Review Article

Improved Technologies for Sustaining Productivity and Profitability of Sheep in India-A Review

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Abstract

In India, grazing lands are around 12 million hectares which constituted the main grazing resources for the huge livestock population (512.05 million). But the productivity of the grazing lands is low due to over grazing and poor management. There is urgent need to improve the productivity of community grazing lands through adaptation of improved technologies such as bush cleaning, re-sowing, grubbing unwanted weeds, burning, fencing, manuring, fertilization, sowing mixed stand of grasses and legumes, measures soil and water conservation, increase grazing period and plantation of fodder trees on grazing lands. The production of grazing lands can be increased through introduction of improved pastures species like Stylosanthesis hamata and Dinanath grass (Pennisetum pedicillium). Intensive feeding of weaner lambs will give higher returns as compared to extensive rearing systems. Enrichment of poor quality roughages can be done with urea treatment. During the scarcity of green fodder complete feed can be developed by using Cenchrus straw (38.6%), dried ardu leaves (37%), wheat bran (14%), mustard cake (7.4%), common salt (1%) and mineral mixture (2%).Simple health management practices such as deticking and deworming can improve the flock performance significantly. Vaccination against various infectious diseases will reduce the morbidity and mortality in sheep. Modern techniques such as oestrus synchronization and early pregnancy diagnosis through using of ultra sound scanner can be used for increasing the reproductive performances. Generally, shepherds follow the traditional techniques of wool shearing. Therefore, improved wool shearing techniques should be adopted for getting higher wool production. The farmers should sell their produce through cooperative societies for fetching higher income and avoid exploitation by middlemen.

Key words: Improved Technologies, Nutrition, Pasture, Rangeland, Reproduction, Sheep, Wool

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Introduction

Sheep rearing provides livelihood to rural households next to agriculture and dairy especially for weaker sections of the society in rain-fed conditions. Livestock grazing-based animal rearing systems play an important role in the rural economy as around 50% of animals depend on grazing In India (Roy and Singh, 2013). This enterprise provides regular and assured income to the sheep farmers. Sheep rearing is economically available viable option in drought prone areas of most of the parts of India, so majority of the farmer in these regions are attracting towards livestock sector especially for sheep and goat farming. The factors such as shorter generation interval, low investment and low risk are motivating the rural farm households to adopt sheep farming practices. Providing inputs such as short-term loans to shepherd, efficient use of whatever available science and technology and scientific management of breeding programme will improve the living standard of the rural farm families. The scientific feeding, breeding and health management are the most important tools for successful sheep production. Still in rural India, shepherds treat their animals with traditional knowledge; age old breeding systems are being followed and migratory feeding practices. But now time has come for scientific sheep rearing, it required to adopt regular systematic preventive health care activities like de-worming, vaccination, de-ticking for improving sheep flock productivity and profitability. The proper pasture and rangelands management will encourage the sheep farmers for providing fodder to sheep round the year which will ultimately increase the body weight, lambing percentage, wool production and maintain good health in animals. Adopting scientific breeding programme in sheep will also help in improving local sheep flock through networking the ram rearing system and regular breeding programme by adoption of open nucleus breeding system.

Grazing Resources in India

In India Pasturelands over an area of 12 Mha constitute the main grazing resources for animals. They are spread across the Eastern and Western Himalayas regions including the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, West Bengal, Arunachal Pradesh and Sikkim states (Roy and Singh, 2013). Jodha (2008) reported that grazing is the cheapest way of feeding. The shepherds have reported area under grazing lands is reducing drastically over the years and productivity of grazing lands declined due to improved strains of grass and legumes are becoming vanished from grazing lands resulted decrease in availability of good quality fodder to sheep during most of the season. Tewari and Arya (2005) reported grazing pressures are crossing the recommended stocking rates; the pressure was 0.87 ACU ha^{-1} in 1981 which increased to 1.02 ACU ha^{-1} ha in 2001 against the optimum desirable density of 0.2

ACU ha^{-1}. Dixit et *al.* (2015) reported that at country level, area under PP (permanent pasture) and GL (Grazing land) has declined from 120 to 102 lakh hectares during the period 1980–81 to 2007–08. High deceleration in area under PP&GL was observed in Karnataka (4.16 lakh hectares) closely followed by Andhra Pradesh (4.15), Maharashtra (3.27) and Madhya Pradesh (2.97). Grazing pressure in terms of livestock per unit of PP and GL at country level increased from 35 to 52 animals during 1982 to 2007 whereas, carrying capacity of per unit of PP&GL was less than 1 adult cattle unit. Increasing trends in the grazing pressure were noticed in Punjab (833 animals/ha of PP and GL) followed by Uttar Pradesh (142), Tamil Nadu (126) and Andhra Pradesh (69) during 1980-81 to 2007–08. The productivity of community grazing lands can be increased through mixed plantation of *Stylosanthesis hamata* and *Cenchrus setigerus* grass. The economic condition of shepherds is poor due to limited resources with them. Generally, shepherds migrate one to another for searching of feed and water for animals. Most of the shepherds store surplus fodder for scarcity period through hay and silage making. The forest department has been planting *Acacia Senegal*, *Prosopis juliflora*, *Cuperous* and *Glyricidia* tree species because they have good fodder value than other plant species. The forest department has allocated some land for grazing purposes with certain policy in which sheep flocks allowed for grazing. Under the poverty alleviation scheme state is giving one animal to each farm woman that should come under below poverty line (BPL). Subramanian, (1992) reported that the Dinnanath grass (*Pennisetum pedicillatum*, *Lasiurus sindicus*, *Cenchrus ciliaris*, *Cenchrussetigerus*, *Diccanthiumannulatum*, *Panicumantidotale*, *Macroptilium atropurpureum* and *Urochloamosambicensis* were preferred by the sheep during grazing. During survey few pockets of perennial grass Sewan (*Lasiurus sindicus*) were observed, among the palatable shrubs Aak, Bui and Biyani were dominated in pasture lands (Chaturvedi *et al.*, 2003). Among the bushes Ker (Capperis decidua) and Bordi (Ziziphus nummularia) were more common on grazing lands. Khejri (*Prosopis cineraria*), *Acacia aneura*, *Leucaena leucocephala*, *Acacia nilotica*, *Sesbaniagrandiflora*, *Acacia albida* and *Acacia bavinosa* trees were found most suitable as top feed trees (Table1). The pods of Vilayatibabool (*Prosopis juliflora*) were relished by sheep and goats. Grazing resources on community grazing lands was less than their carrying capacity (Gulyani and Meena,2012).The deficit of grazing resources on grazing lands ranged varies from 21 to 28.57 % .The composition of grazing species ranged varies from 48 to 78.82 %.

Primary Causes of Pasture and Rangeland Degradation

There are certain constraints which resulted decrease in productivity and carrying capacity of pasture and rangelands such as receive low rainfall; increase animal population; encroachment on grazing lands; shepherds are spreading over these grazing lands because local resources have become privately less owned; shrinkages of community lands; area under pasture and rangeland decreased due to soil and water

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erosion; shifting cultivation; urbanization increased, construction of roads and industries on grazing and community lands; soil degradation leads to reduction in ground water resource and no wasteland management programme low gestation period of pasture /rangeland these were the main factors for responsible for decreasing productivity of pasture and rangelands in India.

Table 1: Suitable pasture species for drought prone area of India

Pasture species	Scientific Name	Soil Type	Seed Rate (kg/ha)	Dry Forage Yield (tons/ha)
Grasses Species				
Sewan	*Lasiurus sindicus*	Light	03-May	3.5
Dhaman	*Cenchrus setigerus*	Light	06-Aug	4.5
Anjan	*Cenchrus ciliaris*	Versatile	05-Jun	4
Blue panic	*Panicumantidotale*	Versatile	02-Apr	3
Marval	*Dicanthiumannulatum*	Medium	04-May	2.5
Dinanath	*Pennisetum pedicellatum*	Versatile	08-Sep	3
Rhodes	*Chlorisgayana*	Sodic	08-Oct	2.5
Legumes Perennial				
Stylo	*Stylosanthes hamata*	Light to Medium	05-Jul	3.5
Siratro	*Macroptilium*	Light to Medium	07-Aug	2.8
Titli matar	*Clitoria ternarea*	Light to Medium	15-20	3
Bankulthi	*Atylosia scarabacoides*	Light to Medium	10-Dec	2
Annual Legumes				
Cowpea	*Vigna unguiculata*	Light to Medium	30-40	3
Guar	*Cyamopsis tetragonoloba*	Light to Medium	25-30	3
Horse gram	*Dolichos biflorus*	Light to Medium	2	2

Source: Meena et al., 2007

Low Productivity in Sheep Due to Degraded Grazing Lands

Due to lack of proper nutrition sheep showed delayed sign of heat and sporadic cases of silent heat, mortality was more common in sheep flocks. Tewari and Arya (2005) reported that land degradation has been exacerbated in rangelands of arid Rajasthan by heavy grazing pressures. In terms of adult cattle units (ACU) the livestock pressure was 9.58 million in 1983, which increased to 11.27 million in 2001. Sheep and goats performed well under harsh climatic condition than other animals with little supplementary of concentrate ration (Mathur *et al*., 2002). Underfeeding animals suffered from debility and become more prone to diseases. Suresh *et al.* (2010) reported that farmers have perceived deterioration of the pastureland has resulted in the reductions of (18%) wool yield and (20%) animal body weight of sheep. Among the sheep flocks mortality percentage was increased remarkable during drought years as compared normal monsoon seasons. Sheep were suffered from protozoan and ecto-parasites due to non-adaptation of prophylactic measures on right time. Grazing condition of pasture was more worsen in

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drought years than normal monsoon. There is an urgent need to meet the nutritional requirement of sheep with balance diet in farmers' flocks.

Technologies for Pasture/Rangeland Establishment

Rangeland establishment is usually practiced in low-medium rainfall areas, where the quantity and quality of the natural pasture decreases during the dry season. The performance of species for rangeland establishment depends on the soil and rainfall conditions and grazing management systems employed (Mapiye*et al*., 2006). There is need to improve the community grazing lands through adaptation of proven techniques like bush cleaning, resowing , grubbing unwanted weeds, burning, fencing, manuring and fertilization, mixed grass and legume seed, soil and water conservation, increase interval of grazing period, avoid illicit grazing, restrict over stocking rate and plantation of fodder trees on pasture land (Meena *et al*., 2011). There are certain proven technologies have been developed for the sheep farmers like creating awareness among the shepherds about pasture and rangeland development and establishment. People participation is essential for rehabilitation of old degradation community land. There is need to increase shepherd awareness about new grass and legumes species for re-sowing of grazing lands. The social mobilization is essential among shepherds for grazing land improvement. Grazing of sheep should be allowed according of carrying capacity of pasture/rangelands and management practices such as grubbing weeds from pasture lands, bush cleaning, soil and water conservation measures, manuring and fertilization of grazing lands, rotational and deferred grazing practice, increasing gestation period of grazing land, shrubs and trees plantation on grazing lands; proper lopping of top feed resources are some of the technologies. Mapiye *et al.* (2006) reported that legumes play a vital role in the improvement of tropical pastures, due to their ability to fix atmospheric nitrogen. There is huge demand of fodder seeds like lucerne, oat, cowpea, sorghum, clitoria, stylo and bajra. Field demonstrations had motivated the sheep breeders to undertake improved methods of cultivation as well. Feed and fodder resources development programmes have been accepted by the farmers. Demonstrations on protection and development of grazing land and silvipasture system on community lands and on farmer lands were implanted in order to increase the productivity and fodder availability throughout the year. The productivity of rangelands and pasture lands were increased in the tune of 5 to 6 time higher than natural grazing lands. Tewari and Arya (2005) reported an increase of 639% in forage yield over control by adopting moisture conservation technique and increase in forage yield was recorded in the range of 30 to 122% in "poor" and 29 to 107% in "fair" class rangelands after 3–5 years of reseeding. Also reported that pre-monsoon sowing of grass seeds give 36% higher forage yield over monsoon sowing. The seed coating of alfalfa with *Rhizobium* improved survival and early nodulation (Horikawa and Ohtsuka, 1995). The improved practices of pasture development are being adopted with the help of

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non-government agencies. Supplying fodder tree saplings to farmers these have about 30 per cent survivability. The trees and shrubs on pasture lands have been supplied good quality fodder to sheep during scarcity period.

Sheep Breeding

In 1962 Rambouillet sheep was used for developing fine wool sheep breed through cross-breeding with native sheep breeds such as Chokla, Malpura and Jaiselmeri. Half-bred were produced by crossing Rambouillet with native breeds. Half-bred produced were crossed with Rambouillet ram for production of ¾ Rambouillet. In 1971 cross-breeding of Chokla and Naliewes with Rambouillet and Russian merino was done. The ¾ crosses of both the projects were merged in 1982 and named as Bharat merino. The synthetic breeds of sheep developed through breeding and level of inheritance is presented in Table 2.

Table 2: Synthetic sheep breeds evolved by cross breeding programme

New Breeds	Parent Breeds		Level of Inheritance %
Bharat Merino	Chokla,Nali	Rambouillet,Merino	75
Avivastra	Chokla,Nali	Rambouillet ,Merino	50
Nilgiri	Coimbatore	Merino	
Nilgiri (Synthetic)	Nilgiri	Merino	62.5
Patanwadi (Synthetic)	Patanwadi	Rambouillet , Merino	50
Avikalin	Malpura	Rambouillet	50
Avimanns	Malpura,Sonadi,	Dorset,Suffolk,	50
Indian Karakul	Marwari, Malpura,Sonadi	Karakul	75
Kashmir Merino	GaddiBhakarwal	Delaine Merino,Rambouillet,Soviet Merino	50-75
Hissardale	Bikaneri (Magra)	Merino	75

Awassi sheep was brought from Israel for rearing in southern states of India like Andhra Pradesh, Maharashtra and Karnataka with an objective to increase the body weight and milk production of local Deccani sheep. Awassi breed of sheep is reared for dual purpose (milk and meat) and it produced around 475kg milk with 7-9 % fat content in 238 days. Genetic improvement in local sheep like Deccani and Nellore was done by Garole sheep. Sharma *et al.* (1999) reported that the body weights of Garole×Avikalin and Garole× Malpura were significantly ($p<0.05$) higher at birth, 3, 6 and 12 months of age than those of pure Garole sheep. The Garole sheep is the source of internationally known Booroola gene for prolificacy. Crossbreeding was initiated in 1997 to introgress the FecB gene from Garole sheep and Malpura to produce the Garolex Malpura(GM) crossbred carrying FecB gene(GMM). The lambing percentage in Garole x Malpura halfbred ewes were encouraging as 44% twinning. In this breeding

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programme only FecB carrier (BB or B+) rams are used. The ¾ crosses were able to produce twins and also had higher body weight compared to half bred. Patanwadi sheep was introduced in the (GM) to increase the milk yield of dams. In this process (GM) animals were crossed with Patanwadi and 3 breed's crosses which resulted in higher prolificacy, higher birth weight along with more milk yield of dam to fed larger lamb crop per ewe. The litter size at birth ranged from 1.07 to 1.42 in GMM. The coarse wool type Coimbatore sheep was crossed with Corriedale with an objective to evolve a dual-purpose sheep for meat and carpet wool production. There was about 100% improvement in wool production (0.92 to 1.0 kg) in crossbreds as compared to Coimbatore sheep (0.46 %). The body weight gain in crossbreds was superior that Coimbatore (Anonymous, 1986). The comparison of growth performance of genetically improved rams distributed to farmers under transfer of technology programme and base line was made at farmer level and results are summarized in Table 3. It is evident from the table, that performance of progeny of genetically improved rams was better than the base line under local feeding system (Mann and Dhaka, 2003).

Table 3: Growth performance of progeny from distributed improved rams as compared to base line information (kg)

Traits	Birth weight		3 month weight	
	Base Line	Progeny of Distributed Sire	Base Line	Progeny of Distributed Sire
Male	3.5	3.78	13.63	14.69
	-204	-112	-76	-46
Female	3.24	3.34	13.41	13.53
	-216	-106	-120	-56

Source: Mann et al., 2003

Sheep Nutrition

Sheep possess a unique ability to survive on natural grasses, shrubs and farm wastes materials like residues of the fields. Unfortunately inadequate availability of feeds and forage due to reduction in area and deterioration of grazing lands possess a serious threat to sheep production because of sheep for the sake of grazing. The sheep production system crippled by a loss of grazing lands and reduced flock sizes (South Asia Pro-Poor Livestock Policy Programme, 2011). Today the most important difficulty in sheep industry is to find the ways and means to resolve the nutritional problem of the current sheep population (65.06 million). For this it is obligatory to develop the community lands for providing sufficient top feed through plantation of suitable fodder trees, bushes, shrubs, grasses and legumes (Meena *et al*., 2005). Pasture land management involves a set of technical and social interventions. The important technical interventions are identification and introduction of suitable grass and legume species, using suitable establishment techniques, fertilization of the pasture lands, regulating the grazing pressure and using an optimum stocking rate, use of rotational grazing system if feasible and increasing period the grazing

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period through introduction of top feed tree species (Meena *et al*., 2001). The access of livestock to pasture should be controlled so that grazing pressure can be managed. It is no exaggeration to say that production from properly management pasture is 5 to 10 times higher than unmanaged land, which is constantly under excessive random grazing pressure. Study on stocking rate was carried out by Vashnumurty (1995) on stocking rate of Deccani sheep on improved pasture and it showed that improved pasture can carry up to 6 sheep/ha in continuous grazing system, without giving any supplementary feeding. Native pastures did not carry even 2 sheep/ha (Table 4).

Table 4: Effect of improved pasture on lambing and lamb weight (kg) at birth

Treatment	Number of Lambs/ Sheep	Lamb Weight at Birth
Natural pasture		
2 Sheep/ha	1.89	2.25
4 Sheep/ha	1.56	2.24
6 Sheep/ha	2	2.23
Improved pasture		
2 Sheep/ha	2.78	2.66
4 Sheep/ha	2.78	2.68
6Sheep/ha	2.44	2.39

Source: Vashnumurty, 1995

Suresh *et al.* (2010) reported that, the reduction of pastureland has resulted in cost production in sheep farming, particularly for the landless and small farmers. Grazing had to be withdrawn from these pastures because of lack of forage on them. There has been a rapid growth in research and development activity in monitoring the spatial behavior of livestock (Trotter *et al*., 2010), the applications of spatial livestock monitoring helps in recording movement and grazing pressure for health and welfare monitoring (Trotter *et al*., 2009). The effect on nutritive quality of pasture was evidenced in terms of number of lambs and lamb weight at birth. The improved pastures produced more number of lambs than grazing on natural pasture, which was due to better quality and quantity available of forage. With watershed development programme, cultivable waste lands gave can yield good amount of fodder/ha/year for grazing purpose to solve the problem of acute shortage of fodder. The forage species on these grazing lands are native origin comprising of short thin and sparse grass. A stocking rate of 5 ewes/ha on *Cenchrus* can give satisfactory performance in ewes. Hence scope existed for introduction of improved pastures species like *Stylosanthesis hamata* and Dinanath grass (*Pennisetum pedicillium*). The sheep can be reared on grazing alone in these areas. Most of the farmers are feeding trees pods of *Acacia nilotica*, Khejari (*Prosopis cineraria*) and *Ziziphus numularia* (Deshi ber) leaves and hay of groundnut and other legumes. Intensive feeding of weaner lambs gave a net profit of Rs 250/per animal within 3-months of period. Urea treatment of roughages @ 4% will increase the protein content with good palatability. Concentrate supplementation

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@ 1% of body weight offered to sheep during late gestation period for improved the production performance and growth rate of lambs (Chaturvedi *et al*., 2000).Feeding of *Lactobacillus acidophilus* and *Saccharomyces cerevisiae* to small ruminants' productive performance (Kochewad *et al*., 2009). The feed requirement and profitability of supplementary feeding in sheep is yet to be decided by the farmers. Complete feed can be developed using *Cenchrus* straw (38.6%), dried ardu leaves (37%), wheat bran (14%), mustard cake (7.4%), common salt (1%) and mineral mixture (2%). Complete feed blocks can be prepared by compressing roughages, concentrate, molasses, urea and salts in desired proportion. The complete feed blocks of roughage and concentrate mixed in 65:35 ratio with 5% of molasses for easy binding. The blocks are prepared by applying pressure of 4000-5000psi by machine. Use of complete feed blocks reduces wastes of feed materials and feed cost by 30-35%. It also reduces bulk density by 35% and can be stored up to 2 years in dry weather. Feeding of complete feed blocks increases dry matter intake by 15-25% as compared to mesh form.

Sheep Health Management

At regular interval farmers sheep faecal samples were assessed to see the worm load and advices were given for ecto and endo parasites control. Shepherds flocks were monitored regularly to assure the faecal worm egg counts and species of worms. Viroji Rao *et al*. (2008) reported that simple health management practices such as deticking and deworming improved the flock performance dramatically. In-spite of these good results only 43.2 and 54.6% farmers are following deticking and deworming. Faecal samples of farmer's flocks were tested in the laboratory. The imminent danger of development of resistance to chemical de-wormers among the internal parasites was caused international concern and the health division actively encourages approaches to avoid its (Nimbkar, 2001). Develop worms-resistance breeds of sheep as Deccani and Bannur and they were crosses with galore rams were also evaluated under field condition. The lambs of Deccani sires and dams have the achievable higher growth rate; lambs of Garole sires were found more resistant to blood-sucking round worm (*Haemonchuscontortus)*. Sheep health services were provided to sheep breeders at their doorstep. Sheep were regularly treated for different ailments, vaccination against Enterotoxaemia, sheep pox and drenching against control of internal parasites loads were under taken in farmers flocks in order to reduce the morbidity and mortality. The detail health management practices for adult sheep and new born lambsare given in table. Services for dipping of sheep were also provided when heavy infestation of external parasites in sheep observed. Annual epidemiological surveillance was conducted on sheep population under coverage indicated considerable decreased mortality (5% in 2003) as early (20% in 1975). Mortality in crossbred lambs was found more (8.84%) in comparison to their native counterparts (Mann *et al*., 2007). However, there was not much difference in the mortality in adult crossbreds (8.74 -10.79 %) and native sheep (8.83-9.42 %).

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After adoption package of practices of sheep health to prevent the diseases in sheep, farmers got higher benefits through reduced the mortality rate and waste due to death and disease. The sheep health practices for adult sheep and new born lams are presented in Table 5.

Table 5: Sheep health management practices for adult and newborn

Event	Frequency and Time	
	Adult	**New Born**
ET vaccination	Twice a year (June and December)	At 2.5 month of age (with booster),followed by every six month with adult
Sheep pox	Once a year (December)	At 3 month of age, followed by annual vaccination
PPR vaccination	Once in 3 years (December - January)	At 3.5 month of age
FMD vaccination	Need based in field blocks (February)	
Deworming	Strategic drench during mid-monsoon (late August and early September) with rotation of anthelmintic type	
Dipping	Once a year 15-21 days after march shearing	
Foot bath	During monsoon, 3-4 times at weekly interval with copper sulphate	

Source: Sheep and Rabbit Production and Utilization Technologies CSWRI 2013

The mortality in sheep under transfer of technology programme had brought below 6.24 % in 1994-95 and 3.09 % in 1997-98.It means under present situation if a sheep cost is about Rs 3500 /head and a farmer is maintaining 100 sheep herd then without adoption of prophylactic measures thus shepherd may lost about 13 sheep's from his flock and ultimate losses up to of Rs 45,500/ per annum. When a sheep farmer was adopting suggested practices had invested of Rs. 50/head thus a total expenditure would come Rs.5000/annum to the saved the flock and net benefit would touched up to Rs.40,500/ annum. This practice had attracted sheep farmers and more than 90% were ready to participate in most of the health programmes.

Sheep Reproduction and Acclimatization

Artificial insemination in sheep plays a pivotal role for improving the sheep productivity in short period of time. But Indian condition the results of AI in sheep are not much encouraging as compared to Russia and in some European counties. The success percentage of AI in farmer's flocks was only 60% and somewhere it was reported 66%. In India through this technique being taken only on experimental basis for some years, still it has not been extended up to field level on large scale except Rajasthan and Andhra Pradesh. Improved rams semen can be frozen to ensure a post thaw progressive motility above

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60% (Naqvi *et al*., 1998). The intra- uterine laparoscopic technique can be used for inseminate of sheep with the frozen semen under field condition. Other modern techniques such as oestrus synchronization and early pregnancy diagnosis through using of ultra-sound scanner were also used for this purpose. Animal husbandry division of NARI, had transferred AI technique of cryopreservation of ram and buck semen with the help of Syrian scientists in farmers flock in south India. The rams had started donation of semen at the age of 8-9 months. It was desirable to use rams after attaining the age 18 months. Good quality semen would obtain from the rams throughout the year with proper management of housing and feeding. Exotic rams should be provided a days rest after one ejaculation for long satisfactory service. The semen quality and sexual desire was affected by energy and protein level in the feed. Fresh semen should be diluted with egg yolk, Citrate-glucose (EYCG) extender could gave 66% fertility success rate, the same diluted semen can be stored for 24 hours resulted in to reduce fertility rate by 10-15%. Administration of Thyroxin with good nutrition resulted in higher fertility rate and wool production. Using of progesterone or prostaglandin F-2 could bring about 90% ewes in heat within 3-4 days. But the cost was prohibited. Administration of vitamin A before the spring season for breeding in arid areas resulted better lambing percentage. Viroji Rao *et al.* (2008) reported that only 20% of the farmers were aware of the advantages of ram rotation and also reported that, not a single farmer was following flushing of the breeding stock, which improves the conception rate considerably.

Wool Utilization and Marketing

The shepherds follow the traditional method of shearing wool by traditional tools because they do not have idea about improved tools for this work. The farmers were selling their wool on head basis but after began this programme most of the farmers are getting their sheep shorn and sale wool in Mandies. Suresh *et al.* (2008) reported that the sheep breeders are highly un-organised and no functional farmer's organization exists to safeguard their interests, they are not able to get better prices for their products. Therefore, there is urgent need to bring the awareness among the shepherds about wool marketing and proper utilization. Around 60-70% shepherds sell their wool after shearing as 20 % at the time of start this programme in early 60s and 70s. Thus, their margin had increased by Rs.15/kg of wool when compared to head basis. The weavers have adopted improved scheme resulted increase their net income by 10-25 % higher after value addition in wool**.** The impact of sheep development programme was assessed by the institute through conduct survey in the surrounding villages as well as other adopted villages. Only a small proportion of sheep (10–15%) have been crossbred (South Asia Pro-Poor Livestock Policy Programme, 2011).The crossbreds produced 19 to 42% higher wool than contemporary indigenous sheep (Singh and Singh, 1998). But fibre diameter and medullation percent were decreased through crossbreds programme and wool was closer to good carpet quality wool. The farmers were fetched 10 to 20% more

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price from selling of pure wool than crossbred wool in the market. The farmers were trained about sheep wool blended with various vegetable, animal and synthetic fibres, spun into yarns in woolen and worsted systems and furnishing fabrics (Gupta, 1992). The fabrics were dyed and finished for value addition. The evaluation of these materials was under taken at the different stages of its processing. The fibers as such and blended with another types of vegetable, animal and synthetic fibres, spun into yarns in woolen and worsted systems and converted into various products like blankets, Shawls, and furnishing fabrics. At the end it was recommended that wool should be graded at the time of shearing stage of each breed and sex wise separate after skirting into coarse, medium and fine wools. Woollenised Jute wool blends of 30: 70 proportions can be used for preparing of carpets and blankets.

Conflict of Interest Statement

The authors do not have any conflict of interest.

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