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Analysis of potentials and problems of dairy production in rainfed agro-ecosystem of India

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ABSTRACT

Rainfed agro-ecosystem occupies 68% of India's cultivated area and supports 40% of the human and 65% of the livestock population. Dairy animals play an important role in the sustainable livelihood of poor people of rainfed agro-ecosystem, because of inherent risk involved in the crop farming due to uncertainty of rainfall and occurrence of recurrent droughts. The objective of the study was to characterize the status of smallholder dairy production systems in rainfed areas to generate information that would assist in designing of strategies for dairy development programmes. These objectives were achieved by adopting a participatory system approach, which uses diagnostic survey and techniques of participatory rural appraisal. The dairy production systems in rainfed areas are complex and generally based on traditional and socio-economic considerations mainly guided by available feed resources. Scarcity of feed and fodder resources, low production potential of animals, non-availability of critical inputs/services in time, access to capital and markets were the primary reasons behind low productivity of dairy animals. The study suggested that the participation of farmers is essential for developing and promoting the technical interventions. To enable the rainfed farmers for dairy development, a favourable policy environment in terms of access to micro-credit, assured market and veterinary services have to be provided and socio-economic and technical constraints needs to be addressed.

Key words: Dairy production, Livelihood, Rainfed areas, Small-holder farmer, System approach

Rainfed agro-ecosystem occupies 68% of India's cultivated area and supports 40% of the human beings and 65% of the livestock population. It produces 44% of food requirements, thus has and will continue to play a critical role in India's agriculture (Singh *et al*. 2004). Livestock rearing plays multiple roles in rainfed agro-ecosystem and have a strong human dimension, as manifested through socio-cultural link and involvement of women (Rangnekar 2006). Besides their well-established role in agriculture, livestock have crucial role in food security and as risk aversion mechanism for sustaining family, whenever there is crop failure (Sastry 2000, Misra 2006). About 23% of households owning milch animals are landless and some 30% are marginal farmers with land holding of less than 1 ha (World Bank 1999). Dairy animals enable poor and landless farmers to earn income using common property resources, provide constant flow of income and reduce the vulnerability of production system. The improvement of dairy production will be particularly important in the coming years, in view of the future demand of livestock products is expected to double by 2020, while the natural resources that sustain agriculture will become increasingly scarce and degraded (Rangnekar 2006). Though technologies to improve productivity of dairy animals do exist, however, the awareness and rate of adoption in smallholder mixed farming systems worldwide is consistently low, because of the existing research and extension set up and related other constraints (Reddy *et al*. 2005, Parthasarthy Rao *et al*. 2005). Any programmes aimed at alleviating poverty through dairy production will have to be based on sound knowledge of the situation in small-holder farming systems, including gender issues, in the context of the prevailing socio-economic conditions (Misra *et al*. 2006).

The objective of the present study was to characterize the status of smallholder dairy production in rainfed areas in order to generate information that would assist in designing of strategies/technological options for livestock development programmes.

MATERIALS AND METHODS

The present study was conducted in a cluster of villages

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each in Mahabubnagar and Anantapur districts of Andhra Pradesh and in Tumkur district of Karnataka. The locations were chosen to represent the natural resource base available to rural communities in semi-arid regions in southern India. The 3 districts have contrasting characteristics in climate and rainfall, viz. semi-arid in Mahaboobnagar and Tumkur and arid in Anantapur; soils range from very shallow-to-shallow mostly alfisols in all the 3 clusters. Anantpur, the largest district of Andhra Pradesh, is a hot arid zone and falls under rain shadow region with a mean annual rainfall of 520 mm. The soils are red sandy loams with patches of black cotton soils in certain areas. Mahabubnagar is another chronically drought prone district of Andhra Pradesh with light textured soils and a mean annual rainfall of 600 mm. Crop failures are common in both the districts due to scanty rainfall and peoples' dependence on livestock is high. Tumkur district is a part of the central dry zone of Karanataka and has bimodal rainfall distribution (650 mm). Soils are mostly loam with high slopes and high erosion rates.

Primary data on dairy production were collected with the use of validated structured questionnaires administered by trained enumerators. From each selected clusters, 20 representative households having at least 1 dairy animal were selected randomly for survey. Each farm was visited at least twice for data collection. The qualitative data were collected using Participatory Rural Appraisal techniques in each cluster. The PRA study assessed the relative importance of dairy production, constraints and opportunities. The farmers were asked to list out the important problems faced by them in rearing of dairy animals. Rank based quotient (RBQ) was worked out to identify the most important constraints. To complement information collected, focussed group discussions were undertaken in each cluster at various stage of implementation. The collected data were analyzed using the MS Excel data sheet. Descriptive statistics were used to process the raw data while analysis of variance was used for some selected variables (Snedecor and Cochran 1989).

RESULTS AND DISCUSSION

Demographic characteristics

Socio-economic characteristics of the farmers in the selected clusters are given in Table 1. The number of SC/ST families varied across the villages, ranging from 26% in Tumkur to 50% in Anantapur cluster. Significant proportions of families in most of the villages are below poverty line and varied between 56% (in Mahabubnagar) and 34% (in Tumkur). Education plays an important role in the adoption of innovations/new technologies, and literate farmers are expected to be early adopters. Literacy rate was highest in Tumkur (76%) whereas lowest in Anantapur cluster (37%). Land is an important asset of farmers, although in dairy production, purchased or exchanged feed and fodder can be substituted for land-holdings. The average size of land holdings was almost similar in all the clusters, ranging from 3.42 to 3.55 ha. It ranged from about 0.82 ha in the case of marginal farmers to about 8.29 ha in the case of large farmers. The landless farmers are dependent on leased land for fodder production and on market-purchased feeds and fodder. Nearly 7% of households had taken land on lease from other farmers for growing of food and forage crops. The terms of lease were mainly a fixed amount per unit of land and varied depending on the availability of water resource and quality of the land.

Table 1. Demographic characteristics of the selected respondents

Particulars/clusters	Anantapur	Mahabubnagar	Tumkur
Total households, Nos.	530	1517	235
SC/ST household%	50	35	26
Landless households%	15	12	9
Rich households%	9	15	11
Middle households%	39	29	55
Poor households%	52	56	34
Literacy%	37	43	76
Average family size Nos.	4.85	5.45	4.25
Farm households%			
Marginal (<1 ha)	27	56	29
Small (1–2 ha)	42	28	29
Medium (2–4 ha)	22	11	28
Large (>4 ha)	9	5	14
Land holdings			
Average land, ha	3.5	3.4	3.6
Irrigate land%	23	27	29
Dryland%	77	73	71

Livestock resources

The average herd size was largest in Mahabubnagar whereas lowest in Tumkur cluster. There were striking differences in terms of composition of animal population across clusters (Table 2). The population of small ruminants (sheep and goats)/household was highest in Mahabubnagar followed by Anantapur cluster whereas large ruminant dominated Tumkur cluster. Buffalo was a main source of milk production in the Ananthpur and Mahabubnagar cluster, while crossbred cattle in Tumkur cluster. Majority of the households reared non-descript local breed of buffaloes, whereas in Tumkur cluster farmer had more number of crossbred cows (86%). The quantity of milk production on a dairy farm does not depend on the total number of animals in the herd but on the number of animals in milk. The higher the proportion of animals in milk the lower the cost of milk production. The proportion of animals in milk was generally higher in Ananthpur (67%) than in Mahabubnagar (56%) and Tumkur (57%). The average number of milk animals kept by farmers were 2.43, ranging from 1 to 20. More than half of the selected households had 1–3 milk animals; fewer kept more than 10 milk animals. The average milk yield / household did not differ significantly, whereas milk yield / lactating animals differ significantly, being highest in Tumkur

Table 2. Livestock resources (number/household) in the selected clusters

Particulars/cluster	Anantapur	Mahabubnagar	Tumkur	Av	SEm	Prob
Number of farms surveyed	20	20	20	20	–	–
Bullock	1.75	1.95	1.95	1.88	0.18	NS
Buffaloes	2.95	4.50	0.95	2.80	0.57*	**
Non-descript (%)	75	89	100	86	–	–
Improved (%)	25	11	0	14	–	–
Cows	1.45	1.10	2.70	1.75	0.24	**
Non-descript (%)	81	63	14	44	–	–
Crossbred (%)	19	37	86	56	–	–
Cows and buffaloes	4.40	5.60	3.65	4.55	0.59	NS
Sheep	15.10	26.70	1.35	14.38	5.38	**
Goats	2.75	13.35	1.25	5.78	3.00	**
Small ruminants	17.85	40.05	2.60	20.17	7.04	**
Adult cattle unit/household	10.31	16.46	6.31	11.03	1.58	**
Adult cattle unit/ha	2.97	4.81	1.78	3.17	0.73	**
Poultry	4.75	3.55	1.00	3.10	1.17	NS
Milch animal	2.55	2.95	1.80	2.43	0.35	NS
Pregnant animal	1.55	2.15	1.15	1.62	0.22	**
Milk yield/household, l/day	9.13	11.95	10.43	10.76	1.69	NS
Av milk yield, l/day/animal	3.42	3.98	6.11	4.50	0.33	**

cluster and lowest in the Ananatpur cluster. Milk yield was below the national average, which shows that the animals in the study area were poorly managed (GoI 2005). Small ruminants were the most predominant species in Mahabubnagar and Ananatpur cluster with widely varying individual holding size. Backyard poultry made up of entirely of *desi* fowl. Average holding size of poultry varies from 1.0 to 4.75 birds/household.

Traditional dairy production and feeding systems

The traditional dairy production systems were complex and based on tradition and socio-economic considerations mainly guided by available feed resources. In the study area, crop and livestock production systems are closely integrated. Crops provide feed and fodder to the animals, while in return dairy animals provide milk as a source of nutrition and cash income, supply draught power and manure for crop production. A close link exists between livestocks and common property resources (CPRs). Animals of the poor depend completely on CPR for grazing during the monsoon season (6 months). The grazing hours in the study area varies from 4.65 h in Tumkur to 6.05 h in Ananatpur. Sastry (2000) reported that on an average 1/3rd of DM come from grazing during monsoon, however; availability of biomass during summer is negligible. About 91% of households in Andhra Pradesh are dependent on open grazing on common lands for an average supply of 35% of the total forage. This complex inter-relationship between CPRs, livestock and crops in rainfed farming systems has contributed to the sustainability of rainfed agriculture for generations. However, this relationship is now under increasing pressure from different sources (Misra and Singh 2002). Traditional grazing lands are being encroached upon or under faulty land distribution system. The inedible weeds like *Parthenium* and *Lantena* have replaced the traditional nutritional species in the grazing lands.

According to farmers, straw, stovers and grasses makes the largest contribution towards livestock feed and comes largely from rice, finger millet, and maize. Average amount of green fodder and concentrate fed to dairy animals differ significantly, being highest in Tumkur and lowest in Ananatpur (Table 3). However, the amount of dry fodder did not differ significantly. The amount of DM fed to milch animals was calculated by taking 0.25 of green fodder and 0.9 of dry fodder and concentrate. The values reflect only stall-feeding as amount consumed through grazing was not available. Preferential feeding was a common practice. Farmers tend to ration their home grown crop residues for optimum use: large ruminant receive priority for crop residues and milking animals in addition receive some supplementary feeding made up of a combination of home grown by-products like rice-bran and purchased raw materials like oil-cakes. Salt and mineral mixture were occasionally provided to animals. Compound cattle feed was only available in Tumkur cluster through co-operative milk societies and restricted to its members only. The average amount of concentrate fed to the lactating animals significantly varies from 1.20 to 1.94 kg/animal/day. The overall average dry matter intake worked out to be 7.60 kg/day/lactating animal, in which contribution of green fodder, dry odder and concentrate was 21.45, 60.13 and 18.42%, respectively. The average intake of bovine in Andhra Pradesh consists of 25% green forage, 66% crop residues and 9% concentrate (Lehman *et al*. 1994). Green and dry fodder account for the major

Table 3. Average feed offered (kg/animal/day) to the animals in selected cluster

Feed resource	Anantapur	Mahabubnagar	Tumkur	Average	SEm	Prob.
Fodder resources	Sorghum stover groundnut haulm, paddy straw, pigeonpea straw, cow pea/ horsegram/ redgram residues	Sorghum and maize stover, paddy straw, groundnut haulm, pigeonpea straw, and fingermillet stover	Fingermillet and sorghum stover, paddy straw, residues of pulses like redgram, horsegram, cowpea and blackgram	-	-	-
Grazing, h	6.05	5.75	4.65	5.48	0.19	**
Green fodder	5.68	6.65	7.25	6.53	0.28	**
Dry fodder	5.13	5.55	5.45	5.38	0.20	NS
Concentrate	1.20	1.51	1.94	1.55	0.13	**
Total dry matter	6.86	7.74	8.19	7.60	0.30	**

proportion of feed consumption in India (World Bank 1999). Sastry (2000) recommended that 25 kg green fodder, 5 kg dry fodder and 1.25 kg of concentrate /day is required for a standard adult cattle having 350 kg body weight and yielding 1.5 kg of milk. It showed that animals in the study area are under fed.

Chopping of the crop residues was not practised in the study area. Long unchopped stover and straw are placed in front of animals on floor of animal shed. Animals eat only leafy portion and left dry stem which ultimately ends up as manure. This practice appears wasteful, but reflects the people's age-old tradition. Farmers have their own ways to respond to the scarcity of fodder.

There is very little cultivation of fodder crops in the selected cluster on account of water scarcity even though farmers were aware of the importance of feeding green fodder and also the existing high-yielding fodder varieties. The average area allocated for improved forage crops ranged from about 3% (Tumkur) to about 6% (Mahabubnagar). Maize, *jowar*, hybrid napier, guinea grass and lucerne were important fodder crops grown in the study area.

Production traits of dairy animals

Information on production traits of animals was rough estimates because it was collected at one point of time during focused group discussion, as farmers were not maintaining the production records in any cluster. Production traits of dairy animals play a crucial role and have a profound

Table 4. Productivity traits of milk animals in the surveyed households

Productivity traits	Anantapur	Mahabubnagar	Tumkur	Average	Desirable targets
Non-descript cattle					
Milk yield (l/day)	2.5	2.97	3.87	3.11	5.0
Age at first calving (months)	43.4	44.1	43.0	43.5	28–34
Lactation length (days)	267	283	278	276	300
Inter calving period (months)	20.3	19.9	18.7	19.6	14–16
Crossbred cattle					
Milk yield (l/day)	4.88	6.12	7.15	6.05	10
Age at first calving (months)	39.8	40.5	38.5	39.6	24–30
Lactation length (days)	283	287	295	288	300
Inter calving period (months)	18.7	18.3	17.5	18.2	13–14
Non-descript buffaloes					
Milk yield (l/day)	3.65	3.75	3.39	3.60	5.0
Age at first calving (months)	46.8	47.7	46.3	46.9	32–36
Lactation length (days)	303	307	314	308	300
Inter calving period (months)	22.9	23.4	22.7	23.0	15–17
Graded buffaloes					
Milk yield (l/day)	4.70	4.32	4.15	4.39	10
Age at first calving (months)	46.2	45.3	45.7	45.7	32–36
Lactation length (days)	309	314	310	311	300
Inter calving period (months)	21.4	22.7	21.3	21.8	15–17

influence on the profitability of dairy enterprise. Important traits such as age at first calving, lactation length, inter-calving period and milk yield per animal are given in Table 4. Most of the livestock in the study area were non-descript having low productivity. The age at first calving is governed by biological factors such as age at maturity and conception rate, which are again influenced by breeding, feeding, management, and environmental factors. The average age at first calving was higher for buffaloes than for crossbred cattle. In general, for the study area as a whole, the average age at first calving for non-descript cattle, crossbred cattle, local buffalo and graded buffalo was found to be 43.5, 39.6, 46.9 and 45.7 months, respectively, which is more than the desired level. The lactation length affects total milk production and, consequently, the returns from dairy animals. The average lactation length was 282 and 310 days in cattle and buffaloes, respectively. A long inter-calving period puts the dairy farmer at a disadvantage, since the animals must be fed and taken care of during this period, increasing the cost of maintenance. The average inter-calving period was 19.6 and 18.2 months in non-descript and crossbred cattle, respectively. The corresponding figures for non-descript and graded buffaloes was 22.7 and 21.3 months, respectively. The average milk yield per day of lactating non-descript and crossbred cattle was 3.11 and 6.05 kg/animal. The corresponding figures for non-descript and graded buffaloes was 3.60 and 4.39 kg/animal/day. The milk yield of non-descript cows was above the state and national average (1.95 l/day for indigenous cows) whereas; milk production of crossbred cattle was less than the state (7.37 l/day) and national average (6.43 l/day). The productivity of buffaloes was almost similar with the national average (GoI 2005). In general, the average productivity of crossbred cows was higher than buffaloes. The Tumkur cluster had higher yields when compared with Mahabubnagar and Anantpur clusters.

Problems related to livestock production

The productivity of dairy animals is affected adversely by number of causes. Most of the problems were common, which are crosscutting and feature prominently in all the clusters. Therefore, common rank based quotient (RBQ) was calculated by clubbing the data together to rank the problems and presented in Table 5. The main constraint faced by the farmers was scarcity of feed and fodder resources and water in summer particularly from April to May, resulting in reduced productivity of animals and high incidence of diseases. Fodder and water scarcity forces many farmers to sell their valuable and productive animals at distress rates during summer in Ananatpur and Mahbubnagar cluster and again repurchase them at higher prices at the onset of monsoon. Collapse of traditional water harvesting systems created the shortage of water in rainfed areas. Change in cropping pattern from traditional food crops to cash crops is resulted in lack of crop residues-a major problem in all the selected clusters. Shrinking of common grazing resources is another factor for scarcity of fodder to livestock. Low production potential of the native breeds, non-availability of services (veterinary, credit, seed, feed, market) in time, high incidence of diseases (foot-and-mouth disease, *haemorrhagic septicemia* and premature abortions) and high cost of maintenance have been mentioned other reasons behind poor milk production. While access to livestock health and breeding services exist in the clusters, farmers resented the need to take their animals to the institution for availing of the services as it costs them money and time. A large majority of farmers expressed their willingness to pay for medicines and services, if available at doorstep.

Milk collection centers were not available in Mahabubnagar and Anantpur cluster and farmers taking milk for selling directly to consumers and milk/sweet shops in city by means of a bicycle. This discourages some farmers from improving their production potentials. During the rainy season when milk production is highest, the markets are flooded; consequently, the price per litre was very low. Apart from this, milk was collected only in the morning by vendors and sale of evening milk was often a problem. In Tumkur

Table 5. Problem identification and their prioritization through RBQ

Problems	Ranks					RBQ	Priority
	1	2	3	4	5		
Scarcity of fodder and water during summer	35	15	5	5	-	85.80	I
Low production potential of animals	35	5	10	10	-	80.85	II
Non-availability of credit	30	10	10	5	5	77.55	III
Non-availability of veterinary services	30	10	5	10	5	75.90	IV
High incidence of diseases	25	10	15	6	4	74.58	V
Repeat breeding/anoestrus problem	25	10	5	5	15	74.25	VI
Non-availability of quality inputs in time	28	12	3	9	8	73.64	VII
High cost of production	25	10	10	10	5	72.60	VIII
Lack of marketing services	20	10	10	10	10	66.00	IX
Lack of knowledge regarding improved practices of dairy management	15	10	10	15	10	61.05	X

cluster, milk collection center was available more than 95% farmers sell their milk to dairy cooperatives. Reddy *et al*. (2005) reported almost similar constraints in rearing of livestock in southern Telangana zone of Andhra Pradesh.

Strategies for improving productivity of dairy animals

The technological model copied from productive areas can not be easily transferred to the rainfed region because of its diverse soils, climate and socio-economic characteristics. To solve the problem of low productivity of dairy animals, favourable policy environment and supporting infrastructure and services will have to be provided and technical and socio-economic constrains needs to be addressed with active consultation and participation of stakeholders. The fodder and feed scarcity was the most critical constraint to livestock production in the selected clusters, therefore, improving the fodder supplies to the animals should be of utmost priority besides improving the quality of animals. The following strategies are recommended for improving the productivity of dairy animals in the rainfed agro-ecosystem:

Improved forage production: Fodder supplies in rainfed areas can be enhanced substantially by increasing the productivity of traditional food and forage crops. Livestock keepers who possess immense knowledge about the traditional forage crops need to be involved in the identification and promotion of fodder production. Short duration and quick growing leguminous forage crops should be promoted in the interspaces of widely spaced crops like sorghum and maize. Revamping the cropping systems to gradually phase out water intensive crops like paddy and replace them with high value but less water dependent crops like sorghum, groundnut, millets and high-yielding perennial fodder and legume crops (guinea grass, napier grass, desmanthes, etc) for milk production.

Effective planning should be made for collection, processing and storage of fodder resources available in the CPRs during the abundance availability (monsoon) for meeting the forage demand during the lean period. The degraded grazing lands and CPRs should be converted in to productive system like silvi-pastoral, which have great potential to increase forage production from 1 tonne/ha to 7.5 tonnes/ha/year (IGFRI 2006). Seasonal surplus biomass should be exploited and efforts should be made for uniform availability throughout the year. Drought tolerant grasses, shrubs and fodder trees need to be promoted on field bunds. Improved fodder cultivars of maize, sorghum PC 23, hybrid napier-Co1/2, guinea grass and Lucerne, etc needs to be promoted under irrigated conditions in a smaller area alongside the farmer's priority of their stable crop of paddy (Misra *et al*. 2005).

Breed improvement: With regard to genetic potential, many attribute the advantage of indigenous over exotic animals to their superiority adaptation to local conditions. However, the indigenous cattle are of low production potential. More productive animals and alien breed and their crosses are less tolerant to diseases, heat and humidity. Therefore, genetic improvement should be achieved in drylands with use of half-bred bulls of high pedigree to stabilise blood inheritance in the population and at the same time maintaining the genetic diversity. Selection of breeds adaptable to the existing agro-climatic conditions that can thrive well on un-conventional feed and fodder resources should be given priority in breeding programme. There is need to encourage the farmers to breed local non-descript cows and buffaloes with improved breeds, particularly 50% Jersey crosses and Murrah buffaloes, through artificial insemination (AI) and adopt pregnancy diagnosis (PD) as a tool to know the status of the pregnant animals. This needs to be done in order to combine the hardy characteristics of indigenous cattle (namely tolerance to poor nutrition, heat stress and tropical disease challenge) with high milk-producing qualities and hence have higher income potential of the improved breeds.

Animal health services: Almost 90% of the farmers in the cluster villages did not follow the deworming and vaccination calendar recommended by the veterinary staff. Most of the farmers lacked confidence in applying the extension advice and cited cash constraints as a compounding problem. Promotional campaigns needs to be launched for conducting animal health camps to encourage farmers to adopt a regular preventive measure. A village-based livestock service delivery mechanism; community driven needs to be promoted because timely availability of vaccination and dewarming could reduce production losses, drastically cut down mortality of livestock, increase out put, protect farmers investment and will help to appreciably increase households income. Windsor (2002) showed that countries that invest more in animal health earn more from livestock. Thus more investment in animal health care might increase production and thereby decrease total milk production cost. Organization of monthly gynaecological camps with the help of State Animal Husbandry Department for treating repeat breeders to reduce the infertility and create awareness among the farmers. Implementation of scheduled prophylactic health measures reduced mortality from 17 to 8% in small ruminants and from 12 to 7% in large ruminants. Most of the farmers reported an increase in growth rate of 25 to 30% in the animals between 6 and 12 months of age in their flocks. Further, organization of camps created awareness among farmers regarding the adoption of better livestock practices (Misra *et al*. 2006).

Improved feeding practices: The farmers reported that repeat breeding and anoestrus was a serious problem in their herds particularly in buffaloes and crossbred cows. Probably, this was the major cause of the long calving intervals. Mineral deficiencies were suspected to cause this problem. Use of mineral mixture in concentrate feed needs to be demonstrated to the farmers. Apart from this, supplementary feeding of mineral mixture through urea molasses mineral blocks can

also be demonstrated to the farmers. Increasing the lactation length and reducing the calving interval should ensure maximum return to the farmers. Better nutrition helps increase individual milk production of cows and also helps shorten intervals between calving. Therefore, dissemination of simple cost effective technologies like chaffing, urea ammoniation of straw/stover and strategic supplementation of mineral salts and UMMB etc. could enhance the productive and reproductive efficiency of dairy animals (Singh and Prasad 2002). Forage conservation and improvement of the nutritional value of crop residues could be the most appropriate options to enhance the forage supply during the lean months to sustain the milk yield and reduce the cost of production. Urea treated straw feeds save on concentrate feeding, increase milk yield by 1–2 litres/day /animal, and offer better economic returns to the farmers (Singh and Prasad 2002). Misra *et al*. (2006) demonstrated the use of mineral mixture in concentrate feed to the farmers of Tumkur cluster to overcome the problem of mineral deficiency and low productivity. They observed an improvement of 0.5 to 1.0 litre/animal in milk yield due to supplementation with mineral mixture. They further reported that mineral supplementation was helpful in increasing the appetite of animals. An average increase in 1.25 litre/day in milk yield was observed due to supplementation of UMMB during summer (Reddy *et al*. 2005), besides improving the dry matter intake of basal roughage and the feed digestibility (Singh and Prasad 2002).

Chopping of crop residues: In all the clusters normally the farmers offer fodder without chopping whereas in sorghum and maize they cut it by sickles into large pieces (50 cm length). In this kind of prevalent practice, wastage of the fodder is very high. To reduce the wastage of feed resources, the chaffing of fodder needs to be promoted. Two kinds of chaff cutter: manual and power operated can be promoted in rainfed areas. Misra *et al*. (2006) reported that by using the chaff cutter wastage of the fodder could be reduced up to 30%. Feeding of chopped roughage reduce the energy wasted while chewing and helps in adopting strategic supplementation, improves palatability of less preferred roughages by mixing with highly palatable fodder, improves digestibility and the net biological vale of the feed (Singh and Prasad 2002).

Policy and support services: For smallholder livestock producers, credit is most critical input, as they require cash for day-to-day management of their household enterprise. Access to credit can enable the subsistence farmers' access to technologies and would enable them to cross the poverty-line and become viable farmers. No intuitional mechanism exists in the study area for giving them cash/micro-credit. It was pointed out that even *Kisan* credit cards deny livestock farmers access to cash credit while as a mixed crop-livestock farmer the same farmer has access to cash through *Kisan* credit card for crop production (Garcia *et al*. 2006). It is therefore, suggested that *Kisan* credit card should include credit for livestock production inputs as well. In Andhra Pradesh and Karnataka women's self help groups (WSHGs) have emerged as effective institutions for providing instant cash credit for small enterprises and that they have very good track record on credit supply and timely recovery (CRIDA 2006). Therefore, WSHGs should be enabled to handle the term loans for livestock production, as this is the simplest solution for accessing loans and repaying them. Besides, women self help groups as institutions for cash/micro-credit for livestock production should be promoted as a part of livestock schemes under rural development programmes. Creation of conducive environment and providing policy and technical support to facilitate the emergence of private extension and service providers in areas where sufficient demand exists. Extension approach should be need based with problem-solving dimensions and participatory in nature. Encourage farmers training and field visits to the progressive farmers filed to improve their skills and understand the all aspects of new technologies facilitating the up-scaling. A massive campaign to launch capacity building and empowerment of village communities that will act as the harbinger of change and technology adoption and to establish the foundation for a farmer-to-farmer livestock extension mechanism. Village service providers should to equip themselves with mobility and communication facilities.

It may be concluded that sustainable development in rainfed areas can only be achieved through optimum utilization of its natural resources. There is tremendous scope of increasing milk production and productivity of indigenous breeds by improving nutrient availability from locally available feed and fodder resources. Availability of key inputs and veterinary services needs to be strengthened and improved to enable the rainfed farmers for dairy development. A favourable policy environment in terms of access to micro-credit and assured market will have to be provided and socio-economic and technical constraints needs to be addressed. Animal health camps and on-farm trials need to be conducted to create awareness among farmers regarding the adoption of better dairy production practices.

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