Characterisation of the livestock production system and the potential of feed-based interventions in the municipality of Ratnanagar and Gitanagar in the Chitwan district of southern Nepal, September 2010

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The Feed Assessment Tool (FEAST) is a systematic method to assess local feed resource availability and use. It helps in the design of intervention strategies aiming to optimize feed utilization and animal production. More information and the manual can be obtained at www.ilri.org/feast

FEAST is a tool in constant development and improvement. Feedback is welcome and should be directed to feast@cgiar.org. The International Livestock Research Institute (ILRI) is not responsible for the quality and validity of results obtained using the FEAST methodology.

1. **Background**

The Feed Assessment Tool (FEAST) was used to characterize the livestock production system with a particular focus on the feed-related aspects of the Ratnanagar and Gitanagar municipalities in the Chitwan district of southern Nepal. The FEAST is a simple questionnaire that utilises a combination of informal group discussions and structured interviews with key farmer informants to rapidly assess on-farm feed availability in a smallholder context. The study was conducted by staff members from the International Livestock Research Institute (ILRI) in partnership with the local Nepali Non-Government Organisation (NGO), Forum for Rural Welfare and Agricultural Reform for Development (FORWARD). The aims of the study were to; firstly gain an understanding of the overall production system with a particular focus on the livestock feeding strategies employed by farmers in both municipalities, and secondly, identify key areas of the feeding strategy that could be altered to improve livestock productivity.

2. **Materials and Methods**

2.1. **Study site**

The municipalities of Ratanagar (GPS co-ordinates N27.59787, E084.50526) and Gitanagar (GPS co-ordinates N27.62196, E084.40830) in the Chitwan district of southern Nepal were selected for the study. The areas were deliberately selected by staff from ILRI and FORWARD as these sites are to be part of future Cereal Systems Initiative of South Asia (CSISA) projects in Nepal.

**Sampling method**

2.2.1. **Selection of villages**

The selection of villages was conducted by FORWARD. Within both municipalities, villages were selected from those that have been working with FORWARD. Additional selection criteria stipulated by ILRI included; that the majority of households raise livestock (namely dairy animals) and participate in cropping activities.
2.2.2 Selection of participants for the group discussion

FORWARD selected participants for the group discussion. Participants were selected that represented the range of wealth statuses in the municipalities, kept dairy animals and participated in cropping. Women were encouraged to participate. Eighteen farmers (13 men and 5 women) were selected in Ratanagar and 30 (26 men and 4 women) were selected in Gitanagar.

2.2.3 Selection of key informant farmers

Three farmers were selected from the participants of the group discussions in Ratanagar and Gitanagar to carry out a further individual questionnaire. These key informant farmers were selected to represent the 3 main categories of wealth in their respective areas. Landholding was used to determine wealth. The three categories of wealth were; below average landholding, average landholding, and above average landholding. The cut-off point between the various wealth categories were determined by the farmers during the group discussions.

2.3. Survey structure and format

The questionnaire was developed by ILRI staff. Previous trials of the questionnaire had been undertaken in east Africa and India. The Ratanagar trial was conducted on the 13th of September, 2010. The Gitanagar trial was conducted on the 14th of September, 2010. The questionnaire was conducted in two sections. The first section was conducted as a 2-hour informal group discussion consisting of open-ended questions in a semi-structured format. Discussions were led by FORWARD and ILRI staff. Discussed topics included; average farm sizes, average household sizes, rainfall pattern, labour requirements, livestock holdings, crops grown in the area, purchased feeds, livestock health, livestock reproduction, livestock management, marketing of milk products, current problems affecting livestock productivity and what farmers view as potential solutions to these problems. The responses provided an overview of the production system with a particular focus on dairy production.

The second section of the questionnaire was a 1-hour long structured interview. Staff from FORWARD conducted the interviews with the 3 informant farmers from each municipality. Farmers answered the questionnaires individually. Topics included; livestock holdings, livelihood activities, milk prices, milk yields, crops grown, ration formulation and farmer perceptions of feed quality. This information provided detail about on-farm feeding strategies and nutrient availability.

2.4. Data analysis

Questionnaire responses were transcribed into Microsoft excel by ILRI staff. Narrative responses collected from the group discussions were examined and reported. Responses collected during the key informant interviews were used to calculate approximate average value on a per household basis for key variables related to feeding such as; the composition of the diet, Metabolizable Energy (ME) availability in the diet, Crude Protein (CP) availability in the diet, income generated from milk sales, and estimates of livestock productivity. Calculation of these variables was based on the quantities of purchased feed stated by farmers and the level of on-farm crop production. Standard grain yield to residue ratios (Brown, 2003) where used to estimate on-farm crop residue production. Standard Dry Matter (DM), ME and CP values for feed materials were obtained from
NRC (2001). Farmer weight estimates of dietary ingredients were considered inaccurate and were not used where possible.

3. Results

3.1. Ratanagar

3.1.1. Overview of the production system

The area is dominated by smallholder producers who utilise an average of 0.33 hectares of land per household. Households are composed of an average of 5 members. The area experiences 3 seasons; Bakhe (rainy) which usually occurs from July to October, Hinde (winter) which occurs from November to March and Chaite (Spring) which occurs from April to July. The main rainfall usually occurs from the early Chaite (May) to mid Barkhe (August). Irrigation is available to over 80% of all households in the area. Labour is most required from June to July for transplantation and September to October for harvest. Labourers from the Terai region usually come to the area during these times to fulfil the labour requirements since much of the locally available labour (approximately 20%) has gone abroad for employment. A wide variety of crops are grown throughout the seasons. The main crops grown by households are shown in Figure 1. During Bakhe and Chaite, rice (*Oryza sativa*) and maize (*Zea mays*) are grown. During Hinde; wheat (*Triticum aestivum*), oil crops such as Mustard (*Brassica rapa*), and vegetables such as Lentils (*Lens culinaris*) and potatoes (*Solanum tuberosum*) are grown. A range of fodder crops such as napier grass (*Pennisetum purpureum*) and fodder oats (*Avena sativa*) are also grown. Cattle, buffalo, goats and poultry are kept by the majority of households in the area. Sheep and pigs are less commonly kept. Only 10% of households keep sheep and 3% keep pigs. Households in the area utilise a wide variety of means to generate income. The majority of household income (56% of total income) comes from off-farm sources such as remittances, businesses and employment. Livestock and agricultural cropping activities contribute the remaining 27% and 17% respectively as shown in Figure 2.

![Crops grown in Ratnanagar municipality, Nepal](image)

Figure 1: The average area of land per household sown to the major crops in Ratnanagar municipality, Nepal.
Figure 2: The average contribution (as a percentage) made by the various livelihood activities to total household income in the Ratanagar municipality of Nepal.

3.1.2 The livestock system

Livestock are integrated into this system primarily as a means of income generation through the sale of milk. Cross-bred Holstein Friesian and Jersey cows, are the main livestock species kept by households for the purpose of milk production. Approximately 75-80% of households in the area own 2-3 cross-bred milking cows. Twenty percent of households keep 1-2 buffalo, predominately Murrah buffalo for milking. When the milk production capabilities of the buffalo cows begin to decline, they are sold for slaughter after a short period of fattening. Local cows are also kept by 5% of households for milking and the provision of draught power. The relative importance of the various dairy animals is reflected in the price of these animals. Local cows and local buffalo are the least expensive milk animal available for purchase at 10,000Rs (USD$141.06) and 40,000Rs (USD$564.25) per head respectively. Improved cows and buffalo are more expensive at 50,000Rs (USD$705.32) and 60,000Rs (USD$846.38) per head respectively. The average price received for milk does not vary significantly throughout the year. However, as price is determined by milk quality in this area, there is a large difference between households. Prices received can range from 24Rs (USD$0.34) to 27Rs (USD$0.38) per litre. On average dairy animals in this area produce 1783.13 litres of milk per head per year.

Goats and poultry are also kept by most households for household consumption. 80% of all households own at least 3 goats and 50% of households own at least 10 poultry birds (chickens and/or ducks). Cattle and buffalo are managed slightly differently due to their different physiological characteristics. Cows, particularly cross-bred cows are stall fed throughout the year. They are kept in close proximity to the household in purpose built open wall sheds. Some farmers have concreted the floor of the structure whilst others utilise sand, rocks and/or rice straw as bedding for the animals. Buffalo are also stall-fed and maintained in a shed (often the same shed as the cattle) throughout most of the year. However, due to the buffalo’s need to wallow, they are taken down to the riverside for 2-4 hours everyday. During this time they are tethered and allowed to wallow and graze on naturally occurring grasses.

At present, there appear to be no veterinarians in the area. Some basic veterinary services such as vaccination, de-worming and mastitis treatments are available from the dairy co-operative. In the
event of a serious disease outbreak, cases are handled by the government appointed District Livestock Service Officer (DLSO). Artificial Insemination (AI) is provided by the Chitwan milk company and another private operator. AI costs 100Rs (USD$1.41) from the Chitwan milk company and 200-300Rs (USD$2.82-USD$4.23) from the private operator. Natural matings with an improved bull are 300Rs (USD$4.23) per service. Natural matings are generally considered more reliable and are used after AI has failed to result in conception.

### 3.1.3 Feed availability throughout the year

Green fodder is the main component of the diet comprising approximately 46% of the diet as shown in Figure 3. Green fodder also makes significant contributions to the Metabolizable Energy (ME) and Crude Protein (CP) content of the diet. 25% of the diets ME and 37% of the diets CP comes from green fodder materials as shown in Figure 4 and Figure 5. The majority of the green fodder material is fed during the Bakhe and Chaite periods as shown in Figure 6. Many households cultivate small areas of fodder crops such as; napier grass, oats, green maize, and berseem clover (*Trifolium alexandrinum*). Additionally, local grasses, weeds from crops and leaf material from species such as *Melia azedarach* and *Leucaena leucocephala* are collected from bunds, roadsides and nearby forests for feeding to livestock.

Crop residues, namely rice straw, is also a key component in the diet of dairy animals in this area (Figure 3). Rice straw is relied on throughout the year and is the primary source of ME, providing approximately 38% of the total ME found in the diet as shown in Figure 4. On average each household produces approximately 850kg of rice straw and 273.33kg of wheat straw for livestock feeding. The straw is usually piled onto a slightly raised platform and left uncovered until required for feeding. The residue material produced on-farm from cropping activities is generally not enough to sustain the livestock throughout the year. Additional rice straw is purchased during October and November (directly after the main rice harvest) and stored until required. On average, each household in the area purchases approximately 2600kg of rice straw annually. The straw is usually purchased for 10Rs (USD$0.14) per kilogram. Each household spends approximately 26000Rs (USD$366.77) on rice straw annually. The straw is usually fed as a whole fibre without any form of processing or manipulation prior to feeding. Many farmers are aware of chopping as a means of improving the quality of straw material, however, no farmers chop the material prior to feeding as it is considered to be labour intensive and impractical. Other residue producing crops such as Pigeon pea (*Cajanus cajan*) and soybean (*Glycine max*) are known to be cultivated along the rice field bunds. However, the residue of these crops is not fed.

Purchased concentrate feeds compose 14% of the diet (as fed). Wheat bran, rice bran and a commercially formulated mixed ration are the main concentrate feeds purchased. These concentrates are the main source of crude protein in the diet contributing approximately 37% of all protein consumed (Figure 5). There is no price differential between the commercially formulated mixed ration and wheat bran. Both are purchased for 18Rs (USD$0.25) per kg. Farmers demonstrate a clear preference for wheat bran over the commercially mixed ration. Each household spends approximately 13014Rs (USD$183.58) on wheat bran and only 2160Rs (USD$30.47) on the commercially mixed feed annually. This preference is reportedly due to farmer familiarity with the use of brans. Variability in the quality of the commercially mixed ration may also be influencing
farmer’s choice of purchased feed. Under the current feeding system, 39% of the dairy animal’s diet (as fed) is purchased feed, costing each household approximately 42074Rs (USD$593.51) annually.

**Dietary overview of dairy animals in Ratnanagar municipality, Nepal**

- Rice straw (grown) 8%
- Wheat straw (grown) 3%
- Maize Stover (grown) 4%
- Green fodder (grown) 46%
- Concentrates (purchased) 14%
- Rice straw (purchased) 25%

**Figure 3:** The contribution made by the various feed sources (as a percentage) to the total diet (as fed) of dairy animals in Ratnanagar municipality, Nepal.

**Metabolizable Energy (ME) content of the diet of dairy animals in Ratnanagar municipality, Nepal**

- Concentrates 28%
- Rice straw 38%
- Green fodder 25%
- Maize Stover 6%
- Wheat straw 3%

**Figure 4:** The contributions made by the various feed sources (as a percentage) to the Metabolizable Energy (ME) content of the diet of dairy animals in Ratnanagar municipality, Nepal.

**Crude Protein (CP) content of the diet of dairy animals in Ratnanagar municipality, Nepal**

- Concentrates 37%
- Rice straw 20%
- Green fodder 37%
- Maize Stover 4%

**Figure 5:** The contributions made by the various feedstuffs (as a percentage) to the crude protein content of the diet of dairy animals in Ratnanagar municipality, Nepal.

**TOTAL ME CONTENT OF DIET:** 51308.30 MJ

**TOTAL CRUDE PROTEIN CONTENT OF DIET:** 1876.85 KG OF DM
3.1.4 Problems, issues and opportunities

There are many issues affecting the productivity of livestock in the area. The main constraint identified by farmers was the lack of knowledge related to the quality of purchased feed. At present farmers rely heavily on purchased feeds such as; rice straw, wheat bran, rice bran and commercially mixed rations. Farmers don’t feel that they have the appropriate knowledge to make an informed choice about which feed (or combination of feeds) will improve productivity in a cost effective manner. Farmers suggested training in regard to assessment of locally available feeds and improved labelling on purchased feeds as potential solutions.

Disease affecting the productivity of dairy animals was the second most important problem identified by farmers. Liver fluke (*Fasciola hepatica*), worms and mastitis were identified as the main constraints to improving milk production levels. Farmers believe the importance of these ailments is due to the lack of a veterinarian in the area. If a veterinarian was easily accessible these problems would not be such a concern as the veterinarian would be able to provide advice as to the best course of action to prevent and manage these diseases. Staff at the milk co-operative are trained in basic veterinary treatments but farmers view their current skill level as inadequate as they have been unable improve the health status of their dairy animals.

Poor conception rates from AI are also a concern for farmers in the area. At present, multiple inseminations are required before conception is achieved. This represents a significant cost to the farmer. Farmers have little understanding of the AI procedure and are largely unsure as to why AI is not resulting in conception. Many farmers believe there may be an underlying problem of infertility.
with their cows and further research should be undertaken to determine if this is the case and what the best course of action should be.

The least important problem identified by farmers was the high cost of milk production. Due to the reliance on purchased feeds, for milk production to be profitable, the price received for milk must off-set the cost of purchasing feeds, medicines, vaccines, AI services and the time spent tending animals. Farmers see this as becoming increasingly unlikely in the future, unless production methods can be improved as farmers do not currently have any control over the price received for their milk. At present, a fixed price for milk is determined by the private dairies which purchase the milk from the village cooperative. Though these private dairies are well below their desired milk quotas, many farmers believe that once the private dairies start to meet their quotas they will start to decrease the price they purchase milk for. This will significantly decrease the profitability of milk production for farmers. To remedy this situation, farmers believe that government subsidies on livestock feed and medicines would effectively decrease the cost of milk production and ensure profit margins are retained should milk price decrease.

3.2. Gitanagar

3.2.1. Overview of the production system

The area is dominated by smallholder producers who utilise an average land area of 0.24 hectares per household. There is a range in land holdings throughout the area from 0.167 hectares to 0.33 hectares. Each household is composed of an average of 5 members who carry out the large majority of agricultural and livestock related activities. Approximately 60% of young people are leaving the area for work. As a result, during peak periods of labour requirement, which is usually from June to October, labourers from outside the area are required. There are generally 3 main seasons, Rainy (Barkhe) which occurs from July to November, Winter (Hindebali) which occurs from November to April and Spring (Basartebali) which occurs from April to July. Access to irrigation varies across the area. Some households can irrigate 100% of their lands, whilst others may only be able to irrigate a small section. On average 30-40% of all land in the area has access to irrigation. A large variety of crops are grown in the area as shown in Figure 7. During the rainy season (Barkhe), rice (Oryza sativa) is the dominant crop. Small amounts of soybean (Glycine max) are also grown during this time. During Winter (Hindebali), wheat (Triticum aestivum) is the dominant crop, however, a large variety of other crops such as; kidney beans (Phaseolus vulgaris) mustard (Brassica rapa), potato (Solanum tuberosum), Jai, berseem clover (Trifolium alexandrium), maize (Zea mays), lentils (Lens culinaris), peas (Pisum sativum), and buckwheat (Eriogonum douglasi) are also grown. During Spring (Basartebali), maize, rice and sesame (Sesamum indicum) are cropped. Goats and cattle are the most commonly kept livestock species. Poultry are also kept by a small percentage of households. Livestock, in particular dairying, is the primary contributor to household income contributing 63% as shown in Figure 8. Agricultural cropping activities contribute the remaining 37% of all household income.
3.2.2 The livestock system

Goats are the most popular livestock species kept within the area. Eighty percent of households keep 2-3 goats which are used to fulfil household meat requirements and/or sold at irregular intervals for slaughter. Poultry (chickens and duck) are only kept by 4% of households who usually keep at least 3 birds. Improved dairy cows, primarily Holstein Freisian and Jersey, are kept by 50% of households. These households generally keep 2-3 cows. Approximately 10% of households maintain local buffalo for milking purposes, whilst 5% keep improved buffalo such as Murrah buffalo for milking. Households with buffalo keep 1-2 animals. Once the milk production capabilities of the buffalo and cows begin to decline they are usually sold after a short period of fattening. Local cows and draught cattle are kept by 1% of households. These households keep 1-2 head. The relative importance of the various categories of dairy animal is reflected in purchase price. Local cows and local buffalo are the cheapest dairy animal available for purchase at approximately 10,000Rs (USD$141.06) and 30,000Rs (USD$423.19) per head respectively. Improved cows and buffalo are available for 80000-90000Rs (USD$1128.51-USD$1269.57) per head. The average price received for
milk tends to vary slightly throughout the year. For the majority of the year the average price received for milk is 26.60Rs (USD$0.38) per litre. However, from July to November the average price ranges from 27 (USD$0.38) to 28.70Rs (USD$0.40) per litres. This increase is associated with decreased levels of milk production per household. Dairy animals in this area produce approximately 3141.20 litres of milk per head per year. The sale of milk generates approximately 249446Rs (USD$3518.78) per household annually.

The dairy animals are usually maintained in purpose built sheds in close proximity to the household and stall fed throughout the year. The shed will generally only have temporary walls that are erected during winter months to keep the animals warm. During summer months, the walls are removed to allow air to circulate around the animals to keep them cool.

There is an animal health centre readily accessible to most of the households within the area. This service provides treatments for most diseases known to farmers. Artificial Insemination (AI) is used by 90% of household for reproduction. The cost of a single service is 150Rs (USD$2.12) (including service fee). The same price is paid whether or not conception is achieved. Natural mating with an improved bull is used by 10% of households, costing 200Rs (USD$ 2.82) per service. If AI fails to result in conception after a number of attempts, natural mating will be used. Approximately 50% of all AI services fail to result in conception.

3.2.3. Feed availability throughout the year

The diet of dairy animals in this area is composed of a number of key elements as shown in Figure 9. Rice straw is the main component of the diet, contributing 45%. Rice straw is also the primary source of Metabolizable Energy (ME), contributing 45% of all dietary ME as shown in Figure 10. Rice straw is primarily fed as a whole fibre with no processes or manipulation being undertaken to improve its quality prior to feeding. 28% of all rice straw in the diet is purchased from outside sources as not enough is generated from cropping activities to sustain the animals throughout the entire year. Each household purchases approximately 9333kg of rice straw per year. Rice straw is purchased for approximately 5Rs (USD$0.07)per kg during October and November directly after the main rice harvest. It is then heaped into a slightly elevated open pile in close proximity to the livestock until required for feeding. On average each household, spends approximately 46667Rs (USD$658.30) on rice straw each year. Some households in the area do not feed all the wheat straw grown that is grown on farm. The more wealthy households often give between 30-100% of the wheat straw to neighbouring households or burn it. Underlying reasons for this need to be examined further.

Green fodder is also a substantial component of the diet contributing 22% (Figure 9). Green fodder has varying levels of importance in the diet throughout the year as shown in Figure 11. During the winter green fodder is a very minor component of the diet. Green maize is the primary contributor to green fodder material fed to dairy animals. Most households are involved in the cropping of maize for the sole purpose of feeding. Other green fodder materials are also obtained and often include; Napier grass (Pennisetum purpureum), Berseem clover, Jai, and naturally occurring grasses. This fodder material is usually collected from fencelines, paddy ridges, and roadsides. It is brought back to the animals and fed without any form of additional processing or further manipulation.

Concentrate feeds are also a key feature of this diet throughout the year, and particularly in Winter (Hindebali) as shown in Figure 11. Concentrates contribute 32% of the total ME (Figure 10) and 50%
of the total Crude Protein (CP) content of the diet as shown in Figure 12. The main concentrate feeds purchased by farmers in the area; wheat bran, rice bran, a locally available commercially mixed ration and rice polishing. Wheat bran is usually purchased for 17Rs (USD$0.24) per kilogram, rice bran and the commercially mixed ration are both purchased for 20Rs (USD$0.28) per kilogram. Farmers demonstrate a slight preference for wheat bran over other available concentrate feeds. Each year, each household in the area purchases approximately 4106 kilograms of wheat bran, 3000 kilograms of commercially mixed ration, 67 kilograms of rice bran, and 67 kilograms of rice polish costing approximately 131147Rs (USD$1850.01). Under the current feeding system, the diet of dairy animals in the area on average costs each household 177813Rs (USD$2508.29) per year. This represents 71.28% of the income generated from milk sales. After the purchase of feed materials, milk sales are generate a profit of approximately 71633Rs (USD$1010.48) per household per year (not considering additional expenses such as vaccines, AI etc.).

Figure 9: The contribution made by the various feed sources (as a percentage) to the total diet of dairy animals Gitanagar, Nepal

Figure 10: The contributions made by the various feed sources (as a percentage) to the Metabolizable Energy (ME) content of the diet of dairy animals in Gitanagar, Nepal.

Figure 11: The composition of the diet of dairy animals according to season in Gitanagar.
3.2.4. Problems, issues and opportunities

The most important problem identified by farmers was disease, in particular mastitis and issues of infertility. According to farmers these diseases are a common problem that most households deal with on a regular basis. There is an animal health facility that can treat the large majority of cases. However, farmers believe more should be done as these issues are still affecting the productivity of their animals. Farmers are unable to determine what course of action would help to minimise the impact of disease on their animals.

The rate of breed improvement was the second most important problem identified by farmers. At present, farmers believe the rate of breed improvement is being limited by the Artificial Insemination (AI) service providers. These providers generally only have semen from a limited number of bulls. The AI procedure is also very unreliable and it usually takes a number of attempts before conception is achieved, which is very costly for farmers. Farmers suggest that these problems can be easily minimised through ensuring semen from a greater number of bulls is available. They would also like AI technicians to be able to provide information and about the various bulls and breeds they carry to allow farmers to make an informed decision. To improve the reliability of the AI procedure, farmers believe the service providers need to improve their method of linkage with the farmers to ensure that the insemination procedure can be carried out at the appropriate time.

Farmers identified feeding as another problem affecting productivity. Farmers do not understand a number of key concepts they believe would help them utilise feed more effectively to improve productivity. Concepts include; understanding feed quality, technologies and/or methodologies that can improve feed quality and formulating a balanced ration with feed already available. Farmers see the solution to this problem as further training in these key areas.
The high cost of milk production was the least important problems identified by farmers. Though this problem is considered by farmers as the least important, farmers understand it is highly dependent and dictated by the other issues identified. Thus, to lower the price of milk production farmers would like to see clear improvement in the other areas of concern. Additionally, they view the further introduction of improved, higher yielding fodder varieties as important in minimising their current reliance on purchased feeds.

4. Discussion

4.1. Potential solutions

4.1.1. Ratanagar

To minimize the impacts of many of the constraints identified by farmers a wide variety of techniques should be considered. Due to the varied nature of the constraints identified, coordination amongst the various components of the value chain such as private dairies, breeding agencies, mixed feed manufacturers, Non-Government Organisations (NGOs), and donor organisations will need to occur to help strengthen the value chain and ensure the success and sustainability of the interventions.

Many of the constraints identified, particularly the more important constraints, are generally due to lack of understanding of the situation by the farmers. Providing farmers with training about how to evaluate the various feed sources available to them, how to mix the feeds to maximise potential productive gains and the introduction of simple techniques or technologies that could be utilised to improve feed quality (such as chopping) will help mitigate the farmers concerns in regard to understanding the quality of feed. However, care should be taken when introducing technologies such as chopping. Chopping feed materials decreases the particle size of the material which increases the rate of passage through the digestive system. This will lead to an increase in feed intake of an animal. Therefore, it is important that adequate quantities of feed (of appropriate quality) are freely available to meet the increased intake. In this area, increased fodder biomass production per hectare needs to be achieved before chopping is introduced. Early introduction of chopping will lead to a further dependence on purchased feeds.

Providing farmers with a greater understanding of common diseases in the area will improve the health of their animals. At present, farmers expect this service to be provided by a veterinarian or the staff at the co-operative. This does not appear to be occurring to their satisfaction. Training the farmers themselves in how to prevent and manage these common ailments will shift the onus of providing this information from the co-op staff to the farmers themselves. This will mean that instead of farmers not understanding what may be wrong with their animals, or why the situation has developed, they will be able to take ownership of the situation and ensure the necessary steps can be taken to manage the problem and prevent it from reoccurring in the future. Improved training of the co-operative staff and the potential placement of a veterinarian in the area should also be considered as their skills and knowledge will be important in providing technical support to the farmers, particularly for more uncommon diseases and severe cases.

The poor conception rates achieved through AI are unlikely due to the low fertility of the cows as indicated by farmers. The poor performance of AI is more likely to be due to a number of factors
including; inability of farmers to recognise and accurately detect oestrous, poor hygiene during the AI procedure, poorly trained AI technicians, improper storage of semen, poor quality semen, high stress levels within the animal pre and post insemination and poor nutrition post insemination. These factors can all result in an AI procedure failing to result in conception. The only elements of the AI procedure that farmers can control is correct identification of oestrous, and management of the animal before and after insemination. Therefore, any intervention at a farmer level should target these areas. Training of farmers to properly recognise the signs of oestrous, ensuring farmers understand the concept of stress and the best ways to ensure their cow is not subject to stressful stimuli immediately prior to, or post insemination should help to improve conception rates. Maintaining the cow on an appropriate plane of nutrition will also help to maintain pregnancy through to parturition. It may also be necessary to further examine the training of the AI technicians to ensure they are appropriately trained and the poor conception rates are not due to their poor skills. Similarly, the systems employed by AI service providers should be examined to ensure that the linkages between the farmer and the technician are appropriate for ensuring the animal can be inseminated in a timely manner.

The high cost of milk production is the least important constraint identified by farmers, yet it underpins and is largely determined by a combination of all the other constraints previously identified. A lack of understanding of feed quality, a high incidence of production limiting diseases and poor AI conception rates all effect and increase the overall cost of production. Mitigating the impacts of these constraints through undertaking the suggested interventions described above, will lessen the cost of production significantly. For example, once farmers are aware of the differing qualities of feeds, they are likely to decrease the quantity of Wheat bran purchased and increase the quantity of commercially mixed ration purchased. This is likely to increase milk production per unit of feed purchased above what could be achieved from feeding Wheat bran. However, as purchased feeds are a major contributor to the high cost of production in this area, attempts should also be made to address this issue through decreasing the overall percentage of purchased feed in the diet. To achieve this it will be necessary to increase the production of fodder material on-farm. Replacing areas of local grass with higher yielding fodder species such as Napier grass will effectively increase per hectare fodder production without compromising grain yields. Similarly, replacing current Pigeon pea varieties with dual purpose varieties which possess grain yields similar to traditional varieties yet also produce high quality residue material that can be feed to livestock could also represent an additional feed source.

Special consideration should also be given to increasing fodder production during Hinde when green fodder only represents a small portion of the diet. As Hinde is usually a very dry time of the year, increasing the quantity of green fodder produced could be achieved through the further use of fodder trees. Fodder trees have large root systems which enable them to access ground water and remain productive during dry periods. Many farmers already collect leaf material from fodder tree species, namely *Melia azedarach* and *Leucaena leucocephala*. This activity should be further expanded with additional trees planted along paddy ridges, fencelines, roadsides and around the homestead.
4.1.2. Gitanagar

The diseases mentioned by farmers are generally very easily treated and should be able to be dealt with effectively by the animal health facility. As farmers believe this is not occurring it can be assumed that they are failing to understand the underlying cause of the disease, and the necessary steps that are required to prevent re-infection occurring. This is likely to be the case in regard to infertility as it is unlikely that diseases of infertility are affecting conception rates as suggested by farmers; rather, poor application of AI or nutritional anoestrus is being mistaken for infertility. It is assumed that staff at the animal health facility would be providing information in regard to such issues. In the event that they are unable or incapable of doing so, it may be necessary to conduct training with the farmers themselves. The development of simple fact sheets in the local language could be easily implemented to aid in the dissemination of such information. Providing the farmers with a basic understanding of common disease issues and the necessary measures required to manage and prevent them affecting productivity will shift the onus of providing such information from the animal health staff to the farmers themselves. This will mean that instead of farmers not understanding what may be wrong with their animals, or why the situation has developed, they will be able to take ownership of the situation and ensure the necessary steps can be taken to manage the problem and prevent it from reoccurring in the future. Improved training of the animal health staff should also be considered as their skills and knowledge will be important in providing technical support to the farmers, particularly for more uncommon diseases and severe cases.

To improve the rate of breed improvement, it will be necessary to improve the selection of semen available to farmers, and improve the conception rate achieved with AI. At present, 50% of all inseminations fail to result in conception. This is a very low conception rate. There could be a number of reasons for this. Reasons could include; inability of farmers to recognise and accurately detect oestrous, poor hygiene during the AI procedure, poorly trained AI technicians, improper storage of semen, poor quality semen, high stress levels within the animal pre and post insemination and poor nutrition post insemination. These factors can all result in an AI procedure failing to result in conception. The only elements of the AI procedure that farmers can control is correct identification of oestrous, and management of the animal before and after insemination. Therefore, any intervention at a farmer level should target these areas. Training of farmers to properly recognise the signs of oestrous, ensuring farmers understand the concept of stress and the best ways to ensure their cow is not subject to stressful stimuli immediately prior to, or post insemination should help to improve conception rates. Maintaining the cow on an appropriate plane of nutrition will also help to stimulate ovulation and subsequently maintain pregnancy through to parturition. It may also be necessary to further examine the training of the AI technicians to ensure they are appropriately trained and the poor conception rates are not due to their poor skills. AI technicians should also be trained in understanding the various breed characteristics and how such characteristics will affect the productivity of offspring in this particular style of production. The systems employed by AI service providers to access farmers should also be examined to ensure that the linkages between the farmer and the technician are appropriate for ensuring the animal can be inseminated in a timely manner.

Training farmers in the key areas of; understanding feed quality, technologies and/or methodologies that can used to improve feed quality (such as chopping) and formulation of a balanced ration with locally available feed, will effectively increase feed utilisation on farm. This should in turn lead to
improved livestock productivity. In addition to this, attempts should also be made to understand why the more wealthy farmers are giving away or burning a portion of the wheat straw generated from cropping activities, whilst also purchasing quantities of rice straw. This may be due to farmers perception that wheat straw is a poor quality feed material. However, giving away and burning the material represents a significant loss of a potential feed source which could be utilised on-farm.

The high cost of milk production was the least important constraint identified by farmers, yet it underpins and is largely determined by a combination of all the other constraints previously identified. An ineffective feeding strategy, a high incidence (and re-occurrence) of disease and poor AI conception rates all effect and increase the overall cost of production. Mitigating the impacts of these constraints through undertaking the suggested interventions described above and educating farmers about these issues, will lessen the cost of production significantly. For example, once farmers are aware of the differing qualities of feeds, they are likely to decrease the quantity of wheat bran purchased and increase the quantity of commercially mixed ration purchased. This is likely to increase milk production per unit of purchased feed above what could be achieved from feeding wheat bran. However, as purchased feeds are a major contributor to the high cost of production in this area, attempts should be made to decrease the overall percentage of purchased feed in the diet. To achieve this it will be necessary to increase the production of green fodder material on-farm, particularly during Hindebali when green fodder only represents a small portion of the diet. As Hindebali is usually a very dry time of the year, increasing the quantity of green fodder produced could be achieved through the further use of fodder trees. Fodder trees have large root systems which enable them to access ground water and remain productive during dry periods. Fodder tree species, Melia azedarach and Leucaena leucocephala could be considered for this purpose. They could be planted along paddy ridges, fencelines, roadsides and around the homestead. Planting in this style will allow additional fodder to be produced per hectare without sacrificing crop yields. Another method of improving green fodder production could be through substituting the maize crops (which is usually fed green) with another higher yielding fodder species. This may result in excesses of green feed being grown. If this does occur, simple methods of fodder preservation (such as small-scale silage production) should be considered to store the feed until it is required during Hindebali.

5. Limitations of the study

The sampling design employed by the FEAST relies on a number of assumptions, particularly in regard to the selection of farmers for individual interview. The sampling methodology dictates that 3 individuals, representative of the various wealth categories within the area are selected. In this area, landholding was used to determine wealth. The responses given by these key farmers were expected to represent the situation of everyone in the area with similar landholdings. Though great care was taken during the selection process this is unlikely to be case. The farmers at the extreme ends of the landholding spectrum (that is, those with excessively large holdings, and those with excessive small holdings) are likely to put forward as representatives by the other farmers and local staff. This could lead to overestimations and/or underestimations of variables. Ideally, the farmers selected for individual survey are considered “average” farmers for their category of wealth. The selection of additional farmers for interview to increase the sample size would minimise the impact of this occurring. However, this would make the interview process much more labour intensive.
The FEAST was developed as a simple, rapid means of assessing on-farm feed availability. This has resulted in the FEAST facing a number of trade-offs, particularly in regard to the accuracy and reliability of feed estimates. Many of the calculations made during data analysis are based on standard values. For example, estimates of crop residue availability are calculated from standard grain yield to crop residue ratios. Similarly, ME, CP and DM calculations rely on standard values. The reliance on such standard values limits the overall accuracy of estimates as these values are known to be influenced by a number of factors that can cause them to vary significantly. Collection and analysis of samples from the research site would improve the accuracy of feed estimate calculations. However, as these values can vary between farms within a specific area, carrying out an investigation to determine site specific values would be very time consuming and costly.

The reliance on farmer estimates for calculating intake during grazing and intake of collected green fodder is another possible source of inaccuracy. Farmer estimates are generally imprecise as farmers do not weigh collected forages prior to feeding, and estimating intake from grazing is particularly difficult due to the number of factors that affect the intake. Additional studies and feeding trials could be undertaken to determine more accurate estimates of these variables; however, this would be very expensive and time consuming.

6. Conclusion

6.1. Ratanagar

This area is a mixed crop livestock system, in which livestock are integrated to generate income from the sale of milk. Dairy cattle, namely Holstein Friesian and Jersey cows are the main livestock species kept for milk production. Murrah buffalo are also kept by some households primarily for milk production. The majority of households also own goats and poultry to fulfil household meat requirements. A large proportion of the diet of dairy animals in this area is composed of purchased feeds such as; rice straw, wheat bran and commercially mixed rations. Each household spends approximately 42074Rs (USD$593.51) on purchased feed annually. The main problems identified by farmers were poor understanding of feed quality, animal health issues, poor reproductive rates from AI and high cost of milk production. To mitigate these constraints it will be necessary to improve farmer training in several key areas of nutrition, reproduction, and animal health management. Improvement in these areas will effectively reduce the cost of producing milk. Additionally, fodder based interventions such as; chopping of straw materials, the further use of improved fodder species, and the introduction of dual purpose crops will also need to be employed to decrease the current reliance of purchased feeds and minimise the cost of production.

6.2. Gitanagar

Farmers in this area generally utilise a small area of land approximately 0.24 hectares in size to produce a wide variety of crops. The cereal crops; rice, maize and wheat are the dominant crops. Goats and dairy cattle, predominately Holstein Friesian and Jersey, are the main livestock species kept. Some households also keep dairy buffalos and poultry. Livestock, namely dairying, contributes 63% of household income. Agricultural cropping contributes the remaining 37%. Crop residues (the majority of which are purchased) are the primary component of the diet and are relied on throughout the year as the main source of ME in the diet. Purchased concentrate feeds such as; wheat bran and commercially mixed rations provide a significant portion of the dietary ME and CP.
The main problems faced by farmers in this area are due to a lack of understanding of key animal health, nutrition and reproduction concepts which is increasing the cost of milk production. Educating farmers in these key concepts and strengthening the services provided by local animal health workers and AI technicians will effectively mitigate the impact of these constraints.

7. **Summary**

7.1. **Ratanagar**

7.1.1. **Key issues**

- Lack of understanding in regard to feed quality amongst farmers.
- Poor understanding of animal health issues.
- Poor conceptions rates from AI
- Milk production is very costly.

7.1.2. **Key metrics**

- Milk yield: 1783.13 litres per cow per year
- Meat offtake: not applicable
- ME per TLU: 25.77MJ ME per day.

7.1.3. **Ways forward**

- Provide farmer training in key areas of nutrition such as; evaluation of feed quality, and ration formulation.
- Introduce simple techniques or technologies that could be utilised to improve feed quality such as chopping.
- Provide farmer training in key areas of animal health such as; identification of common diseases, the role of preventative health management techniques such as worming and vaccination, disease management and methods of minimising re-infection with common ailments such as mastitis.
- Provide farmer training in key areas of reproduction such as; oestrous detection, and prenatal nutrition.
- Examine training of AI technicians and the linkages used by AI service providers to access farmers to ensure insemination can occur in a timely manner.
- Further introduce and advocate the use of improved fodder varieties such as; Napier grass.
- Introduce dual purpose pigeon pea varieties
- Further introduce and advocate the use of fodder trees.

7.2. **Gitanagar**

7.2.1. **Key issues**

- High incidence of diseases such as mastitis affecting milk production capabilities.
- Inefficient AI providers limiting the rate of breed improvement.
- Lack of farmer knowledge in key areas of nutrition such as understanding feed quality.
- The high cost of milk production.

7.2.2. **Key metrics**

- Milk yield: 3141.20 litres per cow per year
- Meat offtake: not applicable
- ME per TLU: 72.22MJ ME per day.

7.2.3. **Ways forward**

- Improve farmer knowledge of animal health issues such as mastitis to prevent such conditions affecting the productivity of the animals.
- Train farmers in key areas of reproductive management to increase the chances of successful conception after a single procedure.
- Strengthen the capacity of AI technicians and AI service providers to ensure a wider selection of semen is available and AI technicians can provide information to farmers about the various breed and bull characteristics to allow them to make informed decisions.
- Train farmers in key areas of nutrition to improve their on-farm feed utilisation ability.
- Decrease the reliance on purchased feeds through increased fodder production per hectare (particularly during Hindebali) through the further introduction of fodder trees and higher yielding fodder varieties. If excess fodder can be produced, the introduction of fodder preservation techniques should also be considered.

8. **References**
