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Livestock Energy in Rural Environment: Case Study from Uttarakhand, India

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ABSTRACT

India is the largest producer of milk in the world. Most of the rural population, practically in hill areas, survive on the livestock maintained with the support of the forests and grazing lands. Animal husbandry yields some cash income from goats and sheep. Hill regions of Uttarakhand have a greater dependence on the earning from the cattle wealth than the plains. Sheep-keeping is popular in higher elevations and wool is a significant raw material for the cottage works in Joshimath, Ukhimath, Bageshwar, Didihat, etc. The pack animals are indispensable due to transportation needs of the region. Mules, horses, yak, sheep, bullocks, etc. serve as the pack animals, and they are also used for ploughing, threshing, levelling, etc. while, the common activities in agriculture are solely managed by bullocks. Cows, buffaloes, goats, etc. are kept in large numbers everywhere. Hill farmers keep animals for the cow-dung and milk yields per cow is hardly 1.50 to 3.00 litres per day, and buffaloes yield milk in ranges between 2.50 and 6.00 litres per day in Kumaon region. The cost of keeping of the cattle wealth is increasing day by day as the fodder is getting rare and grazing lands have been enclosed.

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Introduction

India is the largest producer of milk in the world with estimated production of about 84.6 million tonnes in 2001-02. Besides this, the livestock sector contributed 31.5 billion eggs, 46.4 million kg of wool, and 4.49 million tonnes of meat (Chawala *et al.,* 2004). Hill regions of Uttarakhand have a greater dependence on the earning from the cattle wealth than the plains. Most of the rural population, practically in hill areas, survive on the livestock maintained with the support of the forests and grazing lands. Animal husbandry yields some cash income from goats and sheep. Sheep-keeping is popular in higher elevations and wool is a significant raw material for the cottage works in Joshimath, Ukhimath, Bageshwar, Didihat, etc. The pack animals are indispensable due to transportation needs of the region. Mules, horses, yak, sheep, bullocks, etc. serve as the pack animals, and they are also used for ploughing, threshing, levelling, etc. while, the common activities in agriculture are solely managed by bullocks. Cows, buffaloes, goats, etc. are kept in large numbers everywhere. Hill farmers keep animals for the cow-dung and milk yields per cow is hardly 1.50 to 3.00 litres per day, and buffaloes yield milk in ranges between 2.50 and 6.00 litres per day in Kumaon region. The cost of keeping of the cattle wealth is increasing day by day as the fodder is getting rare and grazing lands have been enclosed.

Milk Processing

The milk-group is the most important contributor to the output from the livestock sector. Besides the organized sector, the market for milk in Kumaon is also in the unorganized sector. The organized sector comprises of three sectors namely the government, the cooperative and the private sector in the region. The processing technologies are generally in use for manufacture of pasteurized milk, cream, butter, ghee, cheeses, condensed milk, milk powder, baby food, yoghurt, lassi/chhach and traditional sweetmeats/ products. Some private sector companies have recently introduced a new range of products such as casein, lactose and whey powder protein concentrates using membrane technology.

Some 35 per cent of the milk produced is consumed as liquid milk, but the bulk of it is traded in the traditional channels. The organized sector handles only 40 per cent of it as processed and largely packaged milk. Milk products from the organized sector are marketed through a vast network of

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wholesalers, distributors and tens of thousands of retailers in a variety of brands. Because of the presence of a vast domestic market, most of the milk products produced is marketed in Kumaon. A vast network of three-tier cooperatives-diary cooperative societies at the village level, milk unions at the district level and Milk Federations at the state level were established under the three phases of operation flood, turning India into modern dairy country.

The cows and oxen are the most important livestock accounting for 45.21% of the total livestock population (21,98,212) in the Kumaon region. They are the dominating livestock in the region. The importance of oxen is due to the vital role which draught force plays on farms in the region. Excluding the Bhabar part and low lying areas in the outskirts of the region, there are no farms which can be ploughed using tractors, and hence, the oxen are the main source of draught power for agricultural operations. The oxen population is 2,44,131 animals in the region. Cow provides milk, which are the main sources of animal protein in the diet of majority of rural people. Numerically the cow is more important as the milk animals, which accounts for 3,22,270 animals or 48.43% of the total population of milch cattle. The cows are found more in districts of Pithoragarh 60.71 %, Champawat 59.93%, Bageshwar 50.47%, Almora 49.14% and less in Nainital 44.75% and U.S.Nagar 37.84% of Kumaon region. The buffalo population is 3,43,069, which is calculated to be 51.56% of the total milch animals of Kumaon region. Buffaloes are important milk yielding animals as their milk yield is generally higher and of better commercial quality with high fat content than of cows. The density of buffalo in an area is determined by availability of fodder for stall-feeding, 62.16% in district U.S.Nagar, 55.25% Nainital, 50.86% Almora, 49.53% Bageshwar, and very low in Champawat i.e., 40.79% and Pithoragarh in 39.28%. The buffaloes are the main source of the milk and yield nearly two to three times more than cows. Buffaloes form only 62.26% of the regional livestock wealth, yet the total annual milk income is Rs. 181013.88 lakh of the region are obtained from bovines. Per day total milk production is 27,55,158 litres in Kumaon (Table 1).

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Table 1 Milch Cow and Buffalo Population with Percentage in Kumaon, 2003

Name of the District	Local cow	Cross breed cow	Buffalo	Total population of milch Animal	Percentage of milch animals in Kumaon
Almora	64177.00	4258.00	70831.00	139266.00	20.93
	(46.08)	(3.06)	(50.86)		
Bageshwar	21164.00	475.00	21236.00	42875.00	6.44
	(49.36)	(1.11)	(49.53)		
Champawat	27581.00	4996.00	22444.00	55021.00	8.27
	(50.13)	(9.08)	(40.79)		
Nainital	24993.00	8980.00	41942.00	75915.00	11.41
	(32.92)	(11.83)	(55.25)		
Pithoragarh	76447.00	9394.00	55535.00	141376.00	21.25
	(54.07)	(6.64)	(39.28)		
U.S. Nagar	34905.00	44900.00	131081.00	210886.00	31.70
	(16.55)	(21.29)	(62.16)		
Total	**249267.00**	**73003.00**	**343069.00**	**665339.00**	**100.00**
	(37.46)	**(10.97)**	**(51.56)**		

Note: Figures given in parentheses are in per cent.
Source: Animal Census, 2003

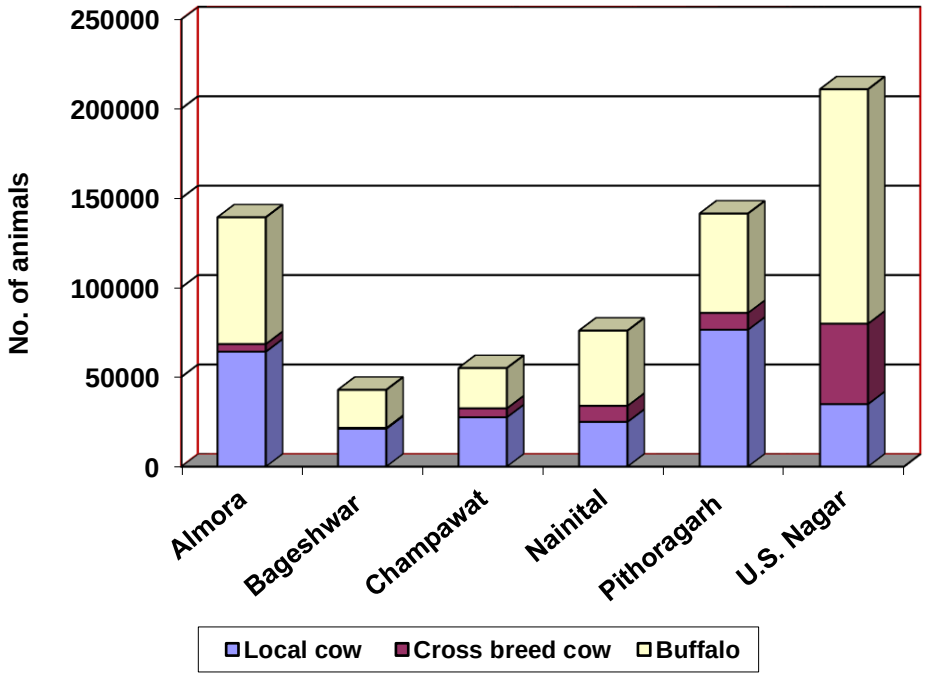

Fig. 1 Milch Cow and Buffalo Population in Kumaon

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Meat and Poultry Processing

Meat foods are mainly obtained from mammals, especially the herbivores and some omnivores. The main sources of meat are goats, sheep and pigs. However, the goat meat is in greater demand. Poultry is another source of meat. The meat animals (goat and pig) population is 5,60,949 which are calculated to be 25.52 % of the total livestock population in the region. Goat and sheep population is least affected by fodder scarcity and have made steady progress even in the distress years. From the food consumption and management point of view, goat is the most economic of all the milk producing animals. It is a very prolific breeder and cheaply reared in the Central Himalayas, kidding twice in twelve to fifteen months and the birth of twins and triplets is common. Goat is considered to be the poor man's cow that provides milk within his reach at a low cost. The farmers rear goats for their meat also. The rearing is common in the central parts of Himalayas and in the proximity of forests (reserved). The total annual income from meat production is Rs.4411.39 lakh, in the region, out of which goat (70.89%), pig (20.77%) and poultries (8.34%), per day total production i.e., of mutton is 7140 kg, poultry is 2510 kg and pork is 1260 kg in Kumaon. Sheep population is greatest in District Pithoragarh (54.61%), and lowest in District Champawat (0.10%). Sheep population is 60,070 i.e. (2.73%) and Goats are more in Districts of Almora (31.07%), Pithoragarh (26.27%) and lowest in district U.S.Nagar (8.05%). The population of goats is 5,54,223 i.e. 25.21% of the total livestock population in the region (Table 2; Fig. 2). Pig population is very limited in Kumaon and is mostly found in district i.e., U.S. Nagar (39.34%), followed by Nainital with 17.48% and lowest in Bageshwar i.e., 1.07%. The pig population is 6,726, which is 0.31% of the total animal population in the region.

Poultry farming for meat purposes is now being taken up in a big way around big cities which are the main consumption centres. Farmers generally keep small blocks of 5 to 10 birds to meet the family requirements of eggs and chicken.

Now a days, poultry is being adopted by a number of people of all social groups. With the introduction of subsidy and other incentives given by various Government agencies engaged in rural development programmes, it is adopted as a profession in the urban areas and its environs. Poultry are found mostly in

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district U.S. Nagar (70.18%) followed by Nainital (15.49%) and the lowest is in district Bageshwar (1.05%). The total poultry is 13,64,993 birds or 38.31% of the total livestock in the region. Per day total meat production is 10,910 kg and eggs production is 47,853 units in the region.

Table 2 District-wise Animal and Bird Populations (with percentage) in Kumaon, 2003

Name of the District	**Sheep (%)**	**Goats (%)**	**Pigs (%)**	**Duck (%)**	**Poultry (%)**	**Total Animals (%)**
Almora	4890	171732	671	17711	44878	220610
	(8.14)	(31.07)	(9.98)	(51.87)	(3.21)	(10.93)
Bageshwar	19983	81105	1477	13	14724	115884
	(33.27)	(14.68)	(1.07)	(0.04)	(1.05)	(5.74)
Champawat	58	48492	605	334	56324	105479
	(0.10)	(8.77)	(8.99)	(0.97)	(4.03)	(5.23)
Nainital	178	63207	1176	194	216729	281290
	(0.30)	(11.44)	(17.48)	(0.57)	(15.49)	(13.93)
Pithoragarh	32804	145173	151	28	50478	228606
	(54.61)	(26.27)	(2.25)	(0.08)	(3.61)	(11.33)
U.S. Nagar	2157	44514	2646	15864	981860	1031177
	(3.59)	(8.05)	(39.34)	(46.46)	(70.18)	(51.08)
Total	**60070**	**554223**	**6726**	**34144**	**1364993**	**2018595**
	(100.00)	**(100.00)**	**(100.00)**	**(100.00)**	**(100.00)**	**(100.00)**

Note: Figures given in parentheses are in per cent.
Source: Animal Census, 2003

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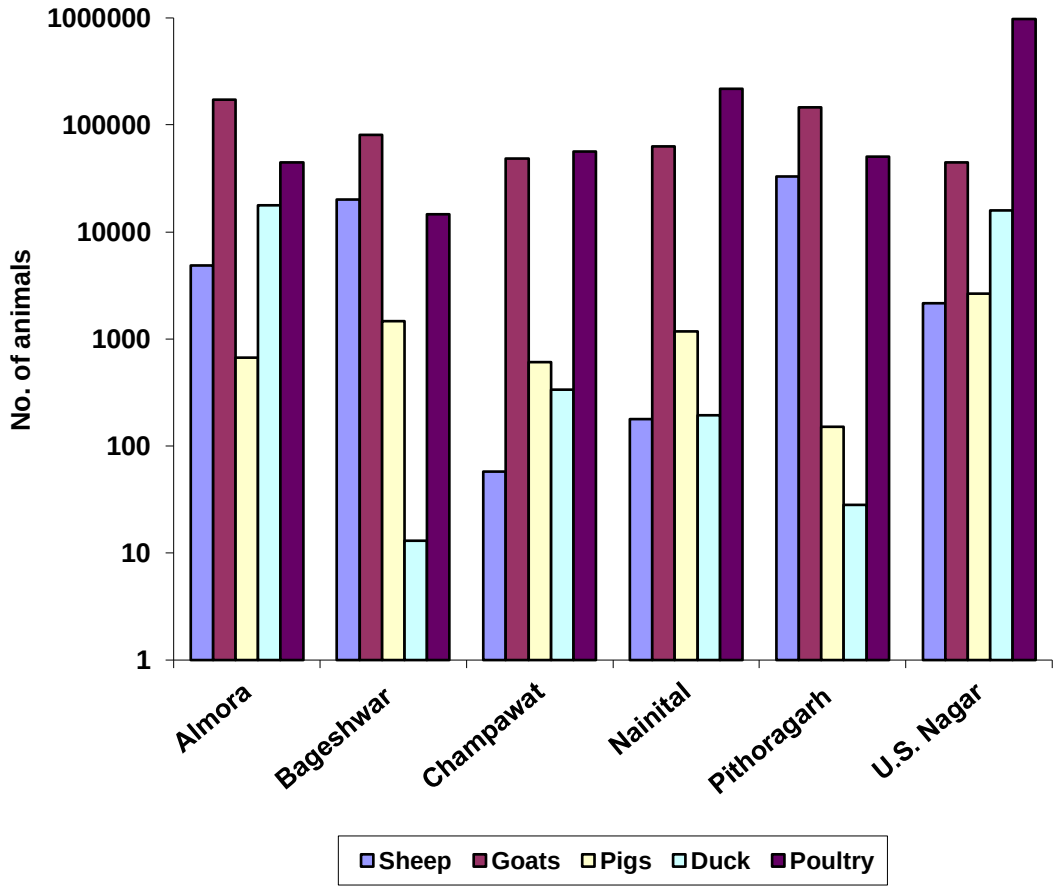

Fig. 2 Animal and Bird (Duck and Poultry) Population in Kumaon, 2003

Draught Animals

Horses, ponies and mules are the backbone of rural transport system in the region. They are used to transport the foodgrains and other materials from road-head to the villages. This mode of transportation is more common in interior areas where other means are not available and are located far from the road-head. Horses are domesticated for tourists, use in tongas and defence purpose, etc. Working animals found are more in district Nainital (34.26%) and the lowest in district Bageshwar (4.04%). The total number of working animals is 7963 heads that gives per day 1012982 hours of work output in the region. The total annual income is Rs. 2130935700 (Table 3; Fig. 3).

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Table 3 Population of Draught Animals, 2003

Name of the District	No. of Mules and Horses	Percentage of total Animals
Almora	1561	19.60
Bageshwar	322	4.04
Champawat	982	12.33
Nainital	2728	34.26
Pithoragarh	1043	13.10
U.S. Nagar	1327	16.66
Total	**7963**	**100.00**

Source: Animal Census 2003

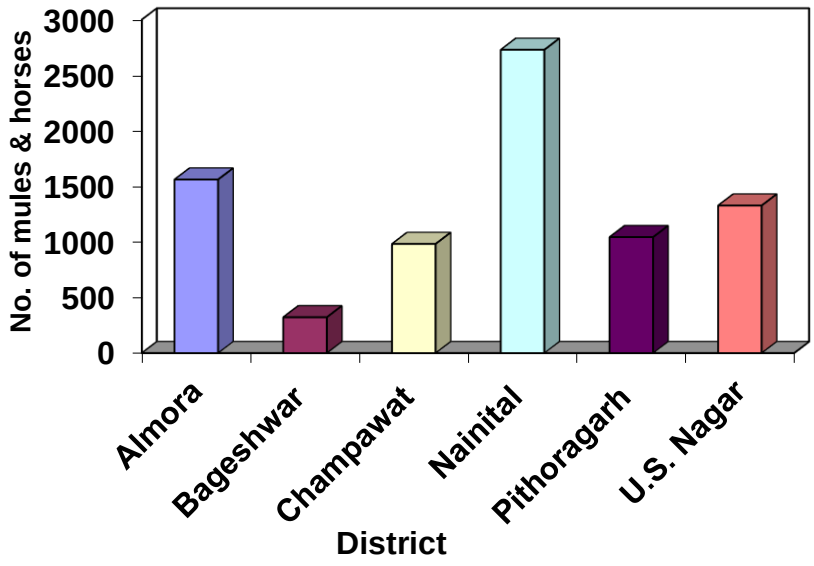

Fig. 3 Draught Animals in Kumaon

Manure

Animal dung is commonly used as biofertilizer in the form of manure in the rural area. Fertilizing capacity of cow and goat dung is very good as compared to the dung of other animals. Per day production of animal dung is 24,675,806 tonnes in the Kumaon. The number of dung animals is 21,83,523 or 99.33% of the total livestock population in Kumaon region (Table 4; Fig. 4).

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Table 4 Total Number of Dung Animals in the Study Region, 2003

Name of Districts	Local and Cross breed cattle (Male, Female, Calves)	Buffalo and Calves	Sheep (Local and Cross breed)	Goats	Total Dung Animal
Almora	237733	109698	4890	171732	524053
	(23.92)	(19.06)	(8.14)	(31.07)	(24.00)
Bageshwar	121121	42250	19983	81105	264459
	(12.19)	(7.34)	(33.27)	(14.68)	(12.11)
Champawat	99637	37621	58	48492	185808
	(10.03)	(6.54)	(0.10)	(8.77)	(8.51)
Nainital	170583	123106	178	63207	357074
	(17.17)	(21.39)	(0.30)	(11.44)	(16.35)
Pithoragarh	240748	86877	32804	145173	505602
	(24.23)	(15.10)	(54.61)	(26.27)	(23.15)
U.S. Nagar	123951	175905	2157	44514	346527
	(12.47)	(30.57)	(3.59)	(8.05)	(15.87)
Total	**993773**	**575457**	**60070**	**554223**	**2183523**
	(100.00)	**(100.00)**	**(100.00)**	**(100.00)**	**(100.00)**

Note: Figures in parentheses are given in per cent.
Source: Animal Census, 2003

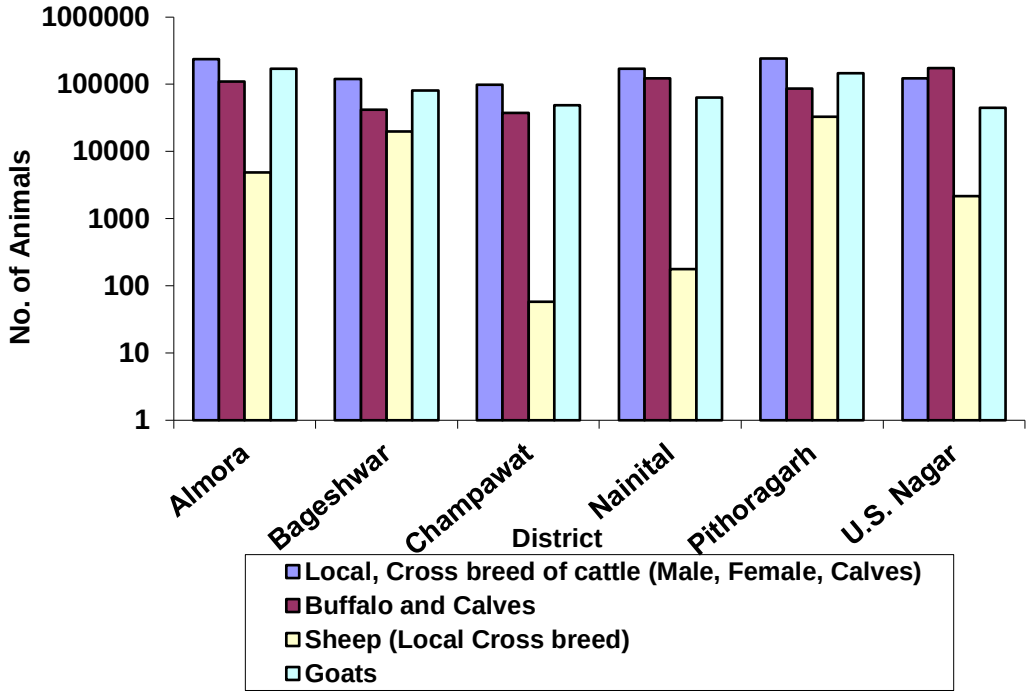

Fig. 4 Dung Animals in Kumaon

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Table 5 Daily Animal Productivity in Kumaon Region

Particulars	**No. of Animals**	**Per Animal Average Productivity Lit/head/day**	**Per day Total Production In Litre**	**Unit Prices in Rs.**	**Daily Income in Rs.**	**Total Annual Income in Lakh Rs.**	**Per cent**
Milk production Cross breed milch cow Local breed milch cow Milch Buffalo **Total**	 73003 249267 343069 **665339**	 4 Lit 3 Lit 5 Lit	 292012 747801 1715345 **2755158**	 18/kg 18/kg 18/kg **18/kg**	 5256216 13460418 30876210 **49592844**	 19185.19 49130.53 112698.17 **181013.88**	 10.60 27.14 62.26 **100**
Meat production Mutton (goat) Poultry meat (birds) Pork (pig) (Total Animals)	 476/day (554223) 2510/day (1364993) 42/day (6726) **(1925942)**	**Avg. weight of dressed meat per Animal in kg** 15 kg 1 kg 30 kg	**In kg** 7140 2510 1260 **10910**	 120/kg 100/kg 80/kg	 856800 251000 100800 **1208600**	 3127.32 916.15 367.92 **4411.40**	 70.89 20.77 8.34 **100**
Egg production Poultry desi Improved **Total**	 67127 26905 **94032**	**Egg/poultry/year** 160 Nos 250 Nos	**In nos.** 29425 18428 **47853**	 2.50 2.00	 73562.5 36856 **110418.5**	 268.50 134.52 **403.03**	 66.62 33.38 **100**
Particulars	**No. of Animals**	**Per Animal Average Productivity**	**Per day Total Production**	**Unit Prices in Rs.**	**Daily Income in Rs.**	**Total Annual Income in Lakh Rs.**	**Per cent**

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Wool production Cross breed sheep Local breed sheep **Total**	16978 43092 **60070**	**Wool/sheep/year** 2.5/kg 2.00/kg	**In kg** 116.3 236.1 **352.4**	60/kg 50/kg	6978 11805 **18783**	2.55 43.09 **68.66**	37.15 62.85 **100**
Dung production Cow/bull Buffalo Sheep/Goat **Total**	993773 575457 614293 **2183523**	**Per Animal/day** 12/kg 20/kg 2/kg	**In kg** 11925276 11509140 1228586 **24663002**	.10/kg .10/kg .10/kg **.10/kg**	1192527.6 1150914.0 122858.6 **2466300.2**	4352.73 4200.84 448.43 **9002.00**	48.35 46.67 4.98 **100**
Work output Bull Mule **Total**	244131 7963 **252094**	**Work out/Animal/day** 2 hour 8 hour	**In hours** 488262 63704 **1012982**	10/hour 15/hour	4882620 955560 **5838180**	17821.56 3487.79 **21309.36**	83.63 16.37 **100**
Total livestock	**3563205**		**27477275.4**		**59236406.1**	**21620.82**	

Source: The above data is based on Animal Census 2003 and Field Survey by the researcher.

Capsule Study

The study was carried out in twelve sample villages of different blocks and in six districts of Kumaon. In district Almora there are two sample villages, Sirkhon in Bhikyashen block and Lawal Bakhal in Syaldeh block. In both the villages daily milk production is 163 litres, while production is meat, egg and wool production is nil, and daily dung production is 1024 kg and the daily work output of animals is just 40 hours. In district Bageshwar there are two sample villages e.g., Sama in Kapkot Block and Bahuli in Bageshwar Block. The per day milk production 2,609 litres, daily meat production is 200 kg, egg production is nil, wool production is just 0.62 kg/day and dung production is 17,650 kg and work output is 920 hours/day. The third district is Champawat, where the two sample villages are Gazina in

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Lohaghat Block and Lodhan Tukra in Champawat Block. The per day milk production of these villages is 142 litres, meat, egg, wool production is nil, while dung production is 857 kg/day and work output is 46 hours/day. (Table 6). The Fourth district is Nainital with the villages Bhagwanpur Jai Singh in Haldwani Block and Gadhura in Dhari Block. The per day milk production of these two villages is 714 litres, meat, egg, wool production is nil, and daily dung production is 2593 kg and work output is 75 hours. Pithoragarh is the fifth district and there are two sample villages, namely, Jajurali in Pithoragarh Block and Balure in Gangolihat Block. There the daily milk production is 391 litres, meat production is 15 kg, egg production is nil, wool production is 0.36 kg, dung production is 4177 kg and work output is 170 hours. The last district is Udham Singh Nagar. The two selected villages are Madnapur in Gadarpur Block and Missarwala in Jaspur Block. There the milk production is 5046 litres/day, meat production is 55 kg/day, egg production is 303 nos. /day, wool production is nil, dung production is 15087 kg/day and work output is 703 hours/day. Cows and buffaloes are the main animals that produce milk. The total number of cows and buffaloes is 1799 in these sample villages (Table 6).

Table 6 Daily Animal Productions in Twelve Sample Villages of Six Districts of Kumaon Himalaya

Name of the sample village/ District	**(1) Milk Production**						**(2) Meat Production**			**(3) Egg Production**		
	Village area (ha)	**No. of households**	**Population (village)**	**No. of milch cattle**	**Per day milk production litre**	**Annual milk production litre/year**	**No. of meat animal**	**Per day meat production kg**	**Annual meat production kg/year**	**No. of poultry**	**Per day (Rs)**	**Annual (Rs/year)**
District Bageshwar												
1. Sama	443.209	212	887	632	2072	756280	481	120	43800	NIL	NIL	NIL
2. Bahuli	51.732	145	416	131	537	196005	444	80	29200	400	120	43800

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District Almora												
3. Sirkhon	15.519	5	17	10	35.5	12957.5	NIL	NIL	NIL	NIL	NIL	NIL
4. Lawal Bakhal	27.334	25	142	30	127.5	46537.5	NIL	NIL	NIL	NIL	NIL	NIL
District Champawat												
5. Gazina	38.989	7	40	10	40	14600	NIL	NIL	NIL	NIL	NIL	NIL
6. LodhanTukra	26.278	8	60	24	102	37230	NIL	NIL	NIL	NIL	NIL	NIL
District Pithoragarh												
7. Jajurali	77.596	128	695	98	336	122640	75	10	3650	NIL	NIL	NIL
8. Balure	41.30	11	45	20	55	20075	25	5	1825	NIL	NIL	NIL
District U.S. Nagar												
9. Madnapur	423.135	441	3215	351	2412	880380	286	15	5475	168	115	41975
10. Missarwala	197.425	350	2560	375	2634	961410	240	40	14600	275	188	68620
District Nainital												
11. Bhagwanpur Jai Singh	62.111	111	647	107	688	251120	NIL	NIL	NIL	NIL	NIL	NIL
12. Gadhura	35.907	3	26	11	26	9490	NIL	NIL	NIL	NIL	NIL	NIL

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Name of the sample village	(4) Wool Production			(5) Dung Animal			(6) Work Output		
	No. of Sheeps	Per day Wool Production kg	Annual wool Production kg/year	No. of Dung Animal	Per day Dung Production kg	Annual Dung Production kg/year	No. of working animals	Per day work output Production hour	Annual Work output Production hour/year
District Bageshwar									
1. Sama	114	.62	226.3	1568	14252	5201980	350	754	275210
2. Bahuli	NIL	NIL	NIL	258	3398	1240270	83	166	60590
District Almora									
3. Sirkhon	NIL	NIL	NIL	15	256	93440	4	8	2920
4.Lawal Bakhal	NIL	NIL	NIL	46	768	280320	16	32	11680
District Champawat									
5. Gazina	NIL	NIL	NIL	27	371	135415	13	26	9490
6. Lodhan Tukra	NIL	NIL	NIL	34	486	177390	10	20	7300
District Pithoragarh									
7. Jajurali	65	.36	131.4	354	3736	1363640	80	160	58400
8. Balure	NIL	NIL	NIL	48	441	160965	5	10	3650
District U.S. Nagar									
9. Madhapur	NIL	NIL	NIL	552	7793	2844445	115	425	155125
10. Missarwala	NIL	NIL	NIL	537	7294	2662310	71	278	101470
District Nainital									
11. Bhagwanpur Jai Singh	NIL	NIL	NIL	133	2371	865415	21	63	22995
12. Gadhura	NIL	NIL	NIL	25	222	81030	6	12	4380

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Table 7 Total Annual Income Generated per Head of Animal Under Different Categories of Cattle.

	Rs.
Cross breed milch cow	26280.00
Local breed milch cow	19710.00
Milch Buffalo	32850.00
Total	**27206.26**
Mutton	2606100.00
Poultry meat	916150.00
Pork	459900.00
Total Animals	**3982150.00**
Egg production	
Poultry desi	399.99
Improved	500.00
Total	**428.61**
Wool production	
Cross breed sheep	150.02
Local breed sheep	99.99
Total	**114.13**
Dung production	
Cattle	438.00
Buffalo	730.00
Sheep/Goat	73.76
Total	**412.48**
Work output	
Bull	7300.00
Mule	43800.00
Total	8452.94
Total livestock	**6067.93**

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Output of Animal Energy

The Animal Husbandry sector (AH), comprising of dairy, poultry, sheep/goat/piggery, rabbit and work animal sub-sectors, contributes significantly to the economy of Uttarakhand state. It provides employment to 16.8 lakhs workforce (54% of total workforce) but accounts for only 9.82% of gross domestic product of the State. The dairy sub-section occupies a dominant position amongst the sub-sectors accounting for livestock activities like mule breeding, Angora rabbit farming, Angora goat farming for mohair production, poultry farming in foothills, etc. Livestock sector output includes milk and milk-products, meat and meat-products, eggs, poultry, wool and hair, dung and other by-products of animal origin.

In 2003 in Kumaon region, the per day milk production was 2755158 litres, meat production was 10910 kg, egg production was 47853, in no. wool, Production was 352.4 kg, dung was 23775806 kg with 1012982 hour work output. The estimated value of output from livestock sector in 2003 was Rs.6,60,91,654.1 among various livestock products. Milk group constitutes a major share in the value of output from livestock sector. The meat group is the second most important contributor to the output from livestock sector. Poultry has made a tremendous progress in numbers and consequently in output. They share of eggs and poultry meat. Wool and hair are relatively minor contributors to the sectoral output value.

Milk

In the Kumaon region the total number of milch cattle is 6,65,339 which produced 2,755,158 litres milk per day and the total annual milk production is 18,10,13,88,060 litres (Animal Census, 2003). Calorific value of 1 kg of milk is 670 kCal for cow milk and 1170 kCal for buffalo milk. Therefore, the total calorific value of milk produced per day is 2703.628 kCal and per year is 986.824 kCal in the region (Table 8; Fig. 5).

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Table 8 Annual Milk Production by all the Cattle in Kumaon Region

Milk production	Daily milk production	Number of cattle	Daily milk production kCal x 10^6	Annual milk production kCal x 10^9
Cross breed milch cow	292012	73003	195.65	71.412
Local breed milch cow	747801	249267	501.03	182.875
Milch Buffalo	1715345	343069	2006.95	732.538
Total	**2755158**	**665339**	**2703.628**	**986.824**

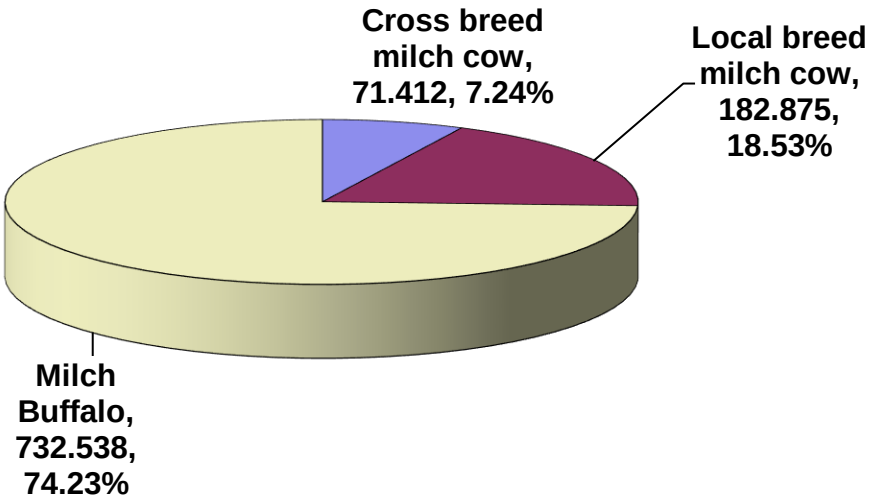

Fig. 5 Annual Milk Production (kCal x 10^6) by all the Cattle in Kumaon Region

4.2.2 Meat

The total number of meat animals is 1,849,895. The number of goats is 539,489 but per day only 476 are used for mutton, producing 7140 kg of mutton. The calorific value of per kilogram mutton is 1180 kCal thus; total calorific value of mutton is 8.4252 x 10^6 kCal per day and 3.075198 x 10^9 kCal per annum. The annual income from sale of mutton is Rs.31,27,32,000.

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One kg poultry meat has 1730 kCal. The total number of poultry birds is 13,05,105 and the per day production of white meat is 2510 kg. Therefore, the total calorific value of poultry produced per day is 4.342 x 10^6 kCal and per year is 1.585 x10^9 kCal. The annual income from sale of poultry meat is Rs.9,16,15,000.

The total number of pigs is 5309 and per day used for the purpose of pork are 42 in number which is about 1260 kg. The calorific value of per kg pork is 1140 kCal thus; the total calorific value of poultry is 1.4364 x 10^6 kCal per day and per year is 524.286x10^6 kCal. (Table 9, 10; Fig. 6)

Table 9 Annual Meat Production by all Animals in Kumaon Region

Meat Production	Daily meat production	Number of animal	Daily meat production (kCal)	Annual meat production (kCal)
Mutton (goat)	7140	539489	8.4252 x 10^6	3.075198 x 10^9
Poultry meat (Chicken)	2510	1305105	4.3423 x 10^6	1.5849395 x10^9
Pork (pig)	1260	5309	1.4364 x 10^6	524.286 x 10^6

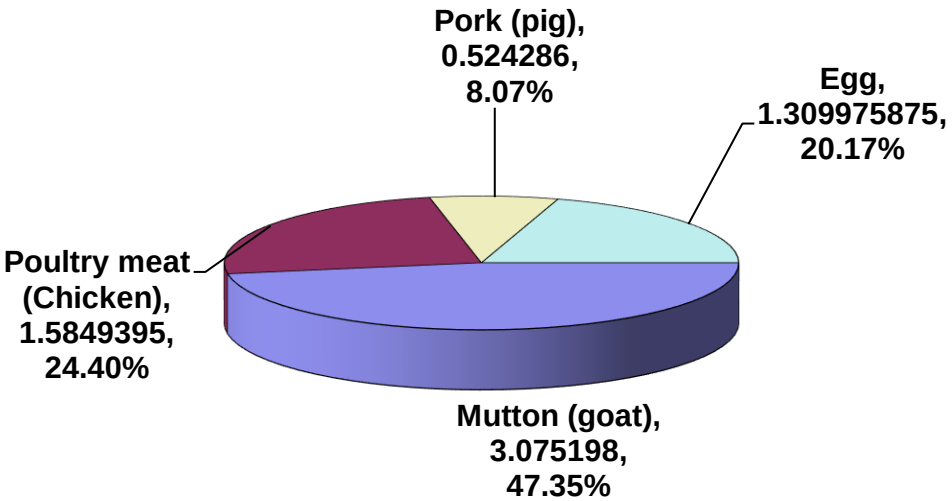

Fig. 6 Annual Meat and Egg Production (KCal x 10^9) by all Animals in Kumaon

Eggs

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In the region the total number of poultry birds is 94032 which produced 47853 eggs per day and the calorific value per egg is 75 kCal. Thus, the total calorific value of eggs is 3.588975 x 10^6 kCal per day or 1.309975875 x 10^9 kCal per year (Table 4.10). The annual income from the sale of desi eggs is Rs. 26850312.5 and from improved eggs is Rs.134,52,440.0 (Table 5).

Table 10 Annual Egg Production by Poultry Birds in Kumaon Region

Egg Production	Daily Egg production	Number of birds	Daily Egg production (kCal)	Annual Egg production (kCal)
Poultry Egg	47853	94032	3.588975 x10^6	1.309975875 x 10^9

Dung

In the Kumaon region 2183523 cattle heads produced 24663002 kg dung daily and 900199573 kg yearly. Thus the Calorific value produced is 52.53219426 x ^{6} kCal dung daily and 1.91742509 x ^{10} kCal. dung yearly. The average daily dung production was calculated for all the cattle. The amount of dung was converted into energy value 2.13 kCal. /kg (Kaira, 2002) and these values were used to calculate yearly dung production in kCal (Table 11).

Table 11 Annual Dung Production of all Cattle in Kumaon Region

Daily Dung production	Number of dung cattle	Daily Dung production kCal x 10^6	Annual Dung production kCal. X 10^{10}
24663002	2183523	52.53219426	1.91742509

Input-Output Analysis of Animal Energy

In order to calculate the budget of animal energy we need first to calculate both the input and the output of the animal energy. The input of animal energy simply put is the fodder given to the animals. However, there is no uniform method to estimate this and different standards for the same have been proposed. Some of the important feeding standards have been given below:

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Important Feeding Standards: Different feeding standards may be classed under three types as follows: (Mahanta, 1958)

i) Comparative type.

ii) Production value type.

iii) Digestible nutrient system.

i) Comparative Types

There are two types of comparative feeding standards which can be described as follows:

Thaer's Feeding Values:

German scientist Thaer (1810) suggested that different feeds should be compared using meadow hay as a unit. It was found out that 91 kg of alfalfa hay were equal to 100 kg of meadow hay and 200 kg of potatoes were equal to 100 kg of meadow hay in feeding value. He did not formulate a feeding standard but simply gave a comparison of the feeding stuff.

Scandinavian Food Unit System:

In 1884, Professor Fjord formulated the Scandinavian feeding standard. One pound of the common grains, such as maize, barley, wheat, etc. is given a value of 1 unit and the value of all the other feeds is based upon this. According to this standard 1 feed unit is required for every 68 kg of body weight, and one additional unit for every 1.36 kg of milk produced. Later on it was suggested that in addition to the feed unit the ration should also include 30 g of digestible protein for every 45.45 kg of body weight and 22 g of digestible protein for 454 .54 g milk produced.

ii) Production Value Types

This standard is also of the following two types:

Kellner Feeding Standard:

Kellner was a German investigator, who published in 1907 a feeding standard based upon starch as the unit of measure. According to this system a 454.54 kg animal needs 272.7 g of digestible protein and 2.89 kg of starch equivalent (S.E.).

The table of starch value was determined by Kellner from the above factors. Thus, the S.E. of different feed ingredients is determined as follows:

Dig. Protein x 0.94 = S.E.

Fat from coarse fodder x 1.9 = S.E.

Fat from cereal grains x 2.1 = S.E

Fat from oilseeds x 2.4 = S.E.

Carbohydrates (dig) + fibre x1 =S.E.

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This may be written as follows:

Digestible protein x 0.94 + digestible fat x 2.4 + nitrogen-free extract + crude fibre = total starch equivalent.

For practical purposes the starch value of fat in general feedstuffs is taken as 2.3.

Armsby Feeding Standard:

In this standard the feeding value is expressed as Net Energy. The energy value of feedstuff is measured in terms of heat units. The amount of heat that will be required to raise the temperature of one gram of water through one degree centigrade is called a calorie. A therm is 1,000 calories. The experiments carried out by Armsby and Kellner on the metabolizing energy of the principal food constituents are deduced from the following equations:

% of Proteins x 2,133 calories

The metabolizing

% of carbohydrates x 1,707 calories}

energy per 454.54 g of

% of fat x 4,000 calories

each respectively.

Armsby's net energy value in terms of therms for wheat straw will be as follows: wheat straw taken is 45.45 kg gross energy from these 45.45 kg of wheat straw is 184.6 therms; energy lost in faeces is 107.5 therms; in methane, 15.3 therms; in urine, 4.4 therms. Therefore, metabolizable energy is 57.4 therms. Energy lost in the work of digestion is 47.3 therms and therefore the net energy is 10.1 therms.

iii) Digestible Nutrient System:

Seven types of digestible nutrient system have been described by various workers:

Grouven's Feeding Standard:

In 1859, Grouven, a German scientist published his feeding standard with crude protein, carbohydrates and fat contained in the feed as the base of the standard. According to his standard a cow weighing 454.54 kg should be fed 13.05 kg of dry matter containing 1.26 kg of crude protein, 391 g of crude fat and 6.61 kg of crude carbohydrates.

Wolff's Feeding Standard:

In 1864 Dr. Emil von Wolff proposed a standard based on the digestible protein, digestible carbohydrates and digestible fats contained in a feedstuff. His standard for dairy

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cows weighing 454.54 kg was: dry matter, 11.14 kg, containing 1.14 kg of digestible protein, 5.68 kg of digestible carbohydrates, and 181.81 g of digestible fat. This has a nutritive ratio of 1:5.4. This standard though is an improvement on the standard of Grouven yet it does not consider the quantity and quality of the milk produced.

Wolff-Lehmann Feeding Standard:

Dr. C. Lehmann of Berlin modified Wolff's standard in 1896. According to this standard for a cow weighing 454.54 kg and producing 10 kg of milk daily the feeds should contain for production 13.18 kg of dry matter, 1.14 kg crude protein, 5.91 carbohydrates and 227.27 g fat. Besides this the cow needs for her maintenance 8.18 kg of dry matter containing 318.18 g crude protein, 3.64 kg carbohydrates and 45.45 g fat.

Requirements for 454.54 kg cow-For maintenance-

Dry matter	8.18 kg,
Crude protein	318.18 g,
Carbohydrates	3.64 kg,
Fat	45.45 g,

4 kg Total nutrients.

For production of daily-

5 kg milk for a 454.54 kg cow

Dry matter	11.36kg
Crude protein	727.27 g
Carbohydrates	4.54 kg
Fat	136.36 g

5.41 kg Total nutrients.

Haecker's Feeding Standard:

Haecker worked with a large number of cattle over a long period of time under normal condition. With this system the needs of a cow of any size, producing any quantity or quality of milk may be computed. His standard included digestible crude protein, carbohydrates and fat. Later it was expressed in digestible crude protein and total digestible nutrients. (Mahanta, 1958) Requirements for maintenance of dairy cows (For production of each kg of milk testing) are given below:

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Table 12 Feeding Standards of Haecker

Weight	**Digestible Crude protein**	**Carbohydrates**	**Fat**	**T.D.N**
Kg	**Kg**	**Kg**	**Kg**	**Kg**
363.64	0.25	2.55	0.04	2.88
386.36	0.27	2.70	0.04	3.06
409.09	0.29	2.86	0.04	1.42
431.82	0.30	3.02	0.04	3.42
454.55	0.32	3.18	0.05	3.60
477.27	0.33	3.34	0.05	3.78
500.00	0.35	3.50	0.05	3.96
522.73	0.37	3.66	0.05	4.14
545.45	0.38	3.82	0.05	4.32

Savage Feeding Standard:

Savage of the Cornell Experiment Station worked on the Haecker's Feeding Standard and found out that the protein recommended by Haecker was too low and he stated that the nutritive ratio should not be wider than 1:6. In his standard therefore the protein requirement was increased by about 20 per cent above the standard of Haecker. In rations for milch cows at least 24 pounds of dry matter for an average cow should be provided. The nutritive ration should not be wider than 1:6 or narrower than 1:4.5. About two- thirds of the dry matter should be from the roughages and one –third from the concentrates.

Table 13 Feeding Standards of Savage

	Digestible crude protein, kg	T. D. N. kg
For maintenance of 1000-pound cow	0.318	3.602
1000-pound cow for producing milk of following fat percentage-nutrients required for every pound of milk in addition to the maintenance ration-	0.000	0.000
3.0 per cent milk	0.026	0.130
4.0 per cent milk	0.029	0.159
5.0 per cent milk	0.033	0.184
6.0 per cent milk	0.037	0.208

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Morrison's Feeding Standard:

The Morrison Feeding standards also recommend the minimum and the maximum allowances for the cattle. This standard is largely used in the United States of America.

Table 14 Feeding Standards of Morrison

	Digestible protein Gram	**T. D. N. kg**	**Net Energy therms**
A. for maintenance (daily requirement per head)			
318.18 kg body weight	200-216.36	2.33-2.64	1.86-2.11
340.91 kg body weight	212.27-230	2.48-2.81	1.98-2.25
363.64 kg body weight	224.55-243.64	2.62-2.97	2.1-2.37
386.36 kg body weight	236.82-256.36	2.76-3.13	2.21-2.5
409.09 kg body weight	248.64-269.55	2.9-3.29	2.32-2.63
431.82 kg body weight	260.91-282.27	3.04-3.45	2.43-2.75
454.54 kg body weight	272.73-295.45	3.18-3.61	2.54-2.88
477.27 kg body weight	284.55-308.18	3.32-3.76	2.65-3.01
500 kg body weight	296.36-320.91	3.45-3.91	2.76-3.13
522.73 kg body weight	307.73-333.64	3.59-4.07	2.87-3.25
	Digestible protein Gram	**T. D. N. kg**	**Net Energy therms**
545.45 kg body weight	319.55-346.36	3.73-4.22	2.98-3.38
For maintenance per every 45.45 kg of body weight the cow would require approximately	27.27	330.91 g	263.64 g
For milk production per kg of milk, to be added to the maintenance ration:			
For 3.0 per cent milk	16.36-19.55 g	118.64-125.45 g	110.45-116.82 g
For 3.5 per cent milk	172.72-20.91 g	129.09-136.36 g	120-126.82 g
For 4.0 per cent milk	18.64-22.27	139.55-147.27	130-136.82 g
For 4.5 per cent milk	20-23.64	726-158.64 g	139.55-147.73 g
For 5.0 per cent milk	20.91-25.45	160.45-169.55 g	149.09-157.73 g
For 5.5 per cent milk	22.27-26.8	170.91-180.45 g	159.09-167.73 g
For 6.0 per cent milk	23.64-28.18	181.36-191.82 g	168.64-178.18 g
For 6.5 per cent milk	24.55-29.55	191.82-200 g	178.18-188.64 g
For 7.0 per cent milk	25.91-30.91	202.27-213.64 g	188.18-198.64 g
Requirements for growing dairy cattle:			

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27.27 body weight	90 91-0.25	454.55-590 g	545.45-727.27 g
45.45 body weight	136.36-181.82	636.36-954.55 g	681.82-1.05 g
68.18 body weight	195.45-236.36	1.136-1.59	1.14-159
90.91 body weight	240.91-28182	1.59-2.05	1.5-1.95
136.36 body weight	304.55-350	2.27-2.73	2.05-2.5
181.82 body weight	345.45-395.45	2.73-3.18	2.45-2.86
227.27 body weight	368.18-418.18	3.14-3.68	2.77-3.27
272.73 body weight	200-431.82	3.59-4.14	3.19-3.64

Scandinavian Feeding System:

One feed unit is equivalent to 454.54 g of ground oats
495.45 g of wheat middling
581.8 g of wheat bran
431.82 g of barley, ground
386.36 g of linseed cake
1.98 kg of oat straw, or
3.66 kg of green corn fodder.

One feed unit is required for every 68.18 kg of body weight and one feed unit for every 1.36 kg of milk produced (Mahanta, 1958)

The following feedstuffs and energy value were calculated by Kaira (2002).

Table 15 Dry Matter and Energy Value of Different Feed Stuffs Consumed per Cow per day

Feedstuffs	**Dry amount consumed per cow (kg)**	**Energy k Cal(all the values are per kilogram)**	**Energy Value of the feed consumed per cow (K cal)**
Wheat straw	5.00	3785.40	18927.00
Wheat flour	1.92	3739.06	7179.00
Green grass	0.84	3802.38	3194.00
Oak leaves	2.02	42.08	85.00
Concentrate	1.16	3209.48	3723.00
Soyabean	0.84	4273.81	3590.00
Total per day	**11.78**	**3115.28**	**36698.00**

Table 16 These Feedstuffs and Feed Values Given by Uttarakhand Livestock Development Board (ULDB) (ASCAD, Champawat)

Feedstuffs	**Per cent**
Oat/Maize	25.87
Rice straw	15.46
Wheat Flour	32.99
Mustard leaves	25.77

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The Input function:

About 75.00 per cent cattle are stall-fed throughout the year in the region. In Kumaon Region, the grazing area is limited, which is only 131862 ha and contributes to 7.33 per cent of the total land use. The major constituents of the animal diet include straw of major grains, namely, madua, savan, paddy, wheat straw, rice straw, wheat flour oat hay, maize stalks, jowar stalks, legume bhusa, grass hay, ragi hay, bajra stalks, berseem hay, lucerene, shaftal, senji, jowar, guara, sugarcane tops, etc. Other important items included are gram, various brans, arhar bran, rice hulls and bhimal leaves, mustard oil-cake, linseed cake, till cake, ground-nut cake, oats, wheat bran, guinea grass, elephant grass and napier grass, etc. Fodder crops are practically non-existent and almost all of the feed items are the by-products of crops grown for human consumption.

The different feeding standards as given by various workers have been described briefly in the foregoing sections. However, here a simplistic feed for the cattle of the region is being proposed keeping in view that the farmers should find the method easy enough to actually implement it in their animal keeping operations. For this purpose the recommendation of the 'Uttarakhand Livestock Development Board' has been followed regarding the ratio of different components of the cattle feed and calculated the weight of these components based on the daily average feed of a cow, that is, 20 kg. The calorific value of the feedstuffs, thus obtained (36446.4 kCal) is almost the same as has been given by Kaira (2002). The proximate analysis of the rice straw shows that it consists of 1440 kCal energy value/ kg and the energy value from the rice straw feed consumed per cattle unit is 4449.60 kCal. Oat/Maize has a net energetic value of 1980 kCal/ kg and the feed consumed by per cattle unit yields 10236.60 kCal energy value. Wheat Flour has an energetic value of 2880 kCal/ kg, while the energy value of the feed is 18979.20 kCal per cattle unit. Berseem has an energy value of 540 kCal/ kg and energy is 2781.00 kCal per feed (Table 13).

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Table 17 Dry Matter and Digestible Energy Value of Different Feed Stuffs Consumed per kg.

Feedstuffs	Feed in Per cent	Feed in kg	Energy value in feed (kCal/kg)	Energy Value of the feed consumed per cattle unit (kCal)
Rice straw	15.45	3.09	1440	4449.60
Oat/Maize	25.85	5.17	1980	10236.60
Wheat Flour	32.95	6.59	2880	18979.20
Berseem	25.75	5.15	540	2781.00
	100.00	**20**	**6840**	**36446.40**

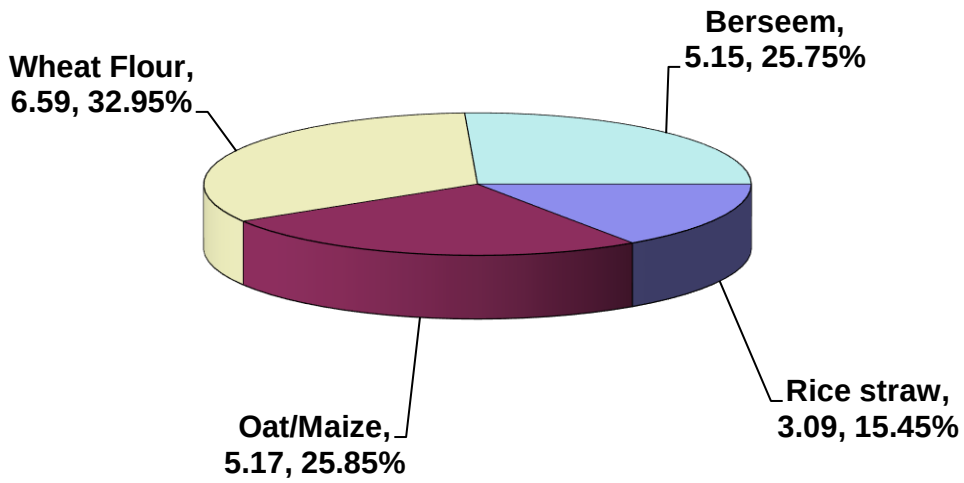

Fig. 7 Weight (in kg) (and per cent share) of Different Feed Stuffs Consumed in an Optimum Diet of Cattle

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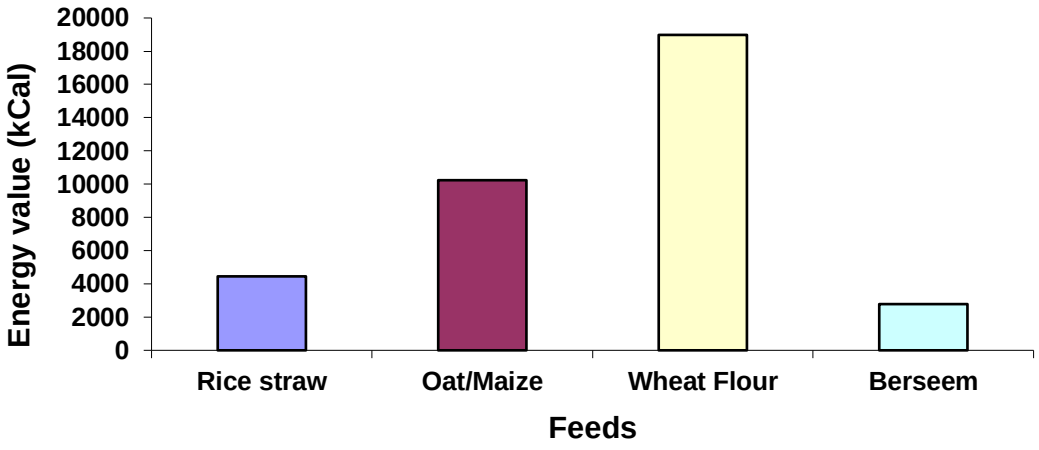

Fig. 8 Energy Value (kCal) of Different Feed Stuffs Consumed Per Cattle Unit

For input output analysis it has been assumed that one cow equals to one cattle unit and one buffalo is equivalent to 1.5 cattle units as given by many scholars (Kaira, 2002). The input of energy for cattle is the fodder that it eats, which is 36446.40 kCal per animal unit per day.

The animal output was calculated in the form of milk and dung because for the present work only milk yielding animals have been considered. On an average one cow yields 3.23 kg per day and buffalo yields 5 kg per day. However, the energy yield is different, being 670 kCal / kg for cow milk and 1170 kCal / kg for buffalo milk. Thus, the total daily energy output of all the milch animals under study is 2.703 x 10^9 kCal, which is equivalent to 4063.535 kCal per unit milch animal per day. Similarly, we have determined the dung output as 12 kg per cow and 20 kg per buffalo, energy yields being 3057.23 kCal / kg for cow and 2818.33 kCal / kg for buffalo. The total energy output of all the milch animals under study from dung is 6.232 x 10^9 kCal, which is equivalent to 9366.960 kCal per animal per day.

Thus, the total input per animal is 36446.40 kCal and 13430.495 kCal is total output, this gives 23015.905 kCal energy that each animal consumes for its sustenance. If these values are converted into efficiency, then on an average the Energy for Maintenance and Growth (Emg) in per cent per animal is 41.44% or 21.565 x 10^9 kCal.

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(i) Energy for Maintenance and Growth (Emg) for per cow
= Calories of total consumption – Calories of Useful Production
= 36446.400 - 9499.125 = 26947.275 kCal
Energy for Maintenance and Growth (Emg) in per cent
= 9499.125 kCal x 100 / 26947.275 kCal
= 35.25%
(ii) Energy for Maintenance and Growth (Emg) for per buffalo
= Calories of total consumption - Calories of Useful Production
= 54669.600 - 17123.520 = 37546.080 kCal
Energy for Maintenance and Growth (Emg) in per cent
= 17123.520 kCal x 100 / 37546.080 kCal
= 45.61%

From the above analysis it is clear that buffaloes are more efficient utilizers of energy, being almost 10% better than cows.

Table 18 Daily Input–Output Analysis of Milch Cattle Animal Energy

S.No.	Dung Production	Nos.	Dry Dung (kg)	kCal/kg	Total kCal
(i)	Cow	322270	773448	3057.23	2364608429
(ii)	Buffalo	343069	1372276	2818.38	3867595233
	Total	**665339**	**2145724**		**6,232,203,662**

S.No.	Milk Production	Nos.	Total Milk (kg)	kCal	Total kCal
(i)	Cow	322270	1039813	670	696674710
(ii)	Buffalo	343069	1715345	1170	2006953650
					2,703,628,360

Input - animal feed	30.501 x 10^9 kCal
Milk production	2.704 x 10^9 kCal
Dung production	6.232 x 10^9 kCal
Total Output	8.936 x 10^9 kCal
Net Production (Output - Input)	21.565 x 10^9 kCal
Gross Energetic Efficiency (E_{ge}) (Output x 100 / Input)	29.30%

Energy for Maintenance and Growth (Emg)
= Calories of total consumption - Calories of Useful Production
= 30.501 x 10^9 - 8.936 x 10^9 kCal= 21.565 x 10^9 kCal

Energy for Maintenance and Growth (Emg) in per cent
= 8.936 x 10^9 kCal x 100 / 21.565 x 10^9 kCal = 41.44%

Energy Development and Management

Energy plays a crucial role in diverse processes and activities that take place in the society. Energy is a complex process as it is possible to convert it into different forms, transport it,

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store it in some forms and use it in various end use modes in numerous places. Most of the energy sources are substitutable to each other due to the fact that some form of energy can be converted to other form (Ramachandra, 2003).

Dung Uses

In many parts of the developing world, cow dung is used as a fertilizer and fuel. Caked and dried cow dung (*kanda*) is used as a fuel to cook food in many parts of India, especially in North India where it is known as gobar. Cow dung is also used as manure.

Manure (Fertilizer)

Manure is organic matter used as fertilizer in agriculture. Manures contribute to the fertility of the soil by adding organic matter and nutrients, such as nitrogen that is trapped by bacteria in the soil. Manure has been used for centuries as a fertilizer for farming, as it is rich in nitrogen and other nutrients which facilitate the growth of plants. Liquid manure from pig/hog operations is usually knifed (injected) directly into the soil to reduce the unpleasant odours. Manure from hogs and cattle are spread on fields using a manure spreader. Due to the relatively lower level of proteins in grasses, which herbivores eat, cattle manure has a milder smell than the dung of carnivores — for example, elephant dung is practically odourless. However, due to the quantity of manure applied to fields, odour can be a problem in some agricultural regions. Poultry droppings are harmful to plants when fresh but after a period of composting are valuable fertilizers.

Crop Residues Mixed with Animal Dung

Biogas (fuel)

Biogas is a product of anaerobic fermentation of organic matters and consists of around 60-70% methane and 30-40% carbon dioxide. The input material for the biogas digesters are the wastes that are found locally, such as animal dung, agricultural residues and leaf litter from forests. The residues are introduced into a closed digester, where in the absence of free oxygen the responsible microorganisms work successively to convert complex organic matter into CH_4, CO_2, H_2 and H_2S (Ramachandra, 2003).

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A View of Biogas Plant

Rural population of Kumaon still depends on the traditional devices for cooking and water heating, space heating, which is energy inefficient and leads to excess consumption of local resources. Lack of information about the resources and technologies may be cited as the reason for this situation. Cattle dung is being predominantly used in rural area either for preparing farmyard manure by composting it or directly preparing dung cakes for burning as cooking fuels. Preparation of cakes and burning are highly uneconomical and unhygienic. In this context, anaerobic digestion of animal residues not only provides valuable cooking fuel, in the form of biogas and enhances the manure value of the waste but also provides a convenient, safe and aesthetic waste disposal method. For several decades, biogas has been promoted as an appropriate rural technology, enabling an effective utilization of a local resource. It is a clean and convenient fuel at low cost, besides being environmentally friendly. Women no longer have to spend hours away from their homes, travelling (often long) distances to collect wood for cooking and heating, they can free up valuable time for activities, which they would otherwise be unable to do. A smoke-free and ash-free kitchen means women are no longer prone to lung and throat infections and can look forward to a longer life expectancy. It is suitable for practically all the fuel requirements in the household, agriculture and industrial sectors. For instance, domestically, it can be used for cooking, lighting, water heating, running refrigerator, water pumps and generators.

The survey carried out during the present study in 12 sample villages of Kumaon Himalaya during July-August, 2007 shows that dung available per animal in case of cow and bull is about 12 kg/adult animal and, buffalo is 20 kg. The total dung available per day per village has been estimated. With the assumption of 0.036 m^3 (Ramachandra *et al.*, 2005) of biogas yield per kg of cattle/buffalo dung, the total quantity of gas available (if all is used for biogas) is estimated. It is estimated that per capita

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requirement of gas for domestic purposes is about 0.34-0.43 m3 (average 0.38) per day.

Table 19 Per day Biogas Production in Sample Villages of the Study Region

Name of the sample village/District	No. of Dung Animals	Per day Dung Production kg	Per day Biogas Production if all is used for biogas (in m^3)
District Bageshwar			
1. Sama	1568	14252	513.08
2. Bahuli	258	3398	122.33
District Almora			
3. Sirkhon	15	256	9.22
4.Lawal Bakhal	46	768	27.65
District Champawat			
5. Gazina	27	371	13.36
6. Lodhan Tukra	34	486	17.50
District Pithoragarh			
7. Jajurali	354	3736	134.50
8. Balure	48	441	15.88
District U.S. Nagar			
9. Madnapur	552	7793	280.55
10. Missarwala	537	7294	262.58
District Nainital			
11. Bhawanpur Jai Singh	133	2371	85.36
12. Gadhuder	25	222	8.00

Source: Field Survey, 2007

A kilogram of dung produces 40 litres of biogas and a family size biogas plant (2-4 m^3) requires 50 kg of dung and equal amount of water to produce 2000 litres of gas/day, which would be sufficient for cooking purposes in a family of 4-5 members. The calorific value of biogas is obtained by multiplying that of methane with the volume fraction of methane in biogas. The calorific value of methane is 8548 kCal m^{-3} (Ravindranath and Hall, 1995). Thus, we can say per person requirement of dung for biogas for cooking purposes is approximately 10.5 kg/day. Biogas demand is computed by multiplying the adult equivalent of a village population and per capita biogas requirement. Demand of 0.34-0.43 m3 per day was considered for computing low and high

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values of biogas demand in a village (Ramachandra *et al.*, 2004).

Table 4.20 Requirement of Dung for Cooking Gas in the Region

District	Total population	Per day Biogas Requirement in (m^3)	Requirement of Dung for cooking gas (in kg /day)
Almora	630567	239615.46	6655985
Bageshwar	249462	94795.56	263810
Nainital	762909	289905.42	8052928
U.S. Nagar	1235614	469533.32	13042592
Pithoragarh	462289	175669.82	4879717
Champawat	224542	85325.96	2370166
Total	**3565383**	**1354845.54**	**35265198**

Source: District Sankhiki Patrika, 2001 and Field Survey

Biogas has a higher heating value than producer gas and coal gas, which implies increased services. As a cooking fuel, it is economical and extremely convenient. Based on the effective heat produced, a 2 m^3 biogas plant could replace, in a month, fuel equivalent of 26 kg of LPG (nearly two standard cylinders), or 37 litres of kerosene, or 88 kg of charcoal, or 210 kg of fuel wood, or 740 kg of animal dung. Also biogas has no danger of health hazards, offensive odour and burns with clean bluish sootless flame thereby making it non-messy to cooking utensils and kitchens. In terms of cost, biogas is more economical, on a life cycle basis, than conventional biomass fuels (dung cakes, fuelwood, crop wastes) as well as LPG and is only fractionally more expensive than kerosene; the commercial fuels like kerosene and LPG, however, have severe supply constraints in the rural areas (Soma *et al.*, 1997). Biogas technology enhances energy supply decentralization, thus enabling rural areas meet their energy requirements especially when the commercial fuels are inaccessible for their use. A comparison of directly using the dung and its use as biogas shows 25 kg fresh dung would give about 5 kg of dry dung, which is equivalent to one m^3 of biogas. An important benefit of the technology is saving on fuelwood. Construction of biogas plants also creates good employment opportunities in rural areas.

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Milk Uses

Efforts to improve dairy production in India began under the First Five Year Plan (1951-56). More than half of the expenditures on dairy development under the First and Second Plans were on crossbreeding and artificial insemination. Government programmes such as the Key Village Scheme (KVS) and the Intensive Cattle Development Programmes (ICDP) emphasized using improved breeds of cattle to enhance milk production. But the total public sector outlay on the dairy sector was not very large - in fact, until the end of the Seventh Five Year Plan, funds for the Animal Husbandry and Dairying Sector equalled only about 1 per cent of the total public sector expenditures (J. George, 1988). Operation Flood (OF), launched in 1970, has played an important role in this transformation (Alderman *et al*., 1987).

Dairy products are generally defined as foodstuffs produced from milk. They are usually high-energy-yielding food products. A production plant for such processing is called a dairy or a dairy factory. Raw milk for processing generally comes from cows, but occasionally from other mammals such as goats, sheep, buffalo.

Milk

Milk after optional homogenization, pasteurization, in several grades after standardization of the fat level, and possible addition of bacteria *Streptococcus lactis* and *Leuconostoc citrovorum*. First use besides milk is its thicker form the cream, which are of different kinds, namely, Creme fraiche, slightly fermented cream, Smetana, Central and Eastern European variety of sour cream, and clotted cream, thick spoonable cream made by heating. The other forms of milk that available are:

- Cultured buttermilk, fermented concentrated (water removed) milk using the same bacteria as sour cream
- Kefir, fermented milk drink resembling buttermilk but based on different yeast and bacteria culture
- Kumis/Airag, slightly fermented mares' milk, popular in Central Asia
- Milk powder (or powdered milk), produced by removing the water from milk are of different varieties:
    a) Whole milk & buttermilk
    b) Skimmed milk
    c) Cream
    d) High milk-fat & nutritional powders (for infant formulas)

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e) Cultured and confectionery powders

- Condensed milk, milk which has been concentrated by evaporation, often with sugar added for longer life in an opened can
- Evaporated milk (less concentrated than condensed), milk without added sugar
- Ricotta cheese, milk heated and reduced in volume, known in Indian cuisine as Khoa
- Infant formula, dried milk powder with specific additives for feeding human infants

Butter

Butter, mostly milk fat is produced by churning cream and is available in the following varieties:

a) Buttermilk, the liquid left over after producing butter from cream, often dried as livestock food

b) Ghee, clarified butter, by gentle heating of butter and removal of the solid matter

c) Anhydrous milk fat

Cheese

Cheese produced by coagulating milk, separating from whey and letting it ripen, generally with bacteria and sometimes also with certain molds. Cheese of different varieties is used in European dishes and an unfermented variety cottage cheese is commonly called paneer is used in India. The various varieties are enumerated below:

a) Curds, the soft curdled part of milk (or skim milk) used to make cheese (or casein)

b) Whey, the liquid drained from curds and used for further processing or as a livestock food

c) Cottage cheese

d) Cream cheese, produced by the addition of cream to milk and then curdled to form a rich curd or cheese made from skim milk with cream added to the curd

Casein

It is produced when milk is curdled by rennet, is the chief constituent of cheese. The different forms of casein are:

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a) Caseinates
b) Milk protein concentrates and isonates
c) Whey protein concentrates and isonates
d) Hydrolysates
e) Mineral concentrates

Yogurt

Yogurt is milk fermented by *Streptococcus salivarius ssp. thermophilus* and *Lactobacillus delbrueckii spp. Bulgaricus* sometimes with additional bacteria, such as *Lactobacillus acidophilus*. The different forms of yogurt are: Ayran, Lassi and Clabber (food), milk naturally fermented top yogurt like state, Gelato, slowly frozen milk and water, lesser fat than ice cream and frozen yogurt, yogurt with emulsifiers that are frozen.

Meat Uses

In the region there are three types of meats - goat meat, poultry meat and pork meat:

Goat meat

While “goat” is usually the name for the meat found in common parlance, producers and marketers may prefer to use the French-derived word chevon (from *chèvre*), since market research in the United States suggests that “chevon eater” is more palatable to consumers than “goat eater”. Goat can be prepared in a variety of ways including stewed, curried, baked, grilled, barbecued, minced, canned, fried, or made into sausage. Goat jerky is also another popular variety. In India, the rice-preparation of mutton biryani uses goat meat as its primary ingredients to produce a rich taste. Goat has a reputation for strong, gamey flavour, but can be mild depending on how it is raised and prepared. Despite being classified as red meat, goat is leaner and contains less cholesterol and saturated fat than both lamb and beef. This makes it healthier to eat, but can require low-heat, slow cooking in order to preserve tenderness and moisture (Fletcher, 2008; Severson, 2008; Alford, 2009).

Poultry Meat

Poultry is the category of domesticated birds which some people keep for the purpose of collecting their eggs, or kill for their meat and/or feathers. These are most typically members of the superorder Galloanserae (fowl), especially the order Galliformes (which includes chickens, quails and turkeys) and the family Anatidae (in order Anseriformes), commonly known as “waterfowl” (e.g. domestic ducks and domestic geese). Poultry also includes other birds which are killed for their meat, such as pigeons or doves or birds

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considered to be game, like pheasants. The meatiest parts of a bird are the flight muscles on its chest, called breast meat, and the walking muscles on the first and second segments of its legs, called the thigh and drumstick, respectively. White meat has less oxygen-carrying myoglobin than the dark meat, and is thus lighter in colour. Dark meat comes from muscles more heavily exercised, which therefore have more fat stored in them. This accounts for both dark meat's reputation as being unhealthier, and yet more flavourful.

Pork Meat

Pork is the culinary name for meat from the domestic pig (*Sus domesticus*). The word, pork, is often meant to denote specifically the fresh meat of the pig, but it can be used as an all-inclusive term, to include cured, smoked, or processed meats (ham, bacon, prosciutto, etc.). It is one of the most-commonly consumed meats worldwide with evidence of pig husbandry dating back to 5000 BC (Raloff, 2003).

Pork is eaten in various forms, including cooked (as roast pork), cured or smoked (ham, including the Italian *prosciutto*) or a combination of these methods (gammon, bacon or *Pancetta*). It is also a common ingredient of sausages. Charcuterie is the branch of cooking devoted to prepared meat products, many from pork. Pork is a taboo food item in Islam and Judaism, and its consumption is forbidden in these two religions.

Poultry Eggs

Bird eggs are a common food and one of the most versatile ingredients used in cooking. They are important in many branches of the modern food industry. The most commonly used bird eggs are those from the chicken, duck and goose eggs (Montagne, 2001; Roux, *et al.*, 2006; Stadelman, 1995). Most commercially produced chicken eggs intended for human consumption are unfertilized, since the laying hens are kept without roosters. Fertile eggs can be purchased and eaten as well, with little nutritional difference. Fertile eggs will not contain a developed embryo, as refrigeration prohibits cellular growth for an extended amount of time. Chicken eggs are widely used in many types of dishes, both sweet and savoury. Eggs can be pickled, hard-boiled, soft-boiled, scrambled, fried and refrigerated. In addition, the protein in raw eggs is only 51% bio-available, whereas that of a cooked egg is nearer 91% bio-available, meaning the protein of cooked eggs is nearly twice as absorbable as the protein from raw

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eggs (Evenepoel *et al.*, 1998). Eggs supply all essential amino acids for humans (FAO) and provide several vitamins and minerals, including vitamin A, riboflavin, folic acid, vitamin B6, vitamin B12, choline, iron, calcium, phosphorus and potassium. They are also an inexpensive single-food source of protein. All of the egg's vitamins A, D and E are in the egg yolk. The egg is one of the few foods which naturally contain Vitamin D. A large egg yolk contains approximately 60 calories (250 kilojoules); the egg white contains about 15 Calories (60 kilojoules). A large yolk contains more than two-thirds of the recommended daily intake of 300 mg of cholesterol (although one study indicates that the human body may not absorb much cholesterol from eggs. Koo, Sung, and Molina, Marcia (2001) the yolk makes up about 33% of the liquid weight of the egg. It contains all of the fat in the egg and slightly less than half of the protein and much of the nutrients. It also contains all of the choline, and one yolk contains approximately half of the recommended daily intake. Choline is an important nutrient for development of the brain.

Wool Uses

Animal fibres are natural fibres that consist largely of particular proteins. Instances are silk, hair/fur (including wool) and feathers. The most commonly used type of animal fibre is hair. The United Nations General Assembly declared 2009 as the "International Year of Natural Fibres" (20 December 2006). Wool is the fibre derived from the fur of animals of the Caprinae family, principally sheep, but the hair of certain species of other mammals such as goats and rabbits may also be called wool.

Sheep Wool

Wool has two qualities that distinguish it from hair or fur: it has scales which overlap like shingles on a roof and it is crimped; in some fleeces the wool fibres have more than 20 bends per inch. Wool varies in diameter from below 17 micrometers to over 35 micrometers. The finer the wool, the softer it will be, while coarser grades are more durable and less prone to pilling

Angora wool

Angora wool or Angora fibre refers to the downy coat produced by the Angora rabbit. Angora is prized for its softness, thin fibres of around 12-16 micrometers for quality fibre,

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and what knitters refer to as a halo (fluffiness). Angora fibre comes in white, black, and various shades of brown.

Cashmere wool

Cashmere wool is wool obtained from the Cashmere goat. Cashmere is characterized by its luxuriously soft fibres, with high napability and loft. In order for a natural goat fibre to be considered Cashmere, it must be under 18.5 micrometers in diameter and be at least 3.175 centimetres long. It is noted as providing natural light-weight insulation without bulk. Fibres are highly adaptable and are easily constructed into fine or thick yarns, and light to heavy-weight fabrics.

Draught Uses

Three basic energy systems used globally are: (1) manual farming tools, (2) draught animal power and (3) mechanized system. In fact these energy systems, barring in some marginal areas, are usually found side by side, although they vary in distribution and relative importance (Bodet, 1987). The role of draught animals is very important in the hill agriculture system as well as of Indian agriculture. Draught animal power (DAP) is obviously the most suited to mountain agriculture (Gill, 1981; Bhalla and Chadha, 1982; Nair, 1982; Ramaswamy, 1983; Bodet, 1987; Singh and Naik, 1987; Reijnties, 1992). The characteristics of draught power can be summarised as:

a. The source of draught energy already exists in the region. DAP does not have to be manufactured or bought at a high cost.

b. Machine-based energy results in the concentration of production on a limited number of crops, thus reducing the diversity of the system.

c. The use of draught animals enables farmers to integrate livestock and crop production and permits the exploitation of the potential of cattle kept on settled, subsistence farms.

d. Animal-drawn implements are cheaper than mechanised equipment. Animal-drawn implements can be made locally and are more suitable for the small, often fragmented and scattered, mountain farms.

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e. Where animals are used as draught power, it is possible for farmers to either cultivate more land or use the time for other activities.

The Primary and Secondary Roles of Draught Animals:

In addition to providing draught power for agriculture, draught animals play many other roles in the mountain farming system; these can be referred to as their secondary roles. Primary roles include ploughing or tillage, levelling, pudding, earthing-up, and weeding and threshing.

Conclusion:

Animal husbandry is an important part of the traditional agricultural systems in the study region. Meat and milk are important diets in the meals of the local people and keeping of domestic animals is a traditional system of the region. Livestock products can be broadly categorized into three groups namely milk, meat (mutton, chevon, pork, and poultry including egg) and inedible products including by-products. The demand and supply of major livestock products, namely milk and milk-products, meat and meat-products, eggs, poultry, etc. are all highly perishable and require immediate processing/preservation to enable their movement from production to the demand centres.

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