The principle of food chains and the working of the laws of thermodynamics are illustrated by the energy flow diagram of a generalised ecosystem (Fig. 4). The boxes represent trophic levels and the pipes depict the energy flow into and out of each trophic level. Energy inflows balance energy outflows.

The energy flow model shown in Fig. 4 is actually a composite figure, consisting of the energy flow models of the constituent trophic levels of the ecosystem, connected together in a sequence. When this composite figure of energy flow model for the entire ecosystem breaks, the energy flow models of the constituent levels of the ecosystem are obtained.

The energy flow model of the producer compartment is shown in figure 16.

In this diagram, E represents the energy received; U is the unused energy; A is the energy assimilated; M is the energy spent in metabolism and G is the energy of growth.
Fig. 17 is the energy flow model for each of the different trophic levels of consumers of the ecosystem. I is the energy ingested; F is the energy excreted as faeces and urine; A is the energy assimilated; M is the energy metabolised and G is the energy of growth.

Because energy flow involves both inputs and outputs and because the law of thermodynamics rules that energy can be transformed from one form to another but can neither be created nor destroyed, a balance sheet for energy and production is drawn up for a community or trophic level with debit and credit sides, and the efficiency of the trophic level or of the ecosystem as a whole estimated by measuring the quantity of energy entering it and the quantity of energy leaving it, although in an altered form. This forms the foundation for energy budgets.

The cattle and the humans of the village Panayakurichi are the consumers of the agroecosystem. The flow of energy through the consumers was estimated through their energy budgets. The formula for the energy budget (Mitchell, 1980) of animals is

\[ I - F = A = G + M \]

where I is the energy of food ingested; F is the energy
of the faces and urine; $A$ is the assimilated energy; $G$ is the growth and $M$ is metabolism.

The energy of food ingested ($I$) was estimated for the human beings (Gopalan et al., 1976) and cattle (Sen, 1966). The energy of food egested ($F$) in the case of the cattle was also estimated (Neelakantan, 1976).

Metabolism ($M$) was measured in the following ways:

i. basal metabolism ($M_b$)

ii. maintenance energy ($A_m$)

iii. caloric increment for labour ($M_a$)

i. Basal metabolism is the energy spent by an animal for simple maintenance at rest. There are empirical measurements of metabolism of mammals and they are closely approximated by: $M_b = 70W^{0.75}$ kcal day$^{-1}$ where $W$ is the wet weight of the animal in kg.

ii. Maintenance energy ($A_m$) is the empirically determined quantity of energy that must be assimilated by an animal to maintain itself at a constant weight. Maintenance energy includes the energy cost of growth as well as the energy of metabolism.

$$A_m = G + M_b$$

In adult mammals, however there is practically no growth.
iii. Caloric increment for work (Ma) is the quantity of energy needed for work.

The cost of activity for humans was estimated from the values of Gopalan et al. (1976) which had been averaged by (Mitchell, 1980).

The cost of activity for cattle was estimated from the diets prescribed by Ranjhan (1976) for cattle of specific weights.

The formula for energy budget (Fig. 17) for animals was extended as:

\[ I - F = A = G + Mb + Ma \]

or

\[ I - F = A = Am + Ma \]

The caloric needs for the humans is given in table 23, and for the cattle in table 24.

In addition to metabolic energy, the human component uses some energy to cook the food. The per capita fuel energy needed per person for an average meal has been estimated by KVIC (1975). The fuel need of the human population was estimated by a survey in the village Panayakurichi (Table 25).

There are two fuel combinations: banana leaf rolls + dung cake or Prosopis shoot + dungcake. The per capita
fuel need per day is 0.726 kg banana leaf rolls + 0.578 kg dungcake or 0.664 kg Prospis shoot + 0.578 kg dungcake.

The outputs of the humans and cattle are the labour input into the agroecosystem, dung and milk. The labour input is given in table 26. The dung output is estimated in table 39.

This chapter analyses the energy budget of the human and cattle population of the village Panayakurichi. The energy budget analyses the inputs and outputs of each compartment of the ecosystem. The inputs constitute the food ingested for maintenance and activity. The metabolic needs for maintenance and the caloric increments needed for labour milk yield are worked out (Tables 23 and 24). The outputs constitute the labour (Table 26) and dung (Table 39).