Energy flows through animal husbandry practices among the tribal communities in North-east India

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Energy and economic efficiencies of different animal husbandry systems (poultry, duck, piggery, goat and cattle) of the Garo, Khasi, Mikirs and Nepali tribes were compared. Swine husbandry was integral to all communities except immigrant Nepalis. The Nepalis and the Mikirs raised cows for milk production while others used them for beef. The output/input patterns varied, depending upon the labour and food energy inputs, and the frequency of slaughter of the animals. The animal husbandry in all communities is based on resource recycling from the agricultural system. The possibilities of more efficiency in recycling resources and improvements in this subsystem of a village are discussed.

Introduction

Closely linked with the shifting agriculture practised by the tribals in North-east India [1–2] is the animal husbandry system involving swine husbandry and poultry [3]. Apart from this, goat and cattle husbandry has been introduced by immigrant Nepalis and the plain tribals (Mikirs) of the Assam valley. In a heterogeneous cluster of villages represented by different tribal communities and the Nepalis, the animal husbandry system would differ because of socio-cultural differences and resource availability. Through earlier studies [4–6] the close linkage that exists between shifting agriculture and swine husbandry has been established. The latter is based on a tight recycling of resources from the agriculture sub-system of the village. Swine husbandry being detritus-based does not cost anything to the tribal farmer. Therefore, the present study is aimed at understanding: (1) the different animal husbandry systems practised by tribal and non-tribal communities at Lailad in Meghalaya under varied socio-economic and socio-cultural backgrounds, and (2) the ecological and economical accounting of energy and monetary inputs and outputs for improving animal husbandry.

Study area

This study was conducted at Lailad located about 70 km north of Shillong (25 °45'N, 91 °45'E) at an altitude of about 2960 m in the Khasi hills of Meghalaya. For this study tribal and non-tribal villages, namely Nongladoh (Garos), Nongkindrih (Khasis), Umsophy (Mikirs) and Tasku (Nepalis) were selected. Table 1 provides the break up of animal types in each village. The climate at Lailad is hot and humid with an annual average rainfall of 1435 mm. The climate has three distinct seasons (1) a dry and windy summer that extends from mid-February to May, with an average maximum temperature of 34°C and a minimum of 23°C, (2) a rainy season from May to October; this is a warm period with high humidity with the average maximum temperature being 35°C and minimum 27°C, and (3) winter, with an average maximum temperature of 28°C and an average minimum of 17°C, extends from November to mid-February.

Description of animal husbandry

With slash-and-burn agriculture being the main pattern of land use in the tribal areas of the north-eastern hill region of India; poultry, duck, swine, goat and cattle rearing are the commonly observed animal husbandry practices. With a relatively richer primary resource base, maintenance of animal husbandry becomes cheap. Swine husbandry is based on recycling of detritus from the agriculture system. Duck husbandry is not very common and is practised only by a few tribal families. Poultry and duck husbandry are based on scavenging by the animals

Table 1. Population of various animal categories in the study area

	Garos/ Nongladoh	Khasis/ Nongkindrih	Mikirs/ Umsophy	Nepalis/ Tasku
Number of households	70	34	10	4
Total human population	624	205	86	27
Total animal population	1071	462	124	49
Cattle (total)	222	32	3	17
Cattle for slaughtering	176	32	..	..
Bullock for ploughing	46	..	..	4
Milking cow	..	..	3	13
Goats (total)	..	39	13	6
Adults	..	35	10	3
Lambs	..	4	2	3
Swine (total)	78	92	24	..
Adults	73	72	20	..
Juvenile	5	20	4	..
Poultry (total)	695	299	84	26
Adult	400	200	70	15
Young	295	99	14	11
Ducks (total)	76	..	..	..

within the village boundary. Often the birds are left unattended but sometimes looked after by children, as among the Khasis. Pigs are reared, within enclosures made of bamboo, by all the tribals, but this is not a component of animal husbandry of the Nepalis. Goats were introduced into the area by immigrants (Nepalis and Mikirs). They largely browse on wild plants. Cattle are raised for meat by the hill tribes, whereas the immigrants rear the same for milk.

Methods

Observations were made for energy and economic inputs and outputs under each category of animal husbandry over a two-year period. Labour input, in man- and woman-hours, were calculated for different activities. Total food energy consumed was apportioned to each activity according to the relative duration, on the basis of groupings involving either sedentary, moderate or heavy work. Per hour energy expenditure of 0.418 MJ for sedentary work, 0.488 MJ for moderate work and 0.679 MJ for heavy work for an adult male; and 0.331 MJ for sedentary work, 0.383 MJ for moderate work and 0.523 MJ for heavy work for an adult woman were used for calculation of labour energy input into the system [7].

The estimation of the feed/fodder consumed by livestock was based on daily ration consumed by the animal, and converted to energy equivalent by multiplying the quantities consumed with standard values (Table 2). The difference between the standard food energy requirement under Indian conditions (Table 3) for each category of animal [8] was subtracted from the stall feeding values to obtain the food energy consumed through grazing/browsing.

The weight gained by each category of animal at the time of slaughter was used for calculating annual meat production. The values thus obtained were corrected using a dressing percentage of 75, 56 and 70 for pig, lamb and fowl, respectively [8] and 70 for beef (based on our observation). Using energy values 4.94, 4.56, 5.46, 4.525, 17.22 and 7.24 MJ kg^{-1} for goat meat, chicken, duck meat, cow's milk, beef and eggs, respectively [7] and 17.12 MJ kg^{-1} for pork [8], the energy equivalent of secondary production through animal husbandry was calculated.

Energy output through animal power (1 bullock hour = 3.03 MJ) was based on another work [9]. The total dung/manure production per animal of each category was expressed on a dry weight basis and then it was converted into energy by multiplying their quantities with standard values given in Table 2.

For monetary input/output analysis, labour charges for male and female workers were calculated on the basis of the prevailing daily wages of

Table 2. Energy value of different components considered in the animal husbandry system

Category	Energy value (dry weight MJ kg^{-1})
Feed/Fodder	
Vegetable waste[1]	16.39
Straw[1]	13.98
Rice bran[1]	16.44
Green fodder[1]	15.30
Tree and shrub leaves[1]	16.80
Banana (rhizome) and Colocasia (petiole)[2]	11.20
Manure	Replacement cost[3]
Swine dung	1.32
Goat dung	2.00
Poultry	4.78
Cattle dung	2.98
Organic manure[1]	7.32

[1]Mitchell, 1979
[2]Gopalan et al., 1978
[3]Percentage of N, P_2O_5 and K_2O in various items was: in swine dung - 1.4, 0.83 and 1.3; in goat dung - 2.2, 0.8 and 1.97; in poultry waste - 5.14, 4.19 and 2.5; in cattle dung - 1.71, 0.65 and 1.2

Table 3. Daily food energy requirements of different categories of animal

Category of animal	MJ/individual
Cattle	
Males over 3 years	65.20
Cow, milking	62.20
Cow, dry	60.30
Goat	
Lamb	10.50
Adult	11.30
Pig	
Juvenile	14.00
Adult	13.64
Fowls and ducks	11.30

Source: Ranjhan, 1977

Rs 10 and Rs 8, respectively. The monetary return in terms of organic manure, feed, meat, milk, egg and/or animal labour was calculated based on the prevailing market prices.

Results

Patterns of poultry raising by all communities with the exception of Khasis are similar. The Khasis alone fed crop grain to the birds (Table 4). Garos feed some grain to the ducks. Scavenging accounted for a major proportion of the food energy input into poultry. Labour input for poultry was higher for the Khasis compared to others. Apart from meat and egg, dung was an important output from poultry. The output from egg and meat was lesser for the poultry of the Khasis compared to that of others. The energy output/input ratio, however, was lower for the poultry of the Khasis compared to others, if scavenging was included, but was higher for Khasis if this input is excluded. The energy efficiency of duck husbandry was similar to poultry though slaughtering for meat takes place only once in a three years.

The monetary input into poultry was lower compared to its output resulting in higher monetary efficiency (Table 4), with maximum values for the Khasis and minimum for the Nepalis. The economic efficiency of the duck system of the Garos was very low, perhaps related to the lesser frequency of slaughter.

The major share of the energy input into piggery sub-system was from the rhizome and petiole of wild colocasia and banana from the forest, and it accounted for 99, 59 and 60% contribution for the Garos, and Khasis and the Mikirs, respectively (Table 5). Vegetable waste was another input with little labour expended for maintenance. These inputs varied for the different tribes. Meat was the main food energy output from the system and accounted for about 80–90% of the total. Slaughtering frequency differed: 6-month intervals for the Garos and up to three years in the case of the Mikirs. The output/input ratio was higher for the Khasis and the Garos and least for the Mikirs. If feed (which is a free commodity) is excluded, then the output/input ratio was very high.

The major cost for swine husbandry was for labour (Table 5), with higher returns through meat for the Khasis. Though the output was comparable to that for Garos, the net return obtained by the Mikirs was lowest because of higher labour input. The monetary efficiency of the system was higher for the Khasis and the Garos compared to the Mikirs.

A major energy input into the goat sub-system was browsing (Table 6). Labour input was only a small fraction of the total, with higher values for the

Table 4. Annual energy input/output pattern (MJ) per fowl and duck raised by different communities. (Values in parentheses are for monetary input/output pattern Rs yr^{-1})

Production measures	Poultry				Duck[1]
	Garos	Khasis	Mikirs	Nepalis	Garos
Input					
Labour	5	28	4	13	24
Grain	121	..	117	120	98
Scavenging	4004	4125	4008	4005	4027
Total±S E	4130±364	4153±335	4129±330	4138±340	4149±326
	(24±2)	(8±0.4)	(20±1)	(19±1)	(40±2)
Output					
Egg	45	37	45	32	32
Meat	3	3	3	2	6
Dung	43	34	30	31	53
Total±S E	91±6	74±5	78±6	65±5	91±7
	(129±10)	(104±8)	(125±9)	(98±5)	(96±6)
Output/input ratio	0.02	0.01	0.02	0.01	0.02
	(5.0)	(13.0)	(6.2)	(5.1)	(2.5)
Meat+egg-(scavenging)	0.4	1.4	0.4	0.3	0.3

[1]Ducks slaughtered at three-year interval
S E: Standard error

Table 5. Annual energy input/output pattern (MJ) per adult pig reared by different communities. (Values in parentheses are for monetary input/output pattern Rs yr^{-1})

Production measures	Garos[1]	Khasis[2]	Mikirs[3]
Input			
Labour	22	59	92
Wild banana and colocasia	2490	2984	2912
Vegetable waste		1994	2066
Total±S E	2512±226	5037±460	5070±467
	(38±2.4)	(94±4.6)	(164±11.0)
Output			
Meat	257	616	308
Dung	37	74	74
Total±S E	294±26	690±60	382±31
	(240±18)	(540±33)	(270±16)
Output/input ratio	0.12	0.14	0.06
	(6.3)	(5.9)	(1.6)
Meat (all types of feed and fodder)	11.7	10.4	3.3

Slaughtering interval: [1]six-month, [2]one-year, [3]three-year
S E: Standard Error

Mikirs. Meat and dung were two important outputs from the system. The energy output/input ratio was similar for all the tribes. But if browsing was excluded from the calculation higher values that were very different for the different communities were observed with higher ratios for the Khasis and the Mikirs and lower values for the Nepalis.

The economic output of goat rearing was maximum for the Mikirs and minimum for the Nepalis (Table 6). This was also reflected in the output/input

Table 6. Annual energy input/output pattern (MJ) for an adult goat reared by different communities. (Values in parentheses are for monetary input/output pattern Rs yr)

Production measures	Garos[1]	Khasis[2]	Mikirs[3]
Input			
Labour	18	26	38
Browsing	4125	4125	4125
Total±S E	4143±335	4151±340	4163±257
	(72±5)	(37±2)	(65±2)
Output			
Meat	128	138	101
Dung	124	122	110
Total±S E	252±22	260±24	211±17
	(520±40)	(560±47)	(410±28)
Output/input ratio	0.06	0.06	0.05
	(7.2)	(15.1)	(6.3)
Meat—(browsing)	7.1	5.3	2.6

Slaughtering interval: [1]six-month, [2]one-year, [3]three-year
S E: Standard error

ratio of the different communities. Because of higher labour input by the Khasis for rearing compared to the Mikirs, the efficiency of goat husbandry was higher for the latter. Further the economic efficiency of the system was also related to the frequency of slaughtering as seen from the net output which was least for the Nepalis, who slaughter animals at a two-year interval compared to the other two.

Energy input through fodder and grazing accounted for major inputs into the cattle sub-system (Table 7). By-products from agriculture was another input. Labour input for rearing the animals was higher for the Nepalis compared to others. The output/input ratio did not vary much for the Garos, the Khasis and the Nepalis for rearing cow. However, the ratio for the rearing of cow by Mikirs and bullock by the Nepalis was lower. If the food that is free is excluded, the output/input ratio increased sharply with highest efficiency for the Khasis and the least for the Nepalis. It may be noted that the slaughtering frequency varied: 3-year interval for the Garos and 2-year for the Khasis. The other two communities used cattle only for milk production.

The total output from cow was maximum for the Khasis and minimum for the Mikirs (Table 7). The output/input ratio was highest for the Khasis and least for the Nepalis. The economic efficiency of the bullocks was very low.

The food energy exported in the form of meat, egg and milk was highest for the Garos followed by the Nepalis and the Khasis, with least values for the Mikirs (Table 8).

Discussion

Of the secondary production systems, swine husbandry and poultry are two traditional activities of tribal communities in the region [3–5]. Goat and cattle rearing are two animal husbandry activities introduced into the region by immigrant Nepalis and practised by the traditional communities wherever the influence of the immigrants has been strong. However, the objective of cattle rearing by the Nepalis and the plains tribal Mikirs is milk production and this differs from the objectives of the hill tribes such as Garos and the Khasis, who raise them exclusively for meat.

An important observation of the present study is the low cost of animal husbandry in the humid tropics [10, 11] which contrasts sharply with that of temperate regions. This is partly because natural resources in the humid tropics are relatively more abundant [12, 13] and in areas such as north-east India the population pressure is less [14]. However, the reduced cost of animal husbandry is reflected in the generally lower outputs. Of all the animal husbandry practices, swine husbandry is perhaps the cheapest to maintain [14]. Swine husbandry is ideal for efficient recycling of resources from and to the agricultural system. The waste products from agriculture including food items unfit for human con-

Table 7. Annual energy input/output pattern (MJ) per adult cattle reared by different communities. (Values in parentheses are for monetary input/output pattern Rs yr^{-1})

Production measures	Garos		Khasis	Mikirs	Nepalis	
	Cattle[1]	Bullock[2]	Cattle[3]	Cow[4]	Cow[5]	Bullock[6]
Input						
Labour	264	264	81	69	430	72
Fodder/grazing	22782	23788	23447	14390	19116	21139
Crop by-product	1016	..	351	8313	3587	2659
Total±S E	24062±2022	24052±2022	23879±1888	22772±1781	23133±1856	23870±1180
	(160±13)	(160±14)	(64±4)	(85±6)	(157±12)	(82±5)
Output						
Meat	1722	..	1937	..	..	..
Milk	..	..	..	767	1745	..
Animal labour	..	566	..	..	..	210
Dung	7130	6882	7197	6270	6882	6882
Total±S E	8852±658	7448±436	9134±686	7037±412	8627±626	7092±418
	(1210±102)	(440±32)	(1500±105)	(556±30)	(1242±110)	(90±6)
Output/input ratio	0.4	0.3	0.4	0.3	0.4	0.3
	(6.6)	(2.5)	(23.4)	(6.5)	(7.9)	(1.1)
Meat/milk/animal labour - (fodder and crop-by-product)	6.5	2.1	24	111.1	4.1	2.9

Slaughtering interval: [1]three-year, [2]two-year
Bullock used for ploughing after age of: [3]four-year, [6]three-year,
Cow milked after age of: [4]three-year, [5]four-year
S E: Standard error

Table 8. Annual energy export (MJ/family) of different communities

Category	Garos	Khasis	Mikirs	Nepalis
Goat Meat	..	96	104	86
Chicken/duck meat	29	12	10	9
Pork	379	1003	398	..
Beef	4092	1741	..	..
Egg	230	85	102	55
Milk	..	..	..	3170
Total	4730	2937	614	3320

sumption are recycled through swine husbandry. This detritus-based system, therefore, is closely interlinked with slash and burn agriculture throughout the world [15, 16, 2, 4–6]. Marked differences exist in the meat production per animal. This is because of differing frequencies for animal slaughter by the different tribes. Thus with slaughter at six monthly intervals, the annual return was lower for the Garos than for the Khasis who slaughter at yearly intervals. A slaughtering interval of one year seems to be more appropriate.

Poultry is another animal husbandry system that is detritus based and this system of the Garos is the most efficient because the animals are allowed to scavenge for longer time along with a rationed supply of grains. Since a substantial amount of poultry dung is not utilized by any of the tribes, this offers possibilities of use either for traditional agriculture or even for raising mushroom as an additional activity for these tribes. Pig dung also under this category at present goes waste.

Compared to piggery, the energy efficiency of the goat husbandry is lower. Interestingly, the efficiency of cattle farming was higher than that of swine husbandry. This is some what misleading because this efficiency is dependent upon the availability of fodder resources and grazing lands, which at present is not a limiting factor but could be so as in western Himalayas, where the grasslands are degraded [17, 18].

While the Mikirs and the Nepalis use cattle only for milk production, the Khasis and the Garos use them for meat. Though the Khasis slaughter cattle once in two years compared to the Garos who do it

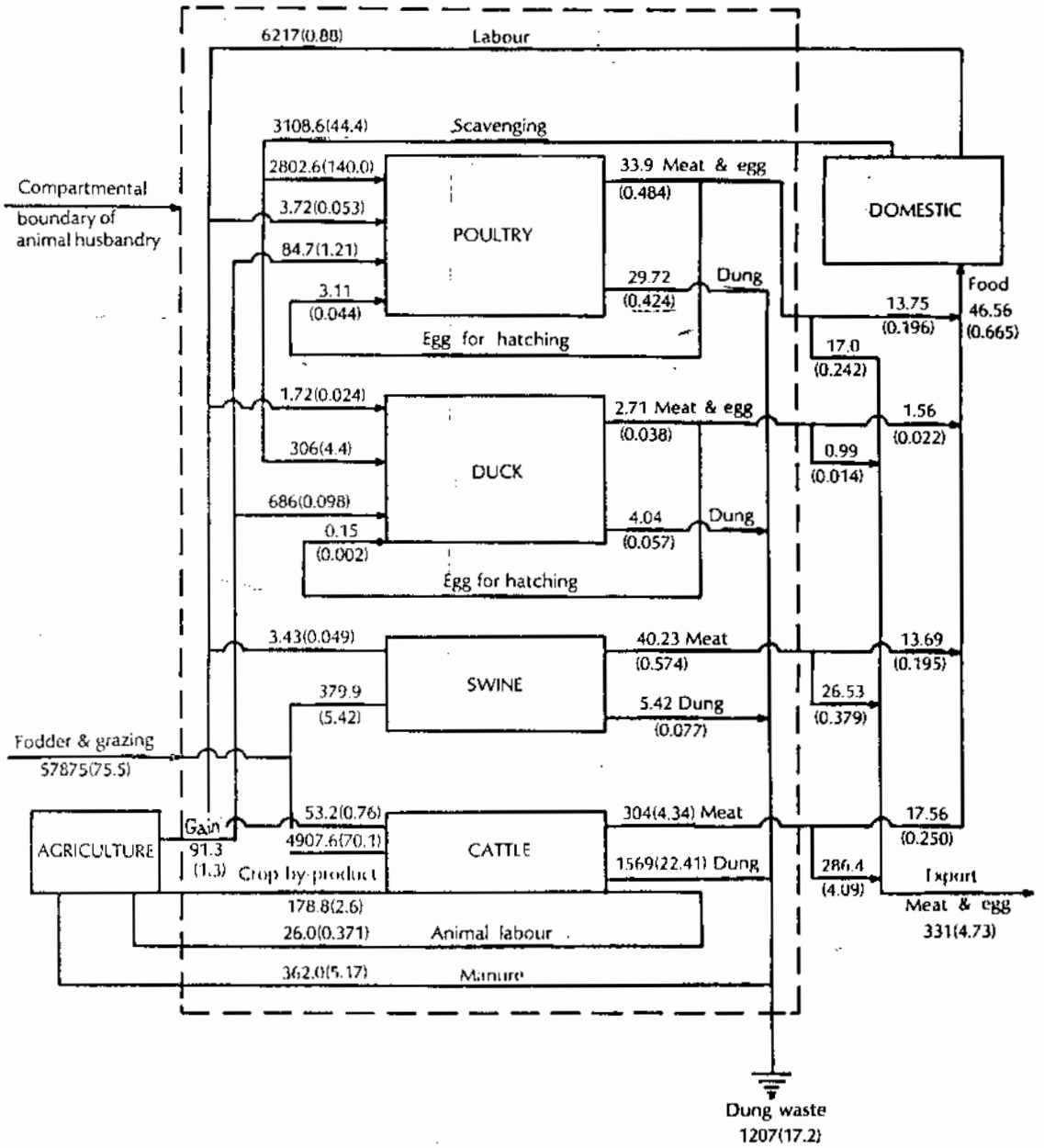

Fig. 1. Energy flow through different components of animal husbandry in a Garo village at Nongladoh. Values in parentheses are per family. Unit = MJ x 10^3

once in three years the efficiency for the former is only slightly lower than for the latter. Raising bullocks as done by the Nepalis, only for labour is the least efficient.

In the same area, different communities show different values for energy export and for monetary returns from animal husbandry systems. Thus the Khasis are better off than others for poultry and cattle. The Garos have an advantage with respect to swine husbandry unlike the Mikirs whose system is inefficient. The goat husbandry of the Mikirs gives better returns for the investment. These are largely related to the kind of produce obtained and the frequency with which animals are slaughtered for meat.

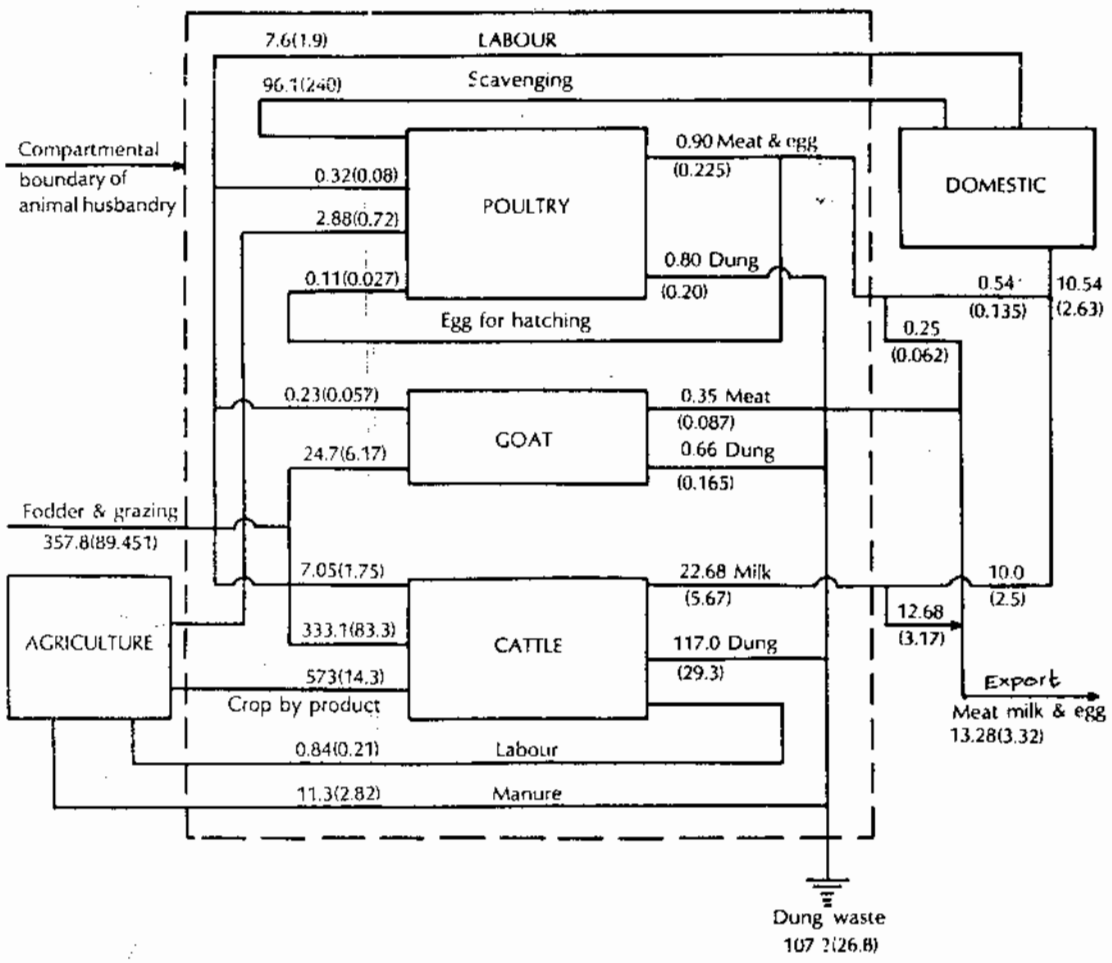

Fig. 2. Energy flow through different components of animal husbandry in a Nepali village at Tasku. Values in parentheses are per family. Unit = MJ x 10^3

The diagrammatic presentation of energy flows in different categories of animal husbandry systems is presented in figures 1 and 2 for the Garos and Nepalis. These show the interlinkage within the animal husbandry systems, and with agriculture and domestic sectors. The total food energy input for the domestic sector from animal husbandry was different with 46.6×10^3 MJ and 10.5×10^3 MJ for the Garos and the Nepalis, respectively. The per capital food consumption was highest for the Nepalis but the Garos were better off amongst the tribals. Further, the food energy exported outside the village boundary through the local market varied for different tribes with the Garos leading on a per capita basis. With a high per capita output of organic manure from the animal husbandry of the Garos, the per capita input for agriculture was higher than that for others. The organic manure wasted on a per capita basis was the highest by the Nepalis.

Conclusion and research needs

The animal husbandry with emphasis on swine husbandry by the tribals and on cattle farming by immigrant Nepalis or plain tribals such as the Mikirs represent two distinct pathways for development. The former along with poultry emphasizes upon a detritus based zero-input animal husbandry, whereas the latter is based upon a high natural resource base for grazing. With differences in animal maintenance costs and with variations in slaughtering frequency,

the ecological and economic efficiencies of the animal husbandry practice differ. The tribals traditionally do not emphasize cattle rearing, and being a recent introduction it has survived only in the areas of high grazing resource base. An important conclusion is that: (1) before introducing any programme, such as cattle rearing the implications on the resource base, short term or long term should be evaluated, and (2) the tribals, with no tradition of milk consumption, are not attuned to accept cattle farming; introduction of cattle farming can only be a long-term strategy.

In general, all the communities are organized on the concept of resource recycling within the village ecosystem. More efficient use of resources, such as dung which often is wasted, and more scientifically managed systems based on better breeds of animals offer possibilities for redevelopment of the village ecosystem based on ecological considerations.

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