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NATIONAL DAIRY RESEARCH AND DEVELOPMENT CENTRE
DEPARTMENT OF LIVESTOCK
MINISTRY OF AGRICULTURE & FORESTS
YUSIPANG, THIMPHU

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PACKAGE OF PRACTICES & RECOMMENDATIONS

for

IMPROVED DAIRY FARMING IN BHUTAN

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PACKAGE OF GOOD PRACTICES AND RECOMMENDATIONS

Practices & Recommendations for Improved Dairy Farming in Bhutan

Manuscript Editing, Layout and Design:
Dr. N.B.Tamang, Specialist Head

Contact Address:
Specialist Head/Program Director
National Dairy Research & Development Centre,
Yusipang, Department of Livestock, MoAF

PO Box: 1058
Office Phone: +97517116985, 17116985 (PABX) Lab: 17116986
Email:ndrc17@gmail.com

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Contributors

1. Dr. N.B. Tamang, Specialist Head/Program Director, NDRDC Yusipang
2. Dr. D.B. Rai, Specialist III, NDRDC Yusipang
3. Mr. Phuntsho T. Norbu, Principal Livestock Production Officer, NDRDC Yusipang
4. Mr.Lokey Thapa,Dy.Chief Livestock Production Officer, NDRDC Yusipang
5. Ms.Deki Choden,Dy.Chief Livestock Production Officer, NDRDC, Yusipang
6. Ms.Kinley Choki,Dy.Chief Livestock Production Officer, NDRDC, Yusipang

SCOPE OF THIS BOOKLET

The Package of Good Practices and Recommendations is gist salient findings of research activities completed and paper published in Bhutan Journal of Animal Science and other International Journals. The recommendations provided in these booklet intents to improve the knowledge-base of the livestock professionals on various aspects of Dairy Cattle Breeding and Management in Bhutan. The knowledge gained could be applied in real life for enhancement of dairy production and income for better livelihoods of Dairy Farmers.

1. CONCEPTION RATES IN COWS AND HEIFERS USING SEXED &CONVENTIONAL SEMEN IN BHUTAN

CONTEXT

Use of Sexed (sex-sorted-female) semen is popular among dairy industries in developed countries for higher female birth assurance (80-90%) as compared to Conventional (unsexed) semen that gives only 50% female birth as replacement herd. The use of conventional semen results in birth of 50% male calves leading to difficulty of its disposal in one hand and insufficient production of replacement heifers in other hand. Thus, the demand for dairy cattle in the country was fulfilled through import along with high associated risks. In order to address the situation, sexed semen was imported and the technology tried in Bhutanese context from August 2014 to March 2018, involving Govt. dairy farms (NJBC, Samtse and CRC, Wangkha) and multiplier herds in extension (Tsirang, Sarpang and Samdrup Jongkhar), and investigated conception rates and sex of calf achieved with Artificial Insemination (AI) of 130 cows and 160 heifers of Jersey pure, Jersey cross and local cattle using sexed semen (151 AI) and conventional semen (271 AI).Both sexed and conventional semen had post thaw motility of 40%.

KEY FINDINGS

- The overall conception rate (heifer and cows in totality) was higher with conventional semen (48%) than with sexed semen (44.4%)
- The conception rate with sexed semen was 47.7% in heifers and only 35% in cows
- Semen yielded 89.6% female births, compared to 51.5% for conventional semen indicating influence of semen type on female births (Figure 1)

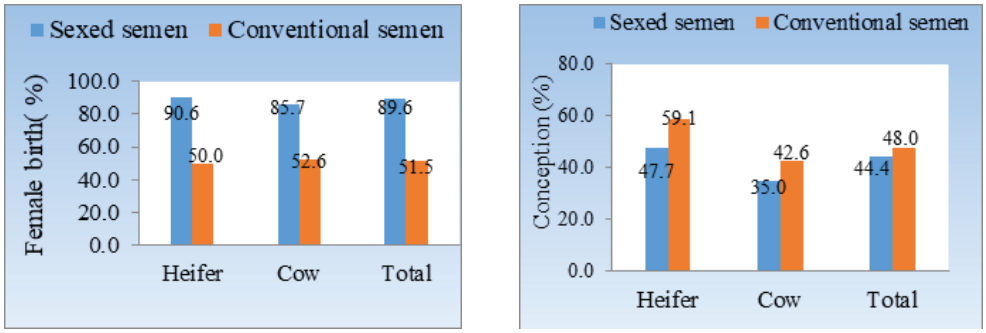


Fig 1. Conception rate and female birth with sexed and conventional semen

RECOMMENDED GOOD PRACTICES

- **Sexed semen (seven times more expensive than conventional semen) be best reserved for use in virgin heifers avoiding repeaters and cows**
- Cows up to 3rd lactation (maximum) with no history of repeat breeding may be considered for AI with sexed semen
- Sexed semen be used only in natural heat to optimize conception rates
- Insemination with Sexed semen be allotted to fluent AI technicians for higher conception rate
- Sexed semen is about five times more expensive than normal semen. Hence if more female birth is desired cost sharing mechanism be inculcated to save Govt. budget and sustain the sexed semen utilization

2. TIPS FOR IMPROVING BREEDING & MANAGEMENT OF LOCAL (THRABAM) CATTLE

CONTEXT

Nublang breed (*Nublang* - male and *Thrabam* -female), is popularly known to the scientific community as a Siri breed (*Bos indicus*). This breed is a foundation stock for crossbreeding to develop superior breeds in Bhutan.

The breed is selected over thousands of years of domestication and natural selection in a wide range of Bhutanese environments. The breed is more disease resistance than exotic dairy breeds, suitable for low input management system owing to its ability to survive better in coarse fodder.

In view of positive attributes of this breed, Royal Government of Bhutan established National *Nublang* Breeding Centre (NNBC) at Tashiyanghu (Tashigang, Bhutan) in 1994 as a nucleus *Nublang/Thrabam* herd. The farm caters to breeding bull needs of the farmers. However, with the changing time, mandate of the farm needs to be expanded not just for breeding bull production but also overall herd improvement.

Therefore, study assessed 3794 individual animal records maintained at the farm for 21 years (1997 to 2018) to determine overall performance of the nucleus herd, including production and reproductive performance at different lactation; so as to provide suitable recommendations to improve breeding and management of nucleus herd.

KEY FINDINGS

- The mean daily milk yield increased from 3.11kg/day in first lactation (lactation) to 3.78kg/day in 4th lactation. Lactation yield in 4th lactation was significantly higher than yields of all other lactations.
- The overall mean milk yield was 3.54±.23kg/day. Champion cow (NBIN 150000047) produced a highest milk yield of 6.5kg/day. The animal producing more than 5kg milk/day. Female calf sex ratio (%) by semen type was recorded for 65counts and 6kg milk/day was recorded for 4counts indicating under good management *Nublang* cattle selected for its genetic superiority can produce about 5kg milk/day.
- The mean lactation length of cows was 230.9±5.4days (7.7months), ranges from 221 to 236 days.

- The mean age at first service was 37.5±8 months(n=173); age at first calving was 47.6 ±8.5 months (n=165).
- Notably, calving interval has decreased from 16.1 ±3.6 months in 1st/2nd lactation to 12.1 ±1.1 months in 7th/8th lactation indicating improvement in reproductive efficiency of the nucleus herd.
- Herd dynamics at NNBC is conducive with 44 heifers and 22 young female calves available to replace 54 aging cows (32%). Equally, it has good number of breeding bulls at the farm to ensure periodic reshuffling in successive generation to avoid inbreeding.

RECOMMENDED GOOD PRACTICES

- Owing to short lactation length and low lactation yield, Nublang/Thrabam cattle may not compete with recognized dairy breeds even if they are rigorously selected. Hence, multiple traits selection giving equal importance to milk production, diseases resistance, adaptability, and foraging ability is necessary.
- Daily/lactation milk yield of Nublang/Thrabam cattle is highest in 4th lactation with gradual decline till 7th lactation. Hence. cows in the nucleus herd if necessary could be retained beyond 7th lactation based on their productivity and fitness
- Interrupted artificial insemination services are required to implement planned breeding program in the farm. Hence, AI Technicians availability at the farms be ensured at all times
- There is need to develop simple, yet effective breeding and user-friendly database record required data for periodic assessment of herd improvement.

3. GOOD BODY CONDITION, RIGHT SEASON OF ESTROUS INDUCTION & INSEMINATION IMPROVES CALVING RATE

CONTEXT

Low fertility and reproductive inefficiency of cattle is common in village herds. To address this problem, treatment of infertile animals with hormonal drugs to induce estrous is tried applying technologies successful in developed world. This is aimed at bringing non-cycling female to bring into production through estrous synchronization and fixed timed artificial insemination (FTAI).Although such effort increased the uniformity of the calf crop in developed countries, it is not known whether similar intervention in harsh Bhutanese farming environment, can bring about substantial benefits to farmers. Hence, to understand efficiency of such interventions, response and calving rates of local *Thrabam* heifers/cows artificially inseminated in induced estrous was assessed during late autumn and winter in three Agro-Ecological Zone of Samtse (Tading) and Tsirang (Barsong&Sergethang). A total of 298 animals were inseminated on induced estrous and followed up till calving. The findings were compared with similar intervention carried out in different season and breed of cattle; in other *Dzongkhags viz.* Tsirang, Sarpang and Samdrup Jongkhar; and authenticated with analogous studies conducted elsewhere in the world.

KEY FINDINGS

- Calving rate was only 12.08% when inseminated on synchronized/induced estrous as compared to 37.5% when animals were inseminated in natural estrous
- *Thrabam* cows/heifers with average Body Condition Score (BCS) of 2.8 had significantly higher response to hormonal treatment, conception and calving than animals with BCS lower than 2.4 (BCS 0 to 5 scale).Good body condition score corresponds to good health, achieved through better plane of nutrition which therefore is pre-requisite for birth of more calves
- Although under-fed animals manifest estrous with hormonal treatment, it does not lead to ovulation because there is low level of circulating Luteinizing Hormone (LH) in such weak animals. LH is required to induce ovulation and subsequent conception/pregnancy. Hence, selection of healthy cattle crucial
- Choice of season of the year for inducing estrous and FTAI of heifers/cows during winter produced less calves (14.2% calved) than estrous induced and

inseminated in summer (31.5% calved) in same cattle type. This indicates that seasonal variation of environmental condition alters conception/calving

RECOMMENDED GOOD PRACTICES

- Artificial Insemination of cattle on induced estrous in Bhutanese environment will be more conducive in summer when weather is favorable for adequate access to green forages by animals.
- Timing of estrous induction and insemination during summer when animals have access to better nutrition can result in better conception rate/calving rate than in winter. Hence, mass estrous induction in lean season especially during winter (when fodder scarcity is obvious) needs to be avoided.
- In order to make judicious use of expensive hormonal drugs to treat infertility and induce estrous, animal in poor health should be excluded until plane of nutrition improves and animals regain their body condition.
- Conception rate of local cattle when inseminated in induced estrous is highly disappointing, more so with sexed semen but animals inseminated in natural estrous had better conception rate even when inseminated in winter. Hence, it is recommended to inseminate local *Thrabam* cattle preferably in natural estrous.
- Except for treatment of infertility and anestrous in animals by Specialists, rampant use of expensive hormonal drugs by livestock professional of all walks of life, for induction of estrous and insemination need to be curtailed because this does not necessarily bring economic benefit to farmers to a large extent; owing to poor conception rate of the synchronized animals.

4. ADOPTION OF AI TECHNOLOGY CAN TRANSFORM SUBSISTENCE TO A MARKET ORIENTED DAIRY PRODUCTION

CONTEXT

Artificial Inseminations (AI) is the most efficient reproductive technology accepted by the scientific community for breed improvement and enhancement of dairy productivity. AI is considered as primary breeding tool for genetic up-gradation of cattle. In Bhutan, AI program has been implemented in a planned manner since 1987.

With increasing urban demand for dairy products in the country, the AI technology has been instrumental in gradual transition from subsistence to a market oriented production system over the years. However, comprehensive review of National AI Program and its impact on dairy development and to national economy was not assessed. Therefore, a review of AI program since its inception was carried out the insemination done and progenies born from 1987 to 2016, compare the AI performance by region and estimate the contribution made by the program to milk production and national economy.

KEY FINDINGS

Regional share of progenies born through AI

Western region has highest share of progenies born through application of AI technology (35%) followed by eastern region (31%). East central region has lower adoption of technology resulting in only 15% of total calves born in the country. Hence east central region has to gear up to take advantage of the technology for up-gradation of local cattle population in the region.

Dzongkhag-wise comparison of AI done and calves born recorded

Record from 1987 to 2016 show that across the 20 Dzongkhags of the country, Paro Dzongkhag is the best performer with 16,360 inseminations done with 5,829 progenies recorded. Gasa Dzongkhag poorly performed with 24 progenies born out of 73 inseminations done. The remoteness of Gasa Dzongkhag, coupled with cold weather could have had the detrimental effect of speed of technology adoption.

Comparison of AI performance in AI centres of Bhutan

Average insemination per month and corresponding progeny born is highest at Veterinary Hospital (VH), Paro, followed by VH Tsirang, Extension Centre (EC) Chaskhar, VH Thimphu and EC Deothang whereas in VH Gasa, EC Tashiding EC Bjemina, EC Goshi average insemination per month is less than one which needs to be reviewed with caution(figure 2). About 50% of the AIOS perform below the national average of 7±1 insemination/ month.

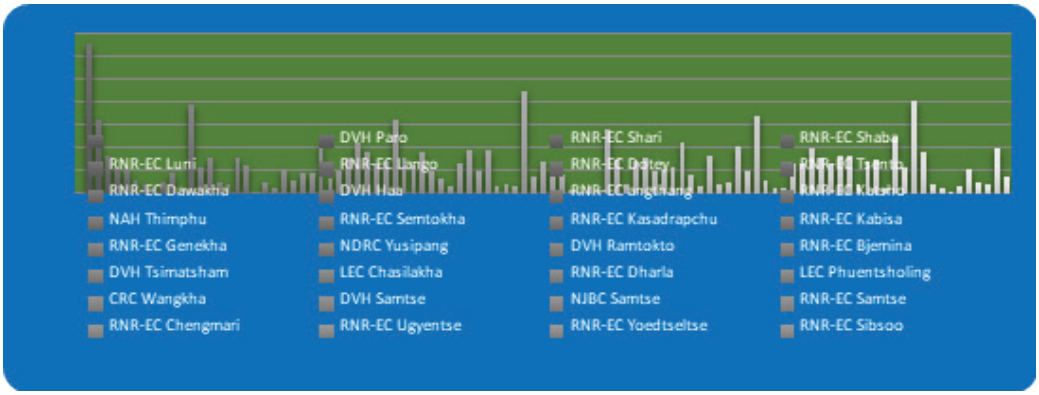


Fig 2. Comparison of AI performance in Bhutan

AI Technology contribution to Bhutanese economy

With the total annual production of 47,270 MT in 2016, dairy sector is contributing 2.1 billion to national economy annually. AI technology application has contributed estimated 48% of total milk produced in the country worth Nu.1.016 billion per annum.

RECOMMENDED GOOD PRACTICES

To strengthen the ongoing AI/dairy breed improvement program it is recommended that:

- Re-training on AI and reproductive management is provided to all AI Technicians
- Increase AI coverage through Training/deployment of Community AI Technician
- Proper deployment of staffs at the right place with proper handing/taking over of AI charges when staffs are transfer.
- LN2 production/ distribution facilities capacity have to be strengthened

- There should be joint ownership among Dzongkhag RLDC, NDRDC and DOL alike to create greater impact of AI program
- Poor performing AI outreach Centres has to be closed/relocated
- Proper feasibility has to be done to establish new AI centre to rationalize use of available resources

5. SAMPLE SURVEYS METHOD HAS POTENTIAL USE IN ESTIMATION OF MILK PRODUCTION

CONTEXT

Annual Livestock Census is data collected on livestock number (population) and published by Department of Livestock (DoL) are the results of complete enumeration of households carried out by Geog Livestock Extension Officers in 205 Geogs using a set of structured questionnaires developed by DoL. Data on livestock population also include animals in government farms.

To overcome specific problems and explore opportunities for the development of national statistics program and to bring improvement in livestock statistics a Pilot Sample Survey on Estimation of Milk Production was implemented in Samdrup Jongkhar Dzongkhag to:

- Develop, test and evaluate method on use of probability sample surveys for projecting milking cattle population to estimate milk production for the year
- Explore the potential use of sample surveys for estimation of milk production in the Dzongkhags/ Geogs making use of household data from the previous year

Population domain for the survey is chosen as 2257 households with milking dairy cattle, a suitable frame available with Department of Livestock (DoL, 2015). Of the total household with milking cattle, 1058 households (47%) were selected for the pilot sample survey.

Planning Analysis Tool and formula prescribed was applied to estimate the trend in milking cattle population annual growth. For calculating percent milking cattle population growth (straight line method) the following formula was used:

$$PR = \frac{(V_{Present} - V_{Past})}{V_{Past}} x100$$

Where:

PR = Percent Rate
$V_{Present}$ = Present or Future Value
V_{Past} = Past or Present Value

The annual percentage growth rate is simply the percent growth divided by N, the number of years (***Source**: Planning analysis course module: calculating percent (straight line) growth rates. University of Oregon, USA*)

KEY FINDINGS

- Average lactation length for Pure Jersey cows and Holstein Friesian (HF) cross is highest (280days); Jersey cross is 241 days(8 months) which is lower than standard lactation length of 305 days(10 months) for *Bos taurus* cattle breeds.

- Milk yield of cattle in production was highest in summer between May to August with average daily milk yield of 6.7 litres/ day for Jersey cross. The average yield of local cattle types *Jatsham. Deobum, Deothram, Thrabam and* Jaba were of similar range: 2.0 to 2.6litres per day.

- Milk production from Jersey cross is all seasons highest. Moreover, maximum milk contribution (59%) is from Jersey cross and other exotic cattle (Figure 3). Thus infusion of Jersey gene in local cattle population can increase milk production substantially.

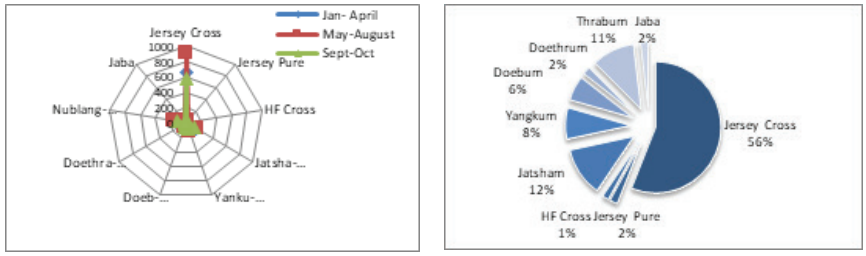


Fig.3 Milk production by season and breed

The survey examined the Standard Error (SE) for the estimates of milk production; estimate is within the 95% confidence level. Hence, sample survey can generate reasonably accurate annual milk production estimate.

RECOMMENDED GOOD PRACTICES

- To bring about improvement in the survey design, progressive adjustments over time on fast changing indicators needed for planning purpose

- For reliable Geog level livestock data, the practice of complete enumeration of livestock census on annual basis is better than estimation from sampled households

- In livestock census in late autumn is the reference period of reporting for milk production is one year. Milk production in a household/*Geog/Dzongkhag* in different seasons has to be determined through more precise survey and research on milk production for the particular season.

6. CONTRACT BREEDING IMPROVES VILLAGE DAIRY HERDS, HELP FARMER TO DERIVE SOCIO-ECONOMIC BENEFITS

CONTEXT

Cattle breeding services in the country are catered through Artificial Insemination (AI) and supply of breeding bulls. The average AI coverage was very low; estimated only 17% in 11th five year plan (NDRDC, 2018), and the demand for breeding bulls particularly jersey exceeded far more than the production capacity of the Govt. nucleus farms. To supplement breeding bull production the Contract Heifer and Bull Production Program (CHBPP) was initiated in 2001 as multiplier herds for Jersey. The CHBPP farmers are provided with progeny tested semen for faster genetic progress and productivity enhancement. The CHBPP since its inception has gained momentum as more farmers have joined the program with added number of quality animals in their herd. As of 2019, there were 55 CHBPPs established across the country covering 20 Dzongkhags (NDRDC, 2018) but no comprehensive assessment was done thus far. Hence, the performance of CHBPP in West and West-central region was assessed in 2019 to ascertain breed improvement progress and milk production of CHBPP cows, socio-economic benefit to the CHBPP members and hindrances if any in pursuit to find way forward to improve dairy breeding program.

The study included supply of jersey breeding bulls from the CHBPP *vis-a-vis* Govt. nucleus farms from 2008 - 2018, and information from 471 CHBPP households with 1793 milk records of 718 milking cows.

KEY FINDINGS

- The CHBPP meets 70% of Jersey breeding bull demand in the country annually and immensely contributed to breed improvement program nation-wide
- The productivity of jersey cross cows increased significantly from 5.9±2.3 l/day (inception) to 7.8±3.0 l/day in 2019as a result of significant increase in jersey cattle population above f3 generation (≥87.5% Jersey blood)through CHBPP Interventions
- The baseline information on productivity of jersey cross cows by blood level and lactation no. was ascertained
- Dairy has emerged as the primary source of income to 72% of CHBPP members and generated four times higher income in 2019 than at inception in the study area

- Initiation of CHBPP triggered formation of dairy groups in every location, enhancing social cohesiveness promoting a harmonious society
- Difficulty in disposal of bull born in the Program is one of the major hindrances
- The government livestock staffs though provided adequate AI services, follow up on progeny recording remained inadequate.

RECOMMENDED GOOD PRACTICES

- Wider use of sexed (sex-sorted female) semen to assure about 90% female birth in progressive CHBPPs is recommended.
- Intensification of Heifer Production Scheme with sexed semen be promoted involving adjoining villages with progressive Dairy Farmers Groups /Contract breeders member under CHBPP through Cluster Village Approach involving all CHBPPs groups vicinity to ease implementation and to create visible impact of interventions
- Application of web-based dairy information system being developed under G2C services online in the form of Mobile Apps shall ease capture field information

7. FARMERS WORKING IN GROUP- FOSTERS ADOPTION OF IMPROVED DAIRY FARMING PRACTICES

CONTEXT

The majority of the dairy farmer is illiterate, smallholders and follows traditional farming system in the country. The Government introduced dairy technology and disseminated in the farmers' field to increase the dairy production for household consumption and generate income. Similarly, through focused approach, the formation of dairy farmers groups and cooperative were introduced for faster technology adoption and increase dairy production.

For adoption of improved recommended practices, it is essential that the farmers/ adopter must possess a desired level of knowledge. Therefore, a study was conducted to analysis the existing knowledge level of the farmers on adoption of dairy technologies, comparing dairy farmers groups and non-dairy group members in three Dzongkhags falling in three agro ecological zones. Sarpang Dzongkhag was selected for low altitude, Tsirang Dzongkhag was selected for mid-altitude, and Haa Dzongkhag was selected for high altitude.

The questionnaire sought information on farmers' knowledge on dairy technology covering socio demographic profile, feeding practices, dairy husbandry practices, breeding practices and health practices.

KEY FINDINGS

- Dairy farmers' group had a high level of technology adoption by rearing more number of crossbred cattle, feed with commercial concentrate, green and improved pasture, bred using Artificial Insemination semen or Jersey bulls, has permanent dairy shed and sale the excess milk to dairy groups for additional income.
- On the other hand non-dairy farmers group rear more number of local cattle, send to jungle for grazing, do not feed with commercial concentrates, sheds are temporary types to semi-permanent, mostly bred with local bulls while grazing in the forest and the milk produced is just enough for their household consumption.
- There is a large gap in technology adoption on breeding practices & artificial insemination technology. The poor performance were related to limited individual capacity, inactive participation, dispersed and scattered location, and complacent attitude (Figure 4).

- Our finding revealed that most of the non-dairy group members have not heard or are aware on this technology (AI) besides not having the facilities in their Geog.

Fig.4 Technology adoption by Dairy Farmer Group members and non members

RECOMMENDED GOOD PRACTICES

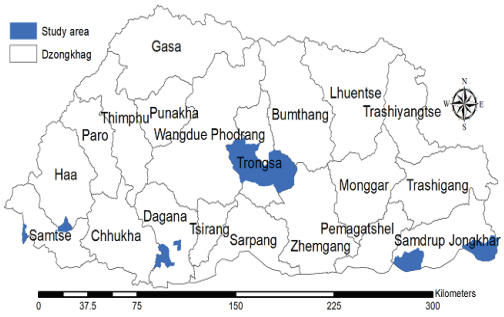
- Training and retraining of farmers on improved technologies, technical support to both members of dairy group and non-dairy group can improve technology adoption
- Adoption of improved dairy technologies is influenced by many factors. Among others, level of farmers' education, awareness and willingness of farmers to adopt technologies, access to financial support are major ones.Creating enabling environment can improve technology adoption.
- There is enormous to improve knowledge management and dissemination to both the members of dairy farmers group and non members. Steps should be taken to remove deficiencies in Breeding and Artificial Insemination practices and other dimensions of the improved dairy technology practices.

8. MODERN DAIRY MANAGEMENT PRACTICES IMPROVES MILK PRODUCTION AND FARMER'S INCOME

CONTEXT

Bhutan is an agrarian country with more than 60 percent of the population depending on subsistence agriculture and livestock farming for their livelihood. Smallholder dairy farming is widely practiced by Bhutanese farmers and is mainly reared for milk and milk products, draught power and manure. Sale of milk products is increasingly a main source of income to farming community among those rearing crossbred cattle. Given the high potential for dairy development and the ongoing technological intervention, the dairy sector has shown considerable progress.

The study was conducted in four randomly selected districts representing the four agro-ecological zones to compare and assess the productivity of dairy cattle and corresponding household income from traditional and improved dairy management system. The data were collected through face-to-face interview using the semi-structured questionnaires from December 2018 to February 2019.



KEY FINDINGS

- The average daily milk yield and monthly household income for traditional and improved management system under smallholder dairy farming were 1.63l/day and 7.37l/day and Nu. 4,167.50/month and Nu. 19,586/month respectively.
- About 75 percent of the respondents adopting improved dairy management system meet their household expenses from income generated by dairy farming whereas only 35 percent of the respondents practicing traditional management system meet their household expenses from income generated by dairy farming
- The study revealed that the milk production in winter was reduced by more than 25 percent due to limited landholding for fodder production. The fodder

shortage was further compounded by farmers' inability to conserve hay and silage when it was available in abundance in summer season

- Crossbreeding local cattle with higher-yielding exotic dairy breeds is an important technology being practiced by the smallholder dairy farmers, however the higher adoption of this technology constrained by technological bottleneck.

RECOMMENDED GOOD PRACTICES

- Dairy farming is potential source of income and livelihoods to smallholder farmers.Encouraging them to scale-up dairy farming with more milking cows would ensure higher socio-economic benefits.
- Technology adoption in dairy farming is higher among educated farmers. Targeting dairy entrepreneurship among educated youth can boost milk production and income besides generating employment opportunity.
- Farmers should be encouraged to adopt dairy shed construction of suitable design to suite the climatic condition of the area for better health and production.
- Government effort in farmers capacity building should continue to ensure faster technology uptake on improved dairy farming

9. COMPOSITIONAL ANALYSIS OF MARKET MILK: ESSENTIAL TO DETECT ADULTERATION

CONTEXT

Milk from Dairy farmers groups sold in the market of Thimphu and Paro is raw milk directly sourced from the dairy farmers groups and sold unprocessed in plastic bottles. The outlets procure the milk from the dairy groups in bulk and packaging is done at the respective outlets in either new or re-used mineral water bottles. Some outlets sell the milk directly from the bulk containers in containers bought by the customers. A common feature in the supply of milk from the dairy groups is the use of middlemen for transportation and sale of milk from the point of production to the marketing outlets.

At the current moment, there is no systematic regulation or monitoring mechanism in place for the sale of raw liquid milk and the compositional quality of milk is not maintained for consumers with variations in compositional quality and adulteration with water being common practice. This use of water to increase the volume of milk sold can pose a risk to human health through the use of contaminated and unclean water that will also lead to the rapid deterioration of milk quality and a reduction of milk solids.

No study to determine the compositional quality of raw milk available in the market has been carried out and this study aims to address the lack of information and quantitative data. Through this study, initial information on the compositional quality of milk will be made available for future reference and corrective measures to be implemented in case of adulteration.

KEY FINDINGS

- Variation in all milk components from normal milk composition has been found.
- Consistent adulteration of milk with water has also been found. This adulteration with water is the primary cause in the variations of milk components from the normal expected milk composition leading to inferior quality milk.
- Adulteration with water further reduces the nutritional value of milk in addition to introducing microbes through use of poor quality water as an adulterant.
- Unfair trade practices and deception of consumer through the sale of adulterated milk at high prices is also an area of major concern as consumers should receive good quality milk. Further study is required to identify whether the source of

adulteration arises from the producers, the middlemen or the retail outlets so that corrective action can be taken and the market quality of milk improved.

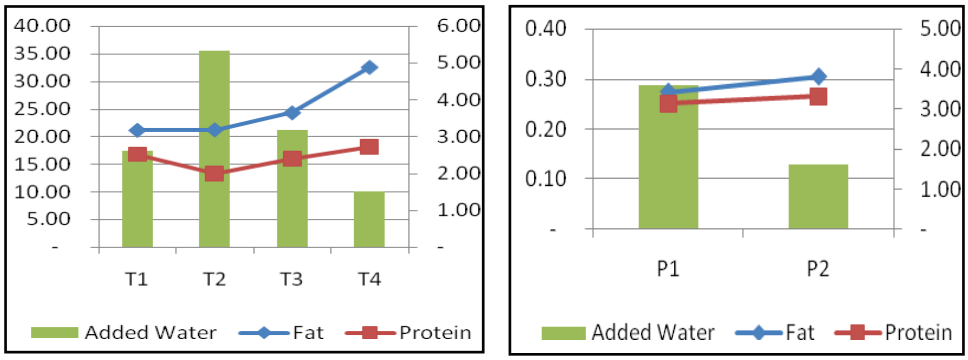


Fig 4. Milk Composition: Thimphu and Paro outlets

RECOMMENDED GOOD PRACTICES

- The use of recycled mineral water containers and in particular fruit juice containers or other plastic bottles needs to be discouraged as these are also potential sources of contamination.
- Consistent inspection of milk across the entire value chain needs to be instituted to ensure good quality milk
- Cleanliness and hygiene throughout the entire value chain needs to be maintained
- Education of dairy farmers on the importance of clean milk production to ensure production of good quality milk is important.

10. JERSEY CROSSES - PREFERED DAIRY BREED IN BHUTAN

CONTEXT

Dairy farming is widely practiced by Bhutanese farmers in the smallholder system. Farmers rear only dairy breeds for milk. The local breeds found in the country are Sire (*Bos indicus*) which is also called as "*Thrabam*" or "*Nublang*". Mithun and its crosses are also found in lower temperate and subtropical broad leaved forest. Jersey and Brown Swiss were two principal exotic breeds introduced in the country for breed improvement program when the first five year development plan started in 1961. Holstein Friesian (HF) is also found after Government allowed import of HF in 2014. The breed improvement program in the early 1960s used exotic breeding bulls, which was followed by Artificial Insemination (AI). Cross breeding program started long ago but very little information has been documented. Hence, to understand the dairy breeds preferred and breeding practices followed by dairy farmers, a total of 566 households spread across all four regions were studied during 2014.

KEY FINDINGS

- Most preferred breed was Jersey (92%) followed by Holstein Friesian (5.3%).
- Brown Swiss, Mithun and Thrabum were the least preferred breed.
- Reason for preferring Jersey was mainly due to high milk yield (71%) and easier to manage because of its docile characteristic (28.5 %).
- Most preferred exotic blood level slab was 75-81.25% (33%) followed by slab 62.5-75% (29.5%) and 50-62.5% slab (14%). About 11% of respondents opted for the higher slabs 81.25% and above.
- Cross breeding methods were natural mating by government supplied as well as private breeding bulls and AI by the government AI Technicians through AI Centre, using the imported or locally produced frozen semen
- Breeding bulls are mostly Jersey and few are Brown Swiss and Mithun, supplied from government farms.
- The most popular breeding practice was AI (66.3%) attributing to widespread of AI facilities in the country and increased accessibility to mobile AI.

RECOMMENDED GOOD PRACTICES

- Jersey breed of exotic blood level between 75-81.25% corresponding to F2-F3 generations shall be suitable to Bhutanese dairy production systems owing to high milking persistence, ability to perform better in scanty pasture, gentle and easy keeping qualities.

- AI outweighs natural mating in breeding methods used by the progressive farmers, hence AI facilities and coverage should be improved over time.

- Implementation of breed improvement programs in the field preferred dairy breed and breeding method of choice should be considered for farmers to ensure better performance of dairy production in the country.

- Improvement in genetic potential of the animals, should be in parallel to promotion of good dairy husbandry practices

11. GOVERNMENT SUBSIDY SUPPORT: ENABLES DIARY FARMERS TO REAP MULTIPLE BENEFITS

CONTEXT

To enhance milk production and reduce import of milk and milk products, large numbers of Dairy Farmers Groups(DFGs)were formed and encouraged to rear improved breeds of cattle to increase production and productivity. With increase in numbers of DFGs the demand for dairy cattle has increased over the years. During 10th FYP Royal Government of Bhutan (RGoB) provided the subsidy support scheme as package to DFG members mainly to purchase improved breed dairy cattle, meet other associated costs such as transportation, construction of dairy shed and silo pit.

Agriculture subsidies have shown positive impact on the income of farmers in India. Similar impact is also felt in Bhutan over the years but has not been studied. Hence, in 2014 a study was carried out in all four regions by randomly sampling 566 households.

KEY FINDINGS

- With Subsidy Support overall average monthly milk production increased by about 45% and so is butter and cheese production. It would mean more milk and milk products can be produced if required Subsidy Support through provision of more milking animals that is managed under proper feeding and care.

- The overall average monthly butter production per household increased by 3kg (little below 5kg before and over 8kg after subsidy support).

- The average monthly cheese production per household increase by 51 balls (little over 94 balls before and over 145 balls after subsidy support).

- Subsidy support resulted in a drastic increase in milk production and sale, which led to corresponding increase in monthly income per household by 43%, thereby improving livelihoods.

RECOMMENDED GOOD PRACTICES

- Dairy farmers reaped several positive benefits from the subsidy support program.
- Increase in income after subsidy support led to increases in number of dairy sheds, able to purchase improved breed dairy cattle, meet expenses on children's education and many farmers were able to improve their living condition and nutritional status of farm families.
- subsidy support must continue in strategic areas to upgrade dairy farming from subsistence to market oriented enterprise

12. MURRAH-CROSS MORE BENEFICIAL TO SMALL-HOLDER FARMERS THAN LOCAL BREED OF BUFFALO

CONTEXT

In Bhutan, buffaloes are reared only in warmer sub-tropical belt viz. Chukha, Samtse, Sarpang, S/Jongkhar, Tsirang and Dagana Dzongkhags. Buffaloes in Bhutan are reared by small holder farmers for milk, meat, manure and for draft purpose. Despite several benefits farmers derive from buffaloes, farmers are giving up buffalo farming. In an effort made to revamp buffalo farming *via* up gradation of local buffalo population with improved buffalo breeds, 17 heifers and 10 breeding bulls of Murrah breed were procured from India and distributed in buffalo farming areas in 2010. But how has this helped farmers remained to be documented and called for further research. Hence, reproduction and production parameters of Murrah-cross and local buffaloes, breed improvement program and its impact on income and livelihood of farming communities was studied to suggest policy and technical support needed to accelerate buffalo farming in the country.



KEY FINDINGS

Reproduction in local buffaloes is irregular with greater variation as compared to Murrah crossbred buffaloes:

- Age at first service: Murrah-cross 25.0±2.8 months, local buffaloes 34.2±6.04 months.

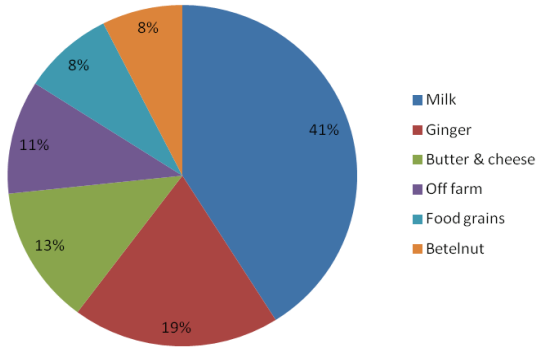


Fig 5. Household income sources

Age at first calving: Murrah cross 35.1±2.49 months, local buffaloes 43.4±6.86 months

- Calving interval: Murrah cross 14.6±0.52 months, local buffaloes 17.4±1.01 months
- Average daily milk yield for Murrah-cross buffaloes 5.9±0.18 l/cow/day, local buffaloes produced an average of 2.6± 0.04l/cow/day
- Milk and milk products from contributed (54%) of household annual income to sustain their livelihoods (Figure 5)

RECOMMENDED GOOD PRACTICES

- Buffaloes are found to be an efficient feed converter and can be easily managed with by small and marginal farmers at minimal management interventions. Thus, it is appropriate to promote buffalo farming with improved breed in the potential areas.
- Shorter age at first calving and calving interval, higher milk yield of Murrah-cross buffalo make it a viable dairy animal for subtropical belt of Bhutan
- Intervention to improve local buffalo breed through supply of improved Murrah heifers and breeding bulls have been very fruitful. This has to be continued with supply of quality heifers, regular exchange of breeding bulls, and introduction of AI services with progeny tested semen of Murrah or other high milk producing buffalo breeds.
- It is imperative to have adequate policy support to intensify buffalo farming and stabilize buffalo population so as to bring about greater positive outcome of enhancing milk production in the country.

13. JERSEY CATTLE BREED IS BETTER THAN KARAN FRIS FOR BHUTANESE SMALLHOLDER SYSTEM

CONTEXT

Karan Fries (KF) a composite dairy breed was imported from India in 2014 and housed at National Jersey Breeding Centre (NJBC), Samtse. This breed although is reported to be hardy with better foraging ability, its comparative advantage to Pure Jersey breed under Bhutanese farming environment remained to be understood. Hence performances (production, reproduction and adaptability) of Karan Fries *Vs* Jersey cattle managed under same/similar environment were studied, retrieving quantitative data on production and reproduction of 320 individual animals from July 2014 to March 2018. The qualitative data on adaptability were gathered through key informant's interview. Based on study results, policy recommendations were made whether or not the KF could be an alternative dairy breed for Bhutanese small holder system.

KEY FINDINGS

- Mean birth weight and monthly weight gain in KF calves was significantly higher than JP
- Mean age at first service and age at first calving for JP were found to be 24.6± 4.7 (months) and 33.9±4.2 (months) respectively, which were significantly lesser than KF.
- Mean daily milk yield (kg) in 1st lactation was significantly higher in JP than KF but there was no yields variation in subsequent lactations, and the difference in milk yield was not statistically significant.

- Milk production closely associated with season in a year with higher production for both the breeds in winter than in summer owing to better quality fodder in winter.

- The incidences of clinical mastitis are higher in JP (39%) whereas sub-clinical mastitis cases are higher in KF (67%), chronic mastitis are not observed in KF. Breed of cattle influences susceptibility to mastitis.

RECOMMENDED GOOD PRACTICES

- Jersey (pure) breed compared to Karan Fries has lower age at first service and age at first calving, medium body size and lower fodder intake will enable it to start producing at earlier age than KF. Hence JP could be of advantage to resource poor farmers to get faster returns to their investment from dairy farming.
- KF has good foraging ability and surefootedness to survive in the rugged terrain. But bad temperament and higher requirement feed and fodder for maintenance and production can be disadvantage for small holder dairy farmers in Bhutan
- KF breed may be more suitable for commercial farms with adequate facilities and resources at hand. At the small farmer's level (subsistence and semi commercial) where feed and fodder availability is a bottleneck, JP and their crosses may continue to remain a breed of choice.
- Induction of imported breed into nucleus herd should be done only under unavoidable circumstances. In doing so appropriate precautions including disease screening measures have to be put in place, pros and cons on mixing of breed are to be thoroughly weighed to enable science based decision making

14. SEXED SEMEN TECHNOLOGY USAGE IN BHUTAN: HOW MUCH DO YOU KNOW ABOUT IT?

What is sexed semen?

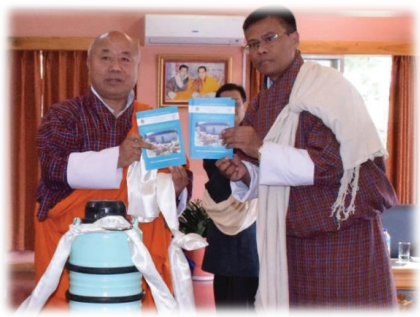
Semen having X or Y bearing sperm to produce progenies of a desired sex either female or male (with about 80-90% accuracy) is known as sexed semen. Sex sorting technology was developed by the USDA (United States Department of Agriculture) researchers in Livermore, California, and Beltsville, Maryland. The technology was patented as "Beltsville Sperm sexing technology". The commercialization of sexed semen started in United States in 2001 with a license granted to Sexing Technologies (ST), Texas. At present, ST commercially produces sex sorted semen in many countries of Europe, USA, Canada, Mexico, Brazil, China, Japan etc.

How Sexed Semen is produced?

Sperm are sorted by identifying differences between the X- and Y- bearing sperm. The X-chromosome (female) contains about 3.8% more DNA than the Y-chromosome (male) in cattle. This difference in DNA content is used to sort the X- from the Y-bearing sperm.

Among several methods for semen sexing, flow cytometry based sorting has emerged as most efficient. The technology is refined through the decades and finally sex sorting is possible at the purity of more than 90%. The technique is well standardized, patented and commercialized in USA, Europe and other countries.

Other methods for sex sorting of sperm (Albumin Gradient/ Percoll gradient/ Gradient swim down, Free flow electrophoresis, Identification of H-Y antigen, Centrifugal counter current distribution, Genetic approaches etc.) have also emerged though these techniques needs further fine tuning for commercial viability.



Sexed Semen Technology officially released by H.E Sanam Lyonpo on 3rd July 2020 for nationwide application

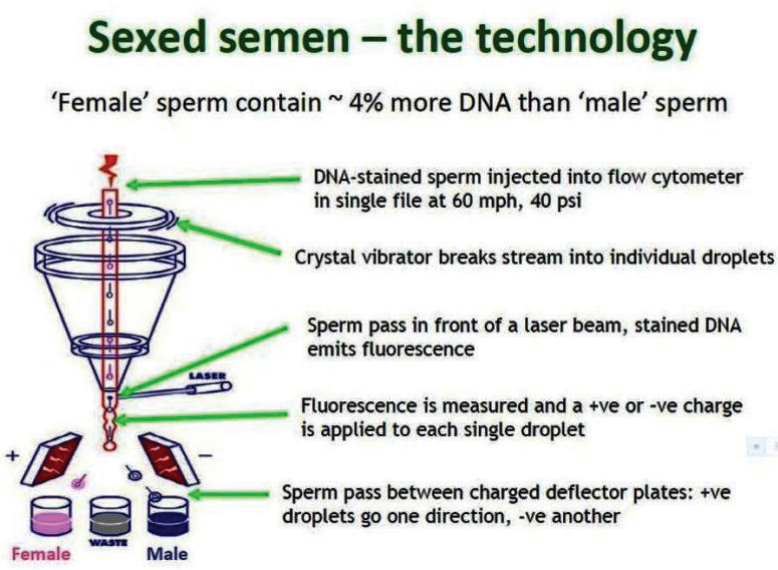


Figure 1: Schematic diagram of sex sorting using flow cytometry method

Photo courtesy: Sexing Technologies, USA

Is it safe?

Yes, it is safe to use sexed semen for artificial insemination. However, as sperm concentration in sexed semen straw is far less than the conventional semen straw and the sorting procedure itself damages the sexed sperm, it is reported that the conception rate is 10 to 15 % less with sexed semen as compared to conventional semen.

What are the advantages of using sexed semen?

- Producing only female calves helps the farmers to save resources that would have been shared with unwanted males.
- Production of more female calves: increase supply of replacement heifers
- Opportunity to sell surplus heifers to other farmers/farms
- Speed up genetic improvement:
    - By increasing efficiency of progeny testing scheme(PTS)
    - By increasing efficiency of embryo transfer and IVF program

- An economic way to increase herd strength with no risk of introducing diseases by purchasing heifers from outside (improves bio-security).
- As dead, dying or damaged sperm cells are removed during the sorting process, only viable sperm are available which helps the sexed semen to be successful even at a low concentration (than conventional semen).
- By producing more female calves using sexed semen, there will be less difficult births compared to male calves (dystocia). This is particularly useful for maiden heifers

What are the limitations of using Sexed Semen Technology?

There are some limitations in terms of technology and implementation aspects of the sexed sorted semen.

Technological limitations

- High cost of sex sorting machine
- Low sorting efficiency and speed
- Require highly skilled person to operate sex sorting machines
- Damage to the sperm due to shear force, electrostatic charge, droplet formation and sudden stop.
- Waste of approximately 50% of sperm
- Reduced freezing potential of the sorted sperm

Implementation limitations

- High cost of the product which include the cost of the intellectual property right
- The conception rate with sex sorted semen is 10-15% less than the conventional semen. This factor will be more critical considering low artificial insemination coverage and low conception rate with artificial insemination
- All Ai technicians in Bhutan may not follow standard operating procedure to perform insemination with sexed semen. This is another area of concern as the sperm concentration of sexed semen ranges between 2 and 4 million/dose whereas it is 20 million/dose in conventional semen. Managing sex semen with lower sperm concentration will be a challenge

Where can we buy and what is the price?

The sexed semen is commercially available mainly from Sexing Technology, USA. However many other breeding companies in USA, Canada and Europe are producing sexed semen commercially using license from Sexing Technology, USA. NDRDC Yusipang presently procure from World Wide Sires, USA and UK. Average price is USD 14 per dose which is five time higher than imported progeny tested conventional semen (imported)

Is it only for Holstein Friesian or Jersey cattle?

Yes, presently it is commercially available only for HF and Jersey breeds of cattle. Sexed semen is not available for any other breed of cattle and buffaloes.

Is sexed semen used only for heifer?

Considering the high fertility rate of the heifers, it is recommended that sexed semen should be used only in heifers (especially virgin heifers) for better conception rate. However, it can also be used in cows up to third lactation with excellent reproduction record.

15

WHY COST OF MILK PRODUCTION IS IMPORTANT?

CONTEXT

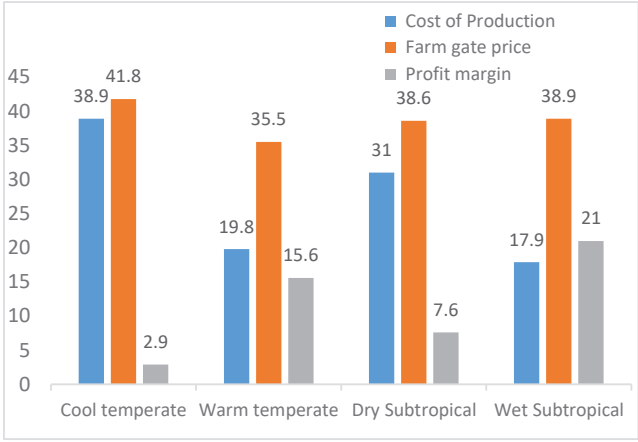
- Cost of Production (CoP) per unit is needed to understand how much it costs to produce a kg or litres of milk and can help farmers to decide on what, when and how much to produce for sale without incurring losses
- Examining the cost of production is one of the foremost factors that have to be considered in any enterprise so as to ascertain profitability or setting selling prices
- Cost of milk production in the country assessed by Agro-Ecological Zones (AEZ), herd size and location of the dairy unit by assessing fixed and variable costs investments in dairy production.

- A simple cost-benefit analysis was carried out in the selected cattle rearing districts representing four Agro-Ecological Zones in the country

KEY FINDINGS

- The overall average annual capital investment per dairy unit under smallholder farming system in Bhutan was Nu. 27,258.The highest investment cost was accounted for cow purchase of 38%, followed by 33.63% on farm machinery and equipment
- The overall annual average variable cost recorded was Nu. 2, 14,052 per dairy unit, with labour constituting the highest cost of 65%, followed by feed cost of 31%

- The overall average cost of production, farm gate price and profit margin recorded per litres of milk were Nu. 26.85, 38.7 and 11.9, respectively. The cost of production was higher in cooler and dryer zones as compared to that of warmer and wetter zones (graph 1).



Graph 1: graphs showing the cost of production in 4 agro ecological zone

Cost of production differed significantly between the different herd sizes, cost of production was three times lower if you rear 6 to 10 milking cow than rear 1 -5 milking cow.

The findings indicate that the dairy farming business in general is a profitable venture in Bhutan

RECOMMENDED GOOD PRACTICES

- The cost of production can help to set price of milk and milk products for marketing
- To harness a better return from investment, dairy farmers in cooler and dry zones besides cost cutting measures, may need to upscale the business volume to have economies of scale in order to reduce the cost and maximize the profit.
- Considering the cost of production as baseline parameter, increasing the Farm Gate Price of milk in the cool temperate and dry subtropical zones may be recommended for increasing income as the cost of production in these area was higher.
- Looking at the cost of production at different agro ecological zone of milk, it is more profitable if dairy farming is carried out in warmer and wetter zone than cooler and drier zone

16 COMPOSITIONAL ANALYSIS OF MARKET MILK TO DETECT ADULTERATION

CONTEXT

Comprehensive study on the composition of milk is continued in Bajo (Wangduephodrang), Kuruthang (Punakha), Darla (Chukha), Gelephu (Sarpang) and Haa to supplement previous study on milk quality in Thimphu and Paro Dzongkhags. The study determined the compositional quality of raw milk available in the market; and recommended corrective measures to be implemented in case of adulteration.

KEY FINDINGS

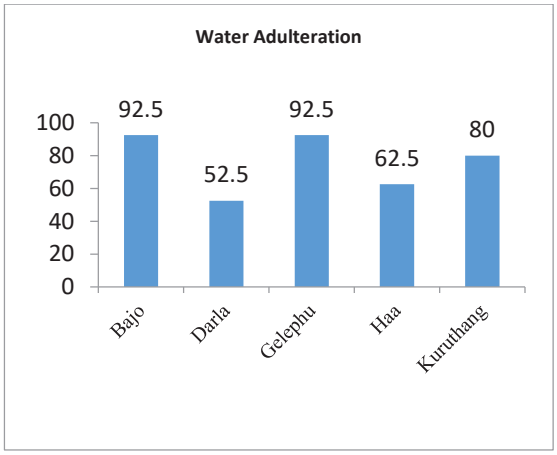
- Milk in the study areas are sold unprocessed in plastic bottles or sold directly from the bulk containers bought by the customers.
- The role of middlemen for transportation and sale of milk also features prominently
- Water adulteration to increase the volume of milk sold can pose a risk to human health because contaminated and unclean water that will lead to the rapid deterioration of milk quality
- There is no regulation or monitoring mechanism in place for the sale of raw liquid milk and the compositional quality varied.
- Fat content found to be within acceptable range, variation in other milk components from normal milk composition found (Table 1).

Table 1: Mean Milk Composition in Study Locations

Dzongkhag	N	Fat	Protein	Lactose	Freezing Point	Added Water
Bajo	40	5.04±1.11	2.49±0.27^{a}	3.70±0.37^{a}	-0.431±0.04^{a}	16.90±9.04^{a}
Darla	40	5.51±0.89^{ac}	2.95±0.23^{bd}	4.38±0.24^{bde}	-0.519±0.03^{bd}	2.39±4.61^{bde}
Gelephu	40	5.06±0.95	2.76±0.14^{ce}	4.16±0.22^{bc}	-0.486±0.02^{ce}	6.75±4.89^{ce}
Haa	40	4.50±0.76^{b}	2.92±0.18^{bde}	4.37±0.21^{bd}	-0.510±0.02^{bde}	3.14±3.56^{bde}
Kuruthang	40	5.17±0.70^{ac}	2.82±0.17^{cde}	4.22±0.21^{bcde}	-0.496±0.02^{cde}	5.20±4.83^{bcde}
Total	200	5.06±0.94	2.79±0.26	4.17±0.36	-0.488±0.04	6.88±7.71

The different superscripts within the column indicate significant differences ($p<0.05$)

- Consistent adulteration of milk with water found causing variations of milk components and leading to inferior quality milk. Adulteration ranged from as high as 92.5 percent to 52.5 percent of samples analyzed.



Graph 1: Extent of Water Adulteration

- Adulteration with water further reduces the nutritional value of milk in addition to introducing microbes through use of poor quality water as an adulterant. Moreover, the processing of such inferior quality milk will also result in low quality dairy products and the proliferation of microbes will drastically reduce the shelf life of the products in addition to posing a risk to public health.
- Unfair trade practices and deception of consumer through the sale of adulterated milk at high prices is also an area of major concern as consumers should receive good quality milk.

RECOMMENDED GOOD PRACTICES

- Use of proper packaging materials for milk marketing needs to be encouraged. The use of recycled mineral water containers or other plastic containers needs to be discouraged as these are potential sources of contamination.
- Consistent inspection of milk needs to be instituted to ensure cleanliness and hygiene throughout the entire value chain
- Advocacy of farmers and all stakeholder involved in the value chain on the importance of clean milk production for the supply of good quality milk is of paramount importance

17 NON-GENETIC FACTORS THAT AFFECTS QUALITY OF BOVINE SEMEN PRODUCTION

CONTEXT

In Bhutan, Artificial Insemination (AI) in cattle was initiated in 1987 using imported frozen semen. In house production of bovine frozen semen began in 1992 from pedigree selected bulls of Jersey, Mithun and Nublang breeds and provided choice of breed to the farmers. The frozen semen production in the country has been on-going for almost three decades but factors that influenced semen quality were not assessed whereas studies elsewhere have revealed that the non-genetic factors greatly affect the semen quality. Therefore, this study was undertaken to assess the effect of non-genetic factors on quality of bovine semen production, guide in production of better quality semen with higher recovery rate as well as control wastage of resources during semen production.

The factors studied were age of bull at procurement and collection, breed, season and collection interval for their effect on semen quality assessed based on volume (Vol.), mass activity (MA), initial sperm motility (ISM) and sperm concentration (SC) in **Fresh semen**, and semen straw produced (SSP), semen straw discarded (SSD), semen straw stored (SSS) and post-thawing motility at production (PTM-P) and post-thawing motility at certification (PTM-C) in **Processed semen.**

KEY FINDINGS

- The average semen recovery rate was 78%, inclusive of ejaculates with ISM of 60% and SC of 600x10^6/ml that were processed and discarded
- Strong correlation was observed between Fresh and Processed semen qualities as best output in processed semen in terms of quantity, quality and recovery rate was found for ejaculates with Vol., MA, ISM

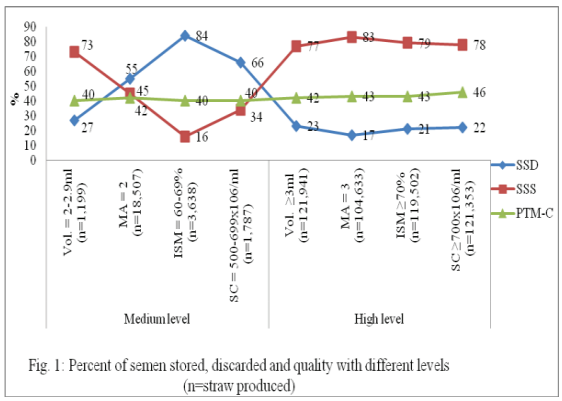


Fig. 1: Percent of semen stored, discarded and quality with different levels (n=straw produced)

and SC of ≥3ml, 3, ≥70% and ≥700x10^6/ml respectively (Fig,1)

- The mean age of bulls at procurement, first semen collection and overall collection ranged from 13 – 25 months, 25 – 47 months and 58 – 123 months respectively (Table 1)

Table 1. Age at procurement and semen production of donor bulls (months)

Breed (nos)	Age at procurement			Age at 1st collection			Age at collection		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Jersey (11)	14	10	36	25	19	42	58	29	113
Mithun (5)	13	9	16	47	31	63	72	31	104
Nublang (3)	25	17	36	36	22	50	123	22	150

- Age at procurement showed significant effect on SSP, having lesser production for bulls procured after 18 months of age
- Age at collection significantly affected MA, ISM, SSP, SSD, SSS, PTM-P and PTM-C, and quality improved with age of bulls
- Breed significantly affected MA, ISM, SSD, SSS, PTM-P and PTM-C, showing best qualities for Nublang, followed by Mithun and Jersey
- Season significantly affected Vol., MA, ISM and SSP, showing better qualities of semen produced in autumn followed by summer and spring
- The frequent semen collection from same bull (twice a week) significantly affected the quality (SSP and SSS), showing best result for collection interval of 11-15 days

RECOMMENDED GOOD PRACTICES

In order to ensure production of good quality semen with optimum semen recovery rate, the following practices needs to be adopted;

- Ejaculates with Vol., mass activity, initial sperm motility and sperm concentration of minimum 2ml, 2, ≥70% and ≥700x10^6/ml respectively can be considered for processing. Any ejaculate with lesser than the indicated level of quality should be discarded
- The young bull procurement intended for semen production should be procured before 15 months of age
- The matured bulls that continue to donate semen can be reared until required semen straws are produced
- Greater emphasis should be given on more semen collection in autumn followed by summer and then spring
- The collection of semen from same bull within six days should be avoided. In the event that there are many semen donor bulls the collection interval of 11-15 days apart is ideal

18 ASSESSMENT OF MICROBIAL QUALITY HELPS TO IMPROVE QUALITY OF TRADITIONAL DAIRY PRODUCTS

CONTEXT

Traditional dairy products such as butter and cheese (*datshi*) form an integral part of Bhutanese cuisine. These traditional dairy products are produced at individual households and collectively under dairy farmers groups. The current operational modalities of dairy farmers groups include marketing of fresh milk or processing milk into local butter and cheese at the milk processing units (MPU). In the MPU, the products are generally produced following the traditional method from unpasteurized milk or cream with the use of modern processing equipment such as cream separator and butter churner. Milk is an ideal medium for growth of microorganisms due to its high nutritional value. The consumption of unpasteurized, inadequately heat-treated milk and post production contamination and raw milk products is associated with several food borne outbreaks globally.

The current traditional practices of producing *datshi* and butter from unpasteurized milk and cream can facilitate growth of pathogenic and spoilage microorganisms. The presence of these microorganisms might result to product spoilage and possibly pose a risk to public health safety.

This study was aimed to determine the microbiological quality of traditionally produced butter and cheese *(datshi).* A total of 100 random samples each of butter and *datshi* were collected from local retailers, dairy sales outlet, road side vendors, milk processing units (MPU), and weekend markets of Chukha, Tsirang, Dagana, Trongsa and Wangduephodrang and analyzed for their microbiological quality at the National Food Testing Laboratory (NFTL) at Yusipang, Thimphu.

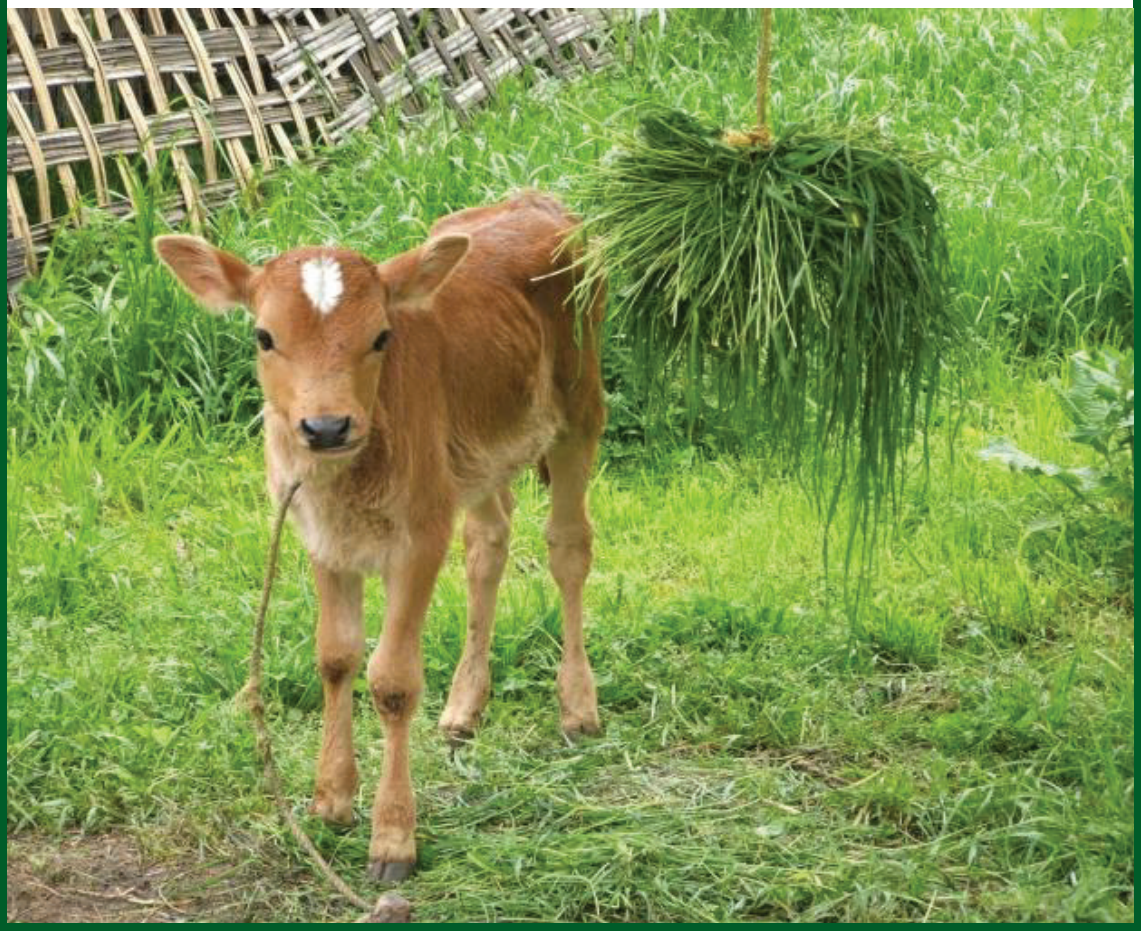
KEY FINDINGS

- The microbiological evaluation showed presence of yeast, mold, *E. coli* and *Staphylococcus aureus* in all the butter and *datshi* samples and presence of Salmonella in some *datshi* samples.
- Of the total samples examined, 22%, 94% and 28% of butter samples and 17%, 100% and 29% of *datshi* samples were found unsatisfactory for mold, yeast and *E. coli,* respectively as per Bhutan Standard Bureau.
- The presence of these spoilage and pathogenic microorganisms in butter and *datshi* samples indicates poor hygienic and animal husbandry practices resulting in poor quality products with reduced shelf life and raises concerns of public health safety.

RECOMMENDED GOOD PRACTICES

- Develop and adopt of Standard Operating Procedures for the processing of traditional dairy products
- Promote pasteurization of raw milk to improve quality of traditional dairy products
- Emphasize on strict implementation of clean milk production/ better animal husbandry practices at the farm and along the dairy value chain

"Today's Calf is Tomorrow's Cow"



NATIONAL DAIRY RESEARCH & DEVELOPMENT CENTRE
DEPARTMENT OF LIVESTOCK
MINISTRY OF AGRICULTURE AND FORESTS
YUSIPANG, THIMPHU, BHUTAN, POST BOX: 1058
17116985 (Direct), 17116986 (Lab), 17116976 (PABX)
www.ndrc.gov.bt