TAMPERE UNIVERSITY
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POTENTIAL FOR A2 MILK PRODUCTION AND BIO FERTILIZER DEVELOPMENT FROM BOS INDICUS CATTLE

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ABSTRACT

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Potential for A2 Milk Production and Bio fertilizer Development from *Bos indicus* Cattle

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The aim of this applied research was to find the potential for A2 milk production and, development of bio fertilizers and bio pesticides utilizing native Indian cattle *(Bos indicus)* in the two villages of Katavali and Ambavali in Sangmeshwar Taluka, North Western Ghats, Maharashtra, India. A community survey, based on a structured interview, was conducted in both these villages to collect information such as: lactation period, milk output, grazing pattern, urine output and population of the native cattle. The research was commissioned by the Applied Environmental Research Foundation (AERF); an NGO concerned with biodiversity conservation in this region.

In Katavli 160 native cattle were identified with a mean of 4.5 cattle per household. Out of these 45 were native cows amongst which 30 were in lactation. Likewise, in Ambavali, 161 native cattle were found, out of which 44 were native cows however only 10 were in lactation. The average lactation period of the native cow was found to be 7 months whereas, the average milk output per cow was 1.4 litres per day. The monthly milk output of the native cows in Katavali and Ambavli was 1260 litres and 420 litres respectively. The monthly urine output of the native cows was found to be 5700 litres and 5550 litres in Katavali and Ambavali respectively. Most of the households of both the villages were interested in selling native cattle urine to produce bio fertilizers and bio pesticides.

Findings of this research suggest that, both villages have potential for increasing A2 milk production and, bio fertilizer and bio pesticide development from native Indian cattle. However, in order to improve the milk output of native cows, better feed needs to be made available to the farmers at affordable prices, water scarcity needs to be resolved during the dry season, cattle sheds need minor modifications to make urine collection easier and awareness should be spread regarding the benefits of stall feeding with respect to milk production and urine collection.

Key words: A2 beta casein, A2 milk production, bio fertilizer, bio pesticide, *Bos indicus*

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ABBREVIATIONS AND TERMS

AERF	Applied Environmental Research Foundation
FAO	Food and Agriculture Organization
NGO	Non-Governmental Organization
Ghat	Mountain
Wadi	Community
Guntha	Unit for measuring area, equivalent to 1089 m^2
Gotha	Cowshed
Taluka	Administrative Division
Dhangar	A village community in Maharashtra, India

1 INTRODUCTION

The native Indian cattle that belong to the *Bos indicus* species are proven to have better milk quality than their European counterpart (Woodford 2007). Milk from these cows contains a higher percentage of the good beta casein A2 protein rather than, its variant, the harmful beta casein A1; found in the European cattle breeds. Various researches conducted around the world, especially in New Zealand and Australia, have demonstrated the association of Beta casein A1 as a risk factor for type-1 diabetes, coronary heart disease, arteriosclerosis, sudden infant death syndrome, autism and schizophrenia. (Elliott et al.1997; Elliott et al.1999; McLachlan 2001, 262–272; Tailford 2003)

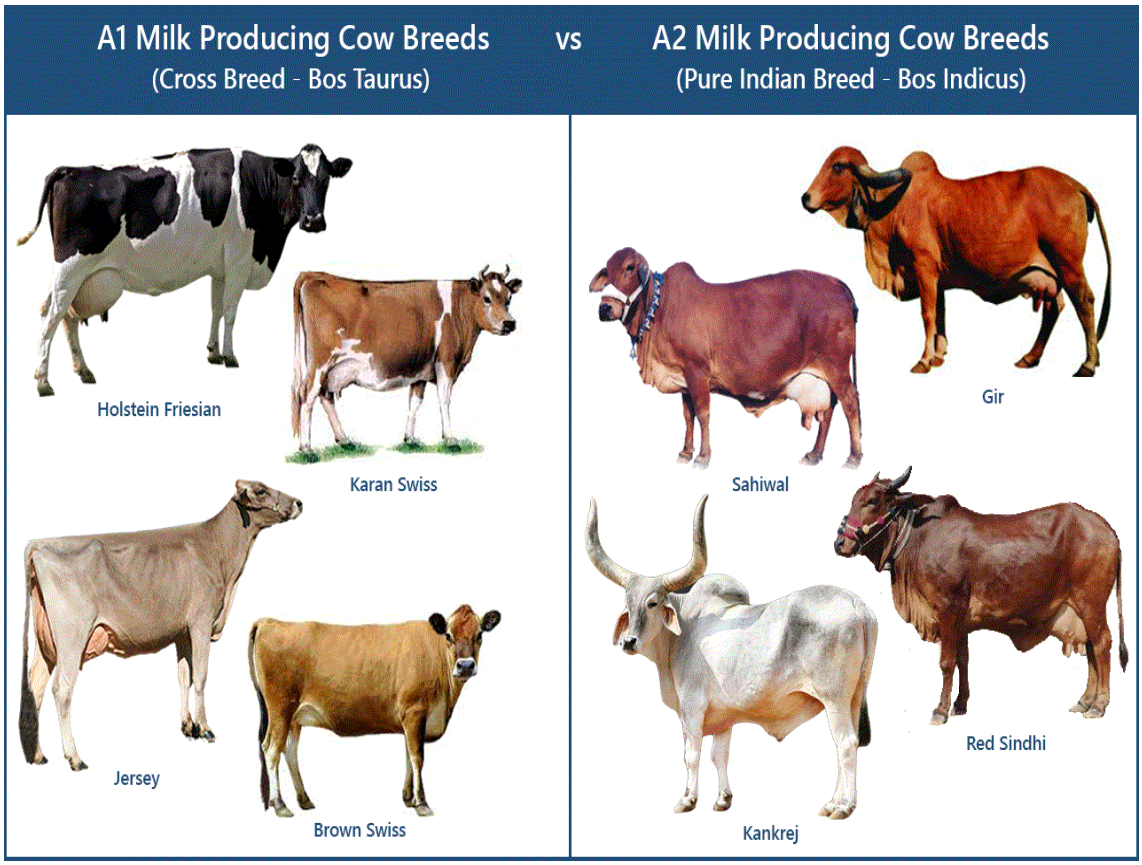
Moreover, urine of the *Bos indicus* cattle species possess anti-bacterial, anti-microbial and anti-fungal properties (Mohanty et al. 2014; Nileemas and M.N. 2010; Patil et al. 2014). It is evident from researches that it can kill many pesticide and herbicide resistant bacteria, viruses and fungi (Jandaik et al. 2015). Thus, it is a great ingredient for bio fertilizers and bio pesticides.

Although India has a vast resource of native cattle which can be utilised for A2 milk production and, development of bio pesticide and bio fertilizers from its urine, very few initiatives have been taken in this direction. The Indian state of Maharashtra has the fourth largest cattle population in India (Ministry of Agriculture, India 2014). Thus, the present applied research commissioned by Applied Environmental Research Foundation (AERF) tried to find out the potential for A2 milk production and development of bio pesticides and bio fertilizers utilizing native Indian cattle in two villages (Katavali & Ambavali), of Sangameshwar Taluka, Maharashtra, India.

Through this study AERF aims to utilize the native Indian cattle to integrate poverty alleviation and participatory biodiversity conservation, in the villages of North Western Ghats of Maharashtra.

1.1 Physical Difference between Native Indian and European Cattle breeds

The Picture 1 below illustrates the physical differences between European cattle (*Bos tarus)* and native Indian cattle (*Bos indicus*).



PICTURE 1. Physical difference between *Bos indicus* and *Bos tarus* cattle breeds (Quora.com 2017)

From the above picture three main physical differences can be identified. Firstly, the native Indian cattle have a profound hump which is absent in the European breeds. Secondly, native Indian cattle have a curved hip whereas the European breeds have an elevated flat hip. The third difference is the loose dewlap present in native Indian breeds unlike the European breeds.

1.2 A2 Milk

Milk is composed of approximately 85% water, 4.6% lactose (milk sugar), 3.7% triacyl-glycerol's, 2.8% casein and whey (milk proteins), 0.54% minerals and 3.36% miscellaneous substances (Cattell and Nelson 2008).

The two major proteins found in milk are: casein and whey. Around 80% of the protein in cow's milk is casein and, approximately 20% is whey. One of the main casein proteins which comprises around 30% of the total protein in cow's milk is Beta-casein. (a2 Milk™ 2017) This casein comprises of 209 amino acids present in a defined sequence. It exists in two main forms: A1 and A2 beta-caseins. The only difference between these two forms is the presence of different amino acids at position 67 in the sequence. Whereas A1 beta casein has amino acid histidine at position 67, A2 beta–casein contains proline at the same position (Figure 1). (Woodford 2007)

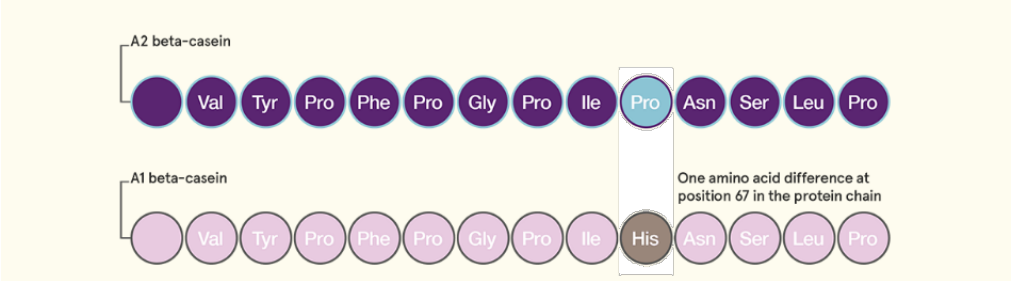


FIGURE 1. Difference between A1 and A2 beta–casein (a2 Milk™ 2017)

A2 milk does not contain A1 beta-casein whereas A1 milk does. The occurrence of A1 and A2 milk varies between different herd of cows and also amidst different countries. Only the *Bos indicus* species, native to Asia do not have A1 beta casein in their milk. However, *Bos tarus* species of cattle, which originated in Europe, have A1 beta–casein in their milk. (Woodford 2007)

Studies have found that long term consumption of milk from European breeds such as Holstein Friesian, Jersey, Brown Swiss, Ayrshire etc., can result in allergies, obesity, type 1 diabetes (Elliott et al. 1997; Elliott et al. 1999), cardiovascular ailments (McLachlan 2001, 262–272; Tailford 2003), autism, sudden infant death syndrome (Woodford 2007), etc. in humans.

The reason behind these ailments is the presence of a higher percentage of beta casein A1 allele (gene) in the milk of these European cattle breeds. Upon digestion, by humans, A1 beta casein protein releases a peptide called beta-casomorphin-7 or BCM-7. It is this protein fragment that has been traced to be responsible for the aforementioned range of health issues. (Woodford 2007)

The world's largest cattle population resides in India. There are around 190.9 million cattle in India as per the Ministry of Agriculture, India (2014) report. Out of the total, 79% of the cattle are of indigenous origin belonging to the *Bos indicus* species (Ministry of Agriculture, India 2014). National Bureau of Animal Genetic Resources has discovered that, frequency of the A2 allele (gene) in Indian milk breeds is 1.0 (100%) while in European breeds, it is nearly 0.6 (60% or less) (Sharma 2015).

Demand for A2 milk is growing across the world, especially in countries such as New Zealand, Australia, and the UK. In Australia and New Zealand, A2 milk has the fastest growing market share of 8% with increasing sales of 57 % in a year (Sharma 2013). Even in India, this milk is gaining popularity. Amul, Desigo milk, Pathmeda and few other Indian milk brands have already launched A2 milk variant in the market (Sharma 2013). With the public becoming more aware about the harmful effects of consuming milk from European breeds of cattle, market for A2 milk is destined to grow in the future.

1.3 Cattle Urine and Dung

The benefits of Indian indigenous cattle are not only limited to superior milk quality but, its urine and dung also possess beneficial properties.

Cattle urine contains 95% water, 2.5% urea while, remaining 2.5% is a mixture of salts, hormones, enzymes, and minerals. Since ages, people in India have been utilizing cow urine to treat various ailments in human beings, as it possesses antioxidant, anti-diabetic, anti-tumour, anti-protozoal, and molluscicidal properties. (Jandaik et al. 2015)

As stated earlier various scientific studies have established that native Indian cattle urine, especially native Indian cow urine, have anti-bacterial, anti-microbial and anti-fungal properties (Mohanty et al. 2014; Nileemas and M.N. 2010; Patil et al. 2014).

According to Jandaik et al. (2015), cow urine can kill a number of pesticide and herbicide resistant bacteria, viruses and fungi making it useful in agricultural operations as a potent bio fertilizer and bio pesticide.

Similarly, the native Indian cow/cattle dung also has many useful properties. It is high in organic matter and rich in nutrients. It contains about 3% nitrogen, 2 % phosphorous and 1% potassium **(**Compost 2017**)**. Therefore, both, native cattle urine and dung are excellent ingredients for making bio-fertilizers and bio pesticides.

Several studies have been conducted around the world that demonstrate the usefulness of various organic pesticides and fertilizer preparations containing native cow/cattle dung and urine. Some of the researched and tested bio pesticides and bio fertilizers made from cow urine and dung are: Panchgavya, Jeevamrut, Beejamrut, Aganiastra, Neemastra, etc. (Babu n.d.)

1.4 State of the Native Indian Cattle Population in India

The past few years have seen a constant decline in the population of native Indian cattle (Figure 2) (Ministry of Agriculture, India 2014), even though indigenous cattle is the largest part of the cattle population in India, as can be seen from Figure 3 on the next page.

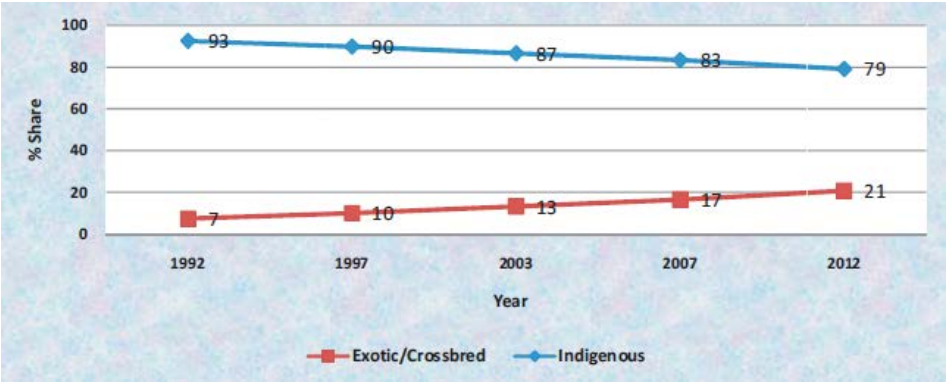


FIGURE 2. Trends in the share of indigenous and exotic/crossbred cattle population in India (Ministry of Agriculture, India 2014)

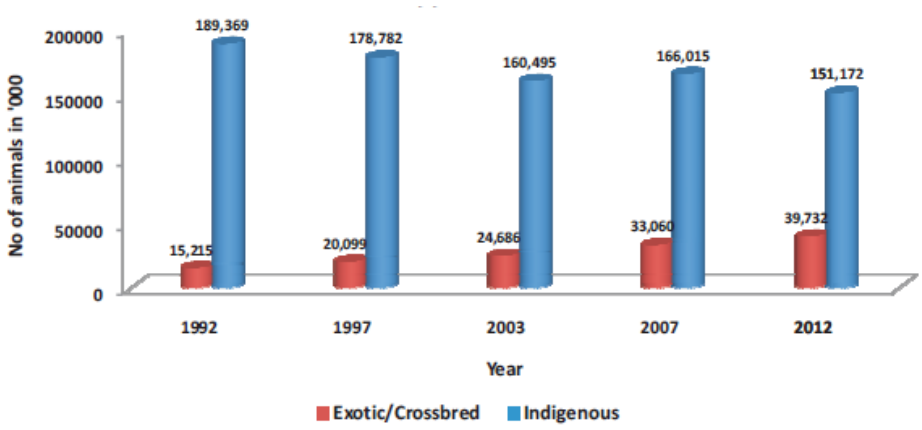


FIGURE 3. Exotic/crossbred and indigenous cattle population during 1992-2012 in India (Ministry of Agriculture, India 2014)

In the present study a survey was conducted in two villages of the North Western Ghats in the Indian state of Maharashtra that ranks number four in cattle population amongst all the Indian states (Figure 4).

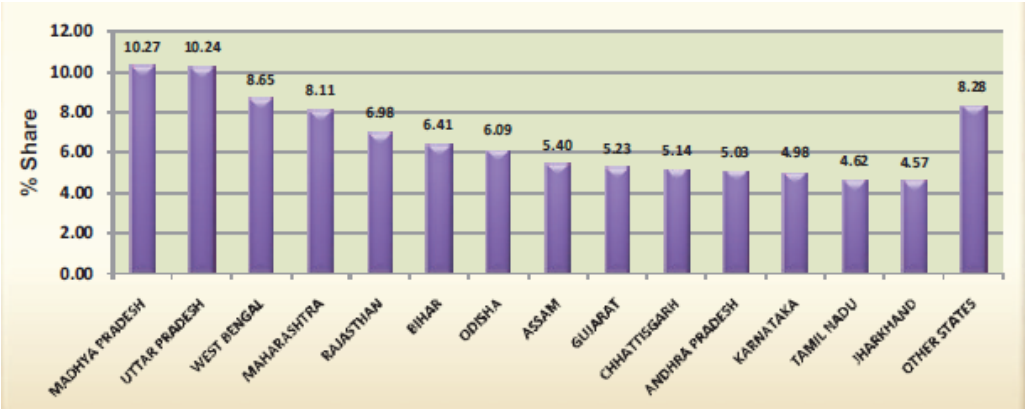


FIGURE 4. Percentage share of cattle population-2012 (Ministry of Agriculture, India 2014)

Maharashtra has a cattle population of 15.5 million (8.11 % share of total cattle in India) with 872 cattle per 1000 households in the rural areas. Further, it has a huge resource of indigenous or native Indian cattle; 11.8 million of the cattle belong to the native Indian species (*Bos indicus)* i.e. 76% of the total cattle population of the state **(**Ministry of Agriculture, India 2014).

Like the other Indian states, the state of Maharashtra has also experienced a decline in the population of native Indian cattle in the past few decades, accompanied by an increase in the number of cross bred and exotic cattle (Figure 5, on the next page).

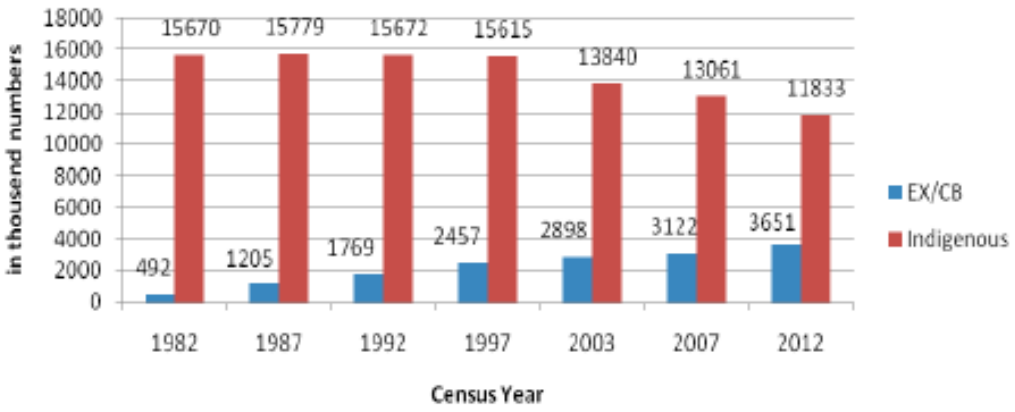


FIGURE 5. Trend in shares of exotic/crossbred and indigenous cattle population in Maharashtra (Commissionerate of Animal Husbandry 2012, 15)

1.5 Applied Environmental Research Foundation (AERF), India

The present research was commissioned by AERF, a non-governmental organisation (NGO) which has been working in the North-Western Ghats of Maharashtra, India since 1994. This NGO works towards community based biodiversity conservation by developing natural resource management models. The organisation's mission is to establish a strong link between research and its effective use in the process of development, poverty alleviation, sustainable resource use and participatory conservation in the region.

Villages in this part of the country have a huge resource of native Indian cattle hence, a model for A2 milk generation and, bio fertilizers and bio pesticides development from native cattle urine and dung may be achieved. Manufacturing and marketing the milk, bio pesticides and bio fertilizers could result in poverty alleviation, promotion of organic farming and conservation of the native Indian species of cattle that is facing a constant decline throughout India.

Two villages, namely Katavali and Ambavali, located in the Sagmeshwar taluka, North-Western Ghats, India were selected for this research. A community survey was conducted based on a structured interview to collect information such as: population of the native cattle, lactation period, milk output, grazing patterns, etc. which would help determine the potential for A2 milk production and, bio fertilizers and bio pesticides development from native Indian cattle present in these villages.

2 SCOPE

With the knowledge that A1 milk from the European *Bos tarus* cattle breeds is detrimental to human health, it is imperative to research potentials for beneficial A2 milk production from native Indian/*Bos indicus* cattle. Moreover, native cattle urine and dung is useful in the production of bio pesticides and bio fertilizers; as well. With an abundance of native cattle population in the selected villages of Ambavali and Katavali located in Sangmeshwar Taluka, North-Western Ghats, Maharastra, India, the present research intends to find the potential for A2 milk production and, development of bio fertilizers and bio pesticides in the region.

As scope of utilising native Indian cattle population for generating income for the marginalised farmers has not been harnessed to its potential, AERF commissioned a survey research during March-May 2017.

Based on the outcome of this research, AERF would develop a project for A2 milk, bio fertilizers and bio pesticides production from the urine and dung of native Indian cattle in the chosen villages.

This project will have innumerable benefits such as: empowerment of the marginal farmers by bringing alternate sources of income, protection of the environment, promotion of organic farming and conservation of native Indian cattle in the region.

3 METHODS

3.1 Study Population and Sampling

The population to which the study could be generalized is the villages in Sangmeshwar Taluka, Ratnagiri District, Maharashtra, India. Sample subset, the subjects who participated in the study, are the inhabitants of the villages of Katavali and Ambavali who are rearing native Indian cattle.

Katavali and Ambavali are two villages located in the Sangmeshwear Taluk of Ratnagiri district (North-Western Ghats) in the Indian State of Maharasthra. Katavali has an area of 1400.63 hectares with 1624 individuals residing in 404 households whereas, Ambavali is spread across an area of 1088.01 hectares with a population of 1303 individuals in 331 households as revealed by the 2011 population census for human in India.

A total of 50 households from each village was targeted for interviewing.

The sampling frame of present research includes all the residents rearing native cattle in the villages.

A list of factors was identified upon discussion with AERF which, was then formulated into a questionnaire to help determine the potential for A2 milk production and, developing bio fertilizers and bio pesticides using the native Indian cattle; present in the selected villages.

The chosen factors were as follows:

1. Nature of sampling group
2. Presence of sufficient number of native cattle in the village
3. Number of native cows
4. Presence of exotic cattle breeds
5. Number of lactating native cows
6. Lactation period of the native cows
7. Milk Output of native cows
8. Grazing pattern of the cattle

9. Feed of the cattle
10. Presence of basic infrastructure required for collection of cattle urine
11. Interest in selling native cattle urine
12. Urine output
13. Proximity of households rearing native cattle

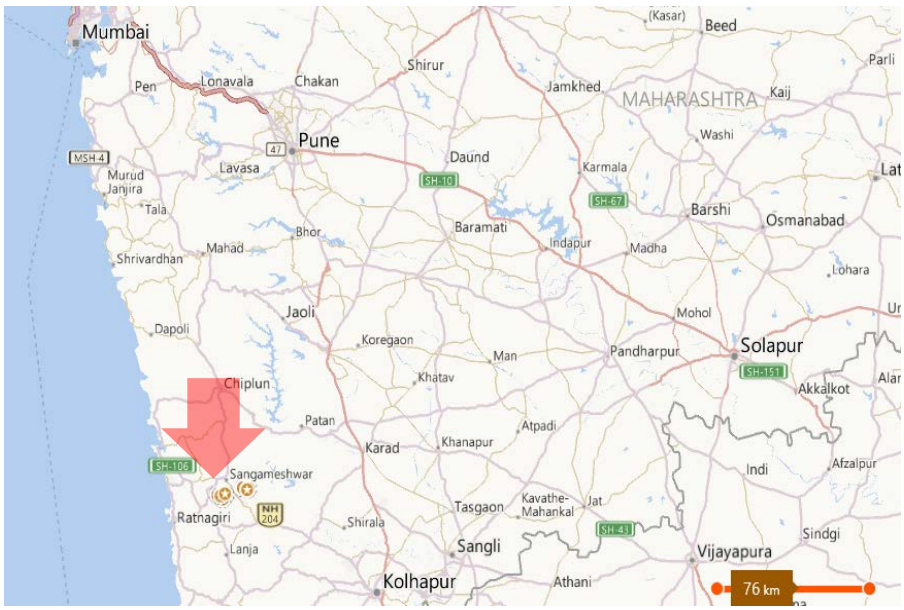
The aforementioned factors intended to provide answers that would determine the challenges and opportunities for A2 milk production and, developing bio fertilizers and bio pesticides. These in turn would be used to ascertain the potential of the region for A2 milk production and, developing bio fertilizers and bio pesticides from native Indian cattle.

3.1.1 Location of the Sampling Area

After conducting a pilot study and communicating with local people, Katavali and Ambavali villages were identified for conducting in depth study. The two villages are, incidentally, in close proximity to the field research office apart from the presence of a considerable number of native Indian cattle; therein.

The location of these two villages is marked in the below Pictures 2 & 3. These villages are located in Sangmeshwar taluka of Ratnagiri district (North-Western Ghats) in the state of Maharashtra, India.

PICTURE 2. Location of the study area (Google maps)



PICTURE 3. Magnified location of the study area (the two villages are marked with yellow circles) (Google maps)

3.1.2 Sample Size and Research Time-line

A sample size of at least 100 native Indian cattle owners was targeted. However, it was only possible to interview a total of 85 households since members of some of the chosen households were not available at the time of the survey; and there were a limited number of households rearing native Indian cattle.

Thus, in the village of Katavali, 44 households were interviewed. The village was divided into 9 wadis, or communities and all of these 9 communities were included in the survey. In the village of Ambavali 41 households were interviewed. This village had 18 wadis of which 7 wadis were covered since, rest of the wadis were reported as not possessing native Indian cattle.

The study was conducted during the months of March, April and May 2017. While conducting the surveys several visits were made to both the villages. The researcher accompanied with a field assistant, visited the villages during the morning hours to conduct the surveys. It took around a month and half to interview the participants.

3.2 Data Collection & Research Strategy

Amongst different data collection techniques such as: self-report, behavioural observation, physiological measures etc. self-report was considered the most suitable technique for the present research. In this technique, respondents are asked to answer the questions on their own by completing a survey or questionnaire via phone, web/email or face-to-face interview (Vanderstoep and Johnston 2009).

Further, face to face structured interview was selected because all other modes were not applicable in the present scenario since most of the participants did not have access to telephone or internet in the sampling locations. Furthermore, face-to-face interviews provides the highest response rate compared to other survey methods (Vanderstoep and Johnston 2009). Moreover, need for visual observations, made physical presence necessary at the location, thus, making face-to-face interview the best option in this case.

Amongst the various research designs such as: one-shot, longitudinal, cross-sectional, repeated independent sample, etc. one-shot data collection design was found appropriate for this survey. In this design one group of participants is studied only once. This design provides efficiency and involves low cost in both time and resources (Vanderstoep and Johnston 2009). As the present research only focused upon determining the potential for A2 milk production and, bio pesticides and bio fertilizers development in the sampling area, need to follow up with the participants overtime and conduct the survey again, was not felt.

The non-random snow ball sampling method was chosen in the current study since the research focused on a set of people who were rearing native Indian cattle and snow-ball sampling is the best way to identify such participants. In a non- random snow-ball sampling method a core group of individuals are initially sampled. The interviewees are then asked to identify other eligible candidates. The second generation of participants lead to the identification of other participants. In this way a rolling snowball builds up on itself and increases in size. (Vanderstoep and Johnston 2009)

3.3 Data Analysis

For the purpose of data analysis, frequency distribution in the form of graphs and pie diagrams was used. Also, descriptive statistics techniques such as central tendency and spread which include: mean, range, variance, standard deviation, were used. Microsoft excel was utilized for this purpose. Results are provided in Figure nos. 6, 7, 9-13, 14-21, 23-28, and Table 1.

4 RESULTS AND DISCUSSION

4.1 Nature of the Sampling Group

People interviewed in Katavali during the survey were mostly farmers. Out of the 43 individuals interviewed 34 were farmers, 5 labourers, 2 auto rickshaw drivers, 1 grocery store owner and 1 carpenter. This finding is supplemented by another study conducted in 2014 by AERF, which found that a majority of people practice agriculture in the region (Varak 2014, 13).

The income sources of the famers were:

1. Milk Sale
2. Cashew Sale
3. Income from paddy farming

Farmers interviewed in Katavali had land holdings ranging between 5 to 40 ‘gunthas’ (1 guntha = 1089 m^2), with an average of 7 ‘gunthas’ per farmer. This finding is contrary to the result of earlier study conducted by AERF in Ratnagiri district in 2014, which had revealed the average size of land under cultivation in the region to be 12 ‘gunthas’ (Varak 2014, 8). This is not surprising since, partition of property amongst Indian families is a regular feature. Turning the landholdings/households smaller and smaller.

Six individuals out of the 43 interviewees had cashew trees ranging between 25 to 700 trees while 5 individuals had alphonso mango trees between a range of 3 to 15. The owners of the cashew trees were selling their produce in the market for a price between rupees 50-150 (0.66-1.97 euros) per kg however the mango produce was being consumed by the households. Eleven households were selling milk to the dairy at a price between rupees 20-30 (0.26-0.39 euros) per litre.

In the village of Ambavali on the other hand all 41 interviewees were low-income marginal farmers doing farming on an area between 1 to 20 ‘gunthas’ (1 guntha = 1089 m^2), with a mean of 5 ‘gunthas’ per farmer. This again is contrary to the study conducted by Varak (2014, 8) wherein, the average size of land under cultivation was reported to be 12 ‘gunthas’ per farmer in Chiplun taluka of Ratnagiri.

The income sources of the farmers were:

1. Cashew Sale
2. Income from paddy farming

Ten out of the 41 interviewees owned cashew trees between a range of 3-400 trees whereas, 7 farmers had alphonso mango trees within a range of 1-70 trees, which was consumed by the households. The cashew was sold in the market for a price between rupees 70-150/kg (0.92-1.97 euros/kg). In contrast to Katavali, none of the individuals in Ambavali were selling milk.

The present study reveals that all farmers in both villages have their own land with individual farm holdings being less than an acre (1 acre = 4046.86 m^2). An earlier study conducted across major Indian states including Maharashtra, had reported that the majority of farmers (60%) were small/marginal farmers with land holdings of less than four acres, while mostly (86%) had their own land (Centre for the Study of Developing Societies 2014, 3–5).

Also, the above-mentioned study points that, a majority of farmers (83%) in the 18 states surveyed including Maharashtra considered agriculture to be their primary occupation. Similar response was noted in the present study. Further, it is also mentioned that 38 % of the farmers indulged in work other than farming to earn extra income. In the present study, whereas 20% of the respondents did additional work to support the household income in Katavali, none of the households were found to be involved in work, other than farming, in Ambavali. The reason behind this could be the remote location of Ambavali that hinders, extra income opportunities for the farmers of this village. (Centre for the Study of Developing Societies 2014, 3–5)

4.2 Breeds of Cattle

There were four different breeds of cattle in Katavali. First and the most prevalent was the indigenous non-descript breed (Gauti/native) (Picture 4). Out of a total of 175 cattle, 155 belonged to this indigenous non-descript breed. The criteria on which they are categorized as non-descript is that, they have less than 50% similarity with the other identified indigenous breeds such as Gir, Sahiwal, Khillari etc. according to the Ministry of Agriculture, India (2014) report.

In the present report, the indigenous non-descript breed is referred to as native Indian cattle.

PICTURE 4. Native Indian cow (Photo: Rishabh Sinha 2017)

The second most prevalent breed in Katavali was Jersey (Picture 5)**.** There were 15 pure Jersey cows, 4 Jersey-native cross breeds (Picture 6) and 1 Khillari cow (Picture 7), which is an indigenous breed.

PICTURE 5. Jersey cow (Photo: Rishabh Sinha 2017)

PICTURE 6. Jersey-native cross cow (Photo: Rishabh Sinha 2017)

PICTURE 7. Khillari Cow (Creative Commons)

Figure 6 below presents the proportion of the different breeds in Katavali.

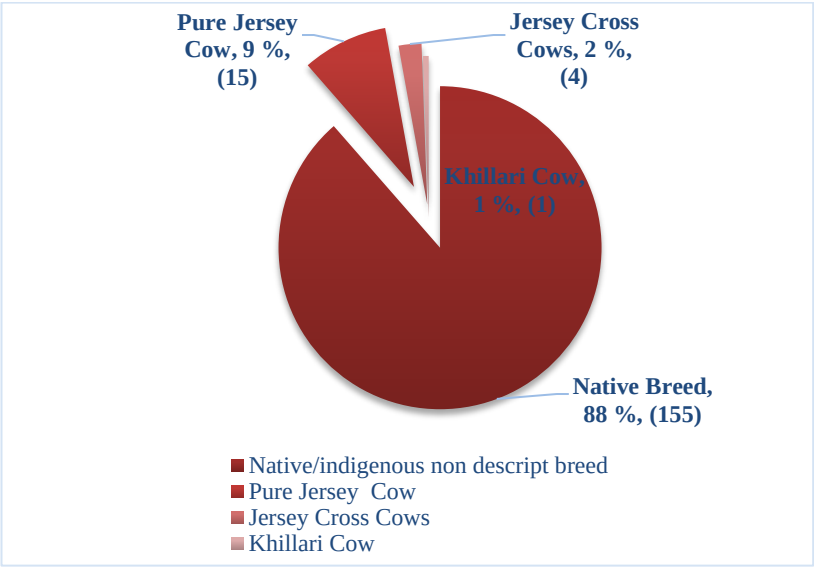


FIGURE 6. Proportion of cattle breeds in Katavali

In Ambavali however, only 2 varieties of cattle were found. Out of 161 cattle, 160 were native or the indigenous non-descript breeds while, only one was a Jersey native cross (Figure 7).

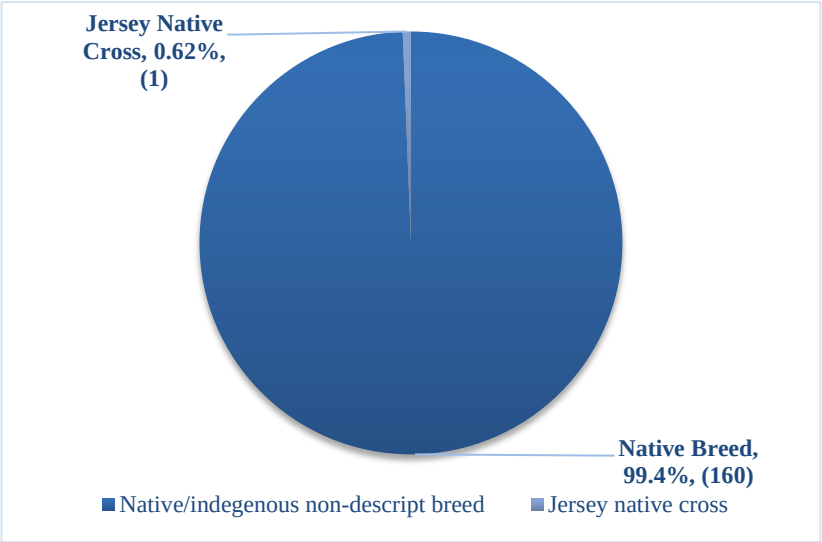


FIGURE 7. Proportion of cattle breeds in Ambavali

The Commissionerate of Animal Husbandry (2012, 16) report shows that there are considerably more number of native cattle compared to exotic breeds in the region of Mumbai, which includes Ratnagiri district where the present study was conducted (Figure 8).

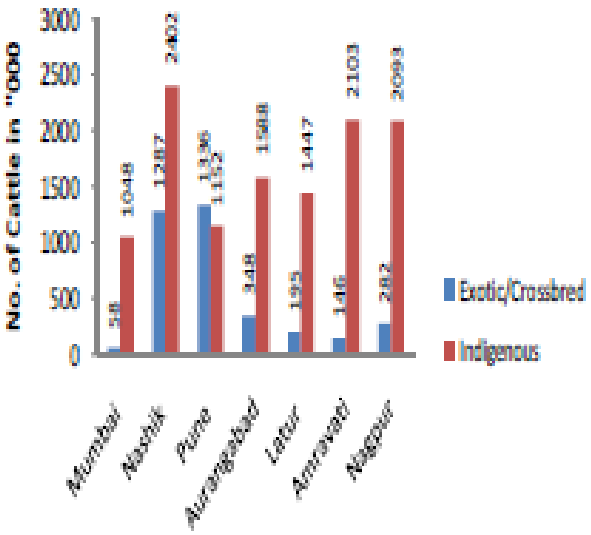


FIGURE 8 Region wise exotic/crossbred and indigenous cattle (Commissionerate of Animal Husbandry 2012, 16)

Likewise, the Ministry of Agriculture, India (2014) report states that 79% of the cattle in India are native breeds and the present report too found the prevalence of native breeds in both the above mentioned villages.

This situation is good from the point of urine collection as most cattle are native in both the villages studied. Consequently, less effort will be required for preventing the inter-mixing of urine of exotic breeds that can contaminate the urine of native breeds.

In Katavali 39 households out of 404 were found to be rearing cattle. These households were spread across 9 wadis as can be seen from Figure 9**.**

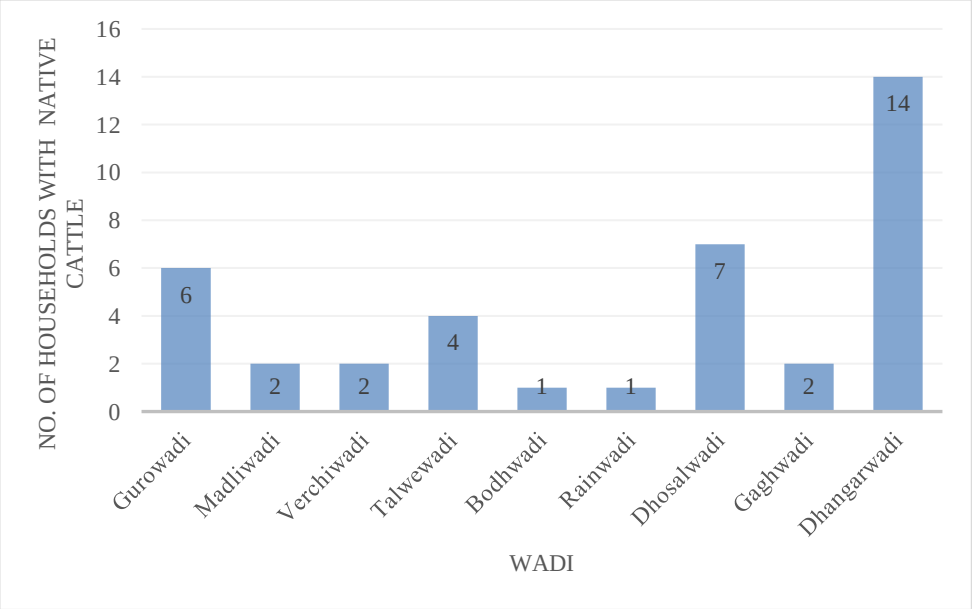


FIGURE 9. Number of households with native cattle in the wadis of Katavali

Out of all the various wadis in Katavali, Dhangarwadi had the maximum number of households rearing native cattle (Figure 9); on the previous page.

In Ambavali 41 households out of 331 had native cattle. These households were spread across 7 wadis as can be seen in Figure 10 below.

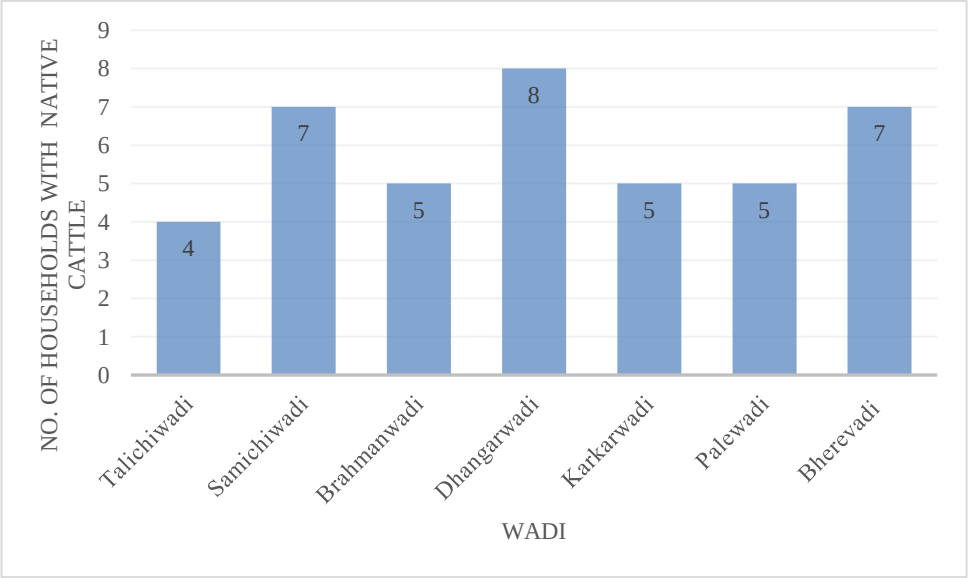


FIGURE 10. Number of households with native cattle in the wadis of Ambavali

Even in Ambavali, Dhangarwadi had the highest number of households having cattle, followed by Bherevadi and Samichiwadi which had equal shares (Figure 10).

4.3 Number of Cattle

In Katavali, a total of 175 cattle were found in the 9 wadis of the village amongst 39 households. The cattle distribution is presented in Figure 11.

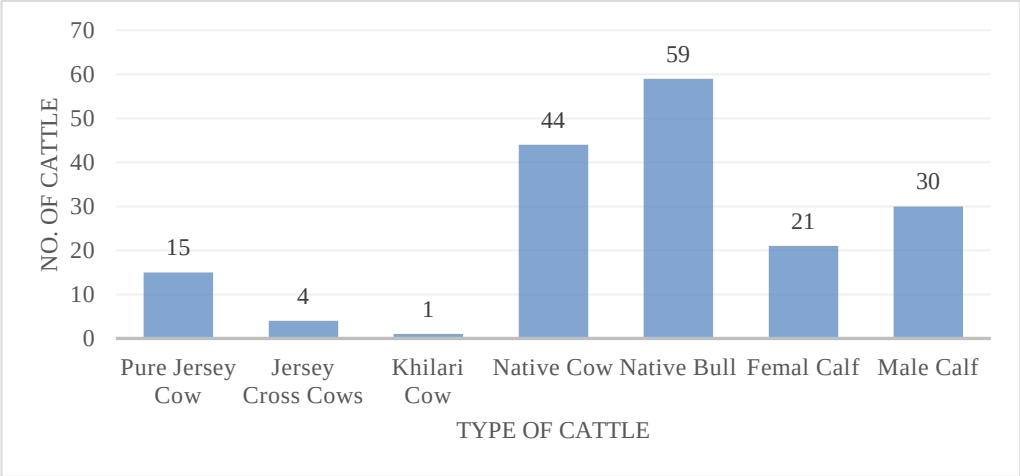


FIGURE 11. Cattle distribution in Katavali

Whereas, the mean value of cattle present in the whole village, with 404 households, was 0.4, the mean value of cattle per household was 4.5, mode was 4, the range was 10 and the standard deviation was 2.7 which means that, there is approximately 1 cattle per two households.

In Ambavali 161 cattle were found amongst 41 households out of the 18 wadis covered in the present surveys. Figure 12 below shows the distribution of cattle in Ambavali.

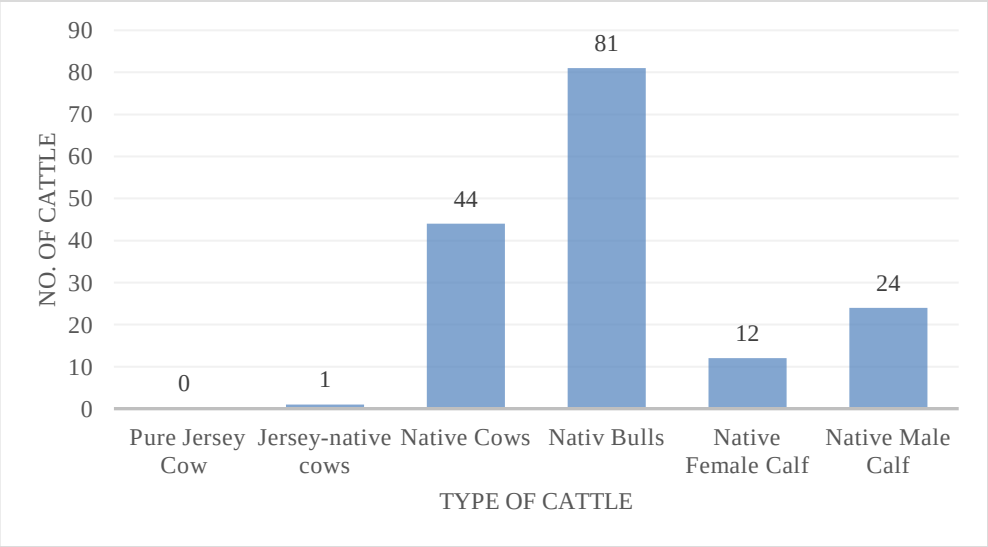


FIGURE 12. Cattle distribution in Ambavali

Likewise in Ambavali, the mean value of cattle present in the entire village of 331 households was 0.5, while, the mean value of cattle per household was found to be 3.9, the mode was 4, the range was 7 and the standard deviation was 1.7, which means that there is 1 cattle every two households. Similar observation was recorded for Katavali village.

It can be seen from Figures (Figure 11 & 12) that there is a high number of native bulls present in both the villages, compared to native cows. Farmers in these villages do not have tractors and are entirely dependent on the bulls for tilling their field. Thus, bulls are considered more useful than cows in these villages, as a result each farmer has at least one pair of bull. The 2014 study conducted in the region by AERF also finds the presence of a higher number of native bulls compared to other livestock (Varak 2015, 8).

The Ministry of Agriculture, India (2014) report states that there are about 872 cattle per 1000 households (i.e. 0.87 cattle per household) in the rural areas of Maharashtra. However, this number includes both native and exotic cattle and therefore is a bit higher than the present statistics of 0.4 and 0.5 cattle per household in Katavali and Ambavali respectively, which only includes native and no exotic cattle. Also, the region studied in the present research comes under the district of Ratnagiri (marked with an arrow in the below Figure 13) in Maharashtra, which has a fewer number of livestock when compared to the rest of the state according to the Commissionerate of Animal Husbandry (2012, 38) report (Figure 13).

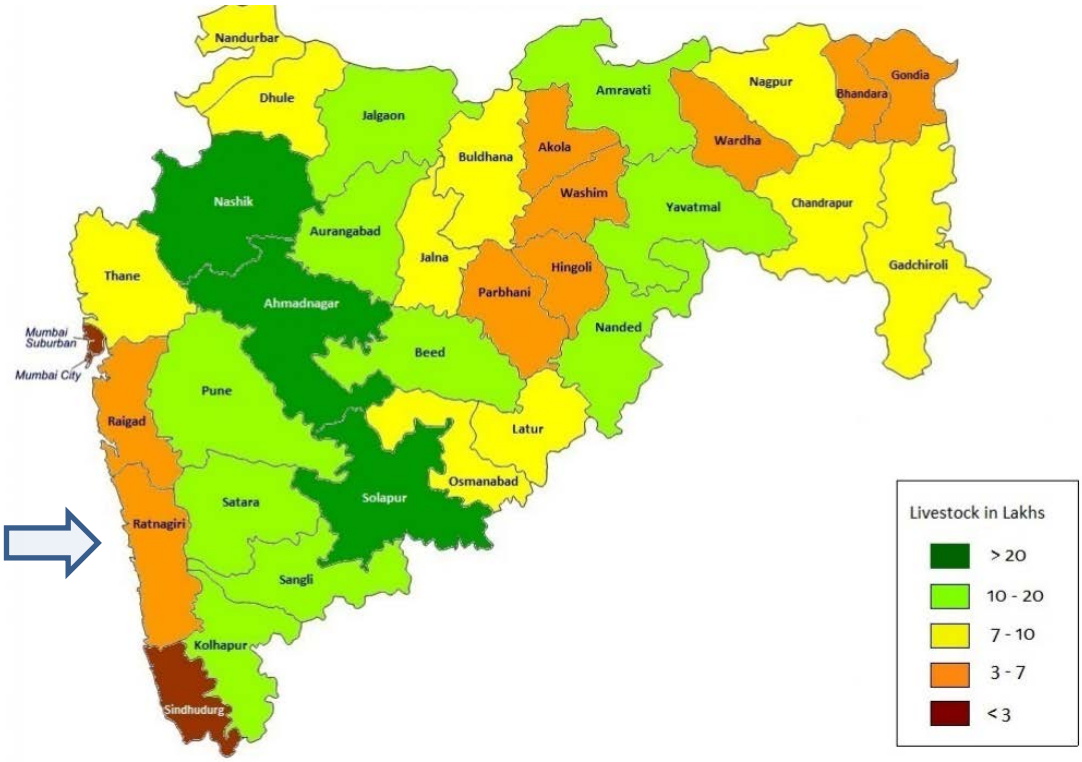


FIGURE 13. Livestock status of Maharashtra (1 Lakh = 100000 units) (Commissionerate of Animal Husbandry 2012, 38)

It had been observed (Figure 9, earlier) that Dhangarwadi of Katavali had the maximum number of households possessing native Indian cattle the present observation (Figure 14) as well, is not at all surprising.

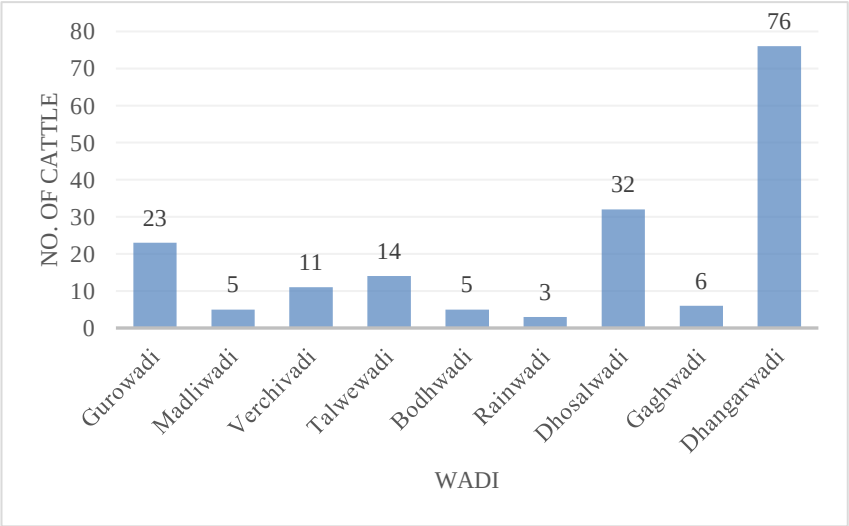


FIGURE 14. Distribution of cattle in different wadis of Katavali

A similar trend was observed in Ambavali where in its Dhangarwadi, once again, had the highest number of cattle as can be seen in Figure 15 below.

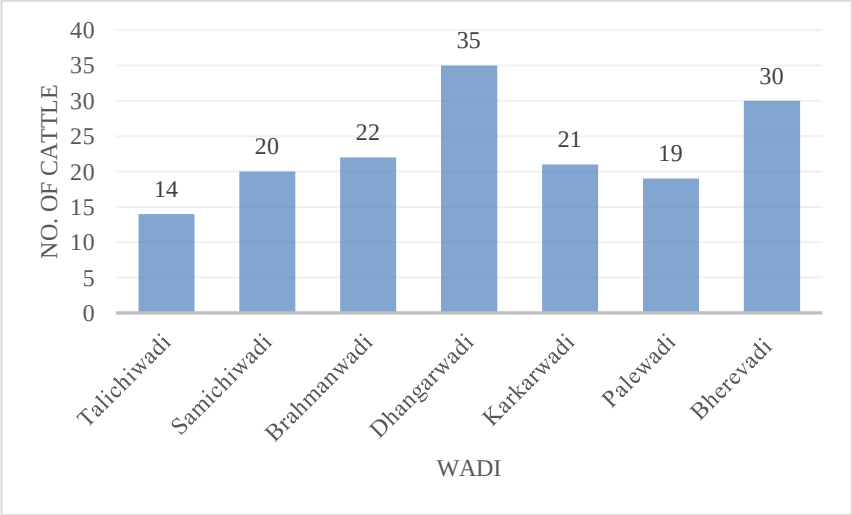


FIGURE 15. Distribution of cattle in different wadis of Ambavali

‘Dhangar’ is a community in Maharashtra, which has been associated with herding cattle. The word ‘dhangar’ is believed to be derived from the word ‘dhenu’ which means cow in Sanskrit or from the word ‘dhan’ meaning wealth in relation to cattle (Singh 1992).

The below satellite images (Picture 8 & 9**)** portray that, Dhangarwadis of both villages (marked with arrows), have the largest pasture for the cattle to graze upon when compared to other wadis that are either situated between dense forest or are located on hilly slopes (Picture 10) which pose difficulty for grazing.

A similar finding was observed in another study conducted in this region, which points that, size of the livestock is dependent on the size of the agricultural land possessed. The study states further that, the mountainous terrain in this region makes rearing livestock difficult (Varak 2015, 8). Therefore, areas with flat lands are favourable for rearing cattle and this was observed in the present study too wherein, Dhangarwadi had an abundance of flat pasture land (Picture 8 & 9) and therefore had the highest number of cattle in comparison to the other wadis.

PICTURE 8. Satellite image of Ambavali village (Google Map)

PICTURE 9. Satellite image of Katavali village (Google Map)

PICTURE 10. Photograph of a hilly slope in one of the wadis (Photo: Rishabh Sinha 2017)

4.4 Occurrence of Native Cows

In Katavali village, a total of 45 native cows were found in 30 households. Out of the total, more than half were present in Dhangarwadi (Figure 16); a wadi of Katavali. The mean value of native cows per household rearing cow, in Katavali was 1.5, the range was 3 and the standard deviation was 0.8. Whereas, the mean of native cows for the whole village with 404 households was 0.1, which means there is 1 native cow per 10 households.

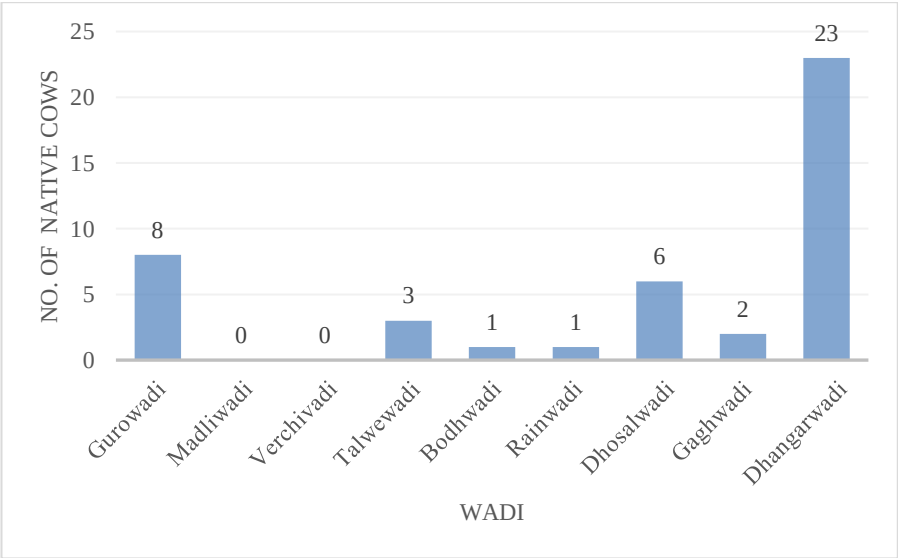


FIGURE 16. Distribution of native cows in Katavali

In Ambavali, a total of 44 native cows were founnd in 32 households. The distribution can be seen in Figure 17 below.

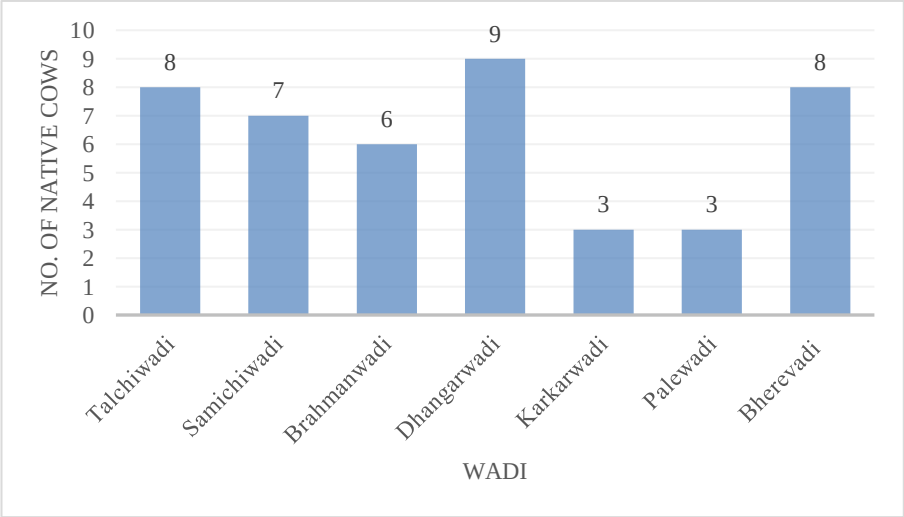


FIGURE 17. Distribution of native cows in Ambavali

The mean value of native cows per household rearing native cows in Ambavali was 1.4, the range was 3 and the standard deviation was 0.7. Whereas, the mean of cow for the whole village with 331 households was 0.1, this means that there is 1 native Indian cow per 10 households in Ambavali as well .

A considerable number of lactating cows were found in Katavali. Out of the 45 native cows in Katavali 30 were in lactation while the other 15 were dry at the time of the survey (Figure 18).

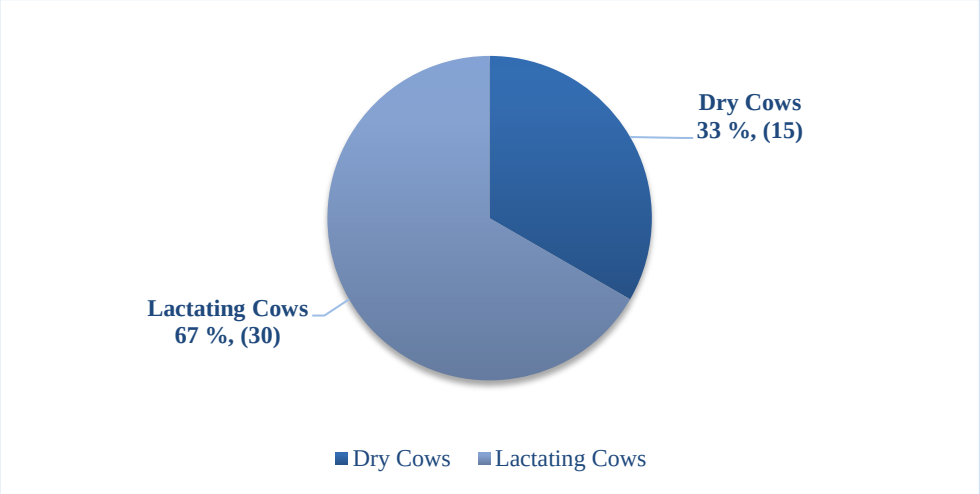


FIGURE 18. Percentage of dry and lactating native cows in Katavali

This ratio suggests that almost 70% of the native cows are capable of producing milk in Katavali. Additionally, Figure 19 below shows that most of the lactating cows were present in Dhangarwadi.

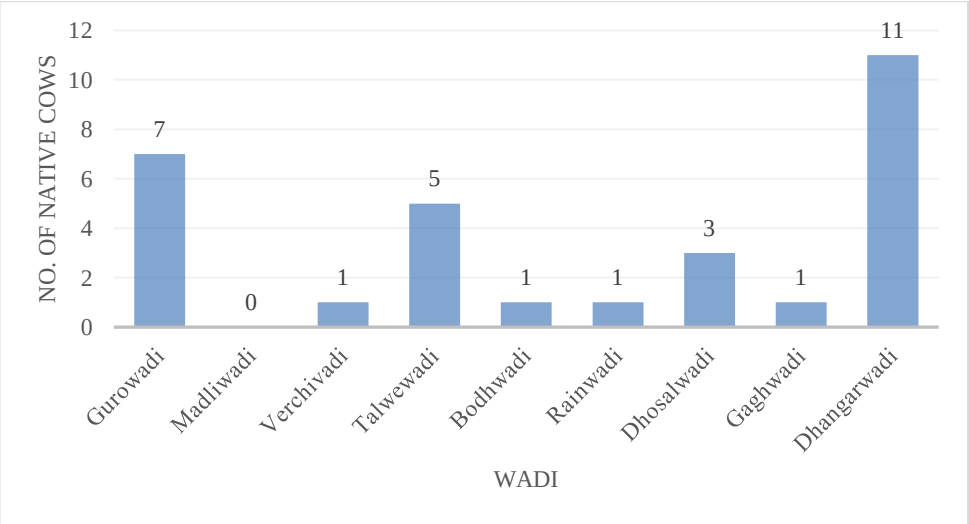


FIGURE 19. Distribution of native cows in Katavali

However, in Ambavali only 10 out of the 44 cows were found to be lactating, rest of the 34 cows were dry at the time of the survey (Figure 20).

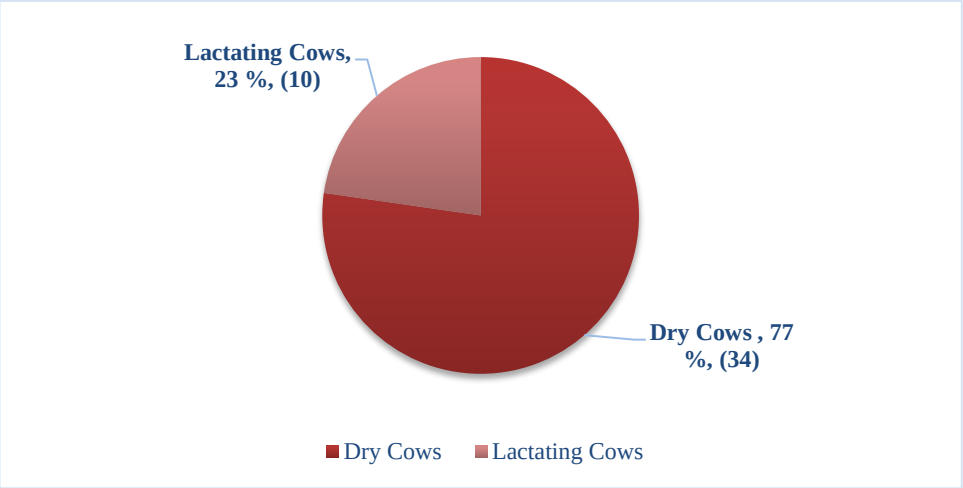


FIGURE 20. Number of dry and lactating native cows in Ambavali

The distribution of the cows amongst the various wadis of Ambavali can be seen in Figure 21 below.

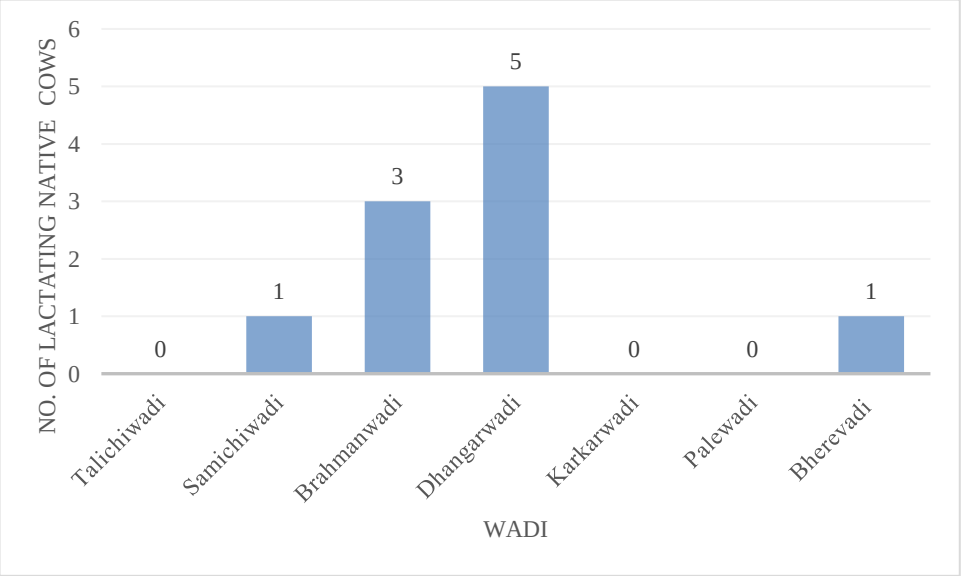


FIGURE 21. Distribution of lactating native cows in Ambavali

Katavali has a higher number of milk producing cows as compared to Ambavali. The reason behind this is that, there is a dairy in Katavali where farmers can sell their milk, and the dairy is responsible for milk collection.

Due to the absence of such an arrangement in Ambavali, there are very few farmers who are focusing on milk production as a result, most of the cows in Ambavali have a very low milk output and are dry.

The information regarding lactation period of native cows was collected from 20 respondents. The range of lactation period was found to be between a minimum of 2 months up to a maximum of 12 months, with an average of 7 months or 210 days. This result coincides with an earlier research carried out to find the potential of Indian native cattle for milk production. That research used 1405 lactation records of 336 native cows at the Central Livestock Research and Breeding Station, Haringhata, India. And the average lactation period of the native Indian cow was found to be 264 ± 81 days (Moulick et al. 1972). The average lactation period found in the present research is 210 days, however, a better picture regarding the lactation period is likely to emerge if surveys are conducted in the two villages during the different seasons of the year.

Though the observed lactation period is good from the point of milk production, it is less than the average lactation period of crossbred or exotic cows. The contemporary Jersey native cross exceeds the lactation length of native cows by 41 days which, comes out to be around 300 days of lactation. (Moulick et al. 1972).

The combined average milk output of the native cows from the two villages was 1.4litres/day. That is about 300 litres per lactation considering the lactation period as 210 days. This value is considerably low when compared to the milk output of Jersey native cross, which according to the study conducted by Moulick et al. (1972), is about 923 litres more than the native cow per lactation. Furthermore, the exotic breeds such as Jersey and Holstein Friesian have even higher milk output, around 6000 litres and 8000 litres per lactation respectively (Agritech.tnau.ac.in, 2017). This is about 20 times more than the average milk output of the native Indian cattle found in the villages of Ambavali and Katavali.

There are a couple of reasons behind the low milk output of native Indian cattle in the villages of Ambavali and Katavali. Firstly, the native Indian cattle in general has gone through little selection for improved milk yields (Moulick et al. 1972), in contrast to the exotic cattle breeds such as Jersey, which is reported as one of the oldest dairy breeds and has been purebred for about six centuries (Agritech.tnau.ac.in 2017).

Secondly, poor nutrition and management is responsible for low milk yield. It has been pointed out in one of the studies conducted in central Africa that, cattle grazing in natural pastures and upon crop residue, shed body weight. Moreover, their cyclic ovarian activity ceases after they lose 20-30% of their mature weight due to under nutrition (Topps and Oliver 1993). In yet another study, inappropriate feeding has been sited to be responsible for limiting milk production (Omore et al. 1994, 116–118). This was observed in the present study as well, where cattle mostly fed on crop residue during the dry season (November to May i.e. 7 months) and, on natural pasture during the wet season (June to October i.e. 5 months). One of the studies points out that the small/marginal farmers in developing countries lack resources for feeding their livestock. They usually feed their livestock with whatever is available at the lowest possible cost. This type of feed has low digestibility and generally lacks protein, which is essential for increased milk production. (Leng 1999, 83) Also, another study states that in order to increase milk production, protein concentrates and growth hormones need to be supplemented in the feed (Walshe et al. 1991). However, this practice was almost absent in both the villages studied due to lack of resource and motivation and thus, cows from these villages had poor milk yield.

The third factor responsible for a low milk output from the native cows was the lack of water supply. This region faces water shortages during the dry season. A report prepared by Varak (2014, 10) points that during the summer, water scarcity in the hilly areas of the region increases. As both the villages are entirely dependent on wells as their main source of drinking water, and barely have any water during the dry season, cattle do not get sufficient water to drink. A report published by the Federal University of Agriculture, Abeokuta (2004), states that, any restriction in the water supply has drastic effects on the milk production of cows as they are not equipped to store water and thus, even a few hours of insufficient water supply will result in a downfall in milk yield. Survey in the present study was conducted during the months of April and May which are the pre monsoon months (Figure 22, on the next page). This period is the hottest and the driest, as a result, water shortages are at peak during these months. Consequently, cattle receive least amount of water during these months and therefore, average milk output of the native cattle in Katavali and Ambavali was this low. Respondents during the survey pointed out that, in the wet season cattle produce more milk as there is sufficient water available for them.

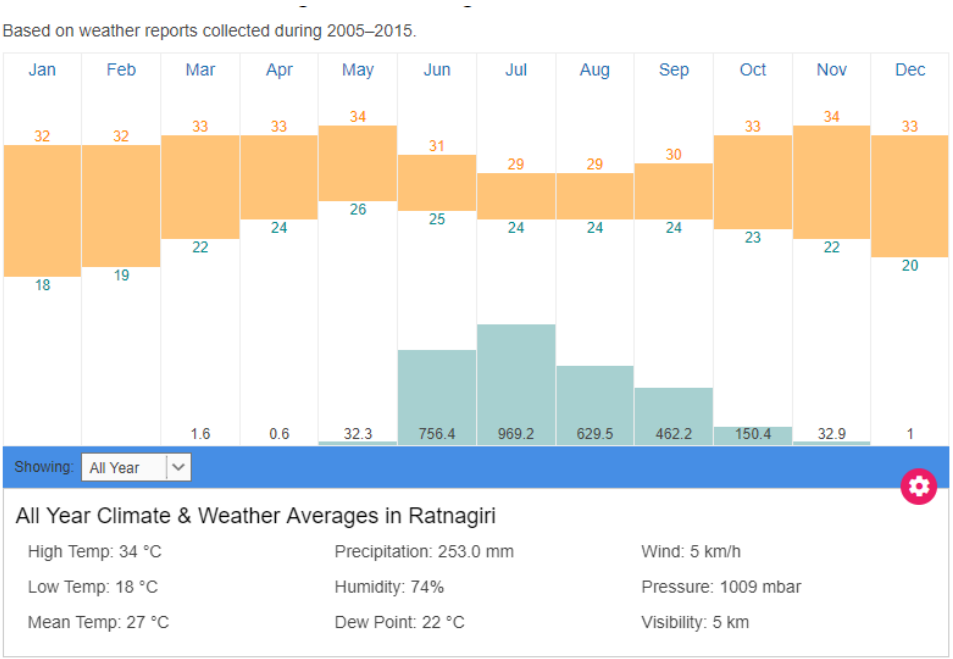


FIGURE 22. Annual weather averages in Ratnagiri (green peaks represent average precipitation in mm) (Timeanddate.com 2017)

Further, it was observed that milk production was high in Katavali village which, had a milk dairy. During the survey in Katavali, 25 households had lactating cows however, only 11 households were selling milk while, the rest were keeping milk for their own use. It was also gathered that, all these households were selling milk to a nearby dairy at a price of rupees 20-30 (0.26-0.39 euros) /litre. The dairy had made arrangements for collecting milk from each of these households in the mornings.

Surprisingly, milk of natives as well as the Jersey cows was being purchased at the same rate of rupees 20-30 (0.26-0.39 euros)/litre by the dairy in Katavali. The native cattle milk i.e. A2 milk could be sold in nearby cities for a price of around 75-100 rupees (1.3 euros)/litre as the people living in cities are more aware and willing to pay extra because of the benefits associated with such milk.

In contrast to Katavali, out of the 10 households that had lactating cows in Ambavali, none were selling milk due to no dairy being present in the village to buy milk.

Based on the average daily milk output of lactating native cows present in the village during the survey, monthly milk output of native cows in Katavali was calculated to be around 1260 litres of A2 milk (1.4 litres × 30 lactating cows× 30 days). If sold at rupees 100 per litre (1.3 euros) in nearby cities, this milk will fetch about 1,26,000 rupees (1640 euros)/month to the farmers of the village.

Similarly, the monthly milk output of Ambavali was calculated to be around 420 litres of A2 milk (1.4 litres × 10 lactating cows × 30 days) which, if sold in nearby cities at 100 rupees per litre will fetch the farmers of the village around 40,000 rupees (520 euros)/month.

This additional income will support the farmers in their livelihood and thus help in alleviating poverty of the region. Further, with improvement in nutrition and management of the cattle, milk output could be increased even more.

4.5 Grazing Pattern

In Katavali village, out of the 39 households possessing cattle, 24 grazed their cattle only during the monsoon season (June to September), while the rest of the time they were stall-fed (Figure 23).

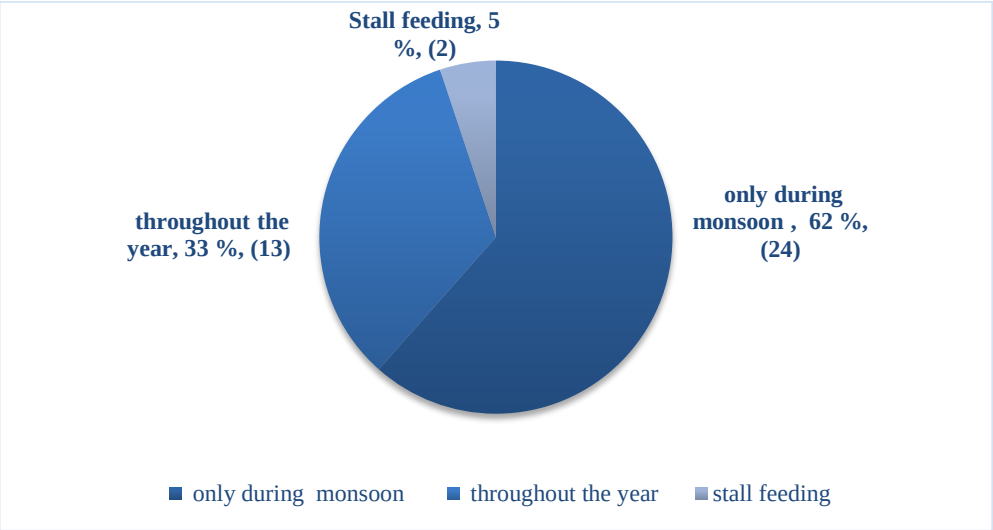


FIGURE 23. Grazing pattern of cattle in Katavali

The grazing pattern of the cattle in Ambavali can be seen in Figure 24 below.

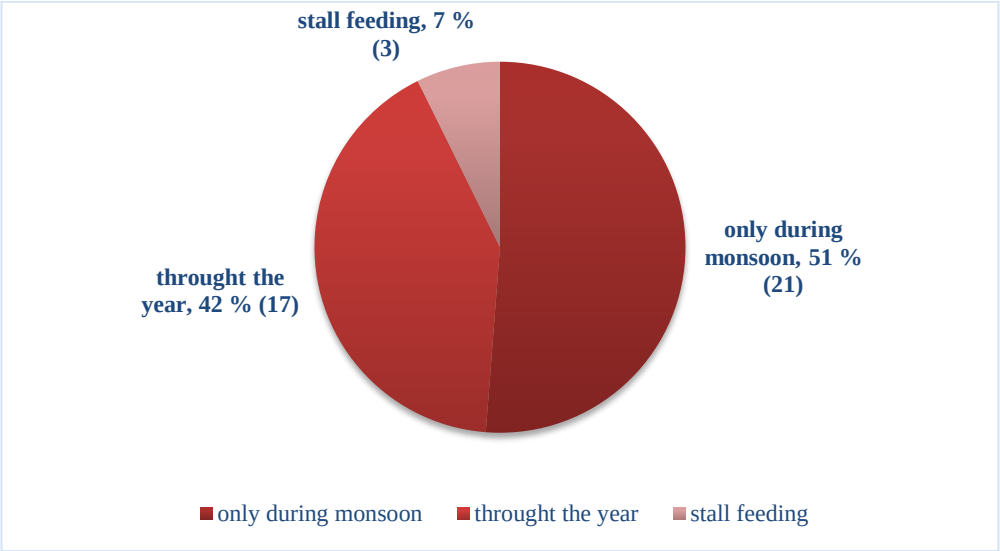


FIGURE 24. Grazing pattern of cattle in Ambavali

The pattern in the above Figure 24 reveals that, more than half of the cattle in this village graze outside for around six months in a year during the monsoon season. The cattle grazing time ranged between 2 to 7 hours per day. While, rest of the time was spent inside the shed. Stall feeding however is good from the point of urine and dung collection.

Moreover, Figures 23 and 24 reveals that there is a considerable percentage of cattle being grazed outside throughout the year: 33% and 42% for Katavali and Ambavali villages respectively. This can be seen as a challenge for urine and dung collection, and milk production.

In the present study though milk outputs of native Indian cattle through stall feeding and grazing is not known separately, average milk output of native Indian cows in the villages of Katavali and Ambavali combining grazing and stall feeding is however found to be 1.4 litres/cow/day (Table 1). A study conducted by the University of Nairobi, Kenya infers that, stall-fed cows produce significantly more milk than the cows that graze in the open. This study recorded data on milk production from 23 dairy farmers amongst whom, 11 were stall feeding the cows whereas, 12 others were grazing the cows in the open pasture. The same study also revealed that, over a 10-month lactation period, average milk output of the stall fed cows was 3150 litres compared to 2299 litres, of milk output from open grazing cattle. (Mbugua et al. 1999)

Another study states that stall-feeding is a better choice amongst small farmers due to the fact that, they have shortage of land, possess small scale of farm size and have limited forage resource (Aminah and Chen 1991).

From an environmental point of view as well as for the satisfaction of cattle, grazing in the open is advisable. However, when money assumes paramount importance, one would like to draw maximum amount of milk from cows thus, there exists enough scope for increasing the poor percentage of stall feeding recorded for both the villages.

The households rearing cattle were feeding dry rice straw (‘penda’) to the cattle during summer. During the monsoon they were fed green grass, and before a few months of delivery of a calf, the cow’s diet was supplemented with soya cakes. Therefore, for almost half the year cattle were feeding on rice straw. The reason behind low milk output of native cattle in the villages could be the poor quality of feed. Various studies have pointed towards this fact. These studies were discussed in section 4.4.

4.6 Infrastructure

4.6.1 Shed

All respondents’ rearing cattle in both the villages had sheds known as ‘gotha’ (Picture 11) for keeping their cattle.

PICTURE 11. Shed for keeping cattle (Photo: Rishabh Sinha 2017)

The roof of the cattle sheds was such that it would keep the cattle cool during summers and would not allow water to seep-in during monsoons. Also, most of these had outlets for urine (indicated by an arrow in Picture 11). This infrastructure in addition to being low cost and environment friendly, would prove useful from the point of urine collection.

Picture 12 below is a good example of arrangements made in one of the households to facilitate urine and dung collection.

PICTURE 12. Arrangement to facilitate urine and dung collection in a household (Photo: Rishabh Sinha 2017)

In Picture 12 above, it can be seen that a narrow drain has been constructed behind the cattle (marked with an arrow), and the floor is slanted towards the drain to allow easy collection of dung and urine. Also, pipes leading to container outside the building have been arranged (marked with an arrow).

4.6.2 Poles and Fodder Bed

In both the villages it was observed that most of the cattle sheds had poles for tying the cattle and feeding beds for the cattle. Picture 13 shows the arrangement.

PICTURE 13. Poles and fodder bed in the cattle shed (Photo: Rishabh Sinha 2017)

From the point of stall-feeding the cattle, both these facilities are essential. Presence of this basic infrastructure would facilitate the collection of cattle urine. Also, it would help in the process of promoting stall-feeding and milk production.

4.7 Interest in Selling Native Cattle Urine

In both the villages, interest for selling native cattle urine was high.

In Katavali out of the 39 households who had cattle, 31 were interested in selling cattle urine and 7 were undecided. There could be several reasons for their doubt. Some of these could be related to time and effort, monetary investment, and marginal gains, etc. One of the individual was not interested in selling cattle urine at all since he was financially well off and had plans of utilizing the cattle urine and dung on his own farm. This suggests that marginal farmers were more motivated in selling cattle urine than financial stable farmers.

Wadi wise distribution of these households can be seen in the Figure 25 below.

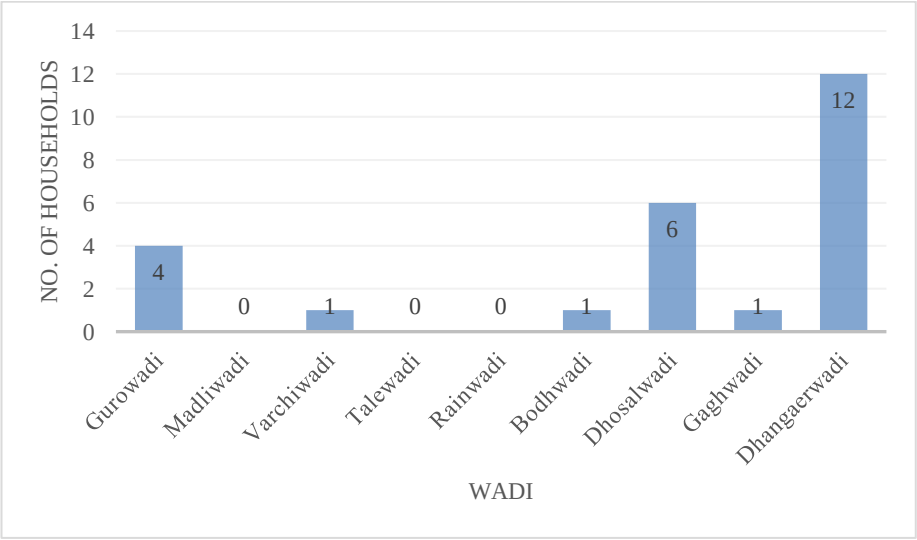


FIGURE 25. Distribution of households interested in selling cattle urine in Katavali

Dhangarwadi had the highest number of households interested in selling cattle urine in Katavali.

The distribution of native cows in the households interested in selling cattle urine can be seen from the Figure 26 below.

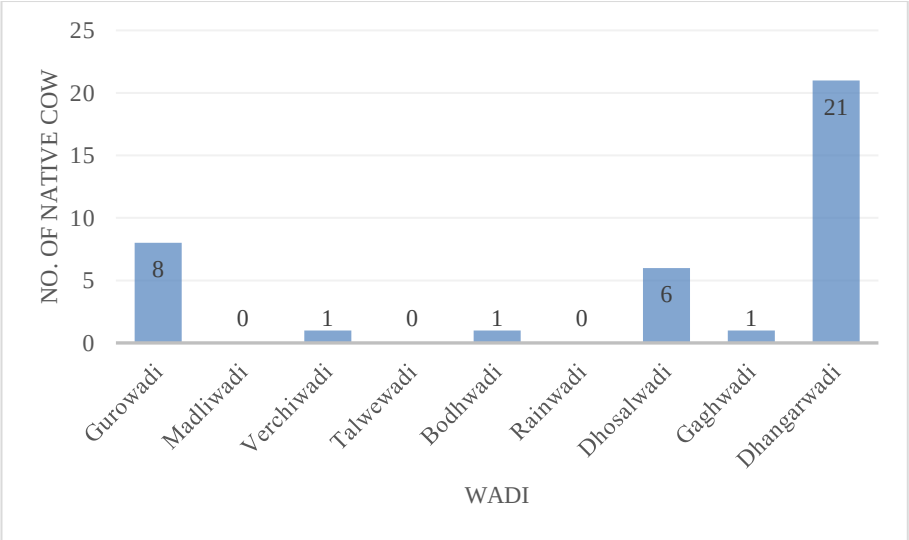


FIGURE 26. Wadi wise distribution of native cows which can be used for urine collection in Katavali

It can be seen that at least a total of 38 native cows can be utilized for urine collection in Katavali (Figure 26). However, more households can be convinced to sell cattle urine.

During the survey, it was difficult to collect data about urine output of cow as, farmers neither kept an account nor utilized it. However, it was reported by some of farmers that cows produced more urine during the wet season when their water intake increases whereas, urine output is very low during the dry season (discussed earlier in section 4.4). According to Veterinary Manual a cow produces about 17-45 mL of urine/kg body weight/day (Gravity 2017). According to a report prepared by FAO (Food and Agriculture Organization) the average weight of a native Indian cow is 313 Kg (Gaur et al. 2003). Considering this, the average urine output of a native Indian cattle comes out to be 5.3 L-14 L of urine/day/cow.

Therefore, the village Katavali has potential to produce about 190 L of urine per day or, 5700L per month from 38 native cows (taking 5L urine/day/cow as an average, since the water intake of cows is low during the dry season). This urine can be processed (purified and distilled) and sold in the market for approximately rupee 160/L (2 euros/L), which is being offered at this price by many brands online (Gomataseva.org 2017). Farmers can make significant profit from selling the urine if proper marketing and management is provided to them. This is being aspired for by Applied Environmental Research Foundation (AERF). Also, AERF is planning to set up production of bio fertilizers and bio pesticides using native cattle urine, which would help to promote organic farming in the region in addition to providing additional income to the farmers.

In Ambavali 34 households out of 42 were interested in selling cattle urine. Whereas 6 were undecided, 2 were not interested at all.

The distribution of the households willing to sell cattle urine can be seen in Figure 27 below.

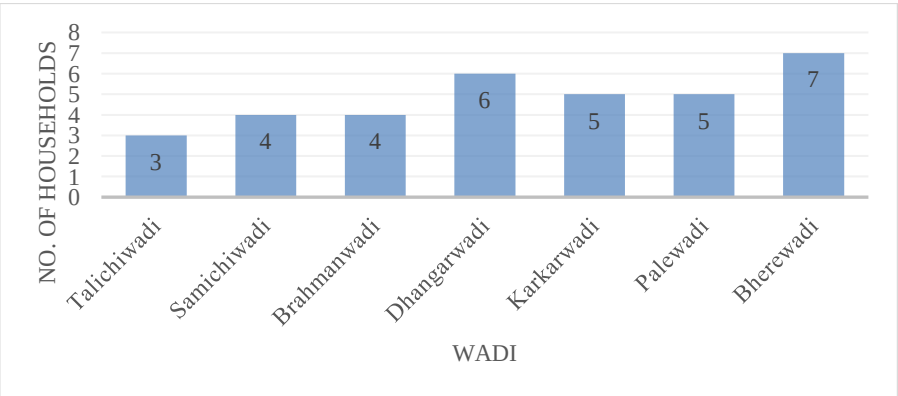


FIGURE 27. Distribution of households interested in selling cattle urine in Ambavali

The distribution of native cows in the households interested in selling cattle urine in Ambavali is presented in Figure 28 below.

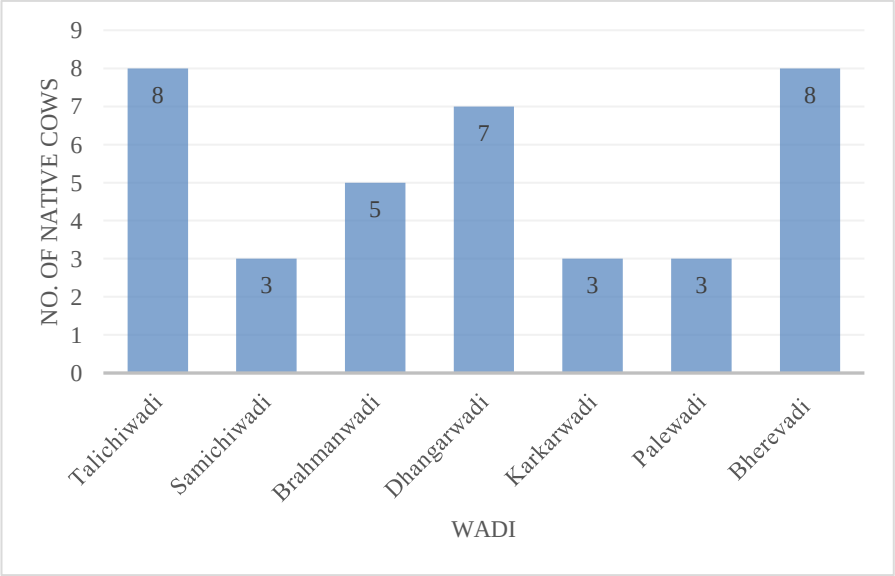


FIGURE 28. Wadi wise distribution of native cows which can be used for urine collection in Ambavali

It can be seen that at least a total of 37 native cows (Figure 28) can be utilized for urine collection in Ambavali according to the survey. However, more households can be convinced to sell cattle urine.

According to the present situation Ambavali has a capacity to produce 185 L of urine per day from the 37 native cows or about 5550 L per month (considering per day output as 5L based on the discussions made above).

Thus, both the villages, Katavali and Ambavali have a huge potential for production of cow urine which can be used to manufacture different products and create extra income for the farming community.

4.8 Usage of Chemical Fertilizers

During the present survey, it was observed that, all farmers cultivating rice were using chemical fertilizers on their field. The most common being Urea (a nitrogen fertilizer) followed by Suphal (a composition of nitrogen, phosphorous, & potash in equal proportions). Similar results were observed in another study conducted in Sangmeshwar Taluka where the villages of the current study are located as well. This study observed that the most widely used fertilizer in the Sangmeshwar Taluka was Urea and Suphla (Figure 29) which agrees with the findings of the present study as well. (Sukumar 2016, 10)

The below Figure 29, represents the percentage of farmers using the different fertilizers.

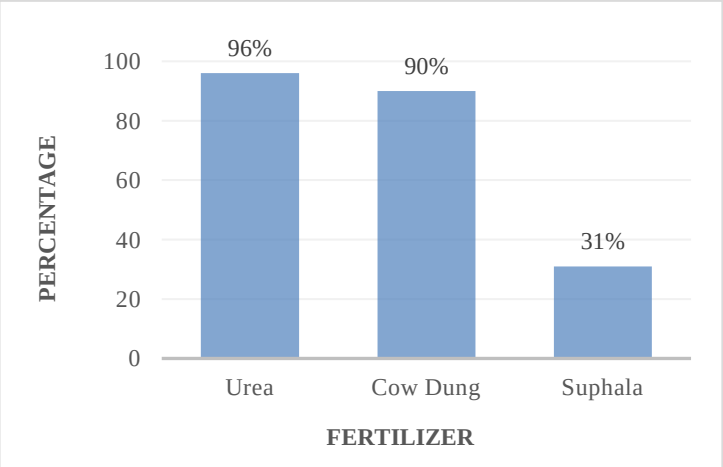
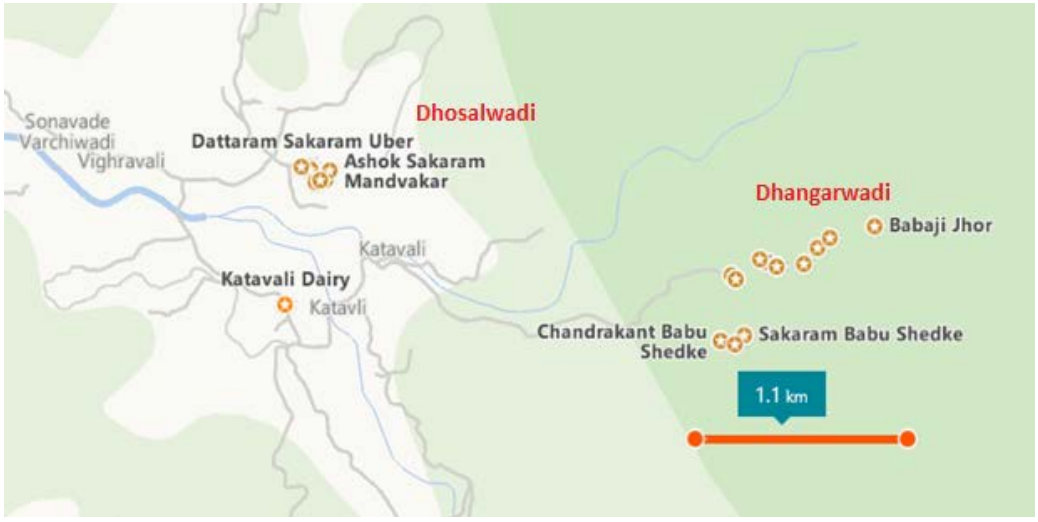


FIGURE 29. Percentage of farmers using different fertilizers in Sangmeshwar Taluk (Sukumar 2016, 10)

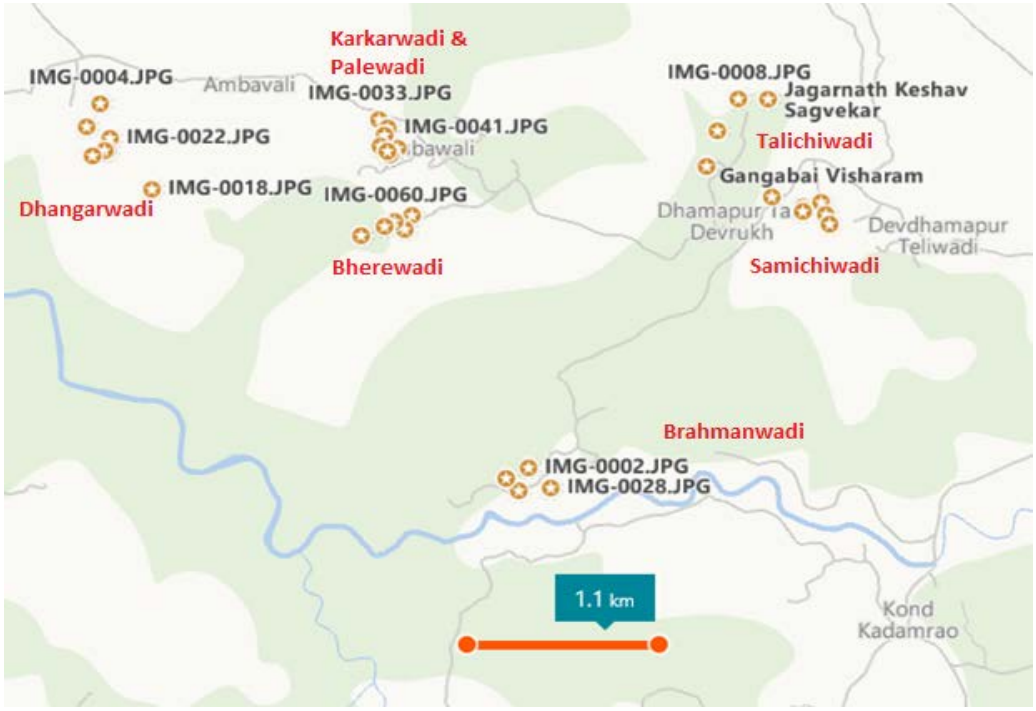
Some of the farmers were aware of the harmful effect of these chemicals on the soil, plants, livestock and human beings. A few reported that fertilizers and growth hormones used on mango and cashew trees, can decrease the life expectancy and the yield of the trees; as well. Most of the individuals agreed with the interviewers' view that chemical fertilizers cause damage to the fields and environment and that bio pesticides and bio fertilizer made from cow dung and urine would benefit their crops apart from increasing soil fertility and help in protecting the environment. Some of the respondents were aware of the liquid bio manure such as Jeevamrut, Panchgavya and a few of them had even tried it on their crops.

4.9 Proximity of Households Rearing Native Cattle

It was found that in both the villages, households rearing native cattle in the wadi or locality were situated very close to each other i.e. within a range of less than a kilometre (Picture 14 & 15). It suggests the viability for the collection of milk and urine from these households in terms of transportation cost and time.



PICTURE 14. Proximity of households rearing native cattle in Katavali (Google Maps)



PICTURE 15. Proximity of households rearing native cattle in Ambavali (Google Maps)

4.10 Result Summary

The below table presents the important findings of the survey.

TABLE 1. Findings of the survey

Parameters	Katavali	Ambavali
Households covered	43	41
Number of Cattle	175	161
Native Bulls	59	81
Native Cows	45	44
Native Male Calf	30	24
Native Female Calf	21	12
Exotic breeds	15	0
Jersey-Native Cross Cows	4	1
Khillari Cow	1	0
Native cows in lactation	30, 67% of total native cows	10, 23% of the total native cows
Average Lactation period of Native cows	7 months	7 months
Average milk output of Native cows	1.4L	1.4L
Total monthly average milk output of Native cows	1260 L	420 L
Households interested in selling native cattle urine	31 (out of the 39 inter-viewed)	34 (out of the 42 inter-viewed)
Total monthly potential of Native cow urine	5700 L	5550 L

5 CONCLUSION

It was found out that both villages had considerable number of native cattle and native cows. Katavali had considerably more number of lactating cows than Ambavali. In both the villages Dhangarwadi had the highest number of native cattle, including cows. The lactation period of the native cow was found to be 7 months on an average, whereas the milk output average was found to be 1.4L/day. The total monthly average milk out of native cows was found to be 1260 L and 420 L in Katavali and Ambavali respectively. Majority of the households rearing native cattle in both the villages were willing to sell cattle urine. The total monthly capacity of native cow urine was 5700 L and 5550 L in Katavali and Ambavali respectively. Also, the households rearing native cattle were located in close proximity which would assist in milk and urine collection. In both the villages, presence of basic infrastructure for keeping and feeding the cattle were present in each of the households in both the villages, which is good from the point of urine and milk collection. These infrastructure are low cost, utilize almost no energy and are environmental friendly. There were almost negligible number of exotic cattle breeds in both the villages, which would prevent intermixing of the urine of exotic verities with that of native breeds thus, preventing contamination.

However, there were very few lactating cows in Ambavali, due to the absence of a dairy, thus making Ambavali an unfavourable location for milk production. The average milk output of the native cows was found to be very low, around 1.4L/day which would be a drawback for milk production. The cattle were spending 2-7 hours grazing outside mostly during monsoon, which would result in wastage of urine. The feed of the cattle was found to be non-nutritive, which might be a big reason behind the poor milk output of the native cows.

6 RECOMMENDATIONS FOR FUTURE WORK

Thus, it is evident from the research that there is scope for developing bio pesticides and bio fertilizer and, A2 milk production from the native cattle present in the villages of Katavali and Ambavali. To improve the milk output of the native cows, better feed would need to be made available to the farmers at affordable prices, the cattle sheds will need minor modifications to make urine collection more easily possible and awareness will need to be spread amongst cattle owners about the environment, about the disadvantages of utilizing chemical fertilizers and pesticides and, open grazing the cattle along with the advantages of stall feeding with respect to milk production and urine and dung collection. Moreover, as pointed out earlier, there exists enough scope for increasing stall-feeding.

The result from this survey can be generalised to all those villages rearing native Indian cattle in the region of North Western Ghats. It became evident during the research that mostly marginal farmers living in specific localities of the villages were rearing native Indian cattle, because of the heavy monetary investment required to rear exotic cattle. Therefore, the development of this project will help them increase the production of A2 milk that is gaining popularity. This will provide them with additional income and thus help alleviate poverty in the region. Also, with the development of this project farmers will be motivated to rear native cattle, which would help in the conservation of the species.

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APPENDICES

Appendix 1. Questionnaire

Name	
Wadi	
Occupation	

1. What are your income sources?
2. How big is your land area?
3. How many cattle do you have? How many are native? How many are cows? How many are bulls? How many are male and female calves?
4. Does the cow produce milk? How much is the milk output per day? Do you sell the milk? If yes at what price?
5. How long is the lactation period of the native cows?
6. What do you feed your cattle?
7. Do you graze the cattle outside? For how long?
8. Do you have a shed to keep your cattle?
9. Do you utilize the cattle urine for any purpose? How much is the urine output of the cattle?
10. Are you interested in selling cattle urine?

Appendix 2. Photographs of researcher during the survey