS), age at first calving (AFC), calving interval (CI), gestation length (GL), post partum estrus (PPE) and productive traits such as daily milk yield (DMY), lactation milk yield (LMY), lactation length (LL), dry period (DP) and milk content (fat%, protein% and valuable solids) of jersey and its crosses were analysed. Data were analysed by least square analysis using Harvey 1990 software package. Rresults revealed that year of semen collection and individual bull both had significant effect on semen volume (P<0.001), initial motility (P<0.001), sperm concentration (P<0.001), pre filling motility (P<0.001), post thaw motility (P<0.001) and doses of semen production (P<0.001). Frequency of semen collection had significant effect on sperm concentration (P<0.001). Density and mass activity of semen both had significant effect on initial motility (P<0.001) and sperm concentration (P<0.001). Mass activity of semen had also significant effect on post thaw motility (P<0.001). Likewise, different time of insemination and site of semen deposition had significant effect on CR (P<0.001). Geographic location had significant effect on AFS (P<0.01) and PPE (P<0.05). Likewise, year had significant effect on AFS (P<0.001), AFC (P<0.001), CI (P<0.01) and GL (P<0.001). Similarly, interaction effect of geographic location (environment) and genetic group i.e. breed had significant effect on AFC (P<0.05). Likewise, parity and performance of dam both had significant effect on LMY (P<0.001) and lactation yield (LYD) had significant effect on protein% (P<0.05) and valuable solid content in milk (P<0.001). The heritability estimates of LMY, fat% and protein% were 0.204, 0.07 and 0.12 respectively. It was expected that effect of correlation and genetic and non genetic factors on reproductive and productive traits of Jersey and its crosses provide concrete scientific basis to select the best dairy animals for future and to estimate the breeding value of dairy animals.*

## INTRODUCTION

Agriculture is the backbone of Nepalese economy which contributes 33.8% of National Gross Domestic Products (GDP). Agriculture provides employment for 65.6% of the total active population and supports livelihood of 79% of farm households in Nepal (MOAC, 2011). In Nepalese context, agriculture comprises both crop and livestock components. Livestock is an integral part of the agricultural production system of Nepal. Livestock plays a vital role to the Nepalese rural economy and contributes about 12% to the total national GDP and about 25.68% to national Agricultural Gross Domestic Products (AGDP) (MOAC, 2009). Dairying is

the most important sub-sector contributing about 63% to the total Livestock Gross Domestic Products (LGDP) which is about 8% of total national GDP. It provides a daily source of income and has been well recognized as a means for poverty reduction across the developing world. It also minimizes the rural-urban income disparities to a great extent through trickle down and gradual monetization of rural economy. It has been reported that one off farm job is created when 10-20 liters of milk comes into processing and marketing chain (FAO, 2010).

Agricultural Prospective Plan (APP) targeted that share of livestock sector in AGDP can go up to 45% in the last period of 2015 AD (APP, 1995). To achieve this progress increase in milk production and productivity is one of the important areas (NLBC, 2010). In the country, milk production is increasing by 4%, where as the demand of milk is increasing by 8% annually (Shrestha, 2010). Per-capita availability of milk (51.49 kg/year) in Nepal is far below than WHO recommendation i.e. 91.25 kg (Chaudhary, 2009, NLBC, 2010). Nepalese cattle are being upgraded with different level of exotic blood (Jersey and HF) in farmers' field with variation in production potentialities. Since 50 years of practices of AI in the country, it is necessary to find out its impact on breed improvement of Nepalese cattle and find out appropriate phenotype and genotype for Nepalese Jersey breed with optimum level of production performance. In this context, present study has been carried out mainly aiming at evaluating the Nepalese cattle herds crossed with Jersey and HF at farmers' field level.

## OBJECTIVES

The study was carried out with the main objective of determining genetic and non-genetic parameters and performance of progenies of Jersey bulls at Central and Western region of Nepal. The specific objectives of this study were to:

- Evaluate the quality and quantity of semen produced from the bulls used for AI.
- Assess the conception rate of Jersey bull semen used for AI.
- Estimate heritability of different economic traits of Jersey crossbreds.
- Analyze the effect of genetic and non-genetic factors and its factorial interactions on production and reproduction traits of Jersey crossbreds born by AI under farmers managed condition.

## LITERATURE REVIEW

### Coverage of AI in Nepal

In spite of widely accepted technology, the coverage of AI is very low in Nepal. In India, Bangladesh and Sri Lanka the coverage of this service in milking dairy animals was 15-30% while it is only 11% in Nepal (NLBC, 2012), the lowest in the region.

### Quality parameter of bull semen production

Quality parameter of bull semen production was discussed below as physical quality parameter and microscopic quality parameter**.**

### Semen volume

Semen consists of spermatozoa and seminal plasma. Average volume of bull semen was 5.0 ml, ranges from 2 ml to 10 ml (JLTA, 2004). Gholami *et al*. (2010) observed HF bulls produced 5.85±0.15 ml of semen per ejaculates. Sarder (2007) also reported that in Bangladesh HF bulls produced 7.14±2.11 ml of semen per ejaculates averagely. Ahamad *et al*. (2003) reported Sahiwal bulls in Pakistan produced 4.59±0.15 ml of semen per ejaculate.

**Semen density**

Sarder (2007) observed overall density (1-5 scale) of semen obtained from HF bull in Bangladesh was 3.23±0.97.

**Mass activity/Mass motility of sperms**

Goswami *et al*. (1991) observed in zebu × taurus bulls that mass activity (0-5 scale) ranges from 3.22 to 3.54. They also observed mass activity (0-5 scale) during hot dry, hot humid, autumn and winter season were 3.24, 3.22, 3.32 and 3.54 respectively. Ahmad *et al*. (2003) reported overall mass activity of sperms ejaculated from Sahiwal bull in Pakistan was 2.61±0.04.

**Initial motility of sperms**

Initial motility of sperms ejaculated in bull semen was ranges from 70-95% (JLTA, 2004). Beran *et al*. (2011) reported initial motility of sperm of HF bulls and Czech Fleckvieh bulls were 77.19±3.38 and 80.33±3.63% respectively. Gholami *et al*. (2010) reported total initial motility of sperms ejaculates from HF bulls was found 81.49±1.16%.

**Concentration of sperms**

Waltl *et al*. (2004) reported ejaculate of breeding bulls contained sperm concentration ($10^9$/ml) were 1.26±0.41, 1.08±0.41 and 0.95±0.41 for first, second and third collection respectively on the same day. Ahmad *et al*. (2003) reported overall concentration ($10^9$/ml) of sperms ejaculated from Sahiwal bull in Pakistan was 0.98±0.01.

**Pre-filling and Pre-freezing motility of sperms**

Beran *et al*. (2011) reported that after dilution motility or pre filling motility percentage of sperm of HF bulls and Czech Fleckvieh bulls were 83.44±2.0 and 85.67±1.6 % respectively.

**Post thaw motility of sperms**

Goswami *et al*. (1991) observed in zebu × taurus bulls that post thaw motility were 51.02, 52.19, 55.87 and 55.54% for hot dry, hot humid, autumn and winter seasons respectively. Beran *et al*. (2011) reported post thaw motility of sperm of HF bulls and Czech Fleckvieh bulls were 62.50±3.4 and 58.67±4.2% respectively.

**Semen doses produced**

Gordon (2004) reported doses of semen produced from breeding bulls in North America, South America and Europe were 4669.31, in 11164.66 and 5952 dose/year respectively.

**Number of sperms per dose of semen**

Gordon (2004) reported the data, refer to the year 1998 that frozen semen usage for cattle AI in different countries having different number of sperms per dose and that were in Australia-25, in Brazil-12-15, in Canada-15, in Denmark-15, in France-20, in Italy-18, in Japan-20, in New Zealand-10-30, in Spain-30 and in USA-10-30 millions.

**Conception Rate (CR) of Jersey bull semen used for AI**

Smith (1982) reported that conception rate of insemination during standing sign of estrus was 55% and not standing sign of estrus was 37% only. Long (1997) reported in Vietnam CR of insemination in Sindhi × Yellow cattle was 67% and in F1 of HF × Yellow cattle and F2 of HF × Yellow cattle were 66.5 and 65.3%, respectively. In heifer and cow inseminated by frozen semen, CR was 51 and 48% respectively (Norman *et al*., 2010) showing that heifers have higher conception rate than the cows.

**Weight Traits**

**Birth Weight (BWT)**

Jersey is a small and early maturing breed of cattle having mean BWT of 20 kg (Alpan, 1990). Jain *et al*. (2000) reported overall BWT of Jersey calves was 19.52±0.18 kg. Khan and Akhtar (1995) reported BWT of Jersey female calves in Pakistan was 23.85±4.2 kg.

**Weaning weight (WWT) and weaning age (WAGE)**

Dezfuli and Mashayekhi (2009) reported WWT of Iranian Najdi calves was 49.56±13.10 kg. Khan and Akhtar (1995) reported WWT at 180 days of Jersey calves in Pakistan was 129.47±23.5 kg.

**Weight at first service (WFS)**

Khan and Akhtar (1995) reported WFS at 365 days of Jersey female heifers in Pakistan was 206.54±37.55 kg. Penno (1997) reported live WFS of Jersey and HF cows under grazing condition in New Zealand were 217.33 and 288.75 kg respectively. Kyabram (2001) reported WFS (puberty) of Jersey cows was 210 kg.

**Weight at first calving (WFC)**

Penno (1997) reported WFC of Jersey and HF cows under grazing condition in New Zealand were 346.67 and 433.75 kg respectively. Kyabram (2006) reported WFC of HF and Jersey cows at age of 24-26 months were 500-550 and 370-410 kg, respectively.

**Daily weight gain (DWG)**

Schrage *et al*. (1997) reported in Sri Lanka DWG of local breeds of calves, Indian crossbred and European crossbred were 150-250, 250-400 and 300-450 gram, respectively. Khan and Akhtar (1995) reported DWG for female Jersey calves in Pakistan from birth to weaning, weaning to yearling and birth to yearling were 1.181±0.248, 0.497±0.106 and 0.286±0.248 kg/day.

**Reproductive traits**

**Age at first service (AFS)**

Sattar *et al*. (2004) found at Punjab of Pakistan that age at maturity in Jersey cows was 615.48±8.23 days (20.23±0.27 months). Penno (1997) reported AFS of Jersey cows under grazing condition in New Zealand was 15 months. Long (1997) reported that in Vietnam AFS or mating of yellow (local) cattle was 23.2±2.7 months.

**Service per conception**

Sattar *et al*. (2004) found at Punjab of Pakistan that service per conception in Jersey cows was 2.81±0.09. Amasaib *et al*. (2011) reported crossbred dairy cows of Sudan under tropical condition shows 2.5-2.7 service per conception. Tadesse *et al.* (2010) reported about reproductive performance of dairy cattle and found service per conception was 1.80±1.

**Age at first calving (AFC)**

Age at First Calving (AFC) for Nepalese native and crossbred cows were 48 and 26 months respectively (ABPSD, 2007). Suhail *et al*. (2010) reported that AFC of Jersey cattle ranging between 760-1628 days (24.98-53.52 months) with a mean 1010.73±21.84 days (33.23±0.71 months).

**Calving interval (CI)**

Calving interval (CI) for Nepalese native and crossbred cows were 21 and 18 months respectively (ABPSD, 2007). Suhail *et al*. (2010) reported average length of CI of Jersey cows

was 487.31±19.08 days (16.02±0.63 months) ranges from 301-904 days (9.89-29.72 months). Dhungana (2011) found the overall mean of CI in 50, 75 and above 75% exotic breeds (genetic groups) were 400±49 days (13.15±1.62 months), 482±40 days (15.85±1.32 months) and 414±22 days (13.61±0.72 months) respectively. Joshi (1992) cited CI days in Jersey cross cattle was 429 days (14.10 months) in western hills of Nepal.

**Post partum estrus (PPE)**

Ajili *et al*. (2007) reported PPE period in Tunisian HF cows was 90 days. Sattar *et al*. (2004) found PPE period 86.65±1.71 days in Jersey cows at Punjab in Pakistan. Crossbred dairy cows of Sudan under tropical condition showed 121.8-143 days PPE period (Amasaib *et al*., 2011). Dhungana (2011) found the overall mean for PPE for 50, 75 and above 75% genetic groups were 131±10, 151±17, 145±17 days respectively at *Sunsari* district of Nepal. Joshi (1992) cited PPE in Jersey cross cattle was 149 days in western hills of Nepal.

**Gestation length (GL)**

GL of cow is about 173-292 days, which is slight difference among breeds. For HF, GL is 278-282 days, where as for Jersey is 277-280 days and 285 days in average for Japanese Black breed (JLTA, 2002).

**Productive traits**

**Daily milk yield (DMY)**

Amasaib *et al*. (2011) reported daily milk yield in crossbred dairy cows of Sudan under tropical condition was 9.20-11.9 kg. Vaish (2011) key person of model dairy farm Kanpur, India reported that Jersey and Jersey cross cows have milk yield capacity of 15 to 25 liters per day. Average DMY of cow was found 8.51±3.85 kg in Nepal (DCIP, 2010).

**Peak daily milk yield (PDMY)**

Ahmad *et al*. (1985) reported PDMY from HF × Sahiwal cows at Faisalabad in Pakistan was 16.39±0.41 kg and also found PDMY at 31.2±2.9 days of calving.

**Lactation milk yield (LMY)**

LMY for Nepalese native and crossbred cows were 438 and 1800 liter respectively (ABPSD, 2007). The mean milk yield of Jersey per lactation is about 3000 to 3500 kg (Ozcan and Yalcin, 1985). Freitas *et al*. (1995) found lactation milk yield ranged from 1695±640-1950±780 liters. Singh and Ram (1998) found 2425 liter of milk production per lactation in Indian crossbred cows.

**Lactation length (LL)**

Singh and Ram (1998) found 299.67 days LL in Indian crossbred cows. Usman *et al*. (2012) observed in HF cattle LL was 366.5±76.71days. Ahmad *et al*. (1985) found in Faisalabad of Pakistan that LL of HF × Sahiwal cows was 394.5±15.4 days. Crossbred dairy cows of Sudan under tropical condition showed 267-274 days LL (Amasaib *et al*., 2011).

**Fat content (fat %)**

Average fat percentage content in milk of cow was found 4.54±1.42% in Nepal which was ranging from 1.76-8.15% (DCIP, 2010). Wagner (2010) reported average fat percent content in milk of cow in Mongolia, Myanmar and Nepal were found 4.08, 4.45 and 4.41%, respectively.

**Protein content of milk (protein %)**

Average protein percentage content in milk of cow was found 3.34±0.45% in Nepal which was ranging from 2.61-4.24% (DCIP, 2010). Wagner (2010) reported average protein percentage

content in milk of cow in Mongolia, Myanmar and Nepal were found 3.47, 3.41 and 3.31%, respectively.

**Valuable solid content of milk**

Valuable solid content of milk of Jersey, HF, Jersey × HF and other crosses cow were found 214.64, 247, 266.1 and 233.0 kg in Nepal (DCIP, 2010). Wagner (2010) reported average per lactation valuable solid content in milk of cow in Mongolia, Myanmar and Nepal were found 160, 199 and 223 kg respectively.

**Heritability of milk yield**

reitas *et al*. (1995) found heritability of milk yield in cows was 0.12. Lobo *et al*. (1984); Nobre *et al*. (1984); Milagres *et al*. (1988) and Freitas *et al*. (1991) were observed heritability of milk yield in Brazil for crossbred cows ranges from 0.16-0.30.

## MATERIALS AND METHODS

**Site of the study/research**

**Evaluation of the quality and quantity of semen of bull used for AI**

The study was carried out at National Livestock Breeding Center (NLBC), Pokhara to evaluate the quality and quantity of frozen jersey bull semen used for AI program in cattle throughout the country. Status and variation in quality and quantity of semen production from Jersey bulls were evaluated for last 5 years. The registered data (for five years) were reviewed to assess the quality and quantity of semen. The analysis of physical and microscopic evaluation of bull semen were done accordingly.

**Estimation of effect of genetic and non-genetic factors**

The whole study was participatory and farmer centered. For the study, Chitwan and Makawanpur districts from Central region and Nawalparasi, Rupandehi, Gorkha, Tanahu and Kaski districts from Western region were selected. The study was carried out at dairy pocket area of those districts. Dairy pocket areas of those selected districts were identified in consultation with line agencies such as NLBC and respective DLSOs. Detailed baseline information on existing AI situation of those districts were collected and documented based on field monitoring system using the check list.

**Duration of the study**

**Duration of the study for analysis of bull semen quality and their conception rate**

The study for analysis of bull semen quality, last five year semen collection data of NLBC from 2006/07-2010/11 were reviewed and analyzed and to assess the conception rate last six year AI performance and field monitoring records from 2006/07-2011/12 were reviewed and analyzed. The recorded data for six years were reviewed and analyzed from November 2011 to October 2012 along with the laboratory quality assessment of bull semen.

**Duration of the study for performance of Jersey crossbred cows**

This study was carried out during the period of November 2011 to October 2012 by collecting data through farmers' field survey and performance record reviewed of Dairy Cattle Improvement Program (DCIP).

### Data Analysis

All together 2851 semen collection data for semen quality analysis, 832 records for conception rate analysis and 538 Jersey and its crosses from 7 study districts were taken as a sample for economic (weight, reproductive and productive) traits analysis. Data generated for this study were entered into MS-excel, grouped, coded and converted in to MS-DOS text documents. Data were analyzed by least square analysis using Harvey 1990 software package.

## RESULTS AND DISCUSSION

### Semen Quality Parameters of Jersey Bulls

Results of this study revealed the overall least square mean and standard errors (LS mean and SE) of semen volume, initial motility, semen concentration ($10^9$), pre-filling motility, post thaw motility, doses of semen production/year and spermatozoa/dose were 5.47±0.08 ml, 74.54±0.15%, 1.072±0.017, 65.64±0.13% and 48.48±0.16%, 18591.41±861.25 dose, 20.55±0.16 million, respectively.

### Conception Rate

Overall LS mean and SE of conception rate of AI was 63.17±4.26%. Overall success rate of AI depending on time of insemination and site of semen deposition were 46.16±0.61 and 41.87±0.59% respectively.

### Weight Traits

Overall LS mean and SE of BWT, WWT, WAGE and WFS were found to be 26.71±0.53 kg, 71.48±0.95 kg, 101.13±0.73 day, 203.22±4.06 kg respectively. Daily weight gain from birth to weaning, weaning to AFS and birth to AFS were 442, 315 and 392 gm respectively.

### Reproductive Traits

Overall LS mean and SE of AFS, AFC, CI, GLand PPE were found to be 17.27±0.37 months, 26.06±0.68 months, 12.03±0.20 months, 280.35±0.30 days and 65.25±0.80 days, respectively.

### Production Traits

Overall LS mean and SE of LMY, LL and DP were found to be 3496.73±40.55 lit., 298.79±1.48 day and 54.99±0.46 day respectively. Average daily milk yield, peak daily milk yield and overall LS mean and SE of fat%, protein% and total valuable solid were 11.44 lit., 15.23 lit., 4.01±0.17%, 3.27±0.055% and 253.73±9.14 kg, respectively.

### Heritability

The heritability estimates of LMY, fat% and protein% were 0.204, 0.07 and 0.12 respectively.

## CONCLUSIONS

Based on the above findings of this study, following conclusions could be made:

- The overall mean of all semen quality parameters, conception rate, weight traits, reproductive traits, productive traits and milk contents were found better than previous findings reported by many authors as described in the literature review part of this study. Semen quality parameters were found good for improving conception rate that has reculted average conception rate higher (63.17%), which can be taken as the best conception rate in the region. So, it is suggested to the dairy farmers of Nepal to use NLBC semen for AI for better conception rate and for breed improvement.

- Weight traits, reproductive traits and productive traits of cross breeds were found better than Nepalese local breeds of cattle and also these performances were in the improving trend every year. Therefore, dairy farmers are suggested to follow the AI method which is the better option for breed improvement.
- Heritability of milk yieldwas found to be medium suggesting that thedaughters born from AI would be better source of milking animals for future. This provide scientific basis for intensive selection for the dairy cattle breed improvement in Nepal.
- Correlation between lactation yield and previous lactation yield were found to be strongly correlated. So, progeny selected form best mothers could be better for future.

**ACKNOWLEDGEMENT**

The author wish to acknowledge Natioanl Livestock breeding Centre, Animal Breding Division, Directorate of Livestock Production, Central Cattle and Buffalo Promotion officesa dn farmers for their direct and indirect support to accomplish the current study.

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# PHENOTYPIC CHARACTERIZATION OF SAKINI CHICKEN OF DIFFERENT AGRO-ECOLOGICAL ZONES OF NEPAL

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## ABSTRACT

*A total of 162 birds were taken for the phenotypic characterization of Sakini chicken from different agro-ecological zones of Nepal. Rasuwa for high hills (61 birds), Kavre for mid hills (40 birds) and Rautahat for Terai (61 birds) districts were taken for the study. The birds were reared in intensive management system. The correlation with wattle length and comb length was found highest with value 0.950 followed by the correlation of body weight and breast girth with value 0.895. On principle component analysis of phenotypic traits first component contributes 68.67%, second component contributes 9.33% and third component contributes 5.01%, respectively*

**Key word:** Phenotype, Genotypes, Sakini, Characterization, Nepal

## INTRODUCTION

Poultry contributes significantly in the agricultural GDP of the country with an annual output of 10 billion rupees from their sector (Dhakal, 2005). The total poultry population of Nepal in fiscal year 2011/2012 is 4,51,71,185 and laying hen population is 79,07,468. The total chicken meat production in fiscal year 2011/2012 was 40,346 metric ton. The total egg production in Nepal was 78,83,18,000 (MOAC, 2012). The egg or meat? production of poultry in fiscal year 2066/67 B.S in High hills, Mid hills and Terai is 7.19%, 54.66% and 38.15% respectively (MoAC, 2067). Commercial poultry farming particularly in urban areas, has been particularly popular and is growing very fast in recent years. However, in rural areas, particularly where there is no electricity, road network and communication, the poultry raising in small scale under scavenging systems is only the option (Sharma, 2012).

Fifty percent of the total poultry population of the country comprises the indigenous stock (Neopane and Gorkhali, 2008). Indigenous poultry under scavenging systems plays a vital role in rural economy and especially to the poor people. The native chickens of Nepal are believed to have descended from *Gallus gallus Murghi* which is found to be in the jungles of India and Nepal (Bhurtel, 2011). Nishida *et al.* (1988) reported that the Nepalese chicken might belong to subspecies of *Gallus gallus mughi.* Five region chicken population in the central part of Nepal were clustered into three groups by Maeda *et al.* (1988). It is considered as one of the five subspecies of the Red Jungle fowl inhabiting wide areas of Nepal from Plain(terai), foot hills and up to 5,000 feet above sea level at the Mahabharata range (Bhurtel, 2011). There are three main indigenous breeds of chicken in country that have been identified so far. They are Sakini, Ghanti Khuile and Puwankh Ulte (Neopane and Gorkhali, 2008) and out of these, Sakini is the most commonly found species in Nepal.

## MATERIALS AND METHODS

The three ecological zones of central region was selected; i.e. Rasuwa for High hills, Kavre for Mid hills and Rauthat for Terai were selected for the sample collection. True to type Sakini breeds were unrelated up to two generations was considered while collecting egg. Maximum four eggs were randomly selected and collected from one household and transported to Animal Breeding Division, NARC, Khumaltar. All together 162 birds were used for the research; 61 for high hills, 40 for mid hills and 61 for plain Terai. The birds were reared and phenotypic measurements were taken.

## RESULTS

### Phenotypic measurement of different lines of Sakini chicken

The overall body weight, breast girth, keel length, shank length, thigh length, wing length, wing span length, body length, cob length, wattle length was found to be 1376.6±476.9 gm, 23.2±0.35,14.3±0.25, 8.7±0.11, 18.6±0.18, 19.7±0.23, 44.2±0.42, 52.9±0.55, 32.7±0.3, 5.2±0.24, 2.8±0.16 cm, respectively (table 1).

Table 1. Analysis of phenotypic parameters of three lines of Sakani chicken

| Variable | Observations | Minimum | Maximum | Mean | Std. deviation |
|---|---|---|---|---|---|
| Body weight (gm) | 52 | 592.000 | 2830.000 | 1338.115 | 476.065 |
| Breast girth (cm) | 52 | 17.000 | 33.000 | 22.856 | 3.625 |
| Keel length (cm) | 52 | 10.000 | 20.000 | 14.288 | 1.993 |
| Shank length (cm) | 52 | 7.000 | 11.000 | 8.625 | 1.128 |
| Thigh length (cm) | 52 | 15.000 | 23.000 | 18.471 | 1.761 |
| Wing length (cm) | 52 | 16.000 | 25.000 | 19.769 | 2.001 |
| Wing span (cm) | 52 | 36.000 | 53.000 | 42.240 | 3.666 |
| Body length (cm) | 52 | 51.000 | 68.000 | 58.990 | 5.344 |
| Leg length (cm) | 52 | 28.000 | 40.000 | 32.712 | 2.867 |
| Comb length (cm) | 52 | 0.500 | 11.000 | 5.031 | 2.906 |
| Wattle length (cm) | 52 | 0.500 | 7.000 | 2.671 | 1.848 |
| Toes length (cm) | 52 | 5.000 | 8.500 | 6.202 | 0.709 |

### Correlation coefficient for phenotype traits

The correlation with wattle length and comb length was found highest with value 0.950 followed by the correlation of body weight and breast girth with value 0.895. The correlation of keel length, shank length, thigh length, wing length, body length, leg length, comb length wattle length and toes length with body weight was found; 0.77, 0.69, 0.74, 0.7, 0.785, 0.63, 0.82, 0.85 and 0.34, respectively. The correlation of all parts was found highly significant $p<0.0001$ except the correlation of toes with all parts (table 2).

Table 2. Pearson's correlation coefficient for phenotype traits experimental birds of different AEZ

| Variables | BW | BG | KL | S L | T L | W L | W S | B L | L L | C L | W L | TL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Body weight (BW) | **1** | | | | | | | | | | | |
| Brest girth (BG) | 0.**89** | **1** | | | | | | | | | | |
| Keel length( KL) | 0.76 | 0.66 | **1** | | | | | | | | | |
| Shank length (SK) | 0.69 | 0.61 | 0.52 | **1** | | | | | | | | |
| Thigh length (TL) | 0.74 | 0.66 | 0.64 | 0.74 | **1** | | | | | | | |
| Wing length (WL) | 0.70 | 0.56 | 0.63 | 0.71 | 0.63 | **1** | | | | | | |
| Wing span (WS) | **0.83** | 0.74 | 0.61 | 0.74 | 0.63 | 0.69 | **1** | | | | | |
| Body length (BL) | 0.78 | 0.67 | 0.64 | 0.76 | 0.79 | 0.71 | 0.64 | **1** | | | | |
| Leg length (LL) | 0.63 | 0.54 | 0.52 | **0.84** | **0.81** | 0.69 | 0.65 | 0.75 | **1** | | | |
| Comb length (CL) | **0.82** | 0.71 | 0.70 | 0.73 | 0.71 | 0.61 | 0.68 | 0.72 | 0.64 | **1** | | |
| Wattle length (WL) | **0.85** | 0.77 | 0.69 | 0.72 | 0.71 | 0.61 | 0.75 | 0.71 | 0.61 | **0.95** | **1** | |
| Toes length (TL) | 0.343 | 0.347 | **0.218** | 0.513 | 0.382 | 0.479 | 0.415 | 0.455 | 0.509 | **0.287** | **0.266** | **1** |

**Principle component analysis of phenotypic traits**

Altogether three components, namely, body weight, breast girth and keel length contribute 83% divergence among the three lines of Sakini chicken in this study. First component contributes 68.67%, second component contributes 9.33% and third component contributes 5.01% respectively. Body weight, breast girth and keel length are major traits contributing variation (table 3).

Table 3. Principal component and proportion of variation generated by 12 Traits

| | B W | BG | K L | S L | T L | WL | WS | BL | LL | CL | W L | T L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eigen value | 8.24 | 1.12 | 0.60 | 0.48 | 0.41 | 0.35 | 0.26 | 0.18 | 0.16 | 0.11 | 0.06 | 0.03 |
| Variability % | 68.67 | 9.33 | 5.01 | 4.01 | 3.39 | 2.96 | 2.18 | 1.48 | 1.31 | 0.93 | 0.49 | 0.25 |
| Cumulative % | 68.67 | 78.00 | 83.01 | 87.02 | 90.41 | 93.37 | 95.55 | 97.03 | 98.33 | 99.26 | 99.75 | 100.00 |

**Discussion**

Sharma (2011) also reported the overall weight of Sakini was 1402 gm which is similar to over all weight of the present study but less than weight of Rasuwa line and higher than weight of Kavre and Rautahat line. Parajuli (2011) presented the body length, comb length, leg length,

wattle length as 18.7, 4.9, 8.8, 2.45 cm respectively which is less than the present study.
Nishida (1988) used leg length of femur, tibiotarsus, tarsometatarsus, third digit, wing and maxilla, and the circumference of tarsometatarus. First three components are better to explain variability in selected lines of Sakani chicken as variance for three components are above more than 80%. According to Dorji *et al.* (2012), there are 13 strains of native chickens in Bhutan. However, the FAO Domestic Animal Diversity Information System lists only 10 strains.
Maeda (1988) presented the first three principle components were 46%, 34% and 18% in protein polymorphism of native chicken of Nepal and concluded five regional chicken population in central part of Nepal were clustered into three groups.

## CONCLUSION

Correlation of body parts with weight was found to be higher ranging from 0.218 to 0.50 and was significantly difference at p value 0.001 except the correlation of toes length and other body parts. The principal component analysis of morphological traits shows first three components are better to explain variability in selected lines of Sakini chicken as variance for three components is more than 80% and separates all three lines of Sakini into three major groups.

## ACKNOWLEDGEMENT

This research was supported by Animal Breeding Division, NARC.

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# MILK PRODUCTION POTENTIALITY OF LULU CATTLE ON FARMERS' FIELD CONDITIONS IN MUSTANG DISTRICT OF NEPAL

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## ABSTRACT

*Lulu is one of the indigenous breeds of cattle found mostly in Mustang and Manang districts of Nepal. Lulu cattle can survive in very harsh climate of the Himalaya regions. The literatures so far state that the milk production of Lulu cattle varies from 0.2 to 3.0 liter/animal/day showing a high variation in its population. However, no evidence can be found upon the research works carried out to verify this figure. Moreover, because of negative selection and inbreeding problems, the productivity of Lulu cattle is decreasing. In this context, a research work was carried out to know the milk production performance of Lulu cattle based upon the scientific methodology and statistical data analysis procedure. Two village development committees (VDCs), namely, Muktinath and Jhong were purposively selected as the research sites for the performance analysis of Lulu cattle. Thirty-five cows of 2nd to 3rd parity were randomly selected from each VDC making a total of seventy as the research animals. Monthly milk recording, two records, morning and evening, of the same day was started after 5th day of freshening of the cows. The recorders for the recording were oriented on the method of taking records in a scientific manner in the already prepared formats. The data on lactation length, average milk production, and lowest and highest milk production were analysed by using SPSS (15).*

*The analysis of the data revealed that the average lactation period was found as 228±48 days where as the minimum and maximum length was found as 180 and 270 days respectively. The average milk production per animal per lactation was found as 409±97 liter where as that of minimum and maximum was 165 and 836 liter per lactation, respectively. Average per animal per day milk yield was found as 1.80±0.36 liter ranging from 0.79 to 3.68 liter per day. These results clearly indicate the potentiality of breed improvement and increase in the milk production and productivity by intensive local selection and use of bulls born from the elite Lulu cow.*

**Key words:** Lactation length, local selection, Lulu, milk recording, Mustang, productivity.

## INTRODUCTION

Lulu is one of the indigenous cattle of Mustang and Manang districts of Nepal (MFSC, 2002). They are of hardy nature (FAO, 2007) and can survive well even in the harsh environmental conditions of these districts. Because of the decrease in the productivity of this breed and less attraction of the youths to rear Lulu, its number is decreasing every year (DoLP, 2012). The main reasons behind this decrease in the population are noted as the deficit of feed (PFRD, 2009), limited attention paid to the breed and health management and no work has been done in the area of estimation of the production performance of this breed (DLSO, 2009). Some of the references show that average milk production of this breed is about 1.25 liter/lactation/animal and very few researches have been done yet on this breed (Paudel et al, 2008). Reports have also shown that some of the Lulu cattle may yield up to 3 liters a day (MoA, 1997). So, there is a high potentiality of local selection. Present study was proposed to identify the high performing animals, by performance recording scheme, for the breed improvement of the next generation.

## MATERIALS AND METHODS

Two VDCs, namely, Jhong and Muktinath, were purposively selected for the performance recording of the Lulu cattle. Availability of pure Lulu breeds in desired numbers CBPO, 2009), easily availability of technical manpower for the performance recording works, as there was the livestock service center (LSC) in Muktinath to provide the livestock related supports for the selected VDCs and very cooperative farmers of these VDCs were the main reasons behind the selection of these sites for the milk performance recoding scheme (MPRS). Thirty five lactating animals at second to third stage of parity were randomly selected and milk recording was started from the fifth day of the freshening of the cow. Monthly milk recording, two records a day (morning and evening, were taken at an interval of 28-33 days up to the full length of the lactation period. The recorder who was taken from the LSC, Muktinath was oriented for the milk recording methods and the records were presented on the prepared formats.

Sample size (total number of cattle '*n*') was calculated in order to show the statistical variation depending on confidence level, coefficient of variation and accepted level of accuracy (Poate and Daplyn, 1993). The following formula was used to calculate the sample size:

$$n = [zc/x]\ 2$$

Where,

n = estimated sample size

z= confidence level, if α (type I error) is 0.05 then z is 1.96

c=coefficient of variation in the population (expected to be high at the field level, so, here it is taken as 30%)

x= accuracy level (10%)

The sample size for the MPRS was calculated as 35 per VDC. Therefore, a total of 70 Lulu cattle were selected for the research from two VDCs. The study was conducted from May 2012 and continued upto April, 2013. Data obtained from the performance recording was analysed by using SPSS 15.0 (SPSS, 2009).

## RESULTS

The analysis of the data revealed that the average lactation period in Lulu cattle was 228±48 days where as the minimum and maximum length was found as 180 and 270 days respectively. The milk production per lactation was found as 409±97 liter where as that of minimum and maximum was 165 and 836 liter per lactation, respectively. Average per day milk yield per animal was found as 1.80±0.36 liter ranging from 0.79 to 3.68 liter per day per animal.

These data shows a bit higher milk production and lactation length as compared to the earlier references about the Lulu cattle performance. It could be because of the purposively selected VDCs as well as sample size and selection procedure used in this study. Nevertheless, it provides the clear idea on the production potentialities of the Lulu cattle in these areas. In this aspect, selection of the bulls from the selected high producing dams for the breed improvement purpose would be a very worthy intervention. This has been taken as the very good outcome of this research work.

## DISCUSSION

The milk production performance study clearly shows that there is a very big difference in the milk production/lactation from Lulu cattle. It clearly depicts the potentiality of intensive local selection (Koehler-Rollefson, 2004). Since the heritability for the milk production trait is medium (Chagunda *et al*, 2001), it would open the door for the breed improvement programs. More specifically, the average milk productivity/lactation/animal was found as 409±97 with a range of 165 and 836 liter and per day per animal 1.80±0.36 liter ranging from 0.79 to 3.68 liter per day. This is very large range which proves the potentiality to work for the livestock professional for the improvement of this breed.

Variation in the production traits is the space to work for the breeders, development workers and the research scientists. In the case of Lulu cattle, present study has opened an avenue to work upon this field. If we let the farmers to continue what they are doing, they may select the bulls or the heifer from any dams or sires. This practice, in spite of improving, will decrease the productivity in every generation. e.g., if the farmers select the bull from the dam which gives 0.79 liter of milk per day and if the selected dam has just the lactation length 180 days, there would certainly be the decrease of milk productivity in each generation. In other way, if the farmer select the bulls and the heifers from the elite dams, e.g., those producing 3.68 liter of milk per day and have the lactation length of 270 days, we can easily increase the milk productivity of Lulu cattle. This is the main outcomes of the study. However, in addition to the breed improvement, we have to provide due care in forage and pasture development, health and management as well to get the expected improvement in the production and productivity of Lulu cattle.

## CONCLUSION AND WAY FORWARD

It can be concluded that there is the high potentiality to increase the production and productivity of milk from Lulu cattle in Mustang district by breed improvement based upon the intensive selection.

As the way forwards, we can suggest following points:

a. Give high priority in breed improvement program based upon the intensive local selection.

b. Make necessary arrangement for the selection of the breeding bulls from the elite dams and distribute them to the farmers' group and encourage them to use only these selected bulls for the natural services of their Lulu cattle.

c. With active participation of the local people, make arrangements to castrate the unwanted bulls, i.e., the bulls born from the poor parents.

d. Make necessary arrangements for the exchange of bulls at least in the interval of three years to mitigate the inbreeding problems in Lulu cattle.

e. Provision of package of practices, e.g., feeding, health care, management and market networking based upon the value chain approach should go side by side with the breed improvement program for the improvement of the production and productivity of Lulu cattle in Mustang and Manang districts.

These package of practices will certainly increase the productivity of Lulu cattle that lead to increase the number of animals as well as attract the people including youth in Lulu cattle farming in Mustang and Manang districts.

## ACKNOWLEDGEMENTS

The study was funded by National Agricultural Research and Development Fund (NARDF). The authors would like to acknowledge NARDF for the financial support and the staff of NARDF, especially Dr. Shyam Kishor Sah, member secretary, Mr. Shankar Sapkota, senior program officer and Mr. Bhishma Kanta Ghimire, agriculture officer for their very friendly cooperation in the implementation of the project work. We would also like to sincerely acknowledge Dr. Laxman Sherchan, the then chairperson of the technical committee, NARDF, for his constructive suggestions for the fruitful implementation of this project. We would like to pay our due respect to the farmers of the research sites who proved themselves as very cooperative in implementing the programs. We would also like to thank the staff of DLSO, Mustang, Central Cattle and Buffalo Promotion Office, Hariharbhawan and the NaRAM Center for their support in getting the very fruitful results from the project.

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# MILK PRODUCTION STATUS OF CHAURI WITH AVAILABILITY OF FORAGE UNDER TRANSHUMANCE SYSTEM AT HIGH HILL OF RASUWA DISTRICT

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## ABSTRACT

*This study was conducted to find milk production status of chauri under transhumance system with forage available in rangeland. A survey was taken to find out the milk production scenario of chauri under transhumance system. The forage sample was collected from 1 x 1 $m^2$ from three sites of each rangeland where the chauri grazed and analysed in the lab and was used to calculate the forage availability in the rangeland. Milk collection center of Dairy Development Corporation collected milk from the month of Baisakh to end of Asoj or mid of Kartik. In remaining month milk production was very little and was not collected by DDC. In this period, milk was either consumed for home purposes or made churpi. The highest milk/ animal/day (2.5kg) was obtained in Asar and least (1.6kg) in Kartik. Amount of milk production and sold to milk collection center was highest in Asar and minimal at mid of kartik. During milk collection period, least fat percent (5.8%) was obtained in Baisakh and the highest (8.0%) in Kartik. Providing 12Kg green forage at Asoj month, each chauri produced 20.5% more milk as compared with control group. Green forage availability was found the highest (34kg/animal) in the month of Asar and the least in mid of Kartik (5kg/animal). Normally, at Rasuwa it was found that chauri were moved gradually from alpine pastures at peak mountain as high as 3300 - 4300m in Asar - Shrawan to downstream around 2000-2500m in mid of Kartik. While in Magsir - Poush chauri were grazed around 1850- 2000m. It was found that farmer sold more amount of milk during Baisakh to Bhadra and earned more income in the same period. During the milk production period the maximum income (NRs. 33,000) was obtained by selling milk in Asar.*

**Key words:** Chauri, Forage, Milk, Transhumance

## INTRODUCTION

Rangelands are integral part of mountain societies and they are managed as open access resources through indigenous practices which vary from place to place. Rangelands of Nepal are rich in biodiversity of plants, animals, and other important genetic materials for future use. About 131 endemic plant species (53% of the total number of endemic plants in Nepal) are found in sub alpine and alpine rangelands (Shrestha, 1997). High altitude transhumance is common from east to west in Nepal along the foothills of the himalayan range and trans-himalaya. The seasonal movement of animals from higher altitude to lower at winter and vice-versa at summer is routine but farmers operate under complex sets of arrangements and schedules. Normally, chauri are moved gradually from alpine pastures at peak mountain as high as 4000-5000m in summer to downstream valley as low as 1500-2000m in winter. According to the physical features climatic conditions, demand for forage and availability of pastureland, the farmers have established different migratory routes and pastures for grazing animals. Rasuwa district in the high hill and mountain region has several grazing land. Depending on the availability of the pasture, animals are kept moving from one place to another. Nowadays,

most of the movement is restricted within the district; however some farmers also bring their animal to adjoining district (Joshi and Shrestha, 2010).

Neopane *et al*. (2001) reported a lower lactation length of chauri at 3 months (98 days). Lactation lengths reported for the Chauri ranges from 120-180 days (Sherchan and Karki, 1996). The raw milk is sold daily to milk collection center and the dairy sub-centre make cheese, which is mostly sold in Kathmandu; some is sold to hotels, shops which resell to tourist. This study was conducted to find out the milk production status of Chauri with availability of forage under transhumance system at high altitude of Rasuwa district.

## MATERIALS AND METHODS

A survey was conducted to find out the milk production scenario of chauri under transhumance system. Chauri grazed pattern under transhumance system was found out. Each month where chauri grazed, the forage sample was collected from the same rangeland. The forage sample was collected from 1 x 1 $m^2$ from three sites of each rangeland and was used to calculate the forage availability in the rangeland. Area of rangeland was taken from rangeland inventory of Rasuwa district, (ARS, Pasture, 2054/55). Milk production/day and amount of selling milk/ day were recorded. Amount of selling milk and fat percent was obtained from record card of farmers who sold to milk collection center. A feeding trial was conducted during Asoj month to find effect of forage on milk production at forage scarce period.

## RESULTS AND DISCUSSIONS

### Average milk production

Milk was collected by milk collection center of Dairy Development Corporation (DDC) from Baisakh to mid of Kartik. In remaining month milk was not collected by collection center. The produced milk in this off-time either consumed for home purposes or used to make churpi by themselves. Fig 1 indicates the average milk yield/animal/day. It was found that milk production increased from Baisakh and reached at peak on Asar (2.9 kg/day/chauri). After Asar the milk production started to decrease and minimum yield was obtained at Kartik month (1.5 kg/day/ Chauri). It was found that at Kartik only 15% of total milking animal of herd continued to give the milk. This finding was supported by many authors. Sherchan and Karki (1996) reported yields of 220 kg in 167 days lactation for the Yak and 300 to 540 kg in lactations ranging from 120 to 180 days for the Chauri. Shrestha (1998) reported yield was 200 kg in 180 days for the Yak and 500 litres in 180 days for the Chauri. Forage availability from rangeland was directly affected to milk production. Fig 2 indicates that average fat percent/month. The least fat percent (5.8%) was obtained in Jestha and maximum (8 .0%) in Kartik month. The reasons of differed milk production with month may be due to variation of availability of amount of green forage with its nutrient content.

Providing 12Kg green fodder at forage scarcity period (Asoj month), each chauri produces 20.5% more milk as compared with control group (not providing green fodder).

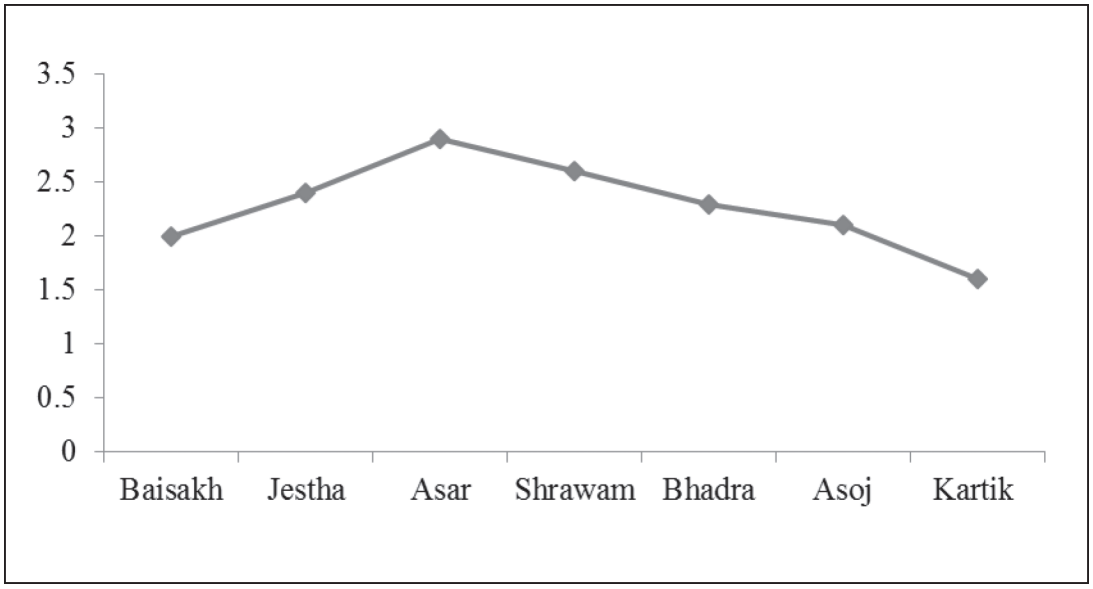


Figure 1: Average milk/animal/day (kg)

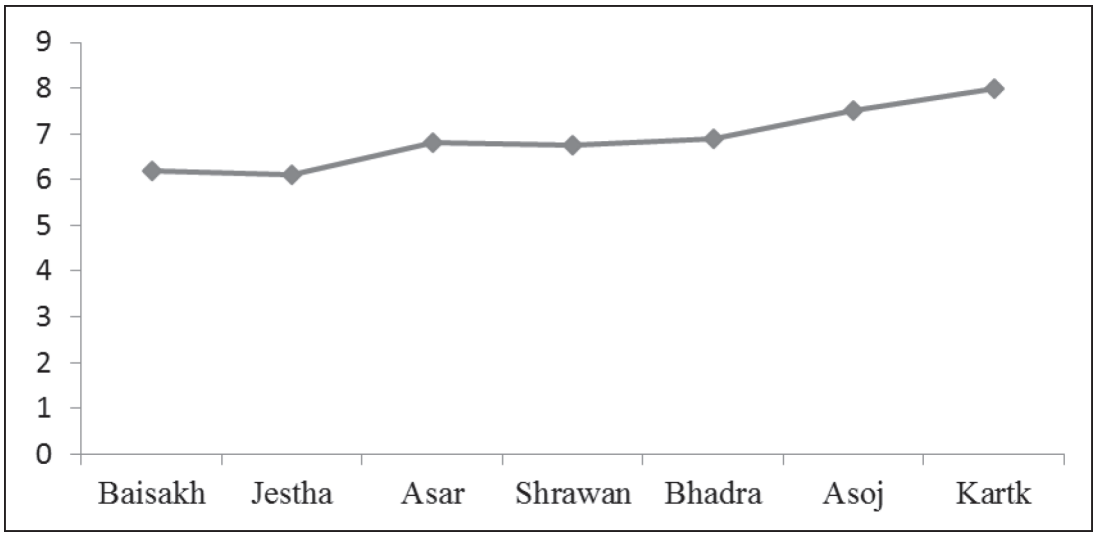


Figure 2: Average fat percent/month

**Grazing pattern**

Fig 3 indicates the overall grazing pattern of Chauri during milk collection period (Baisakh to mid of Kartik) by milk collection center at Rasuwa district. Transhumance system was prevalence at high altitude of Rasuwa district. Normally, at Rasuwa district it was found that chauri moved gradually from alpine pastures at peak mountain as high as 3300 - 4300 m in Asar - Shrawan to downstream around 2000 – 2500 m in mid of Kartik. While in Magsir - Poush chauri grazed in around 1850 – 2000 m. The migratory animals were left free even in night and were not tied. Some herder practiced that some animals were tied either in leg and neck during the milking time. The milk collection center had gone to collect milk wherever the herder moved. Therefore there was no problem for marketing of milk.

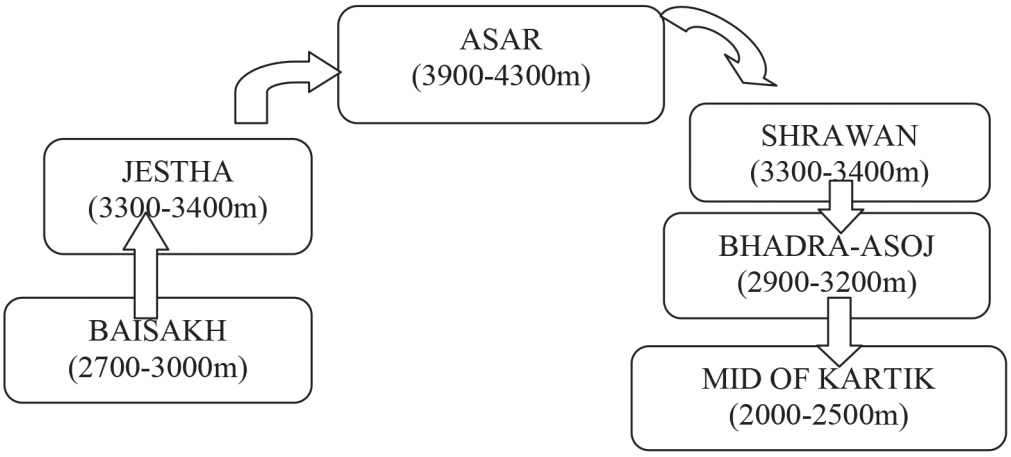


Figure 3: Grazing pattern during the milk collection period (Baisakh to mid of Kartik)

**Forage availability**

The fig 4 indicates the green forage availability during different month (Baisakh to mid of Kartik). It was found that the availability of green forage was only 20 kg/chauri/day in the Baisakh month. It was drastically high around 34 kg/chauri/day in Asar. The availability of green forage/day/area was deceased after Asar and reached to 16 kg/chauri/day in Asoj month. Green forage availability was very low (5kg/chauri/day) in mid of kartik. This figure shows that forage availability for grazing animals was very less. The availability of green forage/area was directly affected to feed intake by animal per unit area, which affected on average milk production. The reasons behind variation of forage availability per unit area might be due to change in monsoon, climatic condition, grazing pattern etc.

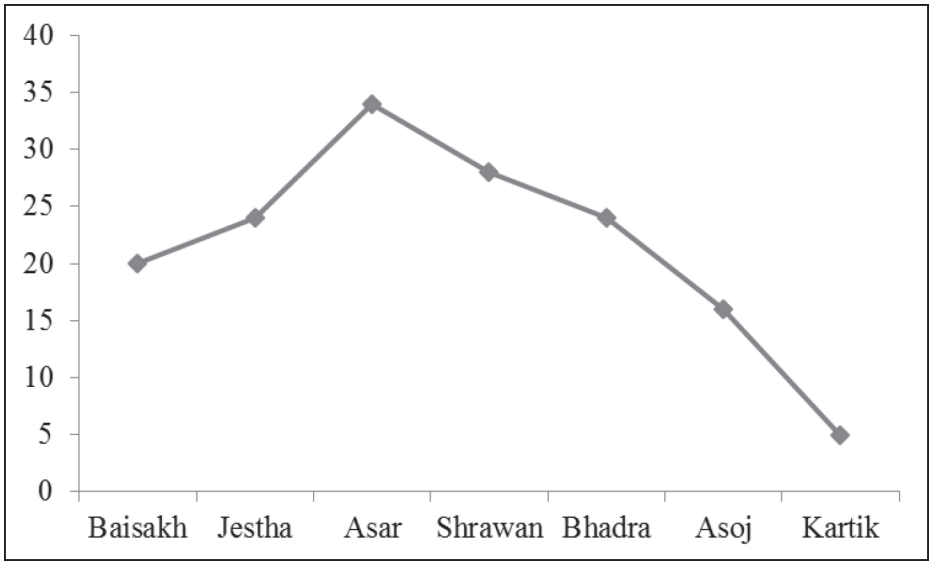


Figure 4: Available forage/animal/day (Kg) in different month

**Average income**

Fig 5 indicates the average income per month by selling milk to milk collection center during milk collection period (first week of Baisakh to mid of Kartik). It was found that farmer sold more amount of milk during Baisakh to Bhadra and earned more income in the same period. During the milk production period the maximum income (NRs. 33,000) was obtained in Asar and the very least income (NRs. 3,500) was obtained in Kartik month. The level of income varied with month was due to variation of milk yield. The reasons of variation of milk yield might be due to variation of amount of green forage intake with nutrient contain, animal condition etc.

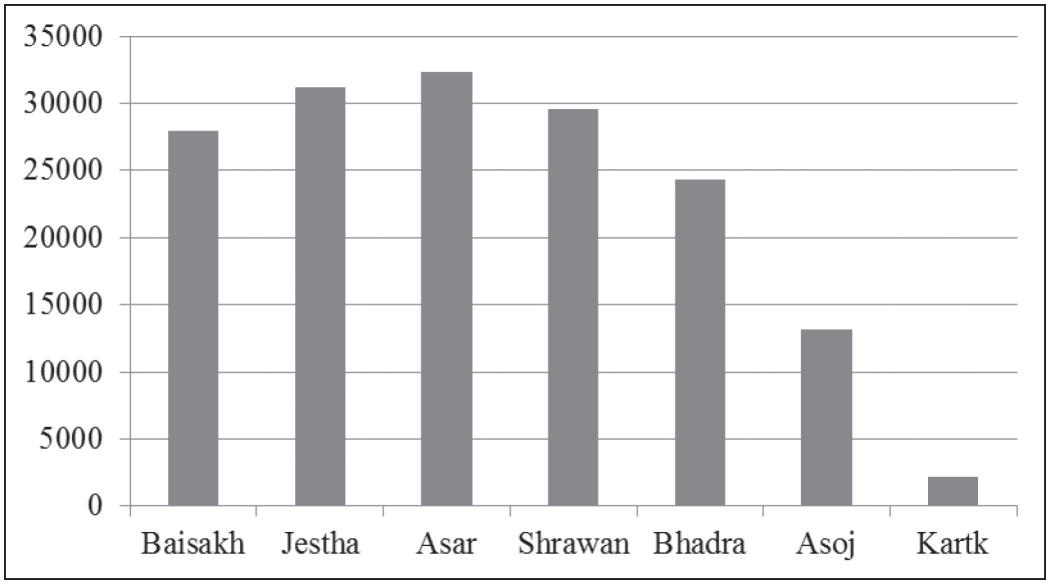


Figure 5: Average income (NRs) per month by selling milk

**CONCLUSION**

The seasonal movement of animals from higher altitude to lower at winter and vise versa at summer prevailed in rearing the Chauri at Rasuwa district. The milk production pattern of chauri was directly related to forage availability from rangeland. Milk production and income level was found high during Basisakh to Bhadra

**ACKNOWLEDGEMENTS**

The authors would like to acknowledge all the staff of Agricultural Research Station (Pasture), Dhunche for their support to collect data. I would like special thanks to Mr. Dinesh Pariyar, former executive director, NARC for his continual encouragement as well as valuable comments to prepare this paper in the present form.

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# A SMALL SCALE GIRIRAJA CHICKEN PRODUCTION TO INCREASE FARM INCOME IN CHARIKOT, DOLAKHA

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Swine and Avian Reseaerch Programme, Khumaltar

## ABSTRACT

*The present on farm study was conducted in Charikot, Dolakha which is about 130 km north east from Kathmandu. The altitude of study site is about 1700 masl. This research was conducted in collaboration with the District Livestock Development Office, Dolakha. The study was carried out on 550 birds up to 52 week s of age. After 4 weeks of age the birds was raised under semi intensive system of management. The birds were randomly distributed to 10 women farmers. The commercial feed were given up to the age of 4 weeks which was then fed with local feed mix like ground maize, brewers grain residue, pote grass, vegetables from garden and grazing in the field were done. The average body weight at 4 weeks, 8 weeks, and 12 weeks was recorded as 226±14.10 gm, 496.9±61.61 gm, and 1.65±0.19 Kg respectively. The body weight of male and female was 3.11 ± 0.40 Kg & 2.22±0.26 Kg at 20 weeks of age and 4.29 ± 0.32 Kg & 2.87±0.26 Kg at the age of 52 weeks respectively. The average hen day egg production was recorded as 41.2 %. The economic analysis showed that farmer rearing 55 chicks could get average net profit of Rs 25300. The average net profit was found as Rs 460/bird in 52 weeks of age.*

## INTRODUCTION

Poultry is one of the most important avian species in Nepalese farmers. It provides cheap protein from the meat and eggs. Poultry sector in Nepal has two characters, Small (rural) and the commercial (Large). Rural system is practiced since the beginning of the recorded history. The commercial poultry production was started in 1969s (Bhurtel, 2001). The revolution on poultry development can be considered during 1950-1951 that was the catalytic events for commercial poultry farming in Nepal. As birds are non-ruminant, mainly depends on crop grain concentrate feeds. These feed stuffs are also largely required by human beings and other animal species. It involves higher cost in feeds such as about 70 % of the total cost for the meat and egg production. There fore it is important to develop a low cost feeding package to reduce the cost by using conventional and non- conventional feed stuffs.

Livestock is one of the major components of integrated farming system of Nepal and poultry is the promising sector in recent years. But very few farmers are raising improved breeds, feeding totally commercial feed to poultry is due in sufficiency of food grains commercial feed is still higher priced which is increasing production cost.

## OBJECTIVES

1. To develop balanced low cost poultry feed
2. To develop appropriate technology and disseminate
3. Production of healthy chicks from local fed ration

## MATERIALS AND METHODS

The study has been conducted under farmers feeding and management practices in outreach sites, Dolakha. Awareness among the farmers has been created by organizing farmers orientation poultry production training , for each 10 farmers 50 day olddual purpose birds has been provided free of cost . The vaccination, regular deworming and health care treatment has been done regularly. The poultry housing and feed made by farmers according to the standard of the project. The following activity has been done.

### Training:

The farmers has been given poultry production and management training, which includes theory, practical class and field visit to poultry raisers . This training was conducted for 3 days.

### Housing Management:

Day old chicks has been brood in the farmers house by managing brooding area. For managing brooder area brooding material like locally available, rice husk , chick guard, electric bulb, electro careetc has been provided by the project in free of cost. The minimum space requirement in housing has been provided to the birds. The construction of the pens has been done according to the specification of the housing design by utilizing the local knowledge and resources in the village.

### Feeds:

Low cost feed is priority, conventionalfeed, cereal crop by products, vegetables and other natural resources has been used to make feeds. The quantity of feedhas been given according to the available of the feed in that area.

### Immunization and health:

Regular vaccine according to the vaccination schedule has been done.

## RESULT AND DISCUSSION

This outreach trial was conducted in outreach sites of Charikot, Dolakha. Where most of the participants are from newar community. This community need more poultry fortheir different functions and for nutrition . The altitude of this area is about 1900 m.a.s.l.

Table 1: The mortality, hen day egg production and body weight.

| Name | Bird No. | Mortality | Mortality % | Hen day % | Body weight 52 weeks (Kg.) | |
|---|---|---|---|---|---|---|
| | | | | | Male | Female |
| Sabitakarki | 100 | 9 | 9 | 51 | 3.7 | 2.4 |
| Devi Thapa | 50 | 7 | 14 | 40 | 4.5 | 3.1 |
| LaxmiShrestha | 50 | 5 | 10 | 45 | 4 | 3.2 |
| ParbatiShrestha | 50 | 0 | 0 | 35 | 4.3 | 2.9 |
| Sitashrestha | 50 | 2 | 4 | 38 | 4.9 | 3 |
| Saraswoti Shrestha | 50 | 2 | 4 | 37 | 4.6 | 3 |
| Ram Maya Shrestha | 50 | 2 | 4 | 39 | 4.2 | 3 |
| DurgaShrestha | 50 | 2 | 4 | 43 | 4.3 | 2.8 |
| JanakiShrestha | 50 | 3 | 6 | 40 | 4.1 | 2.4 |
| SaraswotiThapa | 50 | 2 | 4 | 44 | 4.3 | 2.9 |
| Average | | | 5.9 | 41.2 | 4.29 | 2.87 |
| SD | | | 7.98 | 4.42 | 0.32 | 0.26 |

Above table 1 shows that the Giriraja birds seems well adopted in this area. The result shows that the highest mortality 14% of Devithapa which is due to her negligence management. In average mortality percent was as 5.9 in field condition and in 52 weeks of age male average wt. is 4.29 kg and female is around 3 kg.

Table 2: The growth characters at different ages.

| Name | Bird No. | 4 weeks gm. | 8 weeks gm. | 12 weeks Kg. | 20 weeks (Kg.) | |
|---|---|---|---|---|---|---|
| | | | | | Male | Female |
| Sabitakarki | 100 | 225 | 510 | 1.2 | 2.5 | 2.2 |
| Devi Thapa | 50 | 245 | 419 | 1.6 | 2.6 | 2.2 |
| LaxmiShrestha | 50 | 240 | 550 | 1.8 | 3 | 1.8 |
| ParbatiShrestha | 50 | 240 | 560 | 1.8 | 3.3 | 2 |
| Sitashrestha | 50 | 230 | 580 | 1.9 | 4 | 2.7 |
| Sara SwotiShrestha | 50 | 230 | 450 | 1.6 | 3.5 | 2 |
| Ram Maya Shrestha | 50 | 210 | 380 | 1.7 | 3 | 2.3 |
| DurgaShrestha | 50 | 200 | 540 | 1.8 | 3.2 | 2.6 |
| JanakiShrestha | 50 | 210 | 480 | 1.5 | 3 | 2.3 |
| SaraswotiThapa | 50 | 230 | 500 | 1.6 | 3 | 2.2 |

The table 2 shows that the weight gain in 4 weeks of age is maximum 245 gm. and minimum 210 gm., 8 weeks of age maximum 580 gm and minimum 380 gm , 12 weeks of age maximum

1.9 kg. and minimum 1.2 kg and in 20 weeks of age male maximum 4.0 kg. and minimum 2.5 kg, and in female maximum 2.7 kg. and minimum 1.8 kg. This result shows that the male growth rate is higher and raising 50 birds is best for small farmers condition.

**Egg production**

The egg production was recorded three times a day and average egg production was 165 no. per bird and egg weight was 55 gm.

**Hatchability**

The selected egg containing 50-55 gm. weight of 7-10 days old egg has been given to local hen and its result seems around 85% hatchability.

## CONCLUSION

Charikot, Dolakha is a mid hill of Nepal.Which is around 110 km. far away from Kathmandu and its altitude is around 1900 m.a.s.l.In this area Giriraja chicken has been gaining popularity due to fast body growth , hardy, accepted colour patterns and egg production higher than the local egg. In this area farmers have more preference on male birds than female and they pay high price for male than female. The price of male is Rs. 500 per kg and female is around Rs. 350/kg. For the economic analysis fixed cost were Rs. 50 per bird and other recurring cost were consider feed, medicines and labour cost, poultry birds space was used in their same building which they used to stay so the cost has not been calculated and the economic analysis showed that the average income per bird was Rs. 460.

## ACKNOWLEDGEMENTS

We would like to thanks District livestock Services Office, Dolakha, Women Development Office, Dolakha for their valuable cooperation during site selection and farmers selection.The authors also thanks to the farmers involved in outreach poultry research program.

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# RESPONSE OF HEAT TREATED MUSTARD CAKE FEEDING ON GROWTH PERFORMNCE OF GROWING FEMALE GOATS IN FODDER BASED BASAL DIET

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## ABSTRACT

*Growth comparison of goats fed with treated and none treated mustard cake is not evaluated so far in Nepal. Therefore, an experiment was carried out on eighteen growing female goats (50% Jamunapari 6, 50% Barberi 6 and Khari goats 6) at the Agriculture Research Station (Goat), Bandipur, Tanahun for 90 days after an adaptation period of 7 days. Female goats of average seven months age having body weight 9 kg were allocated into three groups having six animals (2 from each breed) in each group by using Complete Randomized Design (CRD). For T2 and T3 concentrate mixture were composed by using procured feed ingredients with 16% crude protein level while T1 was fed with commercial feed. Experimental animals of T1 group was provided forest mixed fodder (adlib) + commercial concentrate mixture @ 1.5% of body weight, T2 group was provided forest mixed fodder (adlib) + treated mustard cake included concentrate mixture @ 1.5% of body weight whereas T3 was provided forest mixed fodder (adlib) + untreated mustard cake @ 1.5% of body weight. Experiment revealed that the highest feed intake was observed in T1 (174.45 g/day) followed by T2 (165.86 g/day) and T3 (163.44 g/day) whereas fodder intake was found to be higher in T2 (2501.9 g/day) followed by T1 (2481.7 g /day) and T3 (2438.8 g/day). Both feed and fodder intake was highly significant (P<0.001) among diet groups and breeds. In addition, highest FCR was found in T1 (17.14:1kg) followed by T2 (16.03:1 kg) and T3 (13.19:1kg). Similarly, the initial body weight of experimental animals was 9.67 kg, 9.75 kg and 8.92 kg which reached 14.45 kg, 14.873 kg and 14.95 kg by the end of experiment for T1, T2 and T3, respectively. Both initial and final body weights were no significant among diet groups and breeds. Likewise, the total weight gain was highest in T3 (6.03 kg) followed by T2 (5.08 kg) and T1 (4.78 kg) with average daily gain 67.04 g, 56.48 g and 53.15 g for T3, T2 and T1, respectively.*

**Key words:** Goats, bypass protein feeding, Nepal

## INTRODUCTION

Goat has been rearing since the time immemorial. Generally, goat farming means rearing goats for the purpose of harvesting milk, meat and fiber. At present, goat farming has become a profitable business with a very low investment because of its multi functional utility. It keeps a great contribution to the economy and nutrition of a country. Goat has been considered as poor man's cow (mini cow) of poor people because of its immense contribution in rural economy and national income. Goat products like milk and meat are not only nutritious and easily digestible but also a great source of regular income for the poor, landless and marginal farmers. Being a small sized animal it can be easily maintained by women and children (www.rosal-feedmills.com) . Neopane and Pokharel (2008) reported that most of the farmers of

western hills of Nepal are rearing Khari goats, crossbreds of Khari x Jamunapari and Khari and Barberi. Goat population of Nepal is estimated to be 9.19 million. Out of 9.19 million, goat population of western hills is 1.13 million which account 12.32% of total goat population that producing 5284 mt meat per annum (10% of total goat meat production) (MoAD, 2012).

Oil seeds cakes and meals are the residues remaining after removal of the greater part of the oil from oil seeds. The residues are rich in protein and most are valuable feeds for farm animals. Most oil seeds are of tropical origin, they include groundnut, cottonseed, soya bean, mustard, sesame etc (Bajjlieh, 2002). Mustard seeds contain about 30–35% oil and 34–39% crude protein. Mustard cake has a good balance of essential amino acids and relatively high methionine content. Cheaper than other meal or cake, it is used in the feeding of cattle and buffaloes, but information is scanty on its feeding in sheep and goats (Anil Kumar *et. al.,* 2002).

The protein content in diets of ruminant animals is essential for growth and production requirements. Possibility that reasonable portions of high quality protein of feedstuffs may be degraded in the rumen, which negatively affect utilization of the feed. In this context, there are several methods for protection of dietary protein from degradation in the rumen (EL-Shabrawy, 1996). The heat treatment is known one of the methods to increase the protection of the proteins. During the process of manufacturing oil seed meals, they are subjected to different degree of heating which partly explains differences in the degree of protection. Through heating of protein supplement causes denaturation of protein; it provides effective protection against microbial fermentation in the rumen. Heat treatment of protein meal at 125- $150^0$ C for 2-4 hours improves the bypass protein. The main benefit of "*bypass*" protein is that the original amino acids in the protein meal are absorbed in the small intestine instead of converted into microbial protein in the rumen, thereby providing a different balance of essential amino acids for better animal nutrition hence, production (Schroeder, 1997).

Growth comparison of goats fed with heat treated and none treated mustard cake is not evaluated so far in Nepal. Hence, a study was carried out to compare the growth performance of growing female goats fed with heat-treated and none treated mustard cake mixed concentrate mixture at Agriculture Research Station (Goat), Bandipur, Tanahun.

## MATERIALS AND METHODS

### Experimental animal

This experiment was carried out on eighteen growing female goats (50% Jamunapari 6, 50% Barberi 6 and Khari goats 6) at Agriculture Research Station (Goat), Bandipur, Tanahun from 25 August to 22 November 2013 (070/5/9 to 070/8/7). Female goats of average 7 months old with average body weight of 9 kg were allocated into three groups having six animals (50% Jamunapari 2, 50% Barberi 2 and Khari 2) in each group by using Complete Randomized Design (CRD). They were drenched with Fenbendazole @ 5 mg/kg body weight against internal parasites before assigning in experiment.

### Concentrate mixture composition

Feed ingredients maize, mustard cake, rice bran, minerals and salt were procured from Khowpa Feed Industry, Bhaktapur. For T2 and T3 concentrate mixture were composed by using procured feed ingredients with 16% crude protein level that has been presented in Table 1 while for

T1 commercial compound feed was used made by Pancharatna Feed Industry, Narayangadh, Chitwan.

Table 1: Composition of concentrate mixture

| S/n | Ingredients | Part | Crude Protein, % |
|---|---|---|---|
| 1 | Maize | 47 | 4.13 |
| 2 | Mustard cake | 31 | 10.12 |
| 3 | Rice bran | 20 | 1.76 |
| 4 | Mineral mixture | 1 | 0 |
| 5 | Salt | 1 | 0 |
| Total | | 100 | 16.01 |

**Heat treatment of mustard cake**

The drying of forage is known to increase the protection of the proteins. Through heating of protein supplement causes denaturation of protein; it provides effective protection against microbial fermentation in the rumen. Heat treatment was done by using hot air oven at temperature 125- 150$^0$ C for 2-4 hours as suggested by Suresh, *et al* (2009).

**Experimental diet of the animals**

The dry matter requirement of goats was calculated based on 5 kg per 100 kg body weight. Following diets were formulated to the experimental animals (Table 2).

**Table 2: Experimental diets of the animals**

| Treatment | Experimental diet |
|---|---|
| 1 | Forest mixed fodder (adlib) + commercial concentrate mixture @ 1.5% of body weight |
| 2 | Forest mixed fodder (adlib) + heat treated mustard cake included concentrate mixture @ 1.5% of body weight |
| 3 | Forest mixed fodder (adlib) + untreated mustard cake included concentrate mixture @ 1.5% of body weight |

**Feeding regime**

Concentrate mixture and *adlib* amount of fodder was provided to the experimental animals individually in plastic vessel. Concentrate mixture was provided once a day in the morning whereas fodder twice a day (morning and evening). Quantity of concentrate mixture and fodder given daily to the animals was weighed daily and refusal was weighed in next morning. Experimental animal had free access to drinking water.

**Chemical analysis**

The samples of feed ingredients, prepared concentrate mixture and forest mixed fodder were sent to the Animal Nutrition Division, Khumaltar, Lalitpur for proximate analysis. Representative samples were analyzed for dry matter (DM), crude protein (CP), crude fibre (CF), ether extract

(EE) and total ash contents (TA). The DM was determined by oven drying at 100°C for 24 hrs. Crude protein of the samples was determined using the Kjeldahl method. Ether extract was determined using Soxhlet apparatus. Ash content was determined by ashing at 550°C in a muffle furnace for 16 hrs (AOAC, 1980). Crude fibre of the samples was determined using the Van Soest method (Goering, H.K. and Van Soest, 1970).

**Observation recording**

The trial period consisted 90 days after an adaptation period of 7 days. Total feed intake by the goats was recorded daily for all experimental period. The body weight gain of individual animals was measured fortnightly in the morning before feeding.

**Data analysis**

Data of feed intake and body weight gain were analyzed by **"*One Way Annova*"** test for every measurement using computer statistical package Minitab 2003, versions 13.20.

**RESULTS**

**Chemical composition of feedstuffs**

The result of chemical analysis has been given in Table 3 and crude protein content of prepared concentrate mixture was verified in laboratory that is presented in Table 4.

Table 3: Chemical composition of different feed ingredients (% DM basis)

| Ingredient | DM | OM | TA | CP | CF | EE |
|---|---|---|---|---|---|---|
| Maize | 87.69 | 97.97 | 2.03 | 8.92 | 2.34 | 4.48 |
| Rice bran | 87.85 | 89.5 | 10.5 | 11.52 | 4.83 | 5.1 |
| Mustard cake | 87.27 | 90.5 | 9.5 | 35.52 | 9.19 | NA |
| Mixed forest fodder | 30 | 88.23 | 11.77 | 10.3 | NA | NA |

Table 4: Chemical composition of prepared concentrate mixture (% DM basis)

| Particular | DM | OM | TA | CP | CF |
|---|---|---|---|---|---|
| Treated mustard cake included concentrate mixture | 93.15 | 88.12 | 11.78 | 16.79 | 8.57 |
| Untreated mustard cake included concentrate mixture | 93.34 | 87.33 | 12.67 | 16.35 | 7.13 |
| Commercial feed | 93.4 | 86.72 | 13.28 | 12.99 | 6.79 |

**Feed intake**

Average feed and fodder intake of experimental animals is presented in Table 5.

Table 5: Feed intake of experimental animals/day/animal

| Feedstuffs | Mean ± SD | | |
|---|---|---|---|
| | T1 | T2 | T3 |
| Feed intake, g | 174.45±38.17 | 165.86±34.53 | 163.44±44.55 |
| Fodder intake, g | 2491.7±248.1 | 2501.9±254.6 | 2438.8±292.96 |
| Dry matter intake/day, g | 910.4±95.6 | 905.1±100.4 | 884.2±120.2 |
| Crude protein intake/day, g | 98.16±10.55 | 103.25±12.11 | 100.3±14.58 |
| Total dry matter intake (DMI), kg | 81.94 | 81.45 | 79.57 |
| Total crude protein intake, kg | 8.83 | 9.29 | 9.02 |
| Feed conversion ratio (FCR) | 17.14:1 | 16.03:1 | 13.19 |

The highest feed intake was observed in T1 (174.45 g/day) followed by T2 (165.86 g/day) and T3 (163.44 g/day) whereas fodder intake was found to be higher in T2 (2501.9 g/day) followed by T1 (2481.7 g /day) and T3 (2438.8 g/day). Both feed and fodder intake was highly significant (P<0.001) among diet groups and breeds. Consequently average dry matter intake per day was also noted higher for T1 followed by T2 and T3 (910.4 g, 905.1 g and 884.2 g, respectively) which resulted higher DMI for T1 followed by T2 and T3 (81.94, 81.45 and 79.57 kg, respectively). Similarly, highest FCR was found in T1 (17.14:1kg) followed by T2 (16.03:1 kg) and T3 (13.19:1kg). In case of average daily crude protein intake, highest was measured for T2 (103.25 g/day) followed by T3 (100.3 g/day) and T1 (98.16g/day)

**Growth performance**

Average growth performance of experimental animals is presented in Table 6.

The initial body weight of experimental animals was 9.67 kg, 9.75 kg and 8.92 kg which reached 14.45 kg, 14.873 kg and 14.95 kg by the end of experiment (90 days) for T1, T2 and T3, respectively. Both initial and final body weights were no significant among diet groups and breeds, however, in 0, 15 and 30 days weight was significantly (P>0.01) differed among breeds. Further significant effect of breed was not observed. The total weight gain was highest in T3 (6.03kg) followed by T2 (5.08 kg) and T1 (4.78 kg) with average daily gain 67.04 g, 56.48 g and 53.15 g for T3, T2 and T1, respectively.

Table 6: Growth performance of goats

| Parameter | Mean ± SD | | |
|---|---|---|---|
| | T1 | T2 | T3 |
| Initial body weight, kg | 9.67±2.31 | 9.75±1.54 | 8.92±2.67 |
| Initial metabolic weight, kg | 5.48 | 5.51 | 5.16 |
| Final body weight, kg | 14.45±2.08 | 14.83±1.53 | 14.95±3.51 |
| Final metabolic weight, kg | 7.41 | 7.55 | 7.6 |
| Total weight gain, kg | 4.78±1.78 | 5.08±1.35 | 6.03±1.32 |
| Average daily gain, g | 53.15±14.24 | 56.48±15.08 | 67.04±14.68 |

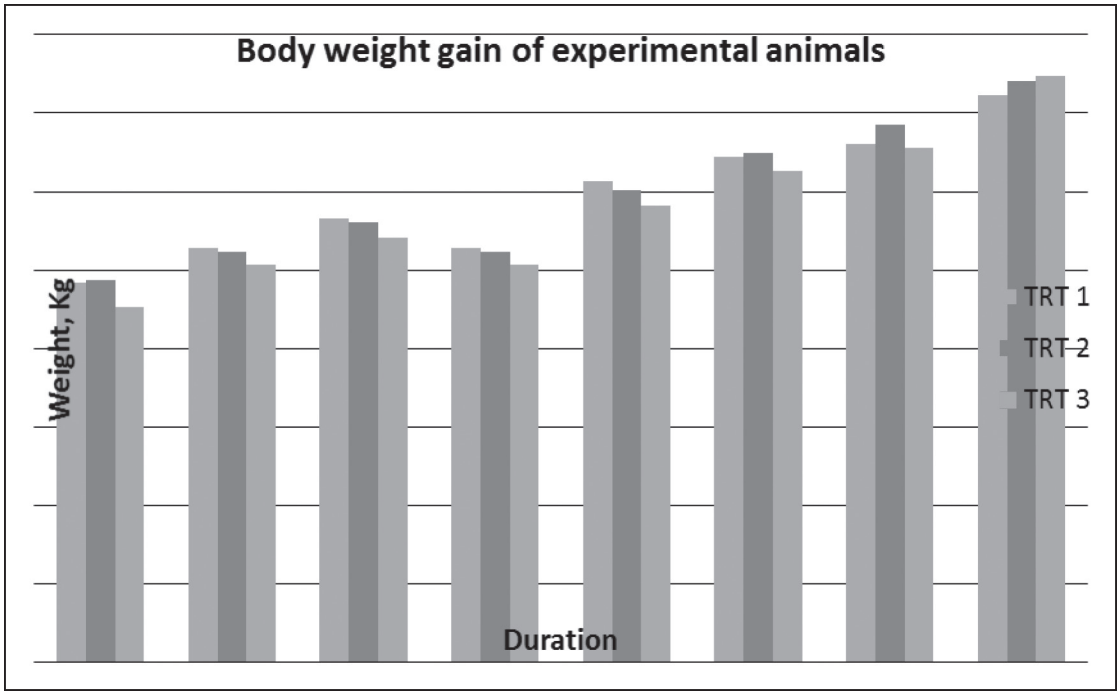


Figure 1: Body weight gain trend of goats during experiment period

## CONCLUSION

Our experiment revealed that there was a no significant effect of heat-treated mustard cake on total body weight gain of goats, however, feed and fodder intake was highly significant ($P<0.001$) among diet groups and breeds. The heat treatment of mustard cake did not enhance the bypass of protein from rumen. Therefore, it is suggested that mustard cake can be incorporated in goats diet without heat treatments.

## ACKNOWLEDGMENTS

The authors would like to express their most sincere gratitude and appreciation to Dr. Bhoj Raj Joshi, Director, National Animal Science Research Institute, Khumaltar, Lalitpur for his encouragement, help, suggestion and support during experimental period. Similarly, work of Mrs. Bishnu Ale (Enumerator) and Mr. Tek Bahadur Ale (Junior Technician of ARS, Bandipur) deserve high appreciation without that conduction of experiment was impossible. Mr. Basanta Kumar Shrestha Technical Officer, Animal Nutrition Division, Khumaltar also deserve appreciation for his dedicated work in chemical analysis of fed ingredients and fodders. Likewise, our thanks also go to the all-technical, admin and finance staff of National Animal Science Research Institute, Khumaltar and Agriculture Research Station (Goat), Bandipur, Tanahu for their help during entire trial period.

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# THE EFFECTS OF MECHANICAL AERATOR ON POND PRODUCTION OF CARPS UNDER HIGH DENSITY POLYCULTURE FISH FARMING

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## ABSTRACT

The effect of paddle wheel aerator (0.75 KVA) on diurnal oxygen fluctuation, and growth and production of carp under polyculture fish farming in pond was carried out at Regional Agriculture Research Station, Tarahara. Fingerlings of common carp, silver carp, bighead carp and grass carp with an average weight of 53 g were stocked at two density 15000 and 20000/ha for aerated and unaerated conditions. Paddle wheel aerator was found effective to transfer oxygen by 2.2 to 3.4 mg/L and 0.7 mg/L in pond bottom and surface, respectively, after 2 hours of aeration at dawn. Diurnal and seasonal dissolve oxygen was high in aerated ponds. Survival of fish at harvest between aerated and unaerated ponds was not significantly different ($P>0.05$). Pond aeration has resulted in 7935 kg/ha and 5466 kg/ha net fish production which was 27.1% and 26.4% more fish production than in unaerated ponds, respectively, at 15000/ha and 20000 fish/ha stocking density. Net profit generated by aeration for carp polyculture fish farming in pond was 64.6% and 82.5% over to that of the unaerated ponds at fish stocking density of 15000 and 20000/ha, respectively. Further research on timing and amount of aeration at various initial fish biomass in pond and feed management has been suggested to maximize profitability from aerated pond.

## INTRODUCTION

In Nepal, most aquacultural fish production is based on low-input systems relaying on low protein agricultural by-products and pond fertilizers. Such resources are also used by agriculture and animal husbandry. Competition for scarce natural resources has recently begun to promote the development of intensive aquaculture. Intensive aquaculture allows increased control over the biotic and abiotic components of the system and the maximization of the production potential. The goal of intensive, high-density aquaculture is to maximize carrying capacity. Carrying capacity in aquaculture is defined in terms of loading density of fish ($kg/m^3$) which often are limited by hydraulic, chemical, physical, and biological parameters (Boyd, 1982; Ali et al., 2000). Stocking densities and harvest yields are finite and determined by pond (environmental) carrying capacity. The availability of dissolved oxygen is the primary factor determining maximum pond biomass. With the increasing of the intensity of pond fish culture, because of the accelerated biological activity (intensive manuring, feeding, high stocking density) the natural oxygen supply becomes more and more insufficient and will be a limiting factor in production. In the practice of pond fish farming oxygen deficiency has been regarded as dangerous mainly because of mass losses of fish. The low oxygen content disadvantageously influences both the food intake and the utilization of food. Anoxia is one of the major causes of fish kills in fertilized ponds during summer conditions (Collins, 1994).

Effective dissolved oxygen (DO) management is essential for high-density aquaculture systems. Increasing the carrying capacity of a fish production facility increases fish and feed loads, thereby increasing oxygen demand and often requires the use of supplemental oxygen. Supplemental oxygen allows fish farmers to increase DO levels, promoting fish health and survival at high densities (Dwyer *et al.* 1991; Colt and Watten 1988; Kindschi et al. 1991). Application of mechanical aeration is effective means to increase DO levels in ponds (Jensen *et al.* 1989). Mayer *et al*. (1973) and Tiemeirer and Deyoe (1973) proved that emergency or partial aeration is best technique for preventing fish kills during dissolved oxygen crisis. Aeration of fish ponds has not only a life-saving role, but it becomes one of the basic factors of production, and ensuring optimal oxygen supply makes possible the maximal utilization of the given biological possibilities.

In Nepal, pond aeration is not so common and developed. However, some farmers in Terai region have installed aeration system in their ponds but efficiency of these aerators and economic benefits of their use in commercial ponds has not been standardized in our local conditions. Keeping in view the economic importance of pond aeration, present study was carried out to determine the effect of pond aeration with paddle wheel type aerator on DO dynamics, survival, yield of fish and economics of aerator use.

## MATERIALS AND METHODS

Experiment was conducted at Regional Agriculture Research Station, Tarahara in four earthen ponds having average water surface area 0.1 ± 0.02 ha for the three consecutive year 2011, 2012 and 2013. The two stocking density viz. 15000 fish/ha and 20000 fish/ha with and without aeration was employed as treatments. Fish species common carp, filter feeders (silver carp and bighead carp) and grass carp was stocked in a proportion of 55%, 20% and 25%, respectively. Stocking size varied greatly among treatments due to unavailability of uniform size at stocking (Table 1). Pre-stocking management of ponds involved was pond liming with 450 kg calcium bicarbonate/ha; fertilization with 4 t/ha FYM, 40 kg/ha each of DAP and urea; and water filling to depth between 110 to 135 cm. Stocked fish were fed with a ration approximately containing 25% protein at 3% of biomass and the daily allotted feed was given in two time. Ponds were fertilized with 20 kg/ha DAP and 30 kg/ha urea each for four time at equal interval of fish growing period. Water was added as and when necessary to maintain water depth 110 cm in the ponds.

Aeration was done with the help of one unit of 0.75 kva paddle wheel aerators each in respective treatments. Ponds were aerated for two hour daily in the morning (4:00 a.m.- 6.00 a.m.) during the month of October to February and three hours daily (3:00 a.m. – 6:00 a.m.) during the month of March to July. Although the experiment was run for 254 ± 9 day from September to July for each year, the aerator was operated for 177±15 days per year. Dissolved oxygen (DO) was measured after 2 hour of aeration at every 3 days interval for 15 days during April at different distance (0 to 30 m at 5 m interval) from the origin of aeration to observe the spatial and vertical transfer of DO. At every 3 hours interval DO was measured at 30 cm depth of surface water during the months of April to June and diel fluctuations were observed. Routine DO, pH and temperature was measured at weekly interval during the fish growing period and seasonal variation on those parameters observed. Ammonia, nitrite plus nitrate and phosphate was measured once at the beginning and the termination of experiment. Fish were sampled monthly for estimation of standing biomass general health conditions of

the fish. Yield and survival data were obtained upon harvest at the end of growing period by complete draining of the ponds.

Table 1. Treatments allocation, percentage composition and the size (g) of fish at stocking

| Species | Stocking % | Aeration, 15000/ha | Aeration, 20000/ha | Unaerated 15000/ha | Unaerated 20000/ha |
|---|---|---|---|---|---|
| | | T1 | T2 | T3 | T4 |
| Common carp | 55.0 | 8.9 | 84.0 | 71.0 | 39.9 |
| Bighead carp | 10.0 | 170.3 | 77.5 | 128.2 | 266.1 |
| Silver carp | 10.0 | 240.0 | 144.6 | 85.0 | 121.2 |
| Grass carp | 25.0 | 4.6 | 30.2 | 4.6 | 4.3 |
| Mean weight, g | | 34.1 | 67.4 | 61.9 | 49.7 |

Three years fish growth and yield data were pooled and analyzed with one-way ANOVA for any significant differences in mean among treatments using STAT Graphics ver. 3.3.

**RESULTS**

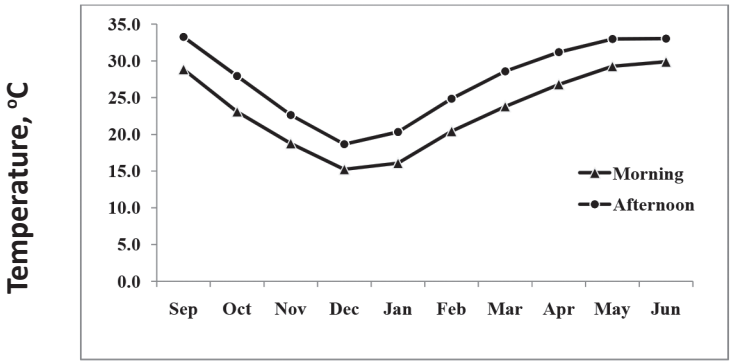


Figure 1. Monthly mean morning and afternoon temperature in experimental ponds during the study period (three years, 2011 to 2013 pooled data)

Temperature of water was between 15.6°C -30.3°C and 16°C -29.5°C at dawn but 18.7°C -33.2°C and 18.6°C -33.5°C at dusk for aerated (T1 and T2) and unaerated (T3 and T4) ponds, respectively. Monthly mean temperatures did not significantly differ ($P>0.05$) among treatments and the mean value at dawn and dusk are illustrated in Figure 1. pH values were 7.0-8.8 and 7.1-8.5 at dawn in aerated ponds T1 and T2, and 6.9-7.9 and 7.0-7.9 at dawn in unaerated ponds T3 and T4, respectively. Mean pH of 7.7 and 7.5 in T1 and T2 was significantly higher ($P<0.05$) to the rest of the treatments (Table 2).

Table 2. Range and mean value of water pH and nutrients in aerated and unareated ponds

| Treatments | pH | Ammonium ($NH_4$-N), mg/L | | Nitrite plus Nitrate ($NO_2$+$NO_3$-N), mg/L | | Phosphate ($PO_4$-P), mg/L | |
|---|---|---|---|---|---|---|---|
| | | Start | End | Start | End | Start | End |
| T1 | 7.7 (7.0-8.8)* | 0.114 | 0.189 | 0.040 | 0.160 | 3.6 | 8.7 |
| T2 | 7.5 (7.1-8.5)* | 0.162 | 0.325 | 0.024 | 0.123 | 2.0 | 13.3* |
| T3 | 7.2 (6.9-7.9) | 0.047 | 0.095 | 0.055 | 0.114 | 1.3 | 9.0 |
| T4 | 7.3 (7.0-7.9) | 0.036 | 0.249* | 0.014 | 0.090 | 5.0 | 10.0 |

* denotes significant at $\alpha$0.05 level within column for pH and within row for nutrients.

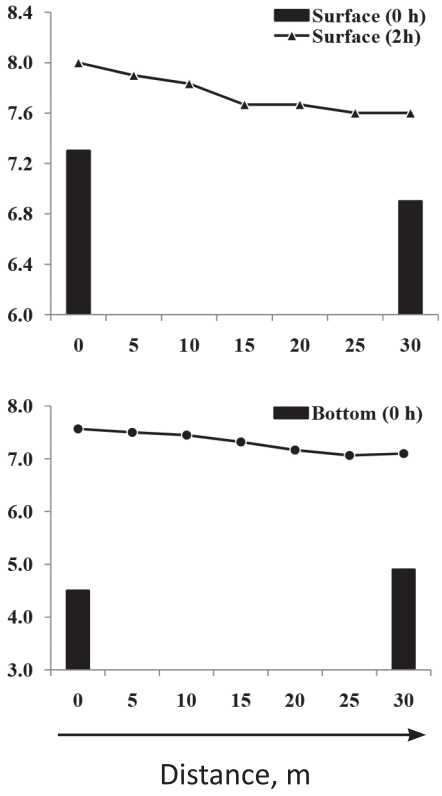


Figure 2. Transfer of dissolve oxygen (DO) from the origin of aerator to the other end of pond

Total ammonia nitrogen concentrations were measured during the months of October (after stocking) and June (before harvesting). Maximum concentration measured was 0.325 mg/L in

T2 just before fish harvest, but not significantly different to the rest of the treatments (Table 2). Ammonia concentration significantly (P<0.05) increased in T4 at harvest compared to the concentration at stocking. Nitrite+nitrate concentrations were not significantly different among treatments and between different times of fish farming operation within treatment. Similar applies to phosphate concentrations except the phosphate level significantly (P<0.05) increased in T2 at harvest (Table 2).

DO was measured before and after 2 hours of aeration in surface and bottom of the pond at every 5 m interval from the origin of aerator to the 30 m towards the length of pond. After aeration both surface and bottom DO increased at decreasing order towards the length of pond (Figure 2). At the origin of aerator surface DO increased from 7.3 mg/L to 8.0 mg/L and the bottom DO from 4.5 mg/L to 7.9 mg/L. Similarly, at 30 m distance the surface DO increased from 6.9 mg/L to 7.6 mg/l and bottom DO from 4.9 mg/L to 7.1 mg/L. Measured DO values indicated that pond aeration has strong influence on vertical distribution of $O_2$ than the spacial distribution. Availability of DO was also increased by the increase of percentage saturation (Figure 3). DO saturation increased by 10.3%, 7.0% and 9.0% in surface, sub-surface and bottom of the pond water column.

DO concentrations fluctuated in both aerated and unaerated ponds during the months of April to June. Minimum DO values were recorded at dawn and maximum DO values were found in the afternoon. Figure 4 show mean diel fluctuations in DO for aerated and unaerated

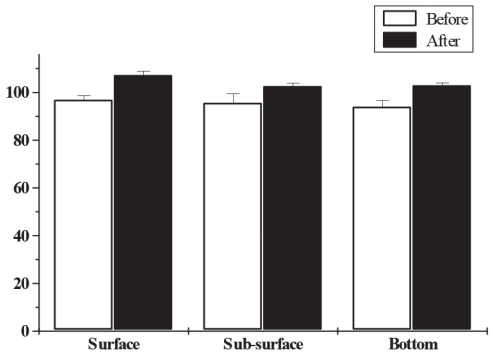


Figure 3. Percent dissolve oxygen saturation before and after aeration

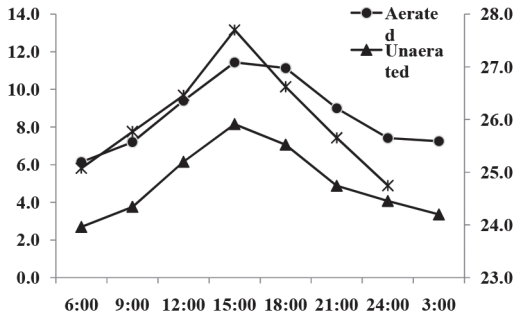


Figure 4. Mean diel fluctuation of dissolve oxygen (P denotes photosynthsis and R denotes respiration)

ponds for study period, 20011-2013. DO was maximum at daytime and minimum during night in both aerated and unaerated ponds. In aerated ponds DO was <7.0 mg/L at 3 a.m. and >11.0 mg/L at 3.0 p.m. but in unaerated ponds these concentrations were < 4.0 mg/L and > 8.0 mg/L, respectively. Plankton abundance and sunshine has favored the photosynthetic rate during daytime, therefore, DO was >5.0 mg/L in both aerated and unaerated ponds (Figure 4). Maximum DO was during the month of February and minimum during the months of April-May followed by October-December. Cloudy and fuggy seasons resulted in decreased oxygen during these months (Figure 5). Aeration from 3.0 a.m. to 6.0 a.m. in T1 and T2 maintained the DO within the desired range resulting in better survival and growth of fish in these treatments as compared to unaerated T3 and T4.

Monthly mean growth rate of common carp was not significantly different (P>0.05) among treatments, although mean growth rate of common carp was relatively highest (2.3 g/day) in aerated pond with fish stocked at 15000/ha (T1) and the lowest (1.63 g/day) was in unaerated pond with fish stocked at 15000/ha (T3). Growth of bighead carp was significantly different (P<0.05) among treatments with highest growth rate (4.02 g/day) in T1 followed by 3.69 g/day in T2 (20000 fish/ha with aeration) and the least (1.29 g/day) was in T4 (20000 fish/ha without aeration). Growth curves show that body weight gain of bighead carp was exponential in T1 and T2 (Figure 5). Although not significant (P>0.05), the growth rate of silver carp was highest (2.61 g/day) in T4 followed by 2.50 g/day in T2 and the least (1.30 g/day) was in T1. The growth of grass carp was poor amongst all fish species included in this experiment. The growth rate varied between 0.53 and 0.66 g/day with highest growth rate in T2. Collectively fish in all treatments showed highly significant increase (P<0.001) in weight during the four months (March-June). Treatment wise the higher gain in body weight was measured in T1 followed by T2 and the lowest gain in T4 (Table 3, Figure 6).

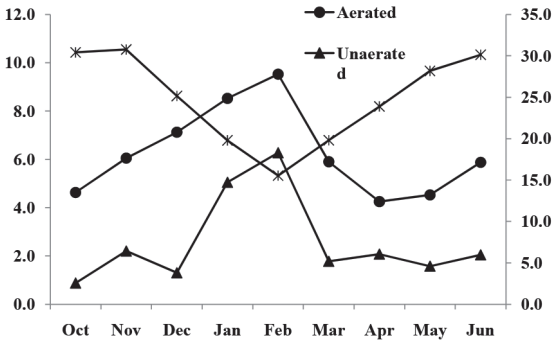


Figure 5. Mean monthly dissolve oxygen

Percentage survival rate was monitored at harvest for all the four species under study. Survival rate of all species was not significantly different (P>0.05) among treatments except the survival rate (69.2%) of grass carp was significantly low (P<0.05) in T3. Survival rates of fish were correlated with the initial stocking weight and density. Survival rate was highest for bighead carp (88.1%) followed by common carp (85.8%) and lowest was for grass carp (79.6%) across treatments. Survival rate for all the four

fish species was 84.3%, 86.0%, 83.2% and 82.7% in T1, T2, T3 and T4, respectively.

**Table 3.** Fish growth, yield and survival comparison between aerated and control ponds

| | Aeration | | Unaeration | |
|---|---|---|---|---|
| | 15000/ha | 20000/ha | 15000/ha | 20000/ha |
| Parameters | (T1) | (T2) | (T3) | (T4) |
| Mean initial size, g | 34.1 | 61.9 | 67.4 | 49.7 |
| Gross wt. at stocking, kg/ha | 537.1 | 1242.1 | 1055.9 | 994.7 |
| Growing days | 254 | 254 | 254 | 254 |
| Mean harvest weight, g | 563.6* | 531.7* | 500.4 | 439.7 |
| Growth rate, g/day | 2.1 | 1.8 | 1.7 | 1.5 |
| Total yield, kg/ha | 7482.4* | 9177.7* | 6522.4 | 7272.9 |
| Net yield, kg/ha | 6945.4* | 7935.6* | 5466.5 | 6278.2 |
| Survival % | 84.3 | 86.1 | 83.2 | 82.7 |
| FCR | 2.14 | 2.36 | 2.65 | 2.70 |
| Yield increase, % | 27.1 | 26.4 | | |

* denotes significant at $\alpha$0.05 level within row between similar stocking densities of fish.

Mean harvest weight was significantly different (P<0.05) among treatments (Table 3). Average fish weight was highest in T1 followed by T2 and the smallest fish produced in T4 (Figure 7). Consequently, growth rate of fish followed the same pattern. Fish production per ha was calculated and compared for the treatments under aeration (T1, T2) and unaeration (T3, T4). Total fish production and net fish yields were significantly higher (P<0.05) in T1 and T2 (aerated ponds) than their respective control treatments T3 and T4 (unaerated ponds).

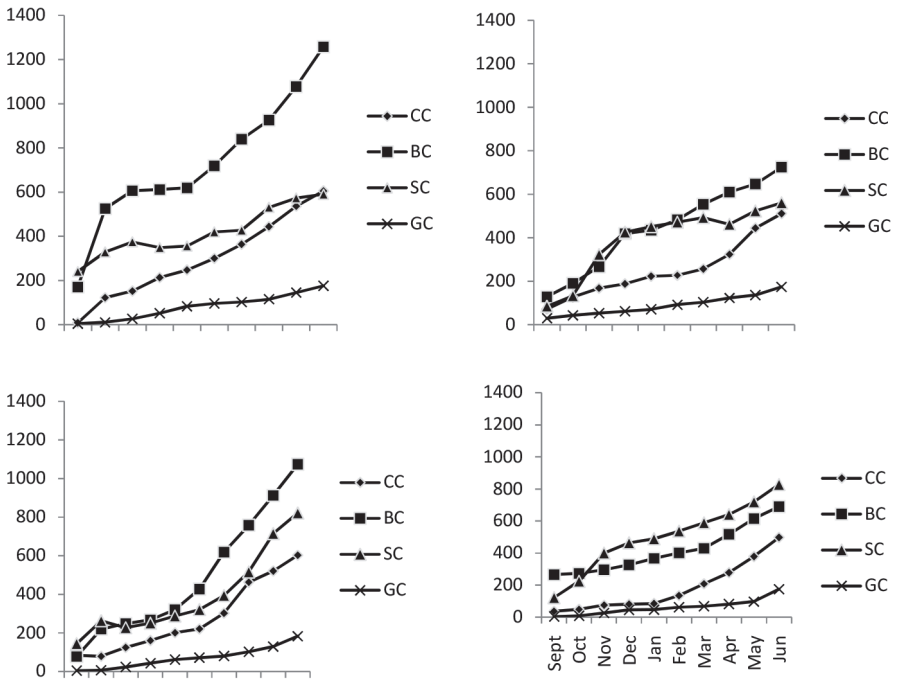


Figure 6. Average weight of common carp (CC), bighead carp (BC), silver carp (SC) and grass carp (GC) in aerated and un-aerated ponds.

Net yield increased by 27.1% and 26.4% in T1 and T2 compared to their control treatments T3 and T4, respectively (Table 3). Feed conversion ratio (FCR) was reduced by 19.2% and 12.6% in T1 and T2 than the FCR estimated for T3 and T4, respectively.Contribution of common carp to the gross yield was 59.5% in T3 followed by T2 (57.6%) and nearly to the stocking proportion in T1 (55%). Silver carp and bighead carp collectively contributed highest in T3 (35.4%) and lowest in T4 (30.4%), but higher than their stocking proportion (20%) in all treatments. Grass carp contribution to the gross yield was poor which ranged between 5.1 to 13.4% despite of their high stocking ratio (Figure 8).

Economic comparisons (cost:benefit) using a five year life expectance of aerator, a 10% discount rate, total costs, estimated carrying capacity, and the current farm gate value for carp fish in Terai were conducted for the two aeration (T1 and T2) and unaeration (T3 and T4) strategies at different fish stocking densities (Table 4).The total cost of fish was Rs 1279725 and Rs. 1107797 per ha from T2 and T1 (aerated ponds ) and Rs 1150018 and Rs 1068304 from T4 and T3 (unaerated ponds, respectively. Total generated return of Rs 1496489.3 from T1 and Rs 1835546.2 from T2 (aerated ponds) was 14.7% and 26.2% higher than the total return from respective unaerated control ponds T3 and T4, respectively. There was Rs 152524 and 251264 per ha more income generation from aerated ponds T1 and T2 by fish sale as compared to the respective unaerated ponds T3 and T4, respectively. Rate of return indicated by return to capital cost and operational cost was higher from T2 (aeration with 20000 fish/ha) followed by T1 (aeration with 15000 fish/ha) and the least was from T3 (un`aeration with 15000 fish/ha). Per unit fish production cost was low in T1 (Rs 96.4/kg) followed by T2 (Rs 97.3/kg) and the highest in T4 (Rs 113.5/kg).

**DISCUSSION**

This study showed that supplemental aeration significantly increases dissolved oxygen in ponds. Supplemental aeration clearly increased mean oxygen concentration in the ponds, as depicted by the diurnal and seasonal mean values (Figures 4 and 5). However, this effect has changed pH but not the total ammonia and other nutrient levels (Table 2); and the results of growth and survival should be explained in terms of dissolved oxygen into the water. Unaerated condition did not reach extremely low concentrations of dissolved oxygen (less than 2 mg/L) in most of the fish growing months except in the October and December, though stocking density was expected to be a biological parameter affecting this variable.

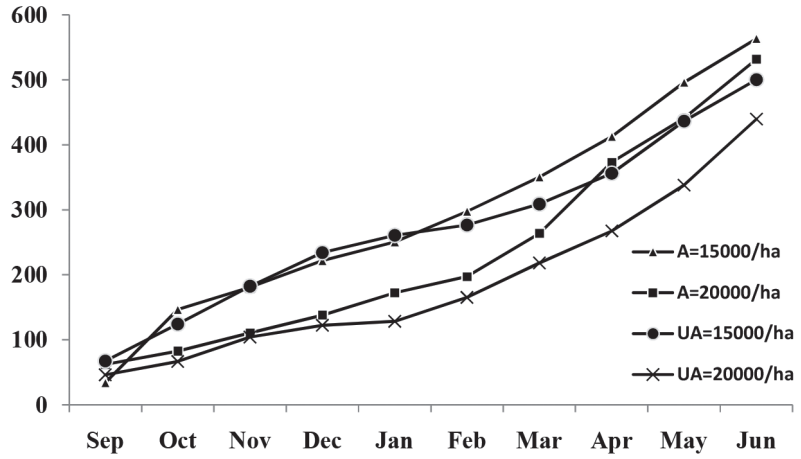


Figure 7. Mean weight of fish in aerated and unaerated ponds at two different densities

**Table 4.** Cost benefit of fish farming at different stocking densities under aerated and non-aerated condition

| | Aeration | | Unaeration | |
|---|---|---|---|---|
| Parameters | T1 | T2 | T3 | T4 |
| Fish density/ha | 15000 | 20000 | 15000 | 20000 |
| Capital cost, Rs | 1230000 | 1230000 | 1100000 | 1100000 |
| Operational cost, Rs | 721397.4 | 893325.4 | 739970.5 | 821684.9 |
| Fixed cost, Rs | 386400.0 | 386400.0 | 328333.3 | 328333.3 |
| Total cost, Rs | 1107797.4 | 1279725.4 | 1068303.8 | 1150018.2 |
| Fish Yield, kg/ha | 7482.4 | 9177.7 | 6522.4 | 7272.9 |
| Fish sale value, Rs | 1496489.3 | 1835546.2 | 1304471.7 | 1454575.3 |
| Net Profit[1] | 388691.9 | 555820.9 | 236167.9 | 304557.1 |
| Return to operational cost, % [2] | 35.1 | 43.4 | 22.1 | 26.5 |
| Per kg fish production cost, Rs | 96.4 | 97.3 | 113.5 | 113.0 |

[1]Net profit = return to management = gross revenues - total costs.

[2]Operating profit = gross revenue - variable costs.

Average survival rate for all the four fish species was 84.3 to 86.1% in aerated ponds and 83.2 to 82.7% in unaerated ponds at stocking density of 15000 and 20000 fish/ha, respectively(Table 3). Hollerman and Boyd (1990) reported 92% survival in aerated ponds and 40% survival in un-aerated ponds in their studies on night aeration in Channel Catfish ponds. Similarly Qayyum et al. (2005) in a study estimated 64% survival with partial aeration and 21% without aeration in ponds stocked with rohu, naini, bighead carp and grass carp at relatively low density of 6270 fish/ha. Percentage survival rate in present study with aeration was comparable to the survival rate reported by them. Relatively high survival rate in unaerated ponds found in this study could have been the effect of supply of freshwater as and when necessary to prevent the fish loss due to hypoxia.

Increase in population density is well known to decrease fish growth, due to changes in water quality (Cole and Boyd, 1986), feed competition (Suresh and Lin, 1992), and social stress (Klinger, 1983). However, this study showed it is not applicable for carp if water dissolved oxygen is artificially supplied. Average fish growth (harvest weight) was significantly high (532 and 564 g) in aerated ponds stocked at 15000 and 20000 fish/ha, respectively, than the unaerated ponds with respective density. Mean final weight was largely contributed by the final weight gain of silver carp and bighead carp in aerated ponds (Figure 6). These two fish species mostly remains in upper and sub surface of water enriched with oxygen, hence their growth is better. The growth of grass carp in all treatments was poorest amongst fish species stocked in this study. Relatively small initial size (10.8 g) of grass carp across treatments at stocking might have constrained their access to feed. Consequently, this fish has lowest contribution in fish yield despite of its significant proportion (25%) in stocking by number.

Gross and net fish yields were significantly high for both aerated ponds (T1 and T2) to that of the unaerated ponds (T3 and T4) at respective stocking density. High oxygen concentration at dawn (Figure 4) and throughout growing season (Figure 5) might have contributed to high final weight and better survival rates which eventually supported to high yields in aerated ponds. Abdalla and Romaire (1996) have also shown that final weight and survival rates of

channel catfish increased by 32% in ponds with partial aeration for 3 hour at dawn. Although, better FCR estimated for aerated ponds (2.14 to 2.36) compared to unaerated ponds (2.65 to 2.70) in the present study, was higher than the FCR (1.75) for channel catfish achieved in ponds with supplemental aeration (Lai-fa and Boyd, 1989). This suggests for further research on improvement in feed quality and feeding practices in aerated pond with carps.

Boyd (1982) employed dissolved oxygen dynamics, aerator performance data and price information in channel catfish ponds and estimated 20% to 25% increase in profit for 1.49 kva/ha of supplemental aeration. Mayer et al. (1973) in his studies on channel catfish ponds reported that the average yield in aerated ponds was 5307 kg/ha with net economic gain of $ 1500/hectare. The unaerated ponds yielded an average of 1400 kg/hectare and were obvious economic failure. In the present study, fish production (9178 and 7482 kg/ha) was significantly high ($P<0.05$) in aerated ponds at stocking density of 20000 and 15000/ha as compared to the fish production (7273 and 6522 kg/kg) in un-aerated ponds with respective density (Table 3). Pond aeration has resulted in 1905 and 960 kg/ha more fish production at density 20000 and 15000/ha, respectively. Fish production in aerated ponds is higher in present studies as compared to the reported fish production by Mayer et al. (1973) in channel catfish ponds. Cost benefit analysis shows that aerated condition generated Rs 152524/ha and Rs 251234/ha more net profit which were 64.6% and 82.5% higher as compared to the unaerated ponds at fish density 15000 and 20000/ha, respectively (Table 4).

With the data obtained from this experiment it was possible to determine that aerators promote an alteration of limnological characteristics, increasing environmental oxygenation and leading to increase fish biomass and economic performance of carp fish farming. However, it is difficult to make recommendations on the amount of aeration needed for a unit of pond with optimum fish biomass in order to secure maximum profitability. According Matos (1996) in tropical areas the ideal time for aeration should begin at 03:00 to 06:00 hr in the spring and 00:00 to 06:00 hr in the summer. An extensive research effort on amount and timing of aeration in ponds with various fish biomass would be worthwhile.

## ACKNOWLEDGEMENT

This research was supported by Nepal Agricultural Research Council under Project No.32068003. Mr. Bedananda Chaudhary, Director of Regional Agriculture Research Station (RARS), Tarahara, is acknowledged for his cooperation during this study. This work could not have been done without the assistance of the staffs of the Fisheries Research Division, Godawari and RARS, Tarahara.

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# EFFECT OF DIFFERENT STORAGE AND TRANSPORTATION CONTAINERS ON THE QUALITY OF FRESH FISH

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## ABSTRACT

*The containers used in Nepal for storage and transportation of fish have poor insulation and this causes uncertainty in the shelf life and the products quality. An experiment with three types of container, viz high density plastic box, Styrofoam box laminated with wooden plate and valve for water discharge and plain Styrofoam box, was carried out to evaluate the insulation ability for storing fish to retain the quality. Twenty-four hour starved Labeo rohita (weight 500-700 g) was stored at a loading rate of 25.0 kg/box in each test container with 1:1 ice fish ratio. Temperature, microbial load, chemical and proximate analyses of the stored fish was made for 66 hour of storage. Styrofoam box laminated with wooden plate showed high insulation ability in maintaining chilling temperature (-0.5 to -0.2 °C) followed by Styrofoam box (0.2-0.4 °C) and the lowest for plastic box (-0.7 to 3.8°C). Total plate count (log 5.53 cfu/g) and peroxide value (0.43 meq $O_2$/kg) was highest in Styrofoam box at the termination of 66 hour study period. Salmonella was absent in fish samples from all test containers. Proximate analysis did not show remarkable differences in nutrients content among the fish samples from test containers. The results indicated that the container Styrofoam box laminated with wooden plate could be promoted in future for storage and transportation of fresh fish as it demonstrated the ability to maintain chilling temperature, slower down the growth of microbes and raise of peroxide value.*

**Keywords:** Fresh fish, insulation ability, temperature, microbial load, peroxide value

## INTRODUCTION

Fish is a very important foodstuff in developing countries due to its high protein content and nutritional value. It is highly perishable, due to its high water activity and protein content, neutral pH and presence of autolytic enzymes which cause fish spoilage. Immediately after catching the fish start to spoil and the rate of spoilage depends on ambient conditions, fishing technology, fishing equipment, species of fish, catching season and handling and preservation activities (Hobbs, 1982). Temperature is the single most important factor affecting post-harvest quality of the products. It is often critical to reach the desired short-term storage temperature rapidly to maintain the highest visual quality, flavor, texture, and nutritional content of fresh fish. The delays in cooling the fish when the temperatures are high reduce shelf-life (Dunsmore and Thompson 1981, Huss 1992).

Fish muscles' less connective tissue and relatively higher moisture content than red meat muscles makes it more susceptible to enzymatic autolysis and to microbial spoilage. In addition, the spoilage due to the fat (oxidative rancidity), varies considerably with species and the composition of the fish since it is known that the higher the temperature the faster the spoilage bacteria growth. The insufficient cleaning may lead to bacterial build up which in turn may act as sources of frequent contamination (Dunsmore and Thompson 1981). Fish auction markets where fish are placed on dirty sacks, wooden, metal or plastic basins in the open can cause potential dangers of bacteria and exposure of the catches to direct sunlight permits multiplication of spoilage organisms.

The most crucial factors determining the quality of fishery products are time and temperature tolerance. Lowering the temperature by icing not only slows down the rigor mortis process, but also reduces the spoilage rate (Quang, 2005). A common way to chill the fish is to arrange it with ice in a box. For a box containing fish the thermal insulation is essential to minimize ice consumption and to keep inside temperature more independent of outside temperature. In Nepal fish is transported by preserving in Styrofoam box and plastic crate are used in the country with ice at alternative layer for the preservation of fish. However their effectiveness in terms of insulation, biochemical and microbial changes related to enhance shelf life of fresh fish has not been quantitatively addressed. Therefore, the present study emphasized to evaluate the different types of fish storing containers on their suitability to preserve fresh fish with its natural quality.

## MATERIALS AND METHODS

An experiment was carried out at Regional Agricultural Research Station (RARS), Tarahara to evaluate the insulation ability of different containers for storing fish to retain the quality of fresh fish. Three types of containers (treatments) were chosen for the experiment: Styrofoam box laminated with wooden plate (FWB), Styrofoam box (SB) and high density plastic crate (PC) (Figure 1). Styrofoam box (SB) and high density plastic crate (PC) used in this trial were the usual containers used by retailer and wholesaler in fish marketing.

(a) (b) (c)

Figure 1. Three types of boxes used for experiment: (a) Styrofoam box laminated with wooden plate, (b) Styrofoam box and (c) plastic crate

Rohu, *Labeo rohita* with individual weight ranged between 500 -700g were harvested from the pond of RARS, Tarahara and conditioned for 24 hours. Fish subjected to preservation was characterized as 24 hour starved, unwashed and with gut. Experimental containers were stocked with 25 kg fish in each box filled with pieces of ice. The fish packing in the container involved a layer of fish at the bottom followed by a layer of ice that alternates with a layer of fish, ending with a layer of ice on top. It was tried to make sure that all spaces between fish was

filled with ice. Fish were packed with ice in experimental container at RARS, Tarahara and the preserved fish were brought to SEAM-MMA Lab at Biratnager and placed in the wet laboratory room. Fish were preserved for 66 hours and physical, chemical and microbial parameters were monitored at different time intervals.

Temperature (°C) of fish inside the experimental boxes was recorded from 6 am to 8 pm at 2 hours interval with sensory thermometer. One fish from each treatment was taken out each time of sampling at 6 hour interval until 66 hour. The samples were immediately possessed for microbiological and chemical analysis. Total Plate Count (TPC) was performed at 6 hour interval until the termination of preservation experiment by Most probable Number (MPN) technique (Apha, 1992). *Salmonella* and Total colilform were counted by Pour Plate Method at the beginning and the end of the trial. Peroxide value was also measured at every 6 hour interval using the Titremetric method. Proximate analysis of preserved fish involves the measurement of levels of crude protein (Kjeldahl method), total ash (Gravimetric method), oil content (Soxjlet method), acid insoluble ash (Gravimetric method) and moisture (Oven drying) which were analyzed at the beginning and end of the experiment.

Fish quality was evaluated by a panel of sensory experts comprised of four people using Quality Index Method (QIM) (Martinsdottir *et al.* 2001). Whole fish samples were examined for appearance of skin, firmness of flesh, colour, and form of eye and finally color, smell and mucus formation of gills using QIM (Annex 1).

The whole fish samples were filleted, skinned and cut into small pieces. Samples were steamed in an aluminum *dekchi* with salt which were blind coded before serving to the panelists of eight peoples. The changes in the eating quality of cooked fish after preservation trial were assessed by Hedonic scaling (Table 1).

Table 1. Hedonic scale for freshness scoring of cooked rohu (Labeo rohita)

| Description | Scores |
|---|---|
| Like extremely | : 9 |
| Like very much | : 8 |
| Like highly | : 7 |
| Like slightly | : 6 |
| Neither like nor dislike | : 5 |
| Unlike slightly | : 4 |
| Unlike highly | : 3 |
| Unlike very much | : 2 |
| Unlike extremely | : 1 |

## RESULTS AND DISCUSSION

FWB showed high insulation ability in maintaining chilling temperature (-0.2 to -0.5 °C) than the insulation ability of PC (-0.7 to 3.8 °C) and SB (0.2-0.4 °C) containers (Figure 2). The chilling temperature of nearly 0°C can maintain freshness quality for a long time (Quang, 2005). Ice melting was rapid in PC while slow melting was observed in FWB. Proliferation of microorganisms requires appropriate high temperatures, while at lower temperatures close to 0ºC, their activity is reduced, thereby extending the shelf life of fish products. The rate

of spoilage is dependent upon the holding temperature and is greatly accelerated at higher temperature due to increased bacterial action (Amos, 2007).

The amount of TPC cfu/g was constant in fish preserved in FWB and PC up to the 12 hours of experiment but increased exponentially in fish preserved in FWB (Figure 3). After 12 hours of preservation the amount of TPC increased very fast up to the 36 hours of experiment in all three treatments. At 66 hours of preservation the TPC was highest (log 5.53 cfu/g) in fresh fish preserved in FWB and lowest (log 5.40 cfu/g) in fish preserved in PC. As recommended by International Commission on Microbiological Specification for Food (ICMSF, (1986), an increase of total plate count (TPC) up to levels exceeding the value of log 6 cfu/g is regarded as microbial spoiled fish muscle not fit for human consumption. TPC counts observed in fish preserved in all three different containers were therefore within the limits of acceptability. Bacterial growth is the main cause of fish spoilage therefore it is logical to use bacterial number as an index of fish quality. Although *Salmonella* was not found in all samples, the growth of total coliform was higher in fish sampled from PC and SB (39 MPN/g) than in FWB (23 MPN/g) (Table 2). Exposure of microorganisms to low temperatures in FWB reduces their rates of growth and reproduction (Fig. 3 & Table 2).

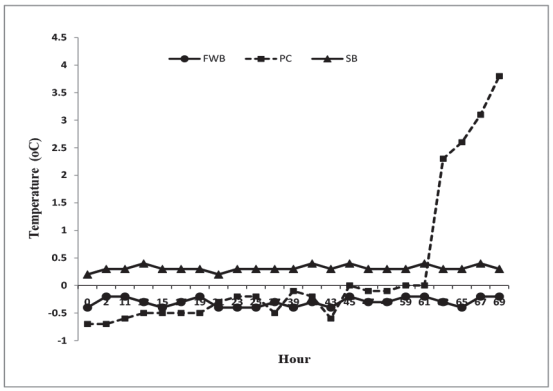


Figure 2. The trend of temperature (°C) rise of fish in ice stored in FWB, PC and SB.

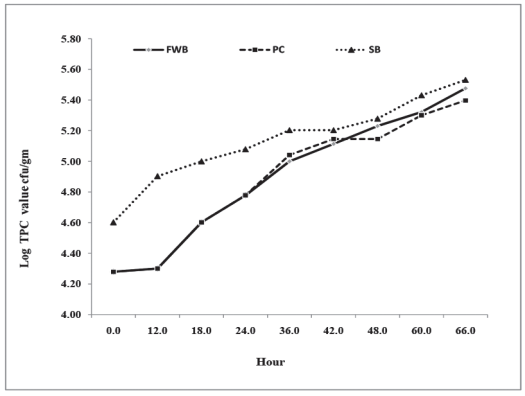


Figure 3. TPC contents of fish in ice stored in FWB, PC and SB.

**Table 2.** *Salmonella* and total colilform in fish preserved in fabricated wooden box, plastic crate and Styrofoam box

| Parameter | | WFB | PC | SB | ICMSF, 1978 |
|---|---|---|---|---|---|
| *Salmonella* cfu/g | Initial | Nil | Nil | Nil | Not to be detected |
| | Final | Nil | Nil | Nil | |
| | Difference | | | | |
| Total coliform MPN/gm | Initial | 21 | 21 | 21 | None |
| | Final | 23 | 39 | 39 | |
| | Difference | 2 | 18 | 18 | |

Increase in peroxide level (Figure 4) followed the similar pattern of TPC with highest value of 0.43 meq $O_2$/kg in SB container at 66 hour of storage. High temperatures are partly responsible for the speed of the oxidation processes in SB. In addition, direct sunlight, wind, heat, light (especially UV-light) and several organic and inorganic substances may also accelerate oxidative processes.

Proximate analysis did not show remarkable differences in nutrients content among the fish samples from test containers (Table 3).

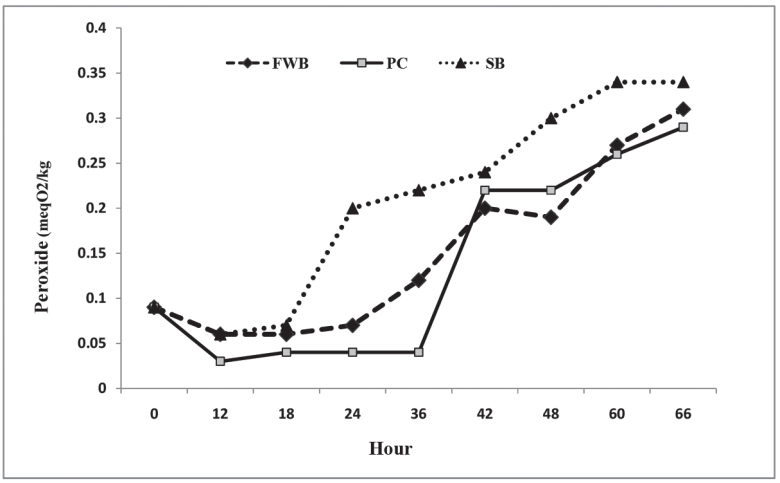


Figure 4. The trend of rise in peroxide level of fish in ice stored in FWB, PC and SB

**Table 3.** Proximate analysis of fish preserved in ice in stored in FWB, PC and SB.

| Parameter (%) | | FB | PC | SB |
|---|---|---|---|---|
| Moisture | Initial | 83.09 | 83.09 | 83.09 |
| | Final | 81.35 | 80.82 | 82.94 |
| | Difference | 1.74 | 2.27 | 0.15 |
| Total ash | Initial | 8.26 | 8.26 | 8.26 |
| | Final | 7.75 | 8.35 | 8.57 |
| | Difference | 0.51 | -0.09 | -0.31 |
| Crude protein | Initial | 18.4 | 18.4 | 18.4 |
| | Final | 18.56 | 19.87 | 18.56 |
| | Difference | -0.16 | -1.47 | -0.16 |
| Acid insoluble ash | Initial | 0.47 | 0.47 | 0.47 |
| | Final | 0.81 | 0.77 | 0.86 |
| | Difference | -0.34 | -0.3 | -0.39 |
| Oil content | Initial | 1.43 | 1.43 | 1.43 |
| | Final | 1.34 | 1.18 | 2.15 |
| | Difference | 0.09 | 0.25 | -0.72 |

Quality is defined as the aesthetic appearance and freshness or degree of spoilage which the fish has undergone (Huss, 1995). Freshness to a certain degree is subjective but it can be measured against an agreed scale by assessment of appearance, odor and taste. Sensory quality attributes of fish samples can be evaluated by panel using the Quality Index Method (QIM) (Martinsdottir *et al.* 2001) where each quality attribute will be rated on a 0-3 demerit point score. Lower scores signify higher quality and the total score can show the general fish quality with a total score of 0-20 for whole fish. Scores from each individual fish will be added

and the sum of the individual fish averaged to give the overall sensory score (quality index) of the fish from the same post-mortem age (post-catch days).

The sensory quality showed that the sum of QIM score was six in PC at the end of experiment, highest amongst the test containers (Table 4). Ice melting in PC might have resulted in high QIM score, however, the fish is considered fit for human consumption when the score is lower than 18 (Martnsdottir, 2001).

**Table 4.** Demerit scores from Quality Index Method for whole rohu preserved in FWB, PC and SB.

| Quality parameter | Character | Average score of preserved fish | | |
|---|---|---|---|---|
| | | Fabricated wooden box | Plastic crate | Styrofoam normal |
| General appearance | Skin | 0.0 | 0.5 | 0.5 |
| | Bloodspot on gill cover | 0.0 | 0.0 | 0.0 |
| | Stiffness | 1.0 | 1.5 | 1.75 |
| | Belly | 0.4 | 0.75 | 0.75 |
| | Smell | 0.8 | 1.0 | 1.0 |
| Eyes | Clarity | 0.0 | 0.25 | 0.0 |
| | Shape | 0.2 | 0.5 | 0.25 |
| Gills | Colour | 0.0 | 0.25 | 0.25 |
| | Smell | 0.6 | 1.25 | 1.0 |
| Sum of scores | | 3.2 | 6.0 | 0.6 |

Eating quality was found best in cooked fish preserved in FWB (Table 5).

**Table 5.** Eating quality evaluation of rohu preserved in FWB, PC and SB

| | FWB | PC | SB |
|---|---|---|---|
| Colour | 6.6 | 7.1 | 7.5 |
| Texture | 7.4 | 6.5 | 7.1 |
| Flavor | 7.8 | 6.5 | 6.9 |
| taste | 8 | 7 | 7 |
| Av. | 7.7 | 6.8 | 7.1 |

## CONCLUSION

FWB showed high insulation ability in maintaining chilling temperature (-0.5 to -0.2 $^{o}$C) than the insulation ability of PC (-0.7 to 3.8 $^{o}$C) and plain SB (0.2-0.4 $^{o}$C) containers. The results indicated that the container FWB could be promoted in future for storage and transportation of fresh fish as it demonstrated the ability to maintain chilling temperature, slower down the growth of microbes and raise of peroxide value.

**ACKNOWLEDGMENTS**

We would like to thank and acknowledge the valuable assistance of the following individuals, staff and offices:

Engineering Division, Khumaltar,

Regional Agricultural Research Station, Tarahara,

SEMMEN Laboratory, Biratnagar,

Nepal Agricultural Research Council.

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# COMPARATIVE PERFORMANCE ANALYSIS OF INTEGRATED PIG-FISH FARMING IN WESTERN TERAI AND HILL OF NEPAL

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## ABSTRACT

*This paper provides an overview of the structure and performance of integrated pond fish farming system with pig, based on analysis of survey data for two farms in western terai (Nawalparasi) and five farms in hill (Tanahun). The paper includes summaries and analyses of data on fish and pig stocking and harvesting, use of feed and fertilizers, pig-fish integration, capital inputs, and overall cost and revenue structure in these two different ecoregions. Average fish yields from integrated pig-fish farms were 5956 and 4208 kg/ha, respectively, in terai and hill. Net profits generated by integrated pig-fish farming were Rs 539400 and 875800/ha, respectively, in terai and hill. Ratio of net profit to gross revenue (0.3) was not different between regions. In addition to variations in aggregate input and output levels, a key differences in productivity between ecoregions is seen to lie in the stocking model of fish and pig utilized; herbivore fish (grass carp) dominate in terai with low number of pig, while feeding fish (common carp and grass carp ) dominate in hill with high density of pig to fertilize the fish ponds. These results are examined in light of ecoregion differences in culturing tradition, technology, climate and geographical factors.*

**Keywords:** Ecoregion, pig-fish integration, input and output, fish yield

## INTRODUCTION

Integrated Agriculture Aquaculture (IAA) combines aquaculture with different agricultural systems into an interactive relationship with the expectation that together, they will generate synergistic effects on conservation of resources and profitability (Ayinla, 2003; Chen, 1989). Agriculture-Aquaculture integration is a complementary interaction between crops livestock and fish in such a way that limited land can be used for different purposes by which waste from one unit can be used to serve as input for other unit. Agriculture- aquaculture promotes efficient utilization of farm space for multiple productions (Eyo et al., 2006). Integrated livestock-fish culture approach envisages the integration of fish farming with cattle, sheep, goats, poultry or pigs husbandry in a design allowing byproducts and or wastes from one system to be used as inputs in another system. Such integration has shown potential to improve income and nutrition of small farm households and to counteract the effect of environmental degradation (Perkin et al., 1998). Livestock production and processing generate by-products that may be important inputs for aquaculture. The main linkages between livestock and fish production involve the direct use of livestock wastes, which function as fertilizers to stimulate natural food webs in fish ponds.

With the view of nutrient recycling from one to another subsystem to enhance the productivity of integrated fish farming system at low input cost, duck program began on a small scale in

Nepal in 1969 (Singh, 1979) and FAO has assisted on the introduction of duck cum fish culture in the country (FAO/UN, 1979). Later several forms of aquaculture integration with livestock (pig, goat, cattle), vegetables and grass have been spontaneously practiced by farmers in small scale. Among the different forms of integration, pig-fish integration is becoming popular among farmers of hill and Terai region irrespective of caste and poor technical know-how and management. Farmers have been raising pig in fish pond dike with the aim of economic utilization of scarce land resources, productive utilization of piggery waste and minimizing the environmental impact of piggery waste (manure). However, the scientific foundations and ecoregion diversity of this system has yet to be fully understood.

Research on integrated fish farming has focused on four principal themes (Chen et al., 1995): (a) biological processes such as the interaction of feed and manure on fish, (b) ecological systems including energy flows (c) farming system approaches, such as the participatory technology dissemination methods and (d) studies of production economics and financial elements of farm operation. Biological processes (Zhu et al.,, 1990), ecological systems (Engle, 1987; Yan and Yao, 1989) and farming systems approaches (Lightfoot, 1990) has been defined in regional context, but the economic performance of integrated aquaculture is meager in literature. Therefore, this paper emphasizes to highlight production economics of pig-fish integration and examine yield and profit structures, through the analysis of bioeconomic survey carried out in two districts representing western terai and hill of Nepal.

## MATERIALS AND METHODS

This study was carried out in Nawalparasi and Tanahu districts representing the two different ecoregion, respectively, terai and hill for bioeconomic assessment of integrated pig-fish farming during 2012 and 2013 (Figure 1). Ecoregion and fish farms selected to monitor production systems and corresponding cost structures were based on dominancy of integrated farming system in the region, size of the farms, level of technical know-how and availability of data and information (Table 1). However, the survey does not constitute a random sample since no definite figures are available on the total number of integrated fish farms in Nawalparasi and Tanahu district representing western terai and hill.

A semi-structured questionnaire was administered, with data recorded on actual inputs, outputs (yields) and overall economic performance of each farm. Beside, relevant data and information on pig-fish husbandry, production input, yield and their real cost and sale values was collected from farm data book. Farm owners were interviewed for their education, skill and experience on the operation and management of integrated farms.

Based on climatic geographical and socio-economic differences between the two regions surveyed, the data were classified into aggregate of stocking levels and fish-pig yields. A wide variety of fish species, feeds and fertilizers is utilized in integrated fish farming. To facilitate data analysis and interpretation of the results, this diversity of inputs has been suitably categorized. With respect to the fish stocks, the relevant species have been aggregated into three categories:

1. Omnivore: common carp (*Cyprinus carpio*)

2. Filtering: silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys bobilis*) and

3. Herbivore: grass carp (*Ctenopharyngodon idella*)

**Table 1.** Survey locations and the training and experience of farmers

| | Western terai (Nawalparasi) | Western hill (Tanahu) |
|---|---|---|
| Location (VDCs) | Tangbhari, Pithauli -3; Daldale, Pragatinagar | Kamalbari, Ghasikuwa-5; Byas Municipality-11; Jamune-7; Pasale, Jamune-7; Bhutia, Dhorphedi-3 |
| Elevation, masl | 165-187 | 470-670 |
| No. of studied farms | 2 | 5 |
| Cast & Religion | Tharu, Bramhan | Magar, Newar, Damai, Bramhan |
| Education | High school-Bachelor | Literate to SLC |
| Training (farmers No.) | | |
| Fish farming | 2 | None |
| Piggery | None | None |
| Experience in FF | 12±3.5 | 4±1.6 |
| Experience in IPF, year | 3.2 ±0.9 | 2.4±1.0 |

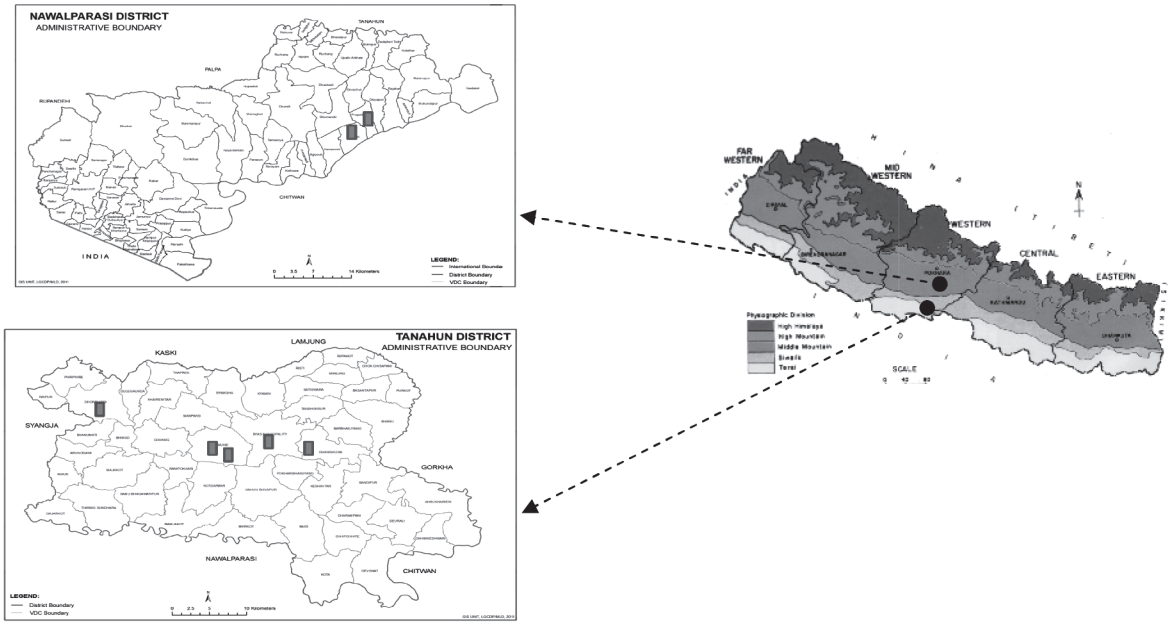


Figure 1. Country and districts map showing survey regions (districts) and locations of integrated fish-pig farming

The other key inputs to the integrated fish farming system, feeds and fertilizers, have also been placed in appropriate categories, as follows: feeds for both fish and pig: (1) grains and cakes, (2) food by-products and (3) grasses and fodder. Fertilizer for fish: (1) pig manure and (2) chemical fertilizer. With respect to aggregation of animal stocking and production data on integrated fish farming, the management, cost and returns of pig farming was used.

Data for feed and fertilizer inputs, stocking and yield of fish and pig were initially recorded for actual pond size; these were then subsequently transformed to a per hectare basis. The results presented here are typically given as kg per ha per year, representing actual inputs or outputs per unit area over the 12-month survey period.

## RESULTS

### Fish farming

Pond size for rearing fish was 1187 $m^2$ with wide variation in size by ecoregion and landscape. Ponds in hills were smaller (0.05 - 0.4 ha) compared to the ponds (0.4-0.5 ha) in terai. Low water depth and high seepage rate was the characteristics of ponds in hill due to terrain landscape and permeable soil profile (Table 2). Despite of high water temperature in ponds of terai, relatively high level of water depth was maintained. In both regions, ponds are usually prepared by drying after each previous crop harvesting during winter months (December-January). Farmers of terai responded that the ponds are regularly limed at recommended dose of lime as they are well aware of importance of liming. However, farmers in hill were unaware of the liming in pond.

**Table 2.** Farm size and condition of rearing environment

| | Western terai (Nawalparasi) | Western hill (Tanahu) |
|---|---|---|
| Fish pond No. | 4.5±0.7 | 2.6±1.7 |
| Pond area, ha | 0.4-0.5 | 0.05-0.4 |
| Avg. pond depth, m | 1.2 | 0.9 |
| Water source | Deep well | Canal |
| Water temp., $^{o}$c | 14-35 | 12-27 |
| Water loss | Low | High |
| Pig shed | Pond dike | Pond dike (3), adjacent field (2) |

Carp was the main choice for farmers in pig-fish integration and all the farmers adopted polyculture fish farming by stocking five major carp species. The choice of fish species for stocking in pond varies across regions depending on climatic condition, consumer preferences and the technical know-how of the farmer. In hill, the pattern involves stocking in spring to summer, using fry all of approximately the same size, harvesting carried out annually at the end of the winter. In terai, fingerlings of two different sizes for some species are used to allow more than one harvest during the year.

Table 3 indicates the stocking densities and stocking costs for each ecoregion. Also indicated are ranges of fingerlings stocking sizes for each species. Stocking levels vary remarkably across regions, with the average density by weight for terai (135.9 kg/ha/year) being approximately 2.5 times that of hills (54.2 kg/ha/year). Fish stocking density by number was higher in hill (38200 fry/ha) than in terai (25100). The study revealed that fish ponds were heavily stocked in both the region which is about three times higher than recommended stocking density (10000 fish/ha).

Table 3. Fish density, composition and cost

| Species | Stocking wt., g | Western terai (Nawalparasi) | | | Western hill (Tanahu) | | |
|---|---|---|---|---|---|---|---|
| | | No./ha | Wt, kg/ha | Cost, Rs | No./ha | Wt, kg/ha | Cost, Rs |
| *Omnivore* | | | | | | | |
| Common | 5-15 | 5700 | 39.9 | 17100 | 16200 | 16.2 | 8100 |
| Naini | 0.5-3.0 | 3600 | 7.2 | 1800 | 0 | 0 | 0 |
| *Herbivore* | | | | | | | |
| Grass | | 4200 | 42 | 21000 | 14000 | 28 | 7000 |
| *Filter feeder* | | | | | | | |
| Silver | 1.0-10.0 | 4000 | 8 | 4000 | 6000 | 6 | 2400 |
| Bighead | 2.0-7.0 | 5200 | 36.4 | 10400 | 2000 | 4 | 800 |
| Rohu | 2.0-7.0 | 2400 | 2.4 | 720 | 0 | 0 | 0 |
| Total | 0.5-3.0 | 25100 | 135.9 | 55020 | 38200 | 54.2 | 18300 |
| Species group | | Composition in terai (%) | | | Composition in hill (%) | | |
| | | Number | Weight | Cost | Number | Weight | Cost |
| Omnivore | | 37 | 32 | 28 | 42.5 | 56 | 61 |
| Herbivore | | 48 | 40 | 47 | 20.9 | 12 | 12 |
| Filter feeder | | 15 | 28 | 25 | 36.6 | 32 | 27 |
| Total | | 100 | 100 | 100 | 100 | 100 | 100 |

Table 2 also indicates the stocking proportion (fraction of total stocking by weight and number) for each species grouping within each region. In terai, herbivore (grass carp) followed by omnivore (common carp and rohu) are the principal species stocked, representing 85% and 72% by number and weight, respectively, of the total stocking. Omnivore is dominant in hill both in number (61%) and weight (56%) with filter-feeding fish (32% in weight and 27% in number) also important. These results highlight the differences between two key stocking patterns in integrated pig-fish farming in terai and hill. In hill, total densities by weight are relatively low and filter feeding fish dominates after omnivore, while in terai, densities are high and herbivore dominate.

Feed and fertilizer represent the principal input cost for fish farming averaging 49.5% of total non-labor costs in survey data. The average utilization of feed and fertilizer for hill and terai are given in Table 4, and is indicated relative to other input costs in Figure 2. Rice bran, wheat flour and soybean cake dominated feed cost (71.8%) in terai, while cost for bran and flour are dominant (93%) in hill. In similar manner, manures were the most heavily utilized fertilizes as measured by quantity, while chemical fertilizers represented the 26.6% of the total fertilizer costs. Although significant quantity of pig manure was spontaneously added to the pond from production process of integrated pig-fish farming, these weights of manure has not been considered to analyze the cost structure.

**Table 4.** Fish Feed and Fertilizer used in fish-pig integrated pond in western terai and hill

| Ingredient | Composition by weight, t/ha | | Composition by cost % | |
|---|---|---|---|---|
| | Terai | Hill | Terai | Hill |
| *Feed* | | | | |
| Ricebran | 3.54 | 5.43 | 28.7 | 51.7 |
| Oil cake | 0.88 | 0.53 | 11.3 | 7.0 |
| Wheatflour | 1.36 | 1.84 | 25.3 | 29.2 |
| Corn flour | 0.78 | 0.85 | 13.6 | 12.1 |
| Soybean | 0.44 | 0 | 17.8 | 0.0 |
| Grass | 3.60 | 0 | 3.3 | 0.0 |
| Cost, Rs | | | 172272 | 189140 |
| *Fertilizer*[*] | | | | |
| Cow dung | 6.0 | 4.7 | 66.8 | 79.6 |
| DAP | 0.08 | 0.0 | 23.2 | 0.0 |
| Urea | 0.03 | 0.04 | 10.0 | 20.4 |
| Cost, Rs | | | 17960 | 11800 |
| [*] Pig manure contribution by the system | 2.6 | 8.2 | | |

The average proportion of feeding fish (grass carp, common carp and naini) is highest in both terai (72%) and hill (68%); this feeding fish model requires high inputs of feed. Although, feed costs did not differ between ecoregions, from an average of Rs 172272/ha/year in terai to 189140/ha/year in hill; better combination of feed ingredients including soybean cakes is used in terai. Direct costs (purchase) for fertilizer increase with productivity level, being highest in terai and low in hill (Rs 17960 and 11800/ha/year, respectively). However, in hill where filter-feeding fish dominate, manure use is relatively more important. This is demonstrated in survey data that the integrated ponds receive 11.9 t manure/ha/year in hill compared to manure use of 8.6 t/ha/year in terai (manure produced from the system included). Stocking of herbivore is favored in both regions and it is dominant in integrated pig-fish farming in terai, but the average cost for grass as major source of feed is very low (3.3% of the total feed cost).

**Pig rearing in pond dike**

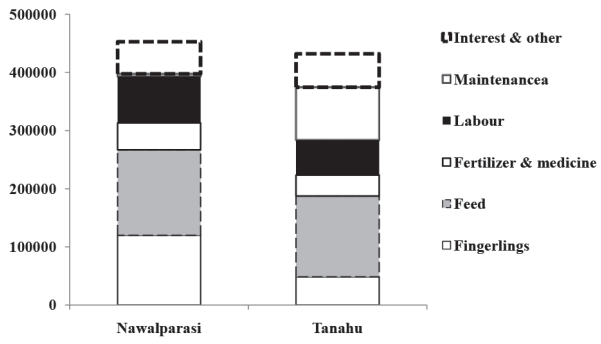


Figure 3. Proportional cost on feed relative to other input for fish farming

Rearing of pig in fish pond dike or adjacent field as the form of fish-animal integration was considered during survey. In that natural fertilizers generated in pig production are recycled into fish production. Farmers have constructed pigsties in pond dike to facilitate convenient washing of pig manures and wastes into the pond and daily discharge of manure heaped in localized place of pond. Overall average floor space provided for pig is 2.8 $m^2$/animal and the 35% deviation from the mean space has been measured in low and high side in terai and hill, respectively. One hill farmer in Tanahu has pig shade apart from pond where the urine

and dung of pigs are first allowed to the oxidation tanks (digestion chambers) of biogas plants for the production of methane for household use. The liquid manure (slurry) is then discharged into the fishponds through small ditches running through pond bunds. The purpose of pig rearing and its management are given in Table 5.

Table 5. Configuration of pig rearing in pond dike

| Description | Western terai (Nawalparasi) | Western hill (Tanahu) |
|---|---|---|
| Flore space of pigsties, $m^2$ | 75-125 | 90-230 |
| Piglets/adults, No/ha | 26 | 96 |
| Pig feed | Commercial feed and grass | Rice bran, kitchen wastes, vegetable leftover, By products of horlicks and confectionary |
| Purpose of rearing | Piglet (1) | Piglet (3) |
| | Fattening (1) | Fattening (2) |

Hybrid pigs (Yorkshire/Landrace/Duroc) are reared by the farmer for pig-fish system. However, there is no choice of the breeds for the farmer since the piglets are procured as and when the types of breeds available from nearby sources. The number of piglet/parents reared was based on farmer's own interest and management plan rather required manure loading rate to fertilize the fish pond. The survey data shows that the mean number of pig reared is 26 animal/ha in terai and 96 animal/ha in hill, which is about half and two folds of recommended density of pig to satisfy the nutrient requirement for fish, respectively (Table 5). The optimum dose of pig manure per hectare has been estimated as five tons for a culture period of one year. Such a quantity may be obtained from 50-60 well-fed pigs (TNAU, 2013). Farmers of both regions responded that they lack knowledge on manure response to fish and they developed integrated system empirically. Piglet input cost for pig rearing averaging 26.7% of total non-labor costs (Rs 711468) in survey data. Despite of less number of piglet reared per unit pond area in terai the relative cost for piglet being high (31.6% of the non-labor input costs) compared that of the hill (26.7%). The average cost of inputs for pig rearing in terai and hill is indicated Figure 3.

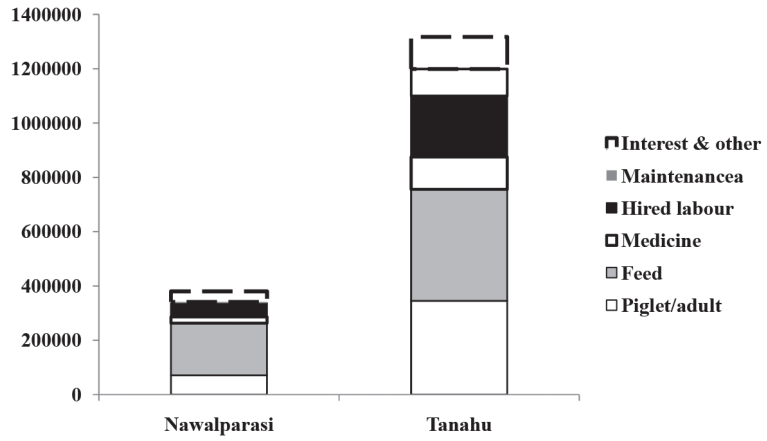


Figure 4. Proportional cost on various inputs for pig rearing

Similar to fish farming, feed represent the principal input cost for pig rearing averaging 47.7% of total non-labor costs in survey data. The major sources of food for pig are kitchen waste, wastage from hotels, local vegetation and in addition to these feed ingredients, rice bran is the main source of bulk to mix with these local ingredients in hill. Similar type of feeding management for pigs in rural Nepal has been reported by Osti and Mandal (2012). By

products from horlics and confectionary, mixed with aquatic plant spontaneously emerged in fish pond has been used by one farmer in hill to feed the pigs as these ingredients are available in cheaper price. Whereas farmers in terai tend to provide branded commercial feed to pig. These regional differences in feed and feeding practices for pig has clearly reflected in cost, where survey data revealed that 57.9% and 37.6% of the non-labour cost involved in feed in terai and hill, respectively.

**Production costs and income**

Production costs and income (revenue) of pig-fish integration and pig and fish subsystem from the survey data are provided in Table 6. In fish culture operation, feed and fish seed accounted for more than 32% and 26% of the operational cost in terai while feed (32%) and hired labor (14%) are the major inputs accounting 32% and 14% of the operational cost in hill, respectively. Since most of the ponds constructed in hill are located in terrace type landscape, significant proportion (21%) of variable cost involve in the yearly maintenance of ponds against land slide, clearing sediment and repair of dikes. Average variable cost accounted for more than 64% and 60% of the total cost and the fixed cost comes second (24.4% and 23.3%), respectively in terai and hill. Table 6 also summarizes fish yields, indicating the clear distinctions across ecoregions. The survey data show that average fish production levels in terai and hill were 5956 and 4208 kg/ha/year, respectively. The average net fish yield in Terai was approximately 1.4 times the respective value in hill ponds; this can be compared with stocking levels, which were 2.5 times higher by weight in terai. Average income also varied greatly between ecoregions being high in terai (Rs 1191300/ha/year) and low in hill (Rs 1052100/ha/year).

The most important component of pig rearing is feed which accounted 50% and 31.2% of operational cost in terai and hill, respectively. Osti and Mandal (2012) reported that 70% of total cost of production is from feeds in non-integrated pig production indicating that aquatic plant and farm produced vegetable offal might have contributed to reduce the cost for feed in integrated system in hill. The cost of piglet (18.9% and 26.2%) and the cost of hired labor (13.5% and 17.0%) accounted second and third proportion of the operational cost, respectively, in terai and hill. Variable cost accounted for more than 83% and 90% of the total cost and the rest was divided between fixed and imputed cost in terai and hill, respectively. Average piglet production and the yield of fattening pigs corresponding to the initial stocking levels of in both ecoregions. The survey data show that average number of piglet production in terai and hill was 90 and 276/farm/year, and average yield of fattening pig was 1600 kg and 6300 kg/farm/year, respectively. Average income also varied greatly between ecoregions being low in terai (Rs 510000/farm/year) and high in hill (Rs 1993800/farm/year).

The average share of variable cost, fixed cost and owned input was more than 71%, 10% and 17% of the total cost in terai and 80%, 8% and 10% in hill, respectively, for the surveyed integrated pig-fish farms. Survey data show that the gross incomes from integrated pig-fish farming varied greatly between the two regions, being low in terai (Rs 1701300/ha/year) and approximately 1.8 times high in hill.

Table 6. Average cost and revenue (rupee in thousand) of pig-fish integrated farms in terai and hill

| Cost and return variables | Western terai (Nawalparasi) | | | Western hill (Tanahu) | | |
|---|---|---|---|---|---|---|
| | Fish | Pig | Total | Fish | Pig | Total |
| ***Variable cost , VC*** ( fingerlings, piglets, feed, lime, fertilizer, medicine, electricity, hired labour, maintenance, transportation, interest on operating capital) | 452.9 | 380.7 | 833.6 | 432.2 | 1317.9 | 1750.1 |
| | (104) | (68) | (253) | (140) | (428) | (568) |
| ***Fixed cost*** (Depriciation of ponds, pig shed, irrigation canal, facilities and interest on fixed cost) | 80.2 | 40.4 | 120.6 | 115.7 | 70.9 | 186.6 |
| | (29) | (17) | (52) | (42) | (21) | (114) |
| ***Owned inputs*** (Opp. Costs, family labour, land use ) | 172.0 | 35.7 | 207.7 | 166.4 | 67.0 | 233.4 |
| | (24) | (9) | (42) | (11) | (19) | (45) |
| | 705.1 | 456.8 | 1161.9 | 714.3 | 1455.8 | 2170.1 |
| | (167) | (102) | (316) | (356) | (462) | (774) |
| ***Total costs*** | | | | | | |
| ***Yield*** | | | | | | |
| Fish yield, kg/ha | 5956 | - | 5956 | 4208 | - | 4208 |
| Piglet, No. | - | 90 | 90 | - | 276 | 276 |
| Fattening, kg | - | 1600 | 1600 | - | 6300 | 6300 |
| | 1191.3 | 510.0 | 1701.3 | 1052.1 | 1993.8 | 3045.9 |
| ***Gross Revenues, GR*** (fish, piglets and fattening pig sale) | (217) | (68) | (416) | (31) | (450) | (522) |

**Profits**

Profitability of fish farming was higher than piggery operation in terai while the profitability was in reverse order in hill in terms of income and profit indicators. Net profit, which is the net of the opportunity costs of owned factors of production, was Rs 486200 and Rs 53200 in terai and Rs 337800 and Rs 538000 in hill from fish and pig subsystem, respectively. Net profit for integrated system was Rs. 539400 and Rs 875800/ha/year in terai and hill, respectively. Alternative concepts of profitability in terms of rate of return to capital and total investment was much higher in fish farming than the pig rearing operation. This is approximately 6 and 1.3 times higher for fish to that of the piggery in terai and hill, respectively (Table 7).This means that fish farming operation has a significant role to recover the investment made in pig farming in both regions.

**Table 7.** Profits and rate of returns from integrated fish-pig farming in terai and hill

| Returns | Western terai (Nawalparasi) | | | Western hill (Tanahu) | | |
|---|---|---|---|---|---|---|
| | Fish | Pig | Integration | Fish | Pig | Integration |
| Operating profit[1] | 738.4 | 129.3 | 867.7 | 619.9 | 675.9 | 1295.8 |
| Net income[2] | 658.2 | 88.8 | 747.0 | 504.1 | 605.0 | 1109.1 |
| Net profit | 486.2 | 53.2 | 539.4 | 337.8 | 538.0 | 875.8 |
| Rate of returns | | | | | | |
| Rate of return to CI[3] | 91.2 | 12.6 | 56.5 | 61.6 | 38.7 | 45.2 |
| Rate of return to TI[4] | 69.0 | 11.6 | 46.4 | 47.3 | 37.0 | 40.4 |
| Ratio of net profits to VC | 1.1 | 0.1 | 0.6 | 0.8 | 0.4 | 0.5 |
| Ratio of net profits to GR | 0.4 | 0.1 | 0.3 | 0.3 | 0.3 | 0.3 |

[1]Operating profit = gross revenue - variable costs,

[2]Net income = return to owned inputs = operating profit - fixed costs,

[3]Rate of return to capital investment (CI) = (return to capital and management/capital investment) x 100,

[4]Rate of return to total investment (TI) = (return to land, capital, and management/total investment) x 100.

**Discussion**

Attempts has been made to present a comparative overview of structural and economic aspects of integrated pig-fish farming of Nepal, emphasizing differences between ecoregion, western terai (Nawalparasi) and western hill (Tanahu) and stocking models of fish and pig. It has been suggested that differences between ecoregion can be traced to variation of both (1) micro factors controllable at the farm level, particularly the levels of input, and (2) macro aspects of the broader environment, including climate, topography, culturing tradition, technology availability and the consumer demands.

Development issue differs notably between ecoregions, influenced in part by local climatic condition, farming tradition and availability of production inputs and technology. For example, warmer terai region, where fish farming has long experience supported by easy access of fish seed, feed, fertilizer and production technology, farmers tend to utilize higher input levels, so as to increase output levels in response to relatively high market demand for fish. In terai with relatively high productivity and high stocking densities, filter feeders comprise only 28% stocking by weight and 25% by cost. Corresponding to manure required for low density of filter feeder fish, farmers in this region has preferred to stock low density of pig (26/ha). In this area, feeding fish-herbivore (grass carp) and omnivore are of greater importance, comprising 72% of stocking by weight and 75% by cost.

Clear differences exist in integrated pig-fish farming across ecoregions. In hill, where fish farming is relatively young and long tradition of backyard pig farming, there is a trend toward more integrated fish farming methods, with key strategy being (a) to promote production by expanding the market for fish and (b) to emphasize the integration of fish with pig production which is in traditional setting. Fish production is low in this region relative to terai despite

of high density of pig per unit pond area (96 pig/ha) and filter feeder fish which comprised 32% by weight and 27% by cost of the total stocking of fish. Farmers still prefer to stock high proportion of omnivore (56% by weight and 61% by cost). This stocking structure seems to reflect differing consumer preferences, climatic variation, topography influencing water use pattern in ponds, tradition and lack of suitable technology for integrated fish farming in the hill. For example, being relatively cooler region and diurnal water loss from ponds in terraced landscape in hill, the production of filter feeder fish (silver and bighead carp) is weakly favored by natural food production in the pond. Habit of fish consumption for hill people is relatively new to that of pork (for certain dominant community) in the region, therefore farmers tended grow less bony fish omnivore (common carp) and integrate with large number of pig in order to satisfy the consumer preference in hill.

There is considerable variation in both the absolute levels of net income and profits, and their relative magnitudes of integrated pig-fish farming system between regions. Comparing total income and net income levels (Table 6 and 7), it can be observed that costs are somewhat greater fraction of gross earnings in hill than in terai (72% vs. 68%). This is why total income is over 2.5 times higher in the former relative to the later, but net income is only 1.5 times higher. This indicates that there is need to increase production levels of both fish and pig by increasing productivity through improving land and labor productivity, and reducing feed costs in hill. To this end some technology transfer from productive terai region may be needed.

## CONCLUSION

From the present study a general conclusion drawn was that the farmers in terai tend to emphasize the rearing of hervivore fish (48%) with low density of pig and in hill feeding fish (42.5%) are of greater importance with high density of pig. Differences in productivity and profitability of integrated pig-fish farming between ecoregions was traced to variations of micro factors (input level and skill) and macro aspects of the broader environment (climate, topography, tradition, technology, consumer demand). These on-farm and macro differences must be addressed when considering the potential for technology transfer and in designing research activities.

## ACKNOWLEDGEMENT

This research was supported by Nepal Agricultural Research Council (NARC) under Project No.32069001. Fisheries Development Officer Mr. Madhav Prasad Dahal of Agriculture Development Office, Nawalparasi is acknowledged for his cooperation during the field survey. This work could not have been done without the support and cooperation of farmers of respective survey regions.

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# TEMPORAL CHANGES ON THE PHYTOPLANKTON DIVERSITY AND ITS IMPLICATION IN FISHERIES MANAGEMENT OF PHEWA LAKE, NEPAL

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## ABSTRACT

*Increase in eutrophication of Phewa Lake has been experienced due to increase in intensive agriculture and urbanisation in its watershed. Study on the changes in phytoplankton community is one of the key indicators for understanding the rate of eutrophication. Time series data on phytoplankton community have been collected from year 1993 to 2010 to know the shifts in diversity, quality and quantity of phytoplankton from phyla to species level. Three phyla and nine species of phytoplankton were not appeared in the year 2010 where as these were abundant in year 1993. One new species Planctonema lauterbornii was appeared during the year 2010. The annual mean density of phytoplankton was increased by 1055 cells.ml$^{-1}$ in the year 2010 as compared to the year 1993. This indicated that shifted in the diversity, quality and quantity of phytoplankton phyla to species level due to cultural eutrophication in this Lake. Annual mean density of Microcystis aeruginosa was increased by three times in water of Phewa Lake in the year 2010 as compared to the year 1993. The possible impact of these changes in phytoplankton community on fisheries of Phewa Lake and possible measures to combat eutrophication in this magnificent lake has been discussed.*

**Key words:** Eutrophication, Phytoplankton, *Microcystis aeruginosa,* Phewa Lake

## INTRODUCTION

Phytoplankton is the base of the food chain. It is govern by the levels of important nutrients such as N, P, morphometry and drainage from the catchments areas of a Lake. Abundance, composition and activity of phytoplankton affect dynamics of other organisms. Study on the changes in phytoplankton community is one of the key indicators for understanding the rate of eutrophication(Wetzel, 2006).

Lake Phewa is a small mountainous lake, and there are well-established tourism activities in its catchment area. This lake is located in a typical mountain environment in central Nepal, where the highest rainfall reaches up to 4846 mm per year (Oli 1997; Paudel & Thapa 2001). The livelihood of 80 Jalari fisher families largely depends on the aquaculture and fisheries of this lake. The total estimated fish production is around 180 mt with monetary value NRs.47 millions from Phewa lake in 2011. Increase in eutrophication of Phewa Lake has been experienced due to increase in intensive agriculture and urbanisation in its watershed (Oli, 1997).This paper highlighted the temporal changes in phytoplankton community during 25 years and its possible impacts on fisheries of Phewa Lake.

## Materials and methods

### Study area

The Lake Phewa watershed is located in south-west Pokhara Valley (28°7'N to 28°12'N and

84°5'E to 84°10'E) in Nepal, and occupies an area of ~123 km2, between 782 and 2508 m.a.s.l. It has a length and width of ~17.0 and 7.0 km, respectively. Of the total catchment surface area, 4.43 km$^2$ is occupied by the lake, which has an average and maximum depth of 8.6 and 23.5 m, respectively (Gurung et al. 2006).

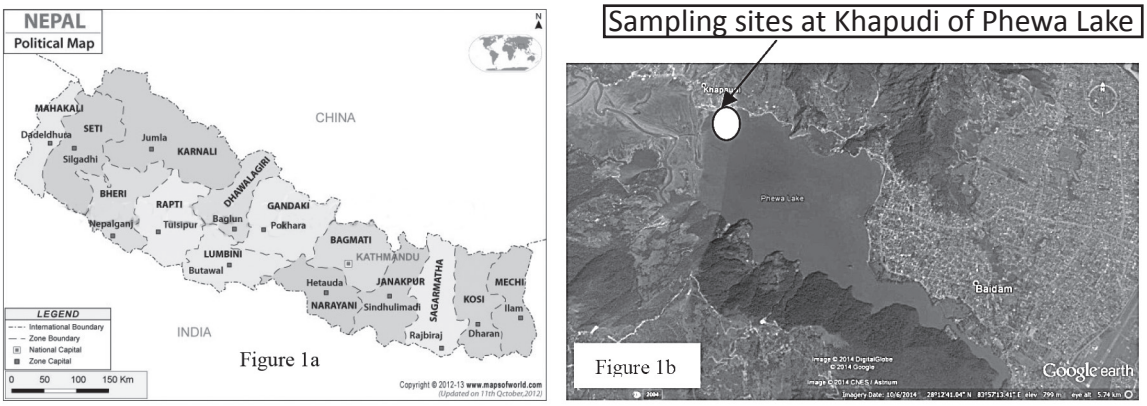


Figure1. (Fig.1a) Maps of Nepal showing locations of Pokhara valley in Nepal and satellite map of Phewa Lake with sampling sites (Fig.1b).

**Sampling and data analysis**

Water samples for phytoplankton were collected monthly in every year from 1993 to 2010 at a site located at the north-west end of the Lake (Khapudi), from surface, 2.5m, 5.0m, 7.5m and 10m depth. 100-ml water sample from each depth was treated with acid Lugol's solution and left overnight in sedimentation chamber. Concentrated phytoplankton samples were enumerated quantitatively with haemocytometer, using a compound microscope at 200 µ magnification. Distribution of major groups of phytoplankton across water column was calculated using Excel ver 7 and SPSS var 17. Data on phytoplankton community have been analyzed for year 1993 and 2010 to know the shifts in diversity, quality and quantity of phytoplankton from phyla to species level. Previous phytoplankton studies in the water column of Phewa Lake were compared with the present study.

**Results**

The phytoplankton phyla richness has been decreased in Lake Phewa by 44% and species richness by 48.7% following 25 years in Lake Phewa(Figure 1& 2). Three phyla and nine species of phytoplankton were not appeared in the year 2010 where as these were abundant in the year 1993(Table 1). One new species *Planctonema lauterbornii* was appeared during the year 2010. The phyla Cyanophyceae was increased in number of cells by 34.5% where as Chlorophyceae decreased by 21.1 %, Bacillariophyceae by 5.3% and Dinophyceae by 7.2% of total phytoplanktonic organism in water of Phewa Lake in the year 2010 as compared to the year 1993(Table 2). The annual mean density of phytoplankton was increased by 1055 cells. ml$^{-1}$ in the year 2010 as compared to the year 1993. Annual mean densities of *Microcystis aeruginosa* have been increased from 542 cells.ml$^{-1}$ in the year 1993 to 1706 cells.ml$^{-1}$ in the year 2010. The percentage composition of *Microcystis aeruginosa* in total phytoplankton community has increased by 30.3% from 33.4% in 1993 to 63.7% in 2011 in water of Phewa Lake.

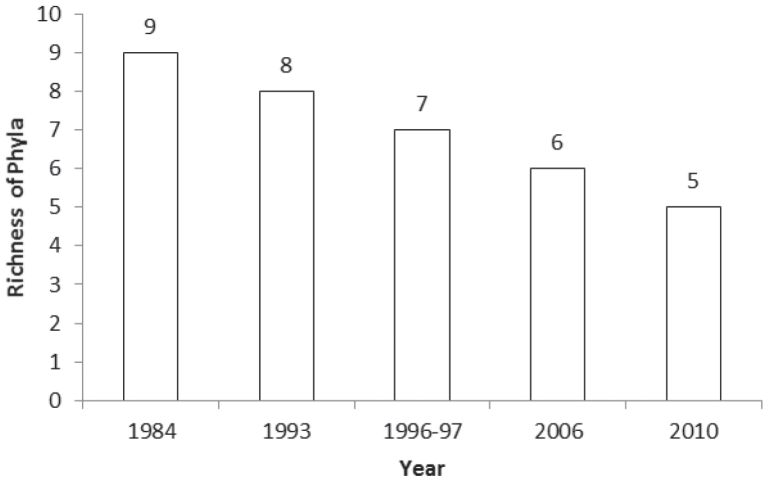


Figure 2. Changes in richness of Phyla of phytoplankton(1984-2010).Data from :Ishida yuzabaro, 1986; Nakanishi et al.,1988; Dhakal et al. 1998; Gurung et al., 2006; Dhakal et al. 2009 and Present study.

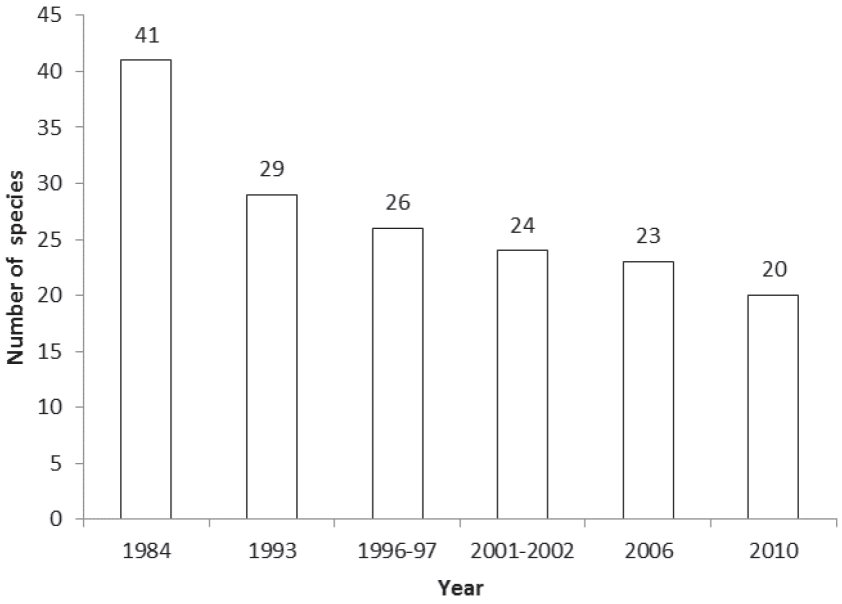


Figure 3.Changes in richness of species of phytoplankton (1984-2010).Data from :Ishida, yuzabaro, 1986; Nakanishi et al.,1988; Dhakal et al., 1998; Gurung et al.,2006; Dhakal et al., 2009 and Present study (1993 and 2010).

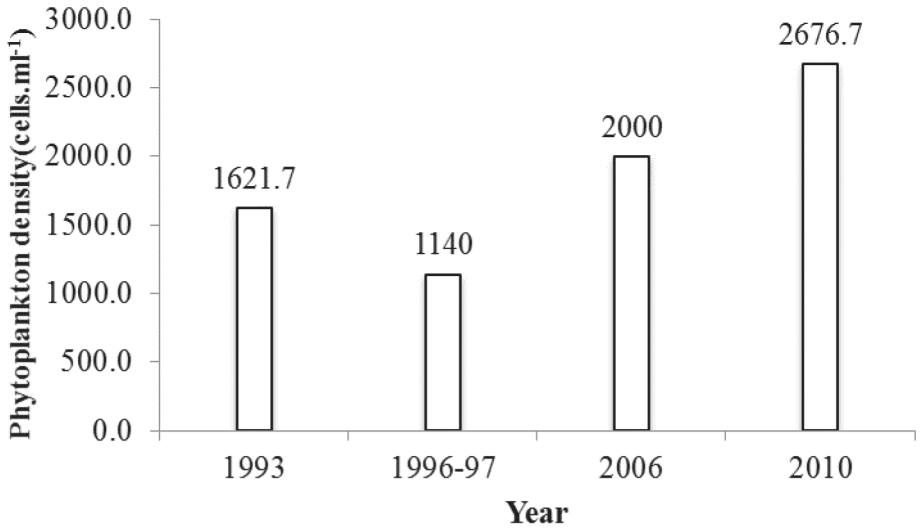


Figure 4.Phytoplankton density in Phewa Lake (1993-2010).Data from: Dhakal et al., 1998; Gurung et al., 2006; Dhakal et al., 2009 and present study (1993 and 2010).

**Table 1**. Phytoplankton phyla and species diversity during 1993-2010 in the water column of Phewa Lake.

| | | Year | | |
|---|---|---|---|---|
| | | 1993 | 2010 | Diffrence |
| **No.** | **Phyla** | **8** | **5** | **3** |
| | | Species | | |
| 1 | Cyanophyceae | 3 | 3 | 0 |
| 2 | Dinophyceae | 2 | 2 | 0 |
| 3 | Cryptophyceae | 1 | 1 | 0 |
| 4 | Bacillariophyceae | 6 | 4 | 2 |
| 5 | Chlorophyceae | 14 | 10 | 4 |
| 6 | Euglenophyceae | 1 | absent | 1 |
| 7 | Chrysophyceae | 1 | absent | 1 |
| 8 | Cryptonophyceae | 1 | absent | 1 |
| | **Total species** | **29** | **20** | **9** |

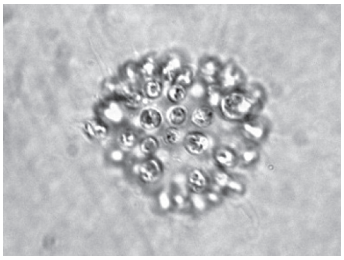

Figure 5.*Microcystis aeruginosa*

**Table-2**.Changes in richness (%) of phytoplankton in the water of Phewa Lake (1993-2010).

| Phytoplankton diversity | Year | | Changes |
|---|---|---|---|
| Phyla | Richness (%) | | |
| | 1993 | 2010 | % increased |
| Cyanophyceae | 37.8 | 72.24 | 34.5 |
| Cryptophyceae | 0.22 | 0.54 | 0.3 |
| | | | % decreased |
| Bacillariophyceae | 14.23 | 8.90 | 5.3 |
| Dinophyceae | 14.68 | 7.50 | 7.2 |
| Chlorophyceae | 32.40 | 11.26 | 21.1 |
| Cryptonophyceae | 0.06 | absent | 0.06 |
| Euglenophyceae | 0.02 | absent | 0.02 |
| Chrysophyceae | 0.62 | absent | 0.62 |

**DISCUSSION**

The results showed decreasing trends of phyla and species richness of phytoplankton communities during 25 years but density (cells $ml^{-1}$) have been increased in Phewa Lake. This indicated that major changes in the diversity, quality and quantity of phytoplankton phyla to species level in the water column of Phewa Lake. It may be due to cultural eutrophication in this Lake. The present results showed that the percentage composition of *Microcystis aeruginosa* has increased by two times in lake water of Phewa. The dominance of *M. aeruginosa* in Lake Phewa could indicate eutrophication impacts (Gurung et al., 2006). A high abundance of *M. aeruginosa* as the dominant phytoplankton is often taken as an indication of cultural eutrophication (Lee et al. 2000; Kim et al. 2001; Wetzel 2006). Microcystis can affect phytoplankton community composition through allelopathy (Legrand et al., 2003). Many studies have demonstrated the effect of Microcystis or its toxins on zooplankton growth and survival (Ghadouani et al., 2006; Federico et al., 2007).

At higher trophic levels, *Microcystis* sp. blooms affect fish health through impacts on growth rate, histopathology, and behavior (Malbrouck & Kestemont, 2006).The Phewa Lake fisheries may be affected by *M.aeruginosa* dominance by shifting in the populations of sensitive local species to toxin of Microcystis and species not sensitive of that toxin will be promoted. Microcystis is considered a toxic species contain powerful hepatotoxins called microcystins that initiate cancer and promote tumor formation in the liver of humans and wildlife (Zegura et al., 2003; Ibelings & Havens, 2008). However, eutrophication of the lake might not yet have been fully realized because monsoon rains might have helped buffered the lake against further degradation, particularly from eutrophication (Gurung et al., 2006). The Phewa lake eutrophication should be managed in time to overcome the harmful effect on the fisheries activities related to livelihood of Jalari community and also to conserve the beauty of lake related to the tourism.

## CONCLUSIONS

The dominance of *Microcystis aeroginosa* in Phewa Lake indicated eutrophication impacts. Monsoon season is an important event affecting the phytoplankton abundance and composition in Lake Phewa. Point and non-point sources of pollutions need to be regulated to check the further deterioration (eutrophication) of lake.

## ACKNOWLEDGEMENT

We thanks to all staffs of ARS(Fisheries), Pokhara. This study was supported by NARC project No 62359001.

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# POND AQUACULTURE PRODUCTION AND PRODUCTIVITY ESTIMATES OF SOUTHERN TERAI AND MID-HILL AGRO-ECOLOGICAL REGIONS OF NEPAL

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## ABSTRACT

*Major pond aquaculture production from southern tropical and mid-hill subtropical agro-ecological regions of Nepal comprises of indigenous (Indian) major carp and Chinese major carp. These carp are Labeo rohita (Rohu), Cirrihinus mrigala (Naini), Catla Catla (Bhakur), Ctenopharyngodon idella (Grass carp), Hypopthalmichthys molitrix (Silver carp), Aristichthys nobilis (Bighead carp), and Cyprinus carpio (Common carp). Carp pond aquaculture has been established in tropical areas, however, the technology also spread up towards hill districts as well. The national average of carp aquaculture production has been estimated to be about 3.9 m ton.ha$^{-1}$. year$^{-1}$ in 2012/13, with highest 5.4 mt.ha$^{-1}$.year$^{-1}$ from Bara district of southern tropics. The production estimates from mid-hill region covering from 400-1200 m elevation has rarely been carried out. Therefore, the aim in this paper was to estimate and compare the carp aquaculture production and productivity from subtropical mid-hill regions. For the purpose, we performed a field survey using the pre-structured questionnaire from 10 districts, 2 from tropical plain and 8 from hill districts. The results showed that the carp aquaculture productivity from 8 mid-hill districts was 0.7 mt.ha$^{-1}$.year$^{-1}$, which is far lower than the southern plain. However, the average national productivity from mid hill and mountain district was 2.1 mt.ha$^{-1}$.year$^{-1}$in 2012/13, proving the fact that indeed the carp introduced into the country more suitable for tropical agro-ecological condition. However, only the fish species is not a factor for production constraints. It is therefore, recommended that cultivation of carps can be done in subtropical mid-hill areas, but to gain economic feasibility more suitable species which can be reared in intensive fish culture system and/or new innovative technologies with adequate inputs might fulfil the ever increasing demand and market opportunities of fish products in Nepal.*

**Keywords**: pond aquaculture, mid-hill region, major carps, economic feasibility, intensive fish culture.

## INTRODUCTION

The fisheries and aquaculture sector is a vital source of livelihoods, nutritious food and economic opportunities. Aquaculture is being one of the fastest-growing and a blooming food production sectors throughout the world. It has a key role to play in supporting to meet one of the world's greatest challenges: feeding a population set to rise to 9.6 billion people by 2050 (FAO, 2014). According to FAO estimation, one third of the world's population relies on fish and other aquatic products and at least 20% of their protein intake contributed by the aquaculture production (Dulvy and Allison, 2009). Fish is an important source of nutrients with high quality protein and wide variety of vitamins, such as A and D and minerals such as calcium,

magnesium, iron and iodine and many other amino acids. Even in the small quantities, fish have a positive effect on nutritional status. It provides essential amino acids that are deficient in staple foods such as rice or cassava and other vegetable diets (FAO, web page). The number of fishers in the world has grown by 400% since 1950, compared with a 35% increase in the number of agricultural workers over the same period (IFAD, 2010). In Nepal, aquaculture is based on inland fish farming utilizing freshwater resources with activities required for aquatic agricultural practices under control conditions. Recently, fish production has been one of the fastest growing food producing activities with generating employment in Nepal similar to many parts of the world (De Silva 2012). Nepal has an ample of water resources comprises warm and coldwater resources (Table 1). However, only 10,927 ha (about 1.3%) have been utilized for aquaculture by the year 2012 (DoFD, 2013).

Table 1: Estimated water resources area (ha) potential for fisheries and aquaculture in Nepal

| Resource details | Estimated area (ha) | Coverage percent | Future projection (ha) | Remarks |
|---|---|---|---|---|
| **Natural water** | **401500** | **48.9** | | |
| Rivers | 395000 | 48.1 | | |
| Lakes | 5000 | 0.6 | | |
| Reservoirs | 1500 | 0.2 | 78000 | |
| **Village ponds** | **8020** | **1.0** | **14000** | |
| **Seasonal water** | **411800** | **50.1** | | |
| Marginal swamps | 13800 | 1.7 | | |
| Irrigated rice fields | 398,000 | 48.4 | | |
| **Total** | **821320** | **100.0** | | |

Source: DoFD (2013)

Pond aquaculture in warm water is the major activity of fish production from southern tropical and few from mid-hill subtropical agro-ecological regions of Nepal. Main species included in warm-water aquaculture comprises of indigenous major carp and Chinese major carp. These carp are *Labeo rohita* (Rohu), *Cirrihinus mrigala* (Naini), *Catla Catla* (Bhakur), *Ctenopharyngodon idella* (Grass carp), *Hypopthalmichthys molitrix* (Silver carp), *Aristichthys nobilis* (Bighead carp), and *Cyprinus carpio* (Common carp) (Gurung, 2013; Wagle and Pradhan, 2013). The history of aquaculture was started in 2003 BS (1946/47), when it was institutionalized by establishing "Fisheries Unit" under "Agriculture Council" and the first ever fisheries development program was launched in 2004 BS (1947/48 AD). However, modern aquaculture was started from late 1950s by introducing exotic species the Common Carp (Rajbanshi, 1980; Swar and Nepal, 1998).

Carp pond aquaculture has been established in tropical areas, however, the technology also spread up towards hill districts as well. Total national fish production was 57,520 m ton in 2012/13. Among the national production 36020 m ton (62.6%) is production from various types of aquaculture activities, whereas rest 37.4 % is from capture fisheries (Table 2). Almost 97% pond area is concentrated in terai, which contributed about 99% of fish out of

pond production. In general, the fish production per capita is low, around 2.14 kg based on production projection by government statistics (Table 2), but shows steadily increasing trend in Nepalese diets since last so many decades (Gurung, 2013; Mishra and Kunwar, 2014).

At present Fisheries Research Division under Nepal Agricultural Research Council (NARC) is responsible to lead with mandate on carrying out fisheries and aquaculture research and technology development in the country, whereas Directorate of Fishaeries Development (DoFD) is the focal governmental organization under Department of Agriculture (DoA), Ministry of Agricultural Development (MoAD) for aquaculture development. Although, the contribution of fish farming is low comparing to general agriculture and livestock sectors, but has been gradually increasing its role and importance as one of agriculture's commercial endeavour in Nepal.

**Table 2**. Status of aquaculture and fisheries production (2012/13) in Nepal (DoFD, 2013).

| Particulars | Total area (ha) | Fish Production (m ton) | Yield kg.ha$^{-1}$ |
|---|---|---|---|
| 1. Production from quaculture practices | | 36020 | |
| **1.1. Pond fish culture** | 8020 | 31221 | 3893 |
| 1.1.1 Mountain | 5 (0.06) | 9 (0.03) | 1800 |
| 1.1.2 HILL | 210 (2.62) | 440 (1.41) | 2095 |
| 1.1.2 terai | 7805 (97.32) | 30772 (98.56) | 3943 |
| 1.2. Swamp and other wetlands | 2700 | 4050 | 1500 |
| 1.3. Rice-fish culture | 100 | 45 | 450 |
| 1.4. Cage fish culture ($m^3$) | 60000 | 360 | 6/$m^3$ |
| 1.5. Enclosure fish culture | 100 | 140 | 1400 |
| 1.6. Trout Culture in Raceway ponds ($m^2$) | 10000 | 180 | 18/$m^2$ |
| 1.7. Fish production from public sector pond | | 24 | |
| **2. Production from capture fisheries** | | 21500 | |
| 2.1. Rivers | 395000 | 7110 | 18 |
| 2.2. Lakes | 5000 | 850 | 170 |
| 2.3. Reservoirs | 1500 | 385 | 257 |
| 2.4 Marginal swamps/wetlands | 11100 | 5990 | 540 |
| 2.5. Irrigated lowland paddy field | 398000 | 7165 | 18 |
| Total Fish Production | | **57520** | |

Percentage in parenthesis

Aquaculture has been playing a significant role in employment generation in Nepal. There are 565,000 populations from 155,000 families involved directly in fisheries and aquaculture activities (DoFD, 2013). Among the total population engaged in this business, female comprises 33% (Mishra and Kunwar, 2014). According to the nutrition security plan of action of Agriculture Development Strategy (ADS) prepared for Government of Nepal, fisheries and aquaculture program will be given especial focus for research and development activities. Present productivity (Table 2) will be reached to achieve 10 mt.ha$^{-1}$ by the 20 years period (ADS, 2013). It is expected that in near future the trend of fish consumption would increased steadily in the country. The river basins and foot-hill valleys of mid-hill districts are feasible for carp aquaculture. However, the area coverage in mid-hill and mountain district is very

low in comparison with terai districts (Tabe 2). Although, the potentiality and climate is in favour, production of fish is low in mid-hills due to some constraints existing in this area. The production estimates from mid-hill region covering from 400-1200 m elevation has rarely been carried out. Therefore, the aim in this paper was to estimate and compare the carp aquaculture production and productivity from subtropical mid-hill regions. This paper will present the status of aquaculture and related information in respective districts for estimation of production and productivity for further improvement in mid-hill agro-ecological region of Nepal.

## Materials and Methods

For the purpose of study, we performed a field survey using the pre-structured questionnaire from 10 districts, 2 from tropical plain and 8 from hill districts. A baseline study was carried out from October to December 2012 in these 10 districts, namely Bara and Sunsari from terai and Ilam, Ramechhap, Nuwakot, Gorkha, Tanahu, Kaski, Baglung and Syangja form mid-hill region (Fig.1) Selected districts were under the "Project, Fish Farming Development in Nepal (FFDN)". So, the cost of study was borne by the FFDN Project. Data collection was carried out through the Agriculture Research Stations (Fisheries), Pokhara, Trishuli, Kali Gandaki Fish Hatchery Beltari, Syangja, Regional Agriculture Research Stations (RARS) Tarhara, RARS Parwanipur, and Fisheries Research Division Godawari under the command districts of respective research stations. For data collection all of the above institutions contacted the district level stakeholder institutions such as District Agriculture Development Offices (ADOs) and District Development Committee (DDC). At the central level the national aquaculture data were also verified with the Directorate of Fisheries Development (DoFD) and Agricultural Statistics Office under Ministry of Agricultural Development (MoAD) in Kathmandu.

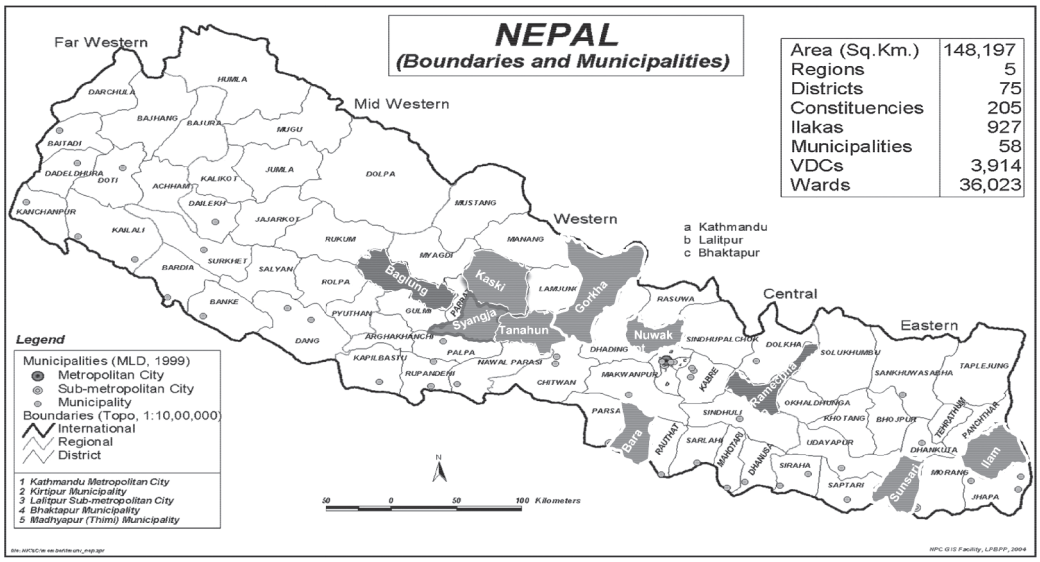


Figure 1. Map of Nepal showing ten districts of study area.

For the purpose structured questionnaire, interviews, secondary information (DoFD reports, ADO annual report, district profile, CBS report) were analyzed. Secondary data was collected by reviewing both print and electronic documents. Key informant interviews were conducted with Fisheries Officers, farmers and farm managers. National production data and records were analyzed and verified form reports published from DoFD. This study has been covered

only the pond aquaculture area and production from aforesaid 10 districts. It is not included the production of cage (lake), enclosure, rice-fish and captured fish from natural water bodies in each district, which may increase the total level of production of respected districts and contributes to the data of national fish production.

### Data analysis

All data collected was used to develop analytical and theoretical explanations. The quantitative information has been analyzed using simple descriptive statistics package available in Microsoft Excel 2007.

## RESULTS

### Ponds and area for fish farming

Among the 10 districts of study area, the number of fish pond, water surface area, and production showed that Bara has the highest number (2139) of ponds with 826 ha of water surface area and 4625.6 metric ton of fish production in year 2012 (Table 3; Fig 2, 3). The pond fish production rate was highest in Bara district having a value of 5.6 m ton of fish production from a hectare in a year. Ramechhap was the district having least number of ponds and pond area, 11 and 0.35 ha respectively. Average rate of production remained 4324 kg per hectare in the ten study districts. However, the major area and production contributed by the tropical districts. This study showed that about 84% pond area and 97% production concentrated in terai region, where, 2 tarai district vs 8 hilly districts data are calculated (Fig. 4: A; B). It states that very low productivity is there in hilly districts. The pond fish production rate was least in Baglung having 857 kg followed by Syangja 1000 kg per ha per year (Table 3).

Table 3. Pond number, water area, fish production and productivity in study districts (2012).

| District | Pond No. | Pond Area (ha) | Fish production (m ton) | Productivity, kg.ha$^{-1}$ |
|---|---|---|---|---|
| Bara | 2139 | 826.00 | 4625.60 | 5600 |
| Sunsari | 1173 | 247.00 | 765.70 | 3100 |
| Kaski | 158 | 23.50 | 50.60 | 2130 |
| Gorkha | 80 | 10.00 | 35.00 | 3500 |
| Tanahun | 173 | 157.00 | 34.54 | 2200 |
| Nuwakot | 267 | 2.45 | 5.00 | 2041 |
| Ramechhap | 11 | 0.35 | 1.00 | 2857 |
| Ilam | 165 | 5.00 | 11.00 | 2200 |
| Syangja | 80 | 8.00 | 8.00 | 1000 |
| Baglung | 30 | 1.40 | 1.20 | 857 |
| Total | 4276 | 1280.7 | 5537.64 | Av. 4324 |

### Total pond fish production in the project area

The total fish production includes those produced from ponds, raceways, rice field, cages, rivers and lakes (Fig 1, 2). Among all the 10 districts highest fish production was in Bara district, reaching 4625.6 m ton in year 2012. The second highest production was in Sunsari followed by Kaski. In Sunsari the production was 765.7 m ton, while in Kaski the production was 50.6 m ton. The least fish production was occurred towards the hill districts such as 1.0 m ton in Ramechhap followed by 1.2 m ton in Baglung in 2012 (Fig. 2). Among other lower production

hill districts the highest was in Nuwakot, comparing in Gorkha and Tanahu. In Ramchap, Ilam and Syangja districts total fish production was very low ranging from 1 to 11 metric ton only (Fig 2).

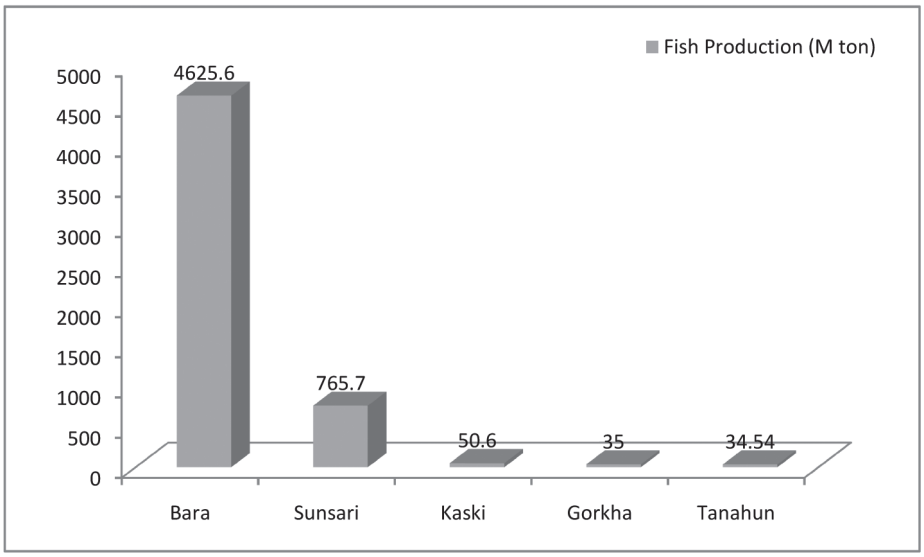


Figure 2: Fish production (m ton) in five higher potential districts/study area

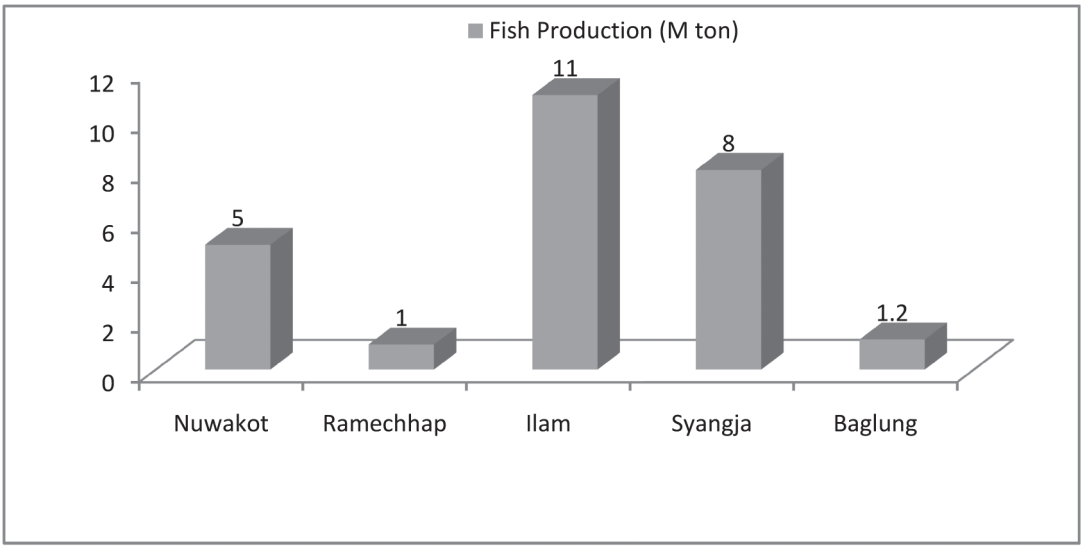


Figure 3. Fish production (m ton) in lower potential hill districts/project area

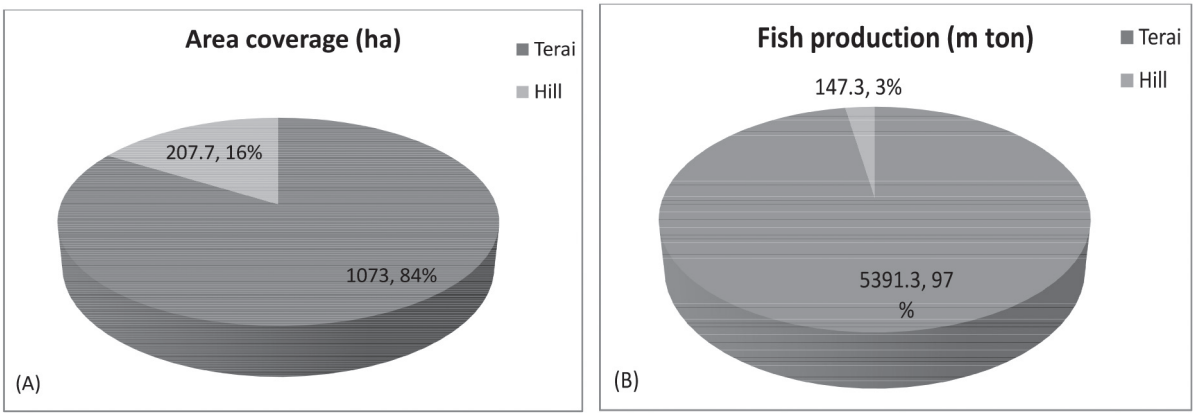


Figure 4. (A) Area coverage and (B) fish production in terai (2) and hills (8) districts

**Pond owned by women and Janjati in the study area**

In category of pond owned by women and janjati in 10 districts under the study area, highest number of ponds occurred in Bara district with highest water surface. The recorded number of pond in Bara was 1450 and area 25 hectare under this category (Table 4). In Sunsari the women and Janjati operated ponds were 102 with 35 hectare of area. In Kaski, Tanahu, Nuwakot no ponds were found to be operated by these specific group of community. In Ramechap and Sanjya, only 2-3 ponds with very small area were operated by the women and ethnic community (Janjati).

**Table 4**. Pond number and area owned by women and Janjati

| District | Pond No. | Area (ha) |
|---|---|---|
| Bara | 1450 | 25.000 |
| Sunsari | 102 | 35.000 |
| Kaski | - | - |
| Gorkha | 25 | 0.225 |
| Tanahu | - | - |
| Nuwakot | - | - |
| Ramechap | 3 | 0.125 |
| Ilam | 22 | 0.500 |
| Sanjya | 2 | 0.070 |
| Baglung | 13 | 0.600 |

**Source of fish seed: Carp hatcheries**

The number of carp hatcheries in private sector was only few in the study area. The highest, four hatcheries are operated in Bara followed by only one in Sunsari in private sector. Seven government owned hatcheries, five under the NARC and two under Department of Agriculture (DoA) have been supplying fish seed to the districts of the surveyed. The five carp hatcheries and few nurseries in private sector have been supporting to the fish farmers by supplying required fish seed (fry and fingerlings) in the districts. The information collected on sources

of carp seed to the districts revealed that there was more than a single source of fish seed in most of the districts (Table 5). In some districts there were none of hatchery or nursery but it was probably some vendors played the role as seed distributers.

Table 5. Source of fish seed in surveyed districts

| Districts | Public hatchery | Private hatchery | Private Nurseries | Vendor |
|---|---|---|---|---|
| Bara | + + | + + | + + | + + |
| Sunsari | + + | + + | + + | + + |
| Kaski | + + | + | + + | |
| Gorkha | + + | | + + | |
| Tanahu | + + | | + + | |
| Nuwakot | + + | | + + | |
| Ramechap | + + | | | |
| Ilam | + + | | + | |
| Sanjya | + + | | + | |
| Baglung | + + | | + | |

+ + Main/depending source; + Alternate source

**Market Price of the fish**

Average market price of the fresh food fish among the study districts was found higher in hill and mountain districts, but cheaper in terai, the higher production areas (Table 6, Fig. 5). The highest price was Rs. 400 in Ramechhap followed by Nuwakot and Baglung Rs. 350, Syangja Rs. 340 and Kaski Rs. 306 excluding the local/indigenous species. However, the survey has been reported only Common carp and Grass carp sold in Nuwakot and Ramechhap. The species wise and price index revealed that local and indigenous fishes fetch the highest price, especially in Nuwakot and Kaski (Table 6, Fig 5). Again fish prices were high in hill and mountains except Ilam but cheaper in general in southern terai. In general, the prices of Rohu, Naini and Bhakur were not less than that of common and grass carp. However, the price of bighead and silver carp was little less than that of Common carp and Indian Major Carp. Sometimes fish price might be governed by the size and season too.

Table 6. Market price of different carp for food purpose (in Nepalese Rupees, NPR)

| Food fish species | Baglung | Kaski | Gorkha | Tanahu | Bara | Syangja | Ramechhap | Nuwakot | Sunsari | Ilam |
|---|---|---|---|---|---|---|---|---|---|---|
| C/C and G/C | 400 | 350 | 260 | 250 | 200 | 340 | 400 | 350 | 200 | 200 |
| Rohu/ Bhakur | - | 350 | - | - | 240 | - | - | - | 200 | 200 |
| Naini | - | 350 | - | - | 200 | - | - | - | 200 | |
| S/C and B/C | - | 250 | 220 | 150 | 175 | 340 | - | - | 170 | 170 |
| Tilapia | - | 230 | - | - | - | - | - | - | - | - |
| Magur | 300 | - | 300 | 300 | 150 | - | - | - | - | - |
| Chhadi | - | - | - | - | 150 | - | - | - | - | - |
| Average | 350 | 306 | 260 | 233 | 186 | 340 | 400 | 350 | 193 | 190 |
| Max | 400 | 350 | 300 | 300 | 240 | 340 | 400 | 350 | 200 | 200 |
| Min | 300 | 230 | 220 | 150 | 150 | 340 | 400 | 350 | 170 | 170 |
| Local/ indigenous | | 400 | | | | | | 600 | | |

C/C = Common carp; G/C = Grass carp; S/C = Silver carp; B/C = Bighead carp

Chhadi = Smaller/finger size fish of Rohu, Naini (Mrigal) and Bhakur (Catla) and occasionally of S/C and B/C.

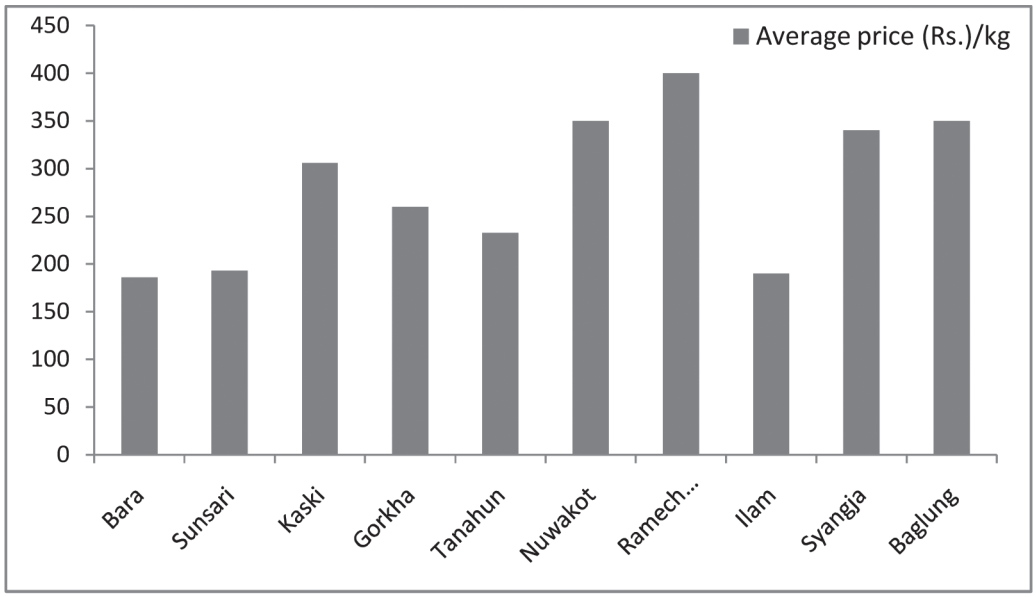


Figure 5. Average market price of food fish (2012)

### Training to fish farmers

The data on trained human resources at farmer level revealed that Bara was the district with highest number of trained farmers on carp fish farming (Table 7). Gorkha and Ramechhap were deprived of any human resource on carp fish farming. Kaski was ranked first in having higher government employee on trained human resource on carp fish farming. The women participation in carp farming was poor in most of the districts. Contrarily, in Kaski and Bara the number of trained women on carp farming was relatively higher than other districts (Table 7).

**Table 7**. Trained human resources at farmers level

| District | Farmers | Janjati | Women |
|---|---|---|---|
| Bara | 1800 | 150 | - |
| Sunsari | 225 | 150 | 97 |
| Kaski | 500 | 250 | 150 |
| Gorkha | - | - | - |
| Tanahun | 5 | - | - |
| Nuwakot | 146 | 95 | 35 |
| Ramechhap | 4 | 1 | 1 |
| Ilam | 3 | 1 | - |
| Sanjya | 60 | 30 | 30 |
| Baglung | 5 | 1 | - |

### Per capita fish availability

Based on pond aquaculture production, the fish availability index showed that Bara and Sunsari remained the first and second districts in terms of fish availability, having per capita 6726 g and 1003 g, respectively (Fig 6). Bara is more than 6 times higher than Sunsari in per capita fish contribution. In general all hill districts have low level of fish availability, where 5 districts are below 40 g level. Kaski is highest with 129 g per capita fish available from pond production among hilly districts. The least fish availability was estimated in Baglung, 4 kg followed by Ramechhap 5 g and Nuwakot 18 g. Other two among those five mid-hill districts under below 40 kg category in per capita availability are Syangja, 28 kg and Ilam 38 kg of pond fish (Fig 5).

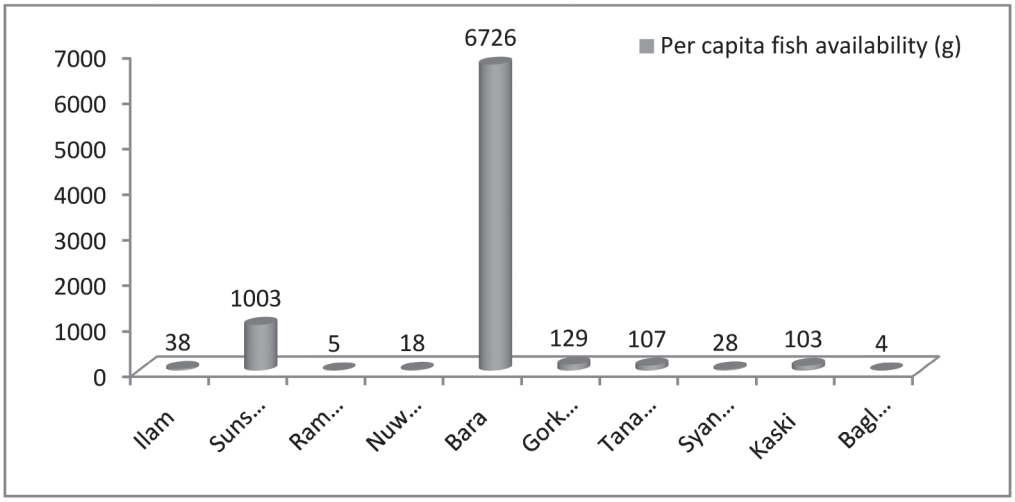


Figure 6. Per capita fish availability (g) based on district's own aquaculture product

## DISCUSSIONS

In Nepal, water resources availability (Table 1) considers high, almost represented about 5.6% of total land area (147181 $km^2$) of the country. It is obvious that higher potentiality of the southern terai is far ahead in aquaculture production than its northern districts (Table 1 and 2; Fig 2 and 3). Among the study area Bara remained highest in area, production and productivity followed by Sunsari, where the national average of carp aquaculture productivity has been estimated to be about 3.9 mt $ha^{-1}$. $year^{-1}$ in 2012/13 with highest 5.4 mt $ha^{-1}$. $year^{-1}$ from Bara, southern tropical district (DoFD, 2013). There are many attributes behind the area coverage and aquaculture production factors at present, such as landscape, source of water, water quality parameters, input availability, climate, technology, investment, market etc. The production estimates from mid-hill region, where altitude is higher than southern plain, has rarely been carried out. Therefore, for clarity and realistic findings about the aquaculture status, it is necessary to assess them into two categories. So, in this study the aquaculture was classified by two categories of most potential southern parts and hilly mountainous districts, where aquaculture is limited. Probably it would be easier to scale up new aquaculture technologies suitable to warm water aquaculture in southern side than the northern part. However, there are many possibilities of carp aquaculture in mid-hills eco-region of Nepal. Carps, represented by Chinese and indigenous major carps (IMC) are the main species (about 99%) grown up and produced in warm water resources (Gurung 2013).

According to the results of this study carp aquaculture productivity from 8 mid-hill districts was 0.7 mt.$ha^{-1}$.$year^{-1}$ (Table 3), which is far lower than the southern plain. However, the average national productivity from mid hill and mountain district was 2.1 mt.$ha^{-1}$.$year^{-1}$in 2012/13 (Table 2), proving the fact that indeed the carp introduced into the country more suitable for tropical agro-ecological condition. However, there is a lack of enough information about the appropriate fish species and technology suitable to overcome the production constraints in mid-hill region.

Ethnic communities/Janajati engaged in fish farming is substantially higher towards the terai (Table 4). The traditional ethnic communities, such as Tharus, only in terai, and others namely Malaha, Darai, Bote, Majhi, Danuwar, Jalari etc are more concentrated in both southern terai and in lower river basin area of mid-hill region. For over a period of a decade these communities clearly demonstrated that likely to be more resilient to cope with ecological, social and economic perturbation than their traditional mixed crop-livestock farming practices (Pant *et al*., 2012). However, many households of these community are shifted their occupation from fishing to others, due to low catch and high efforts in natural water bodies, which effected their traditional means of livelihoods. The role of these ethnic communities and women groups found more responsible and sincere for successful aquaculture practices, where projects were intervened and community were mobilized by governmental and non-governmental organizations in recent years in Nepal (Bhujel *et al*., 2008). It seems more effective due to matching with their traditional fishing professions.

Among the major constraints in increasing national fish production, proper seed supply in terms of quantity and quality for fish farming is crucial factors, which is vital besides others (Gurung, 2012; Nepal *et al*., 2012). The study shows that all districts are receiving fish seed/ fry and fingerlings from public hatchery and few private nurseries (Table 5). However, the terai districts do not depend only on public and private hatchery/nursery but, vendors also trade and

supply the fry to fish growers. Terai area is more privileged than hilly districts in terms of seed availability, where about 80 percent of total seed supply for aquaculture contributes by the privet sector, through hatcheries, nurseries and even from venders/traders in terai (DoFD, 2013; Mishra and Kunwar, 2014). This study has revealed that there is limited number of hatchery in private sector. Even in Bara districts there are only 4 privately owned hatcheries for fish seed distribution, whereas Sunsari has 7 and Kaski has 2. Other hilly districts among surveyed have none of private hatcheries. Therefore, there would also be made efforts to establish enough carp hatcheries in private sector and decentralized seed distribution mechanisms to support the fish seed supply system to farmers in the required area, even in mid-hill region also would be highly desirable (Gurung, 2013; Mishra and Kunwar, 2014; Nepal *et al*., 2012).

It is clear from the study that the food fish market prices are higher in remote hilly districts. The reasons behind that could be several but one of the most prominent reasons is cost of production with meagre production in hilly areas (Table 3). According to the government records, present national fish production from natural catch is constant, 21500 m ton per year (DoFD, 2013). However, there is still a need of authentic data collection mechanism from the Nepalese rivers, where individual river systems have different characteristics in water volume, gradient, water quality, species abundance etc. It may differ in habitat with fish species abundance and population. Therefore, every river system is necessary to study the estimation of fish catch and effort in series of parts of single river system for collection of actual and more reliable catch data based on maximum sustainable yield (MSY) of respective river system in the country. In other hand, the fishermen expressed that the fish population in natural water body has been declining year by year (personal interview with fishermen), but, the quantity can be determined only by the further research. In consequence, it is a fact that fish production from both catch from natural water bodies and aquaculture is low in hilly districts, so that fish availability there is less and the price of fish is higher than terai. However, demand of food fish is high in hilly district too. For that reason, aquaculture is necessary in potential areas, which helps to conserve the riverine fish species and increases fish production.

In aquaculture production, the qualified human resources would have very important role besides the other infra structures and facilities, such as water resources, seed, feed, health support means etc. It is also clear that the number of trained farmers, personnel, women and marginalized and deprived ethic communities in fish farming was far less in hilly district than terai (Table 7). Fisheries extension officers/staff are limit and deputed only in 22 districts under Department of Agriculture (DoA), with 21 in terai and one in Kaski the mid-hill district. However, 58 districts out of 75 have been covered by the carp aquaculture activities in different scale (DoFD, 2013). Adequate extension officers for scale-up of the technology in the country are another requirement for aquaculture development. Development of the technologies required for enhancement of aquaculture production is only possible, if qualified scientists/ researchers are enough for involving in need based research activities. All together 30 officer-level manpower has been involved for fisheries and aquaculture technology generation activities under Nepal Agricultural Research Council (NARC) with 12 Scientists including only one Principle Scientist. The number of qualified personnel is far below for research and development of fisheries and aquaculture sector in Nepal.

In general, carp culture are hardly fed in ponds in present socio-economic set up that is one of the reasons for low production rate of carp in Nepal. However, feeding fishes has been started, especially in trout cultivation in hills (Gurung, 2008). Therefore, this was the reasons

that pellet feed use as fish feed was higher most in Nuwakot and Kaski. In Kaski also pellet feeding to carp in private sector is very limited. There are several other factors associated with low carp production. Generally hilly region is not that suitable for fish production compare to the terai due to unsuitable terrain for fish farming in hills and lower water temperature for more months than terai. However, there remains some wetland and areas in lower and river basin parts, where carp production can be still enhanced from the hills too. The carp production from such water bodies including that of ponds can be increased substantially by increasing the input level in fish cultivation. For this the current ministerial program and the upcoming fisheries and aquaculture policy as well as strategy would take some initiatives to increase fish production in the country.

The number of cooperatives and groups are limited in the districts for fish farming purpose. Due to limited fish production the fish availability is still poor (Fig 6). To enhance the fish production several approaches might need to be adopted. The average number of ponds per household is low in mid-hill area in compari. The policy would also emphasize and women and marginalized ethnic communities should sensitize and mobilize in participatory fish farming activities in terai as well and hills. The participation of women and marginalized farmers may support significantly to increase fish production. The aquaculture is expected to provide food and nutritional security to those engaged in fish farming directly or indirectly. The fish production would also serve to the purpose of job and income opportunities to local communities (FAO, 2014).

In Nepal, majority of fish farming has still at small and subsistence level (Gurung *et al*., 2012). Considering the importance of fish in human diet and the presence of abundant natural water resources, the fish farming has been given due consideration in Nepal's national policies for food and nutritional security (ADS, 2013). It has been envisaged that fish production from natural lakes, rivers, wetlands, rice-fields and other marginal land by constructing ponds. Plenty of ponds can be constructed in the land, where, it is not suitable for grain production, but water resources are available. Priority should be given to this type of land for fisheries and aquaculture development in the river basins and valleys of mid-hill districts. Nepal has thousands of rivers which have been projected to be the most potential resources for hydropower generation (Rajbanshi, 2012). The water used in hydropower stations is mostly free of the silt and other impurities. Therefore, it is envisaged that clean hydropower tail water is a useful and potential source for aquaculture production.

Finally, the analyses of all aspects of aquaculture in Nepal seems that there is a need of more research works to determine the appropriate aquaculture technology suitable for improving scale of production from terai and promotion of aquaculture in mid-hill and mountain areas. It is necessary to answer the question of scientific reason of differences in fish production in different eco-region of Nepal. Adequate supports for encouraging policies and service system for technology and inputs can go a long way to empower such entrepreneurs to perform a vital role in rural aquaculture (Little *et al*., 2007; Nepal *et al*., 2012). A network of decentralized seed distribution with marketing mechanism and education jointly seem most necessary for conquering the present constraints to aquaculture development in the mid-hills of Nepal. It is therefore, recommended that cultivation of carps can be done in subtropical mid-hill areas, but to gain economic feasibility more suitable species which can be reared in intensive fish culture system and new innovative technologies with adequate inputs might fulfil the ever increasing demand and market opportunities of fish products in Nepal.

## CONCLUSION

Indeed, the carp introduced into the country more suitable for tropical agro-ecological condition. However, there are many areas suitable for carp aquaculture in mid-hill sub-tropical regions too. Only the fish species is not a factor for production constraints. It is therefore, recommended that cultivation of carps can be done in subtropical mid-hill areas, but to gain economic feasibility more suitable species which can be reared in intensive fish culture system and/or new innovative technologies with supply of inputs in subsidised mechanism might fulfil the ever increasing demand and market opportunities of fish products in Nepal. It is interesting to note that some of the districts of the study area are highly advanced in aquaculture production but some are poor, which are needed to lunch the research and development program in need and priority basis.

## ACKNOWLEDGEMENTS

We express gratitude to all the station chiefs from ARS (Fish), Kali Gandaki Fish Hatchery Regional Directors and Unit In charge of aquaculture section, Senior Agriculture Development Officers of District Agriculture Development Offices, Regional Agriculture Directorates and all others from respective areas who cordially supported us in collection of the data related to the study. Thanks to all farmers and extension officers for supporting in data collection.

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# CURRENT SCENARIO OF CAGE CULTURE WITH GRASS CARP (*CTENOPHARYNGODON IDELLA*) IN LAKES OF POKHARA VALLEY, NEPAL: MANAGEMENT AND TECHNICAL ISSUES

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**Abstract**

*Cage culture of grass carp had been encouraged in Lake Phewa of Pokhara valley since year 2007 to utilize naturally produced aquatic grass as fish feed for environmental and economic benefit. The productivity of grass carp (8.4 kg/m$^3$) fed with aquatic grass in cage culture in Phewa Lake was higher than the productivity of herbivorous fish (3.7 kg/m$^3$) relying on plankton as feed. This technology had proven to provide more production and income than traditional cage culture with planktivore and many poor people are keen to enter the business. In recent years there has been increasing problems with the decreasing productivity (1.46 kg/m$^3$) of grass carp cages in the Lake Phewa. This low productivity have affected income and livelihood of large number of farmers and discouraged some households to continue cage culture with grass carp. The major problems associated with the sustainability of this technology include unavailability of natural supply of grass, besides some managerial and technical issues. This paper reviews the current scenario and discusses managerial and technical strategies for sustainable development of cage aquaculture of grass carp in Lake Phewa.*

**Keywords***:* Cage culture, grass carp, aquatic feed, *Ctenopharyngodon idella*

## INTRODUCTION

Cage culture has been successfully launched in the lakes of Pokhara valley since the late 1970s (Sharma, 1990) and subsequently to Kulekhani reservoir near Kathmandu in 1985's (Gurung *et al.*, 2010). Cage aquaculture has significant potential to contribute towards food security, economic growth and employment in dependent community of these areas. Current forms of traditional cage culture with silver carp and bighead carp rely largely on the production of natural foods through natural process in water bodies. Later, cage culture of grass carp had been encouraged in Lake Phewa of Pokhara valley since year 2007 to utilize invasive aquatic grass as fish feed for environmental, economic and commercial benefit. In the past 5 years cage culture with grass carp witnessed rapid developments in lake of phewa in terms of production. This technology had proven to provide more production and income than traditional cage culture (3.7 kg/m$^3$) with planktivore (Wagle *et al*., 2003; Prasad *et al.*, 2012) and considered environmental friendly because of consuming plants, phosphorus as a nutrient withdrawn from systems by grass carps. Grass carp retain 50- 90% of this phosphorus in their flesh (Chapman *et al*., 1987; Kirkagac and Pulatsu, 2001; Masser, 2002) indicated that the utilization of grass carp might be an effective method of removing phosphorus from aquatic systems. The grass carp (*Ctenopharyngodon idella*) among other Chinese carps has been receiving worldwide attention as a biological control agent for aquatic vegetation and as a source of food. The benefits of using grass carp for plant control include its long term effects, constant feeding activity on invasive macrophytes, low long term costs and the potential for conversion of weed biomass to fish protein (Kirkagac, 2011).

Currently, their development is facing a number of constraints and the sustainability of this technology is threatened. The main constraint is unavailability of locally produced aquatic grass, hydrilla (*Hydrilla verticillata*) due to various reasons besides some managerial and technical issues. This discouraged some households to continue cage culture of grass carp. For sustainable development of cage culture with grass carp, some strategies are needed to be considered. This paper reviews the current scenario and discusses managerial and technical strategies for sustainable development of cage aquaculture of grass carp in Lake Phewa based on data collected from farmers currently engaged in grass carp cage culture.

**Current Scenario**

Cage culture with grass carp had been initiated in lakes of Phewa since year 2007 to utilize aquatic grass mainly hydrilla as feed for fish. This technology had good potential to contribute source of income for poor farming households. Currently scenario of cage culture with grass carp had been changed during the past 5-6 years. The number of household engaged in grass carp cage culture had been decreased. The data of the year 2007 revealed that out of total cages landed 28.3 % (65 family) cages with average of 2.19 cages/household was used for grass carp while in the year 2013 it dropped down to 4.2 % (22 family) with averages cages of only 0.25/household (**Figure 1, 2 & 3**). The size of the production cages used for grass carp cage culture was same about 50 $m^3$ and nursery cage of 27 $m^3$. In cages, grass carp was usually stocked as major species in monoculture. Production cycle involved nursery and grow-out phase. During first phase fry was stocked in nursery cage @ 100 fish/$m^3$ for 5-6 months fed with local feed (rice bran, oilcake, maize flour) getting 85% recovery rate. During second cycle the stocking density varied from 4 -7 fry/ $m^3$ with an average size of 150-200 g. During this phase the fish was fed with hydrilla collected from same water bodies as in the past years. Currently hydrilla was supplemented with karaute grass (*Leersia hexandra*) fed one times a day early in the morning. The culture period was usually 12-15 months. The overall production of 22 existing household are shown in **figure 4** while comparative trends in overall production are shown in **table 1.** The mean yield was decreased from 8.4 kg/$m^3$ to 1.46 kg/$m^3$ in the year 2008 and 2013 with growth rate of 3.11 g/day to 0.96 g/day, respectively. The recovery rate was 95%. The average size of fish harvested was also decreased from 1540 g to 290 g. There was a large variation in body weight gain among individual fish (**Figure 5**) with majority of fish (54.5 %) fall under 200-300g size. The decreasing adoption rate and production of cage culture with grass carp seemed to be limited by natural supply of grass particularly in winter indicated that the availability of aquatic grasses as feed is the key factors to the success of cage culture with grass carp.

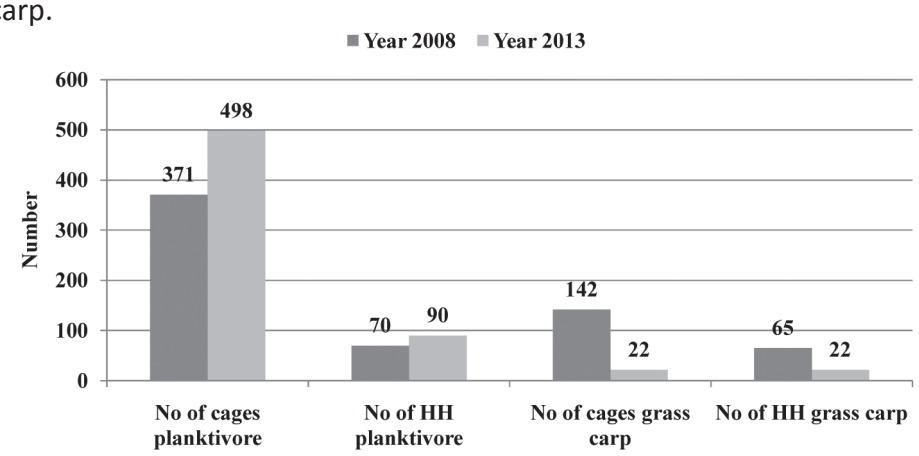


Figure 1: Household involvement in cage culture with grass carp (Ctenopharyngodon idella) during 2008 and 2013 in Phewa Lake, Pokhara, Nepal

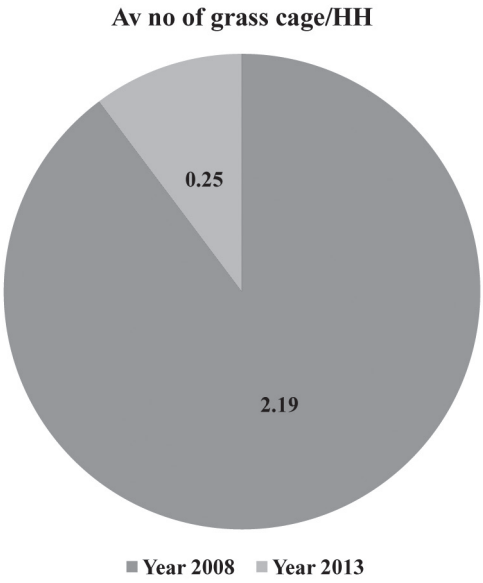


Figure 2: Average number of cages with grass carp (*Ctenopharyngodon idella*) in household during 2008 and 2013 in Phewa Lake, Pokhara, Nepal

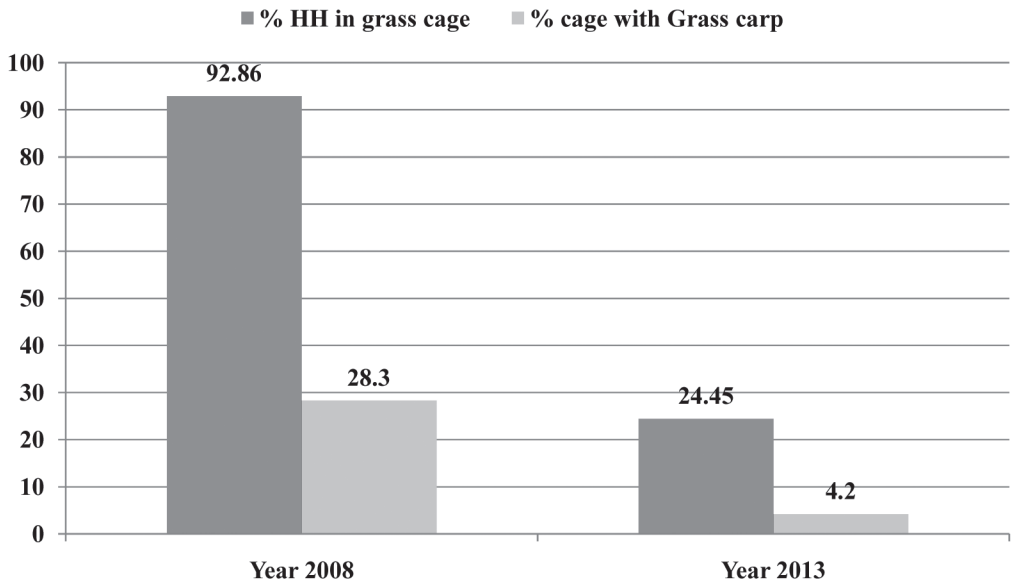


Figure 3: Percentage of cages with grass carp (Ctenopharyngodon idella) in household during 2008 and 2013 in Phewa Lake, Pokhara, Nepal

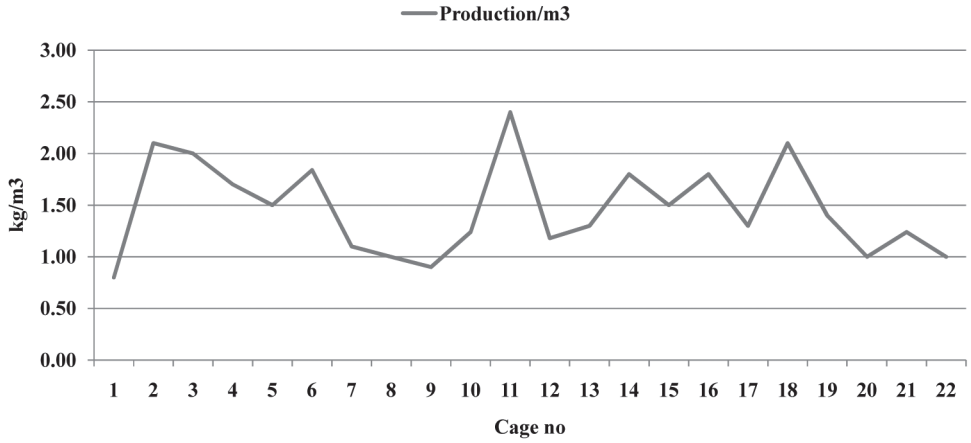


Figure 4: Overall production of grass carp (*Ctenopharyngodon idella*) in household cages during 2013 in Phewa Lake, Pokhara, Nepal

**Table 1:** Growth and yield description of grass carp (*Ctenopharyngodon idella*) in cage culture during 2008 and 2013 in Phewa Lake, Pokhara, Nepal

| | **Year 2008** | **Year 2013** |
|---|---|---|
| Cage size | 50 $m^3$ | 50 $m^3$ |
| Fry stocking no/ $m^3$ | 10 | 5 (4-7) |
| Av. size fish harvest (g) | 1540 | 290 |
| Av. Production /cage (kg) | 416.83 | 73.18 |
| Production kg / $m^3$ | 8.4 | 1.46 |
| Growth rate g/day | 3.11 | 0.96 |

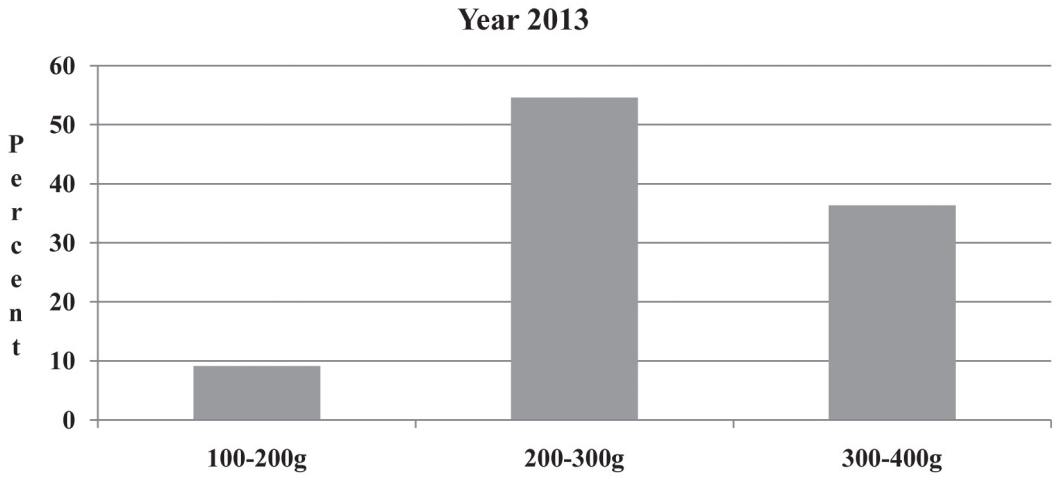


**Figure 5:** Growth variation of grass carp (*Ctenopharyngodon idella*) in cage in Phewa Lake, Pokhara, Nepal

## Issues and Challenges

Grass carp cage culture is presently facing some challenges which must be address for sustainability of production. These challenges and probable solutions are discussed under topics of management and researchable issue.

## Management Issues

### *Disturbance of weed beds*

Weed beds can provide cover for some fish and may protect them prom predation. Secondly, weed beds provide a habitat for some invertebrates which are a food for fish ( Nukurangi, 2008). However, it was evident that proliferation of aquatic weeds had been disturbed from anthropogenic activities and mismanagement of Lake Phewa. The main reason was removal of productive soil from lake bottom for constructing foot track close to lake as well as sediment removal near inlet canal which not only affected weed proliferation but also had negative effect on inhabitant fish species. Therefore, there is need of multi-sector approach to protect and revive aquatic environment.

### *Excessive removal of weeds*

Considering high production and income from grass carp cage culture, huge number of cages was landed resulted in huge removal of grass to feed fish. The area infested with weeds in relation to the total area had not been taken into consideration when determining to increase the number of cages for grass carp. Removal of grass should be minimizing to recover the growth of vegetation. There should be regulatory authority (like current cooperative in phewa lake) to decide the number of cages allowed or removed based on quantity of aquatic grass.

### Location change

Farmers should be encouraged to periodically move their cages location to allow areas to recover grass and increase the economic efficiency.

### Limited or no access to other lakes to expand in other water bodies

Pokhara Valley is endowed with many lakes. Policy level strategy is required for prioritization of access to other water bodies infested with aquatic weeds.

### Fry stocking management

Currently farmers should stock at low density together with other species. The gap of income could be bridged by high growth rate and supplementary production, respectively.

### Temporarily feeding (win-win situation)

Grass carp is not only grows quickly but has a low requirement for dietary protein. Grass carp could be temporarily fed at low cost by feeding them with other aquatic weeds, terrestrial grasses and by-products from grain processing. However, research is required for technical and economic feasibility as well as minimal environmental impact.

**Rearing of fry**

Farmers are always facing problems of quality fingerlings in their required time. Majority of households do not have own ponds, accessibility to ponds was found a major hurdle for fry nursing. Rearing in cages takes 6-7 month to reach 100-150 g size which is suitable for production cage. By rearing fry in pond time of production cycle could be minimized. However, despite of many efforts farmers are reluctant to develop their own rearing facilities for fingerlings rearing.

**Researchable Issues**

**Alternate grass species**

Although hydrilla is a preferred food for grass carp (Bonar *et al.*, 1990, Cooke *et al.*, 2005; Prasad *et al.*, 2012) there abundance was less nowadays. Some grass species like karaute (*Leersia hexandra*) are abundantly available in phewa lake. Different other types of aquatic weeds like *Lemna minor*, and *Chara* sp., etc. also available to some extent which could be researched as fish feed in cage including consumption rates and its preferences as well as economics of production with particular grasses.

**Species composition**

Currently monoculture based cage fishery with grass carp are followed. In the absence of aquatic vegetation, research should directed towards mixing of planktivore with reduced density of grass carp that could compensate the production by enabling full use of the food resources and space in cages. Phytoplankton abundance and chlorophyll *a* concentration were found at higher rates inside the cage without grass carp (Lembi *et al*., 1978) indicating partial stocking of filter feeder fish could be stocked for additional production.

**Stocking density**

Research should focus on optimizing optimum stocking density and economic effectiveness of grass carp with the available amount of grass.

**Exploration of other feeding possibility**

It is necessary to have a win-win situation for the farmer and the environment. Therefore, possibilities of grass cage culture with terrestrial grasses and/or farm by-products, local feed types should be studied.

**Impact of grass reduction**

Vegetated habitats provide important nursery grounds and hiding places (Von Zon, 1977) for many native fishes. It is claimed by farmers that eradication of submerged macrophytes resulted in decline population of fish community particularly Chhue bam, Bhitte etc. It should be verified.

**Exploration of untapped area**

Cage culture of grass carp was focused only in lake phewa now. Research should also focus on

to explore possibilities of cage aquaculture with grass carp into new untapped open-water culture areas such as lakes of Begnas, Khaste, Deepang, Neureni, Maidi etc.), infested with several types of aquatic weeds.

**Impact of escaped release**

Grass carp are now sometimes recorded in lake catch. Long persistence in the environment may hinder future native macrophyte re-vegetation efforts (Kirk *et al.*, 2000, Kirk and Socha 2003). Young grass carp may therefore alter trophic dynamics within communities by directly competing for food with native fishes and their larvae. Assessment of grass carp impacts on plant / aquatic community and primary production is necessary to maintain aquatic biodiversity.

## CONCLUSION

The availability of aquatic grasses as feed is the key factors to the success of cage culture with grass carp. Although hydrilla is a preferred food for grass carp, there is a need to reduce the current dependence on hydrilla and explore new grass species including its economics of production with particular grasses.

Considering the current situation, it seemed that further expansion of cages with grass carp might result in problems in the future. It is necessary to aware about carrying capacity based on available amount of aquatic weed. While the grass carp cage culture should be prioritized for developmental assistance, the traditional cage culture should not be ignored as it supports the livelihood and employs the poor.

## ACKNOWLEDGEMENT

The authors like to thank Chairman Mr. G.B. Jalari and all the members of the Harpan Khola Matsya Sahakari Sanstha for their support in collecting data and providing valuable suggestions.

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# Programme

## Day 1 (2070/12/23)

| | | |
|---|---|---|
| 10:00 – 11:00 | Registration | Shiva Nath Mahato and Sujaya Upreti |

## Inaugural Session

| | | |
|---|---|---|
| Convener: | Ms. Sunita Sanjel | Rapporteurs: Mr. Tulsi Paudel and Mr. HN Aryal |
| 11:00 – 11:10 | Chairing | |
| Chairperson: | President, NASA, Mr. Uday Chandra Thakur | |
| Chief Guest: | Hon. Minister for Agricultural Development, Mr. Hari Prasad Parajuli | |
| Special Guest: | Vice Chancellor, AFU, Prof. Dr. Kailash Nath Pyakurel | |
| Special Guest: | Secretary, Public Service Commission, Mr. Nathu P Chaudary | |
| Special Guest: | Secretary, MoAD, Mr. Jaya Mukund Khanal | |
| Guest: | Executive Director, NARC, Dr. Dil Bahadur Gurung | |
| Guest: | Executive Director, NDDB, Mr. Babu Kaji Panta | |
| Guest: | Dean, IAAS, TU, Prof. Narendra Chaudhary | |
| Guest: | Director General, DLS, Dr. Nar B Rajwar | |
| Guest: | Director General, DoAD. Mr. Suresh Babu Tiwari | |
| Guest | Director General, DFTQC, Ms Jeevan Prabha Lama | |
| Guest: | Ms Geeta Keshary | |
| Guest: | Dr. Heramba Bahadur Rajbhandary | |
| Guest: | President, NVA, Dr. Bimal Kumar Nirmal | |
| Guest: | President, Nepalese Fisheries Association | |
| Guest: | President, NEVLA, Mr. Purna Bahadur Budha | |
| Guest: | President, NDA, Mr. Megh Raj Dhakal | |
| Guest: | President, DIA, Mr. Pradeep Maharjan | |
| Guest: | President, CDCAN, Mr Narayan Devkota | |
| Guest: | President, Feed Association, Nepal, Dr. TC Bhattarai | |
| Guest: | President, Poultry Association of Nepal | |
| Guest: | President, Piggery Development Association of Nepal | |
| 11:10 – 11:15 | Welcome address by Mr. Rudra P Poudel, Gen Secretary, NASA | |
| 11:15 – 11:20 | Inauguration of Convention by Hon Minister, Mr. Hari Prasad Parajuli | |
| 11:20 – 11:30 | Recognition for outstanding contribution | |

| | |
|---|---|
| 11:30 – 11:45 | Global livestock trend and national livestock scenario with respect to food and nutrition security in Nepal by Mr. UC Thakur and Dr. LN Paudel |
| 11:45 - 12:00 | Impact of climate change on livestock based livelihood and appropriate adaptation measures in Nepal by Dr. SP Neopane and NR Devkota |
| 12:00 – 12:15 | Climate Change Impact on Aquaculture in Nepal: Possible Mitigation by Climate Smart Management? by Dr. TB Gurung, SK Wagle, AP Nepal and N Pradhan |
| 12:15 – 12:30 | Current Scenario (problem and solution) of dairy industries in Nepal by Mr. Sumeet Kedia |
| 12:30 – 13:00 | Few Words |
| | Mr. Purna Bahadur Budha, NEVLA |
| | Dr. Bimal Kumar Nirmal, NVA |
| | Ms. Geeta Keshary |
| | Dr. Heramba Bahadur Rajbhandary, Executive Chairman, Nepal Dairy |
| | Dr. Nar Bahadur Rajwar, DG, DLS |
| | Mr SB Tiwari, DG, DOA |
| | Dr. Dil Bahadur Gurung, ED, NARC |
| | Mr. Jaya Mukunda Khanal, Secretary, MOAD |
| | Mr. Nathu Chaudhary, Secretary, PSC |
| 13:00 – 13:10 | Remarks by Chief Guest, Hon Minister Mr. Hari Prasad Parajuli |
| 13:10 – 13:20 | Vote of Thanks by Dr. Chet Raj Upreti |
| 13:20 – 13:30 | Chair Person's closing Remarks |
| 13:30 – 14:30 | Lunch Break |

## Technical Session: Emerging Issues

| | |
|---|---|
| Chairperson: | Dr. Surya Bahadur Singh |
| Rapporteurs: | Shiva Acharya and Saroj Sapkota |
| 14:30 – 14:45 | Emerging opportunities to NASA by Dr. Heramba B Rajbhandary |
| 14:45 – 15:00 | Goat Management and Production by Pro-poor: An Experience of Leasehold Forestry and Livestock Programme by D P Yadav and PC Tara |
| 15:00 – 15:15 | Present situation, constraints and opportunities in Dairy sector of Nepal by Mr. BK Panta |
| 15:15 – 15:30 | Commercialization potential of *Moringa oleifera* in Nepal - A thematic review by BB Chhetri |
| 15:30 – 15:40 | Discussion |
| 15:40 – 15:45 | Chairperson's Closing Remarks |

15:45 – 16:00 Tea Break

### Technical Session: Forage and Fodder Production and Utilization

Chairperson: Mr. Dinesh Pariyar

Rapporteurs: Ms Sunita Sanjel and Raju Kandel

16:00 – 16:15 Characterization and selection of native forage species of Rasuwa district by B Khanal and BR Baral

16:15 – 16:30 Fodder yield and chemical composition of major fodder tree species of the selected districts in the mid hills of Nepal by Sujaya Upreti, NR Devkota, JL Yadav and BS Shrestha

16:30 – 16:45 Fertilizer response of cocksfoot and rye grass at high hill of Rasuwa district by B.R. Baral and B.Khanal

16:45 – 16:55 Discussion

16:55 – 17:00 Chairperson's closing remarks

## Day 2 (2070/12/24)

08:00 – 09:00 Breakfast

## Technical Session: Livestock Production (Breeding and Management)

Chairperson: Shatrughan Lal Pradhan

Rapporteurs: Nirajan Bhattarai and Shiva Nath Mahato

09:00 - 09:15 Effect of altitude on growth and reproductive performance of goats in Nawalparasi Nepal, by MR Kolachhapati, NR Devkota and N Bhattarai

09:15 – 09:30 Study of Semen and Economic Parameters of Jersey and its Crosses under Farmers Managed Condition at Central and Western Nepal by SN Mahato, MR Kolachhapati, BK Nirmal, N Bhattarai and KR Sapkota

09:30 – 09:45 Parity and season effect to the milk production traits of cattle ×Yak hybrids (Dimjo chauris, Bos *taurus × Bos grunniens*) in transhumance system by I Barshila, NR Devkota and SR Barsila

09:45 – 10:00 Phenotypic and molecular characterization of Sakini chicken of different agro ecological zones of Nepal by R Dhakal, M Sharma, S Sapkota and MR Kolachhapati

10:00 – 10:15 Milk production potentiality of Lulu cattle on farmers' field condition in Mustang district, Nepal by LN Paudel, IP Pandey and SP Neopane

10:15 – 10:30 Milk production status of Chauri under transhumance system at high hill of Rasuwa district by B Khanal, BR Baral and KK Shrestha

10:30 – 10:45 A Small Scale Giriraja Chicken Production to increase farm income in Charikot, Dolakha, by SB Shrestha

| | |
|---|---|
| 10:45 – 10:55 | Discussion |
| 10:55 – 11:00 | Chairperson's Closing Remarks |
| 11:00 – 11:15 | Tea Break |

## Technical Session: Livestock Production (Nutrition)

| | |
|---|---|
| Chairperson: | Mr. SB Pandey |
| Rapporteurs: | Mr. Sagar Paudel and Krishna Kanta Neopane |
| 11:15 – 11:30 | Effect of different level of Allo leaves (*Urtica himalayansis*) on growth, egg parameter and internal parasite of Giriraja chicks by RP Sah and S Jha |
| 11:30 - 11:45 | Response of heat treated mustard cake feeding on growth performance of growing female goats in fodder based basal diet by MR Tiwari, RP Ghimire, D Adhikari, DP Adhikari and SH Ghimire |
| 11:45 – 12:00 | Effect of garlic (*Allium sativum* L) on the growth performance, immunity and serum cholesterol level of broiler (COBB 500) chicken by R Acharya, JL Yadav, HB Basnet, R Sah and N Chapagain |
| 12:00 – 12:10 | Discussion |
| 12:10 – 12:15 | Chairperson's closing remarks |
| 12:15 – 13:15 | Lunch Break |

## Technical Session: Fisheries

Chairperson: Dr. TB Gurung

Rapporteurs: Ms N Pradhan and Mr. AP Nepal

| | |
|---|---|
| 13:15 – 13:30 | The effects of paddlewheel aeration on pond production of carps under high density polyculture fish farming by SK Wagle, SN Mehta, AB Thapa and A Jha |
| 13:30 – 13:45 | Effect of different containers on the quality of fresh fish preserved for transportation by N Pradhan, A Mishra, SK Wagle and P Shrestha |
| 13:45 – 14:00 | Integrated fish farming in western Terai and hill of Nepal: a comparative bioeconomic analysis by A Jha and SK Wagle |
| 14:00 - 14:15 | Temporal changes on the phytoplankton diversity and its implication in fisheries management in Phewa Lake, Nepal by Md A Husain, RP Dhakal, JD Bista and S Prasad |
| 14:15 – 14:30 | Current scenario of cage culture with grass carp (*Ctenopharyngodon idella*) in lakes of Pokhara Valley, Nepal: management and technical issues by S Prasad, JD Bista, RK Shrestha, GB Jalari and DP Sharma |
| 14:30 – 14:45 | Pond aquaculture production and productivity estimates of southern terai and mid-hill agro-ecological regions of Nepal by Agni Nepal, TB Gurung and SK Wagle |

| | |
|---|---|
| 14:45 – 15:00 | Study on Present Economic Status of Rainbow Trout Seed Technology in Nepal by KR Joshi, GP Lamsal and K Gharti |
| 15:00 – 15:15 | Recent trend in aquaculture development in Nepal by RN Mishra |
| 15:15 – 15:25 | Discussion |
| 15:25 – 15:30 | Chairperson's Closing Remarks |

## NASA Closed Session and Election

15:30 – 17:00

NASA Progress Report Presentation by Mr. Rudra P Poudel

NASA Financial Report Presentation by Mr. Ram B Sah

Open Discussion

Election of New Executive Committee

Oath taking by New Executive Members

## Closing Session

| | |
|---|---|
| 17:00 – 17:05 | Chairing |
| | Chairperson: Newly elected NASA President |
| | Chief Guest: Secretary, Ministry of Agricultural Development |
| | Guest: DG, Department of Livestock Services |
| | Guest ED, Nepal Agricultural Research Council |
| | Guest: GM, Dairy Development Corporations |
| 17:05- 17:15 | Synopsis and recommendations of the convention by Dr. NP Shrestha and Dr. L Sherchand |
| 17:15 – 17:30 | Few Words |
| | GM, DDC |
| | DG, DLS |
| | ED, NARC |
| | Chief Guest Remarks by Secretary, MoAD |
| 17:30 – 17:35 | Vote of Thanks by Dr. Mana Raj Kolachhapati |
| 17:35 – 17:45 | Chairperson's closing remarks and end of Convention |
| 18:00 – 21:00 | Closing Dinner at Yak Palace, Pulchowk |

# RECOMMENDATION and DECLARATION

## Mandate for Executive Committee, NASA 2070

- Classify and prioritize recommendation and declaration into short term and long term
- Develop strategic plan for implementation of recommendation and declaration
- Implement the strategic plan
- Follow up for the implementation
- Presentation of the progress update for implementation of the recommendation in the 8th convention

## 1. Policy formulation and implementation

- Need of mission oriented political commitment to achieve white, red and blue revolution in the long run with special funding mechanism to support private industries related to livestock and fisheries.
- Establish "Nepal Council for Animal welfare and genetic resources conservation and utilization".
- Establish "Nepal Meat Development Board" in the Ministry of Agricultural Development with market oriented Public Private Partnership model
- Prioritize approval and implementation of livestock policy
- Focus on quality breeding animal production and market development through establishment of commercial resource centre by private entrepreneurship approach
- Encourage commercial farmers and entrepreneurs by removing the limitation of insurance coverage up to 10 million. Furthermore, increase the premium subsidies rate up to 75 % for marginalized and young entrepreneurs
- Regularization and standardization of hygienic quality meat, milk and egg production and processing and marketing
- Encouraging Banking institution to provide fund for livestock and related industry at minimum interest rate enforcing 3 % interest rebate
- Need of amendment and implementation of slaughter house and meat inspection act 2055, and Animal health, Feed Act 2033 and Livestock Services Act 2055
- The pricing system of livestock products should be based on cost of production and marketing system
- Government Programmes should focus to address the food and nutrition security as recommended by FAO standard

- Government should facilitate to include pork items in the menu of hotel and restaurant
- Act should be developed for animal welfare, conservation, use, feeds and feeding standardization for livestock, swine and aviation and fisheries.
- Need of strong policy for long term human resource development plan to meet the need of public and private livestock and fisheries development.
- Consideration for global warming and environmentally sustainable farming system should be emphasized in the fragile hills and mountain.
- Community based climate change adaptation livestock system should be focused
- Develop mitigation measures to address the impact of climate change to Livestock system and related industries
- The research and development program on Livestock, pasture and agro-forestry, swine and avian, fisheries and other related industries should be given high priority based on their feasibility and reproduction potential across agro-ecological zones. For an example of trout farming in all the sixteen high altitude districts of Nepal, pig and ostrich farming to meet the demand of quality meat by rising urban population with higher earnings.
- There should be representative in Nepal Veterinary Council from NASA
- Amend and improve course curriculum to provide B.Sc. Ag & AH to replace the present B.Sc, Ag to meet the need of Public and Private Livestock and related sector
- Inclusion of B.Sc. Ag in the Public Service Commission for Livestock, Poultry and Dairy development group of Agricultural services of Government of Nepal

## 2. Institutional strengthening

- Suggestion to the government and NARC to integrate and develop NASRI and NARI to implement and institutionalize DEEMED University for solving long term problem oriented basic and strategic research
- Development of program providing Research Degree in various disciplinary field of Animal Sciences including fisheries and crop sciences which will help SMS graduate for district livestock extension offices
- University should give high priority to initiate the livestock related programs to meet the need of public and private livestock related sectors
- Establish BSc Dairy Science programme in AFU
- Restart the suspended BSc Animal Science course either in TU or by any private company after getting affiliation from TU
- NASA will facilitate private investor to start college in partnership with NASA

for B.Sc. Animal Science, B.Sc. Ag & AH, and B.Sc. Animal Husbandry
- Each VDC should be provided with one livestock technician to make effective livestock extension

## 3. Integration of Research, Education & Development

- The research laboratory for research, development and education should be modernized
- Applied and adaptive research should be done directly in farmer herds/ flock/ ponds without going through long chain of research at the station and then through outreach research. This will help to obtain quick results
- Upgrading the education level of technician to graduate level (Bachelor in Animal husbandry) at livestock service center to provide quality extension services to the farmers through the use of modern information technology
- DLSO should be provided with subject matter specialist to support specialized technical services
- Development of management information system to provide technical services to relevant clients
- Provision to provide Keshab Raj Keshary memorial award to outstanding livestock related entrepreneurs

## 4. Upgrading & Empowering NASA

- Upgrade or change NASA to Federation Level
- Through establishing organization or partnership address the different issues of marketing system of supply and demand of inputs and outputs relevant to production, processing, marketing and consumer of animal origin feed, food, fiber, to serve people of Nepal and abroad by providing professional expertise services to develop into an business entrepreneurs for animal related industry development
- Facilitate and work in partnership with either NEVLA or Private company to make investment and earn regular income to run NASA and using its professionalism in business form by getting affiliation from any university to run:
- Private College of Agriculture and Animal Husbandry (CAAH) to provide degree
  - B. Sc. Animal Science
  - .Sc. Ag & A.H
  - B.Sc. Animal Husbandry
- Recognition and honoring of senior official

## 5. CAAH for (i) Sustainable Growth for NASA and (ii) partnership work for

- Creation of different forum for better understanding among the member professionals
- Development and creation of specialized professional group to support and facilitate commercial oriented livestock & fishery development
- Development of viable enterprises focusing to young entrepreneurs & professional to undertake businesses related to livestock and fishery in the followings areas:
  - Breeds and Breeding Services and marketing
  - Feeds feeding standard and feed industry
  - Fodder, forage and pasture seeds
  - Veterinary Health Services and pharmaceutical industry
  - Livestock related equipment and suppliers
  - Slaughter house and meat processing
  - Dairy and milk processing
  - Wool processing
  - Food diversification
  - Leather industry
- Facilitate to partner with the Government to use these enterprises which are instrumental to develop Livestock and related industries in feed, milk, meat, wool, leather and other food processing
- Supplying human resources for development of livestock and related industries such as feed, milk, meat, wool, leather and other food processing