TASK 2. ESTIMATE THE PROPORTIONS OF OUTPUT OF A COMMODITY PRODUCED IN THE DIFFERENT COUNTRIES IN THE GIVEN AGRO-CLIMATIC ZONES

This task involved estimating, for about 200 countries (the countries that provide data to FAO), the proportions of output of a commodity produced in the adopted agro-climatic zones. As ACIAR pointed out, estimates can be derived using a variety of methods, including (i) knowledge of economic geography; (ii) geographic information systems; and (iii) model-based approaches. Different ways of aggregating, classifying and presenting the FAO data (e.g. within zones across countries) were investigated.

It was anticipated that the methodology for Task 2 would depend significantly on the agro-climatic zones identified within Task 1. The six selected zones to which livestock numbers and commodities would be allocated within countries were desert, arid, semi-arid, dry sub-humid, moist sub-humid and humid. Ideally, biophysical constraints such as soil type and extent of degradation, climate variability, and animal health (e.g. tick and tsetse fly) should also be taken into account in refining this task of determining the number and species of animals that are farmed in different environments (Morley and White 1985). Economic constraints such as high debt or low income levels may also preclude certain options. For example, cattle are more expensive than sheep and goats. There are useful decision trees that may be used to determine which livestock species a farmer (or farming community) might opt for in a given locality. Economic parameters dominate this decision process. There also needs to be an awareness of the proportion of domestic produce that reaches the marketplace and can influence the official statistics.

Table 1 gives the commodities and commodity groups to be covered in the analysis.

Table 1. Commodities and commodity groups to be included in the analysis

	Commodity group to be included	Commodities to be included in the group
1.	Beef and buffalo meat	Beef meat; buffalo meat
2.	Dairy milk	
3.	Other milk	
4.	Sheep and goat meat	Mutton and lamb meat; goat meat
5.	Wool	
6.	Pig meat	
7.	Poultry meat	Chicken meat; duck meat
8.	Eggs	Chicken eggs; duck eggs
9.	Cow hides	
10.	Goat skins	
11.	Sheep skins	
12.	Manure	
13.	Draught power	

Quantitative framework of global livestock production (FAO 1996a,b; Slingenbergh and Wint 1997)

Officers of the FAO Division of Animal Production and Health (AGA) have been engaged in defining a global, quantitative analysis framework for livestock systems and associated

livestock mapping software applications. Many of the Division's current activities require at least a continental, but preferably a global, appreciation of livestock distributions in relation to agro-ecological factors and human demographic patterns. A consultancy involving ERGO explored and demonstrated the possibilities of using techniques inherent in geographic information systems (GIS) to produce a database containing information on global livestock distributions, human demographic data, and agro-ecological information. This enables maps to be derived from these data; and possible avenues for future development to be investigated.

National data on domestic livestock numbers for 1996 were obtained by ASIT Consulting from the FAO WAICENT global dataset, along with country agricultural and land-use data for 1994. The data acquired were converted to a spreadsheet format using FAOCONV and EXCEL software. The FAO data may be downloaded from the FAO Internet site (http://www.fao.org/lim500/agri_db.pl)), or from FAO diskettes or CD-ROM.

It needs to be clearly understood that the 1996 FAO data referred to here and elsewhere in this report are the data supplied by member nations for that year. These data should not be confused with the data from FAO (1996a,b) which were based on 1994 FAO data.

Other data sets used by ERGO Consulting (FAO 1996a,b) included raster images of agro-ecological zones (AEZ) and national boundaries, and raster images of global human population numbers at a resolution of 5 × 5 minutes.

Animal population data were available only at national level, and not for within-country agro-ecological zones. In contrast, global human population is available, in image format, at a resolution of approximately 10 × 10 km. By dint of relatively simple, if labour-intensive, image processing and GIS techniques, these can be used to produce human population numbers for each agro-ecological zone within each country.

Methodology for allocating livestock data to agro-climatic zones

In Task 1 it was decided that the agreed agro-climatic zones would be those classified according to the estimated length of the growing period (LGP). These zones are designated desert, arid, semi-arid, dry sub-humid, moist sub-humid and humid (FAO 1996a,b; Slingenbergh and Wint 1997).

FAO and ERGO (Wint, pers. comm.) kindly provided estimates of total livestock biomass for each domesticated livestock species within each agro-ecological zone within each country in an Excel worksheet. Using the mean weights assigned to livestock for each continent (Table 2) (FAO 1996a) it is a relatively simple calculation to estimate the number of 'livestock units' in each agro-ecological zone within each country. These weights reflect both the genotypes and nutritional regimes that dominate each continent.

These estimates were compared with livestock numbers from the FAO Waicent database for 1996. In most cases, particularly those involving developing countries, these estimates corresponded very well with the raw data. In other countries, such as those in the former Soviet Union, there were appreciable differences between the estimates and the raw data. Some differences are to be expected, of course, given the variable quality of the national data, variability about the functions relating 1994 livestock levels to human populations within and between continents (see Table 4 of FAO (1996a)), and other factors discussed by Slingenbergh

and Wint (1997). In the case of the former Soviet States, the numbers of sheep and cattle were often significantly less than one would have expected, this not being compensated for by taking goat numbers into account. This may largely reflect deficiencies in the quality of the data, or that ruminant production in these areas is well below that expected. It was decided that the most reliable approach was to use the FAO (1996a,b) analyses to determine for each livestock species the percentage of livestock biomass, livestock units or livestock commodity within each agro-ecological zone within each country. These percentages were then used to reallocate the most recent FAO data (1996) to the different zones. This was aided by the data sort and data filter facilities of Excel, together with some minor programming.

Table 2. Weights (kg) assigned to livestock for each continent (FAO 1996a).

Livestock species	Africa/Oceania	Asia	South America	North America/ Europe/Australia
Equines	125	125	125	125
Cattle	175	325	400	450
Sheep	25	30	50	50
Goats	25	25	40	45
Camels	250	250	250	250
Pigs	30	50	50	50
Buffalo	400	400	400	400
Other camelids	100	100	100	100
Chickens	2	2	2	2

These steps are summarised below:

1. Estimates of total livestock biomass (within species, based on FAO 1994 data) were allocated to agro-climatic zones by FAO (1996b); i.e. by Dr William Wint of ERGO Consulting (Oxford University), in collaboration with Dr Jan Slingenbergh of FAO.
2. Data in Table 2 were used to convert the total livestock biomass to estimates of livestock units within agro-climatic zones within countries.
3. For each livestock species, the proportion of livestock numbers within each agro-climatic zone within each country was then used to allocate the 1996 FAO data for livestock numbers to the different agro-climatic zones. This gave a more up-to-date estimate and, more importantly, ensured that the total of all agro-climatic zones added up to the national total for 1996, according to the FAO database.
4. This process was repeated for the major livestock commodities.

It is of course appreciated that ruminant animals are more strongly influenced by agro-ecological conditions than non-ruminants (e.g. Anon 1992). This report by Winrock International states that the arid and semi-arid zones, which together have 54 per cent of the land area of sub-Saharan Africa, account for 57 per cent of the ruminant livestock measured in tropical livestock units (TLU). The humid zone, making up 19 per cent of the land mass, has 6 per cent of ruminant TLUs. The largest share of goats (38 per cent) and sheep (34 per cent) and nearly all of the camels are found in the arid zone. Most cattle are in the semi-arid zone (31 per cent) and the sub-humid zone (23 per cent). Pigs are mostly found in the humid and sub-humid zones. Poultry are evenly distributed over all zones except the arid zone. Pigs and poultry are also produced in intensive commercial livestock systems that are influenced more by proximity to population centres and ports than by agro-ecological conditions.

The method of allocating livestock numbers to agro-climatic zones on the basis of human density distribution (FAO 1996a) does not directly discriminate between species. However, this is largely compensated for by entering the total number of each livestock species for each country (FAO 1996b). For example, if there are few large ruminants in a country then the area suitable for grazing ruminants will probably be dominated by sheep and goats.

Levels of livestock commodities may be estimated in different ways. For example, FAO provide data on slaughterings and indigenous production. 'Gross indigenous livestock production', defined as 'Meat production from slaughtered animals, plus the meat equivalent of all animals exported live, minus the meat equivalent of all animals imported during the reference period' allows for trade distortions. Emphasis has therefore been on using the indigenous livestock production where these data were available.

A 'livestock commodity production index' is defined as the weight of product per kg of live animal (FAO 1996b). It is therefore an input/output ratio, being 'a very preliminary measure of production efficiency which can be made more complex in due course'. Livestock commodity production indices—representing estimates of the amount of meat or other commodity produced per kg of livestock biomass were estimated for 1994 for each continent by FAO (1996b), as shown in Table 3. Although these estimates were available in spreadsheet form, it was decided to instead use the 1996 data from FAO on the quantities of livestock commodities produced. This was not because the 1996 FAO data were necessarily more accurate, but because they were less likely to be disputed than the derived data produced by FAO (1996b).

Table 3. Calculated livestock commodity production indices for 1994, by continent (FAO 1996b)

Continent	Red meat	Pig meat	Chicken meat	Hen eggs	White meat	All milk
Africa	0.12	1.17	1.05	0.92	1.06	0.44
Asia	0.09	2.12	1.11	1.85	1.66	0.50
Australia	0.36	2.51	3.73	1.37	3.07	1.42
Europe	0.18	2.36	2.44	2.57	2.33	2.27
N. America	0.19	2.22	3.17	1.50	2.67	1.17
Oceania	0.13	2.29	2.52	2.03	2.28	0.02
S. America	0.08	0.91	2.47	1.06	1.65	0.26

Results

The FAO (1996b) approach provides estimates of livestock species biomass within each of the six agro-ecological zones as they occur within each country. These have been based on using a direct ratio between animal numbers and people (animals per person) calculated from the FAO country numbers. It also means that the calculated national total should approximate the FAO national figures.

Figure 6 shows the global distribution of humans, which was used as the major determinant of animal numbers. Figures 7, 8 and 9 from FAO (1996b) show global distributions of cattle, sheep and goats based on FAO 1994 data. Figures 10 and 11 are maps of the livestock production indices for red meat (beef, and sheep and goat meat) and for milk. Global numbers of buffalo are shown in Figure 12, using the FAO map viewer and FAO 1996 data. High densities are found in China, correlated with the high human population (Slingenbergh and Wint 1997). Cattle concentrations are most pronounced in India, Europe, North America and Argentina. Small ruminants, especially sheep, are shown to be most abundant in Australia, New Zealand, southeastern Europe and the United Kingdom. Other ruminants monitored by

FAO include buffalo, camels and other camelids (alpaca, llamas, vicuna), and equines. Care needs to be taken in interpreting Figure 10, in particular, in that cattle, sheep and goats are capable of producing milk, skins, fibre, draught power and manure in addition to meat.

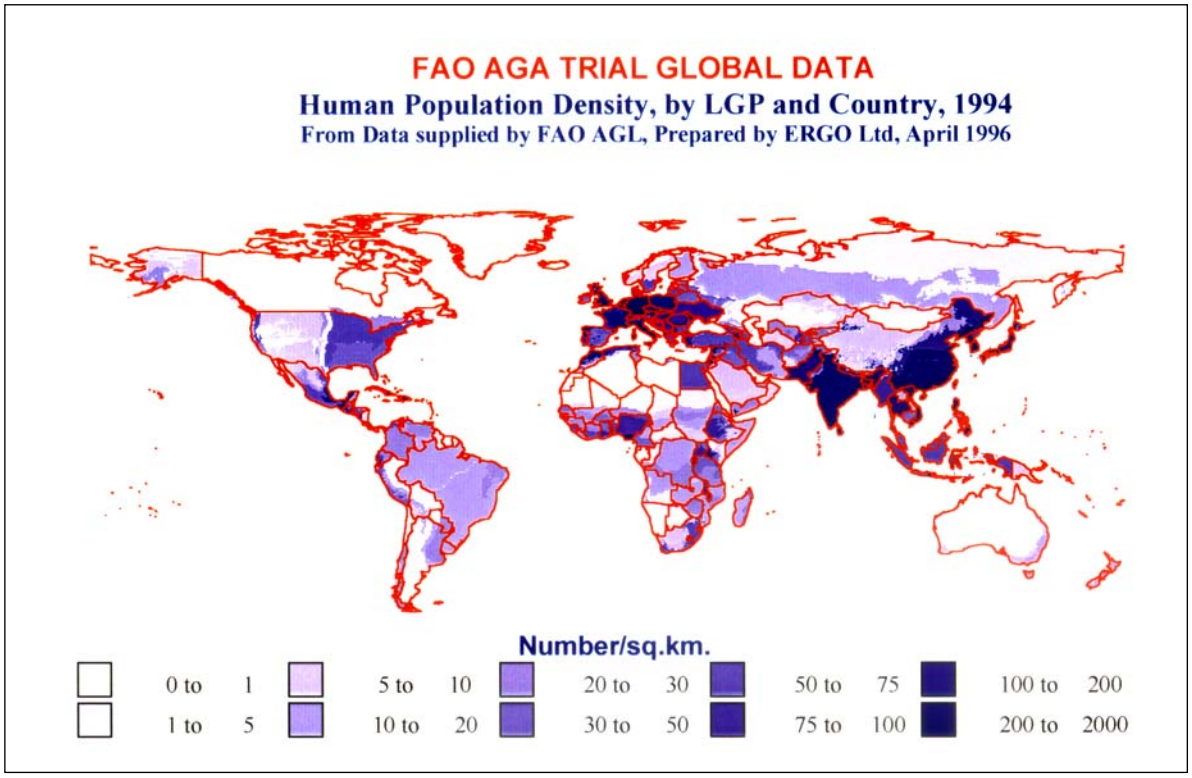

Figure 6. Human population density, by LPG and country (FAO 1996a)

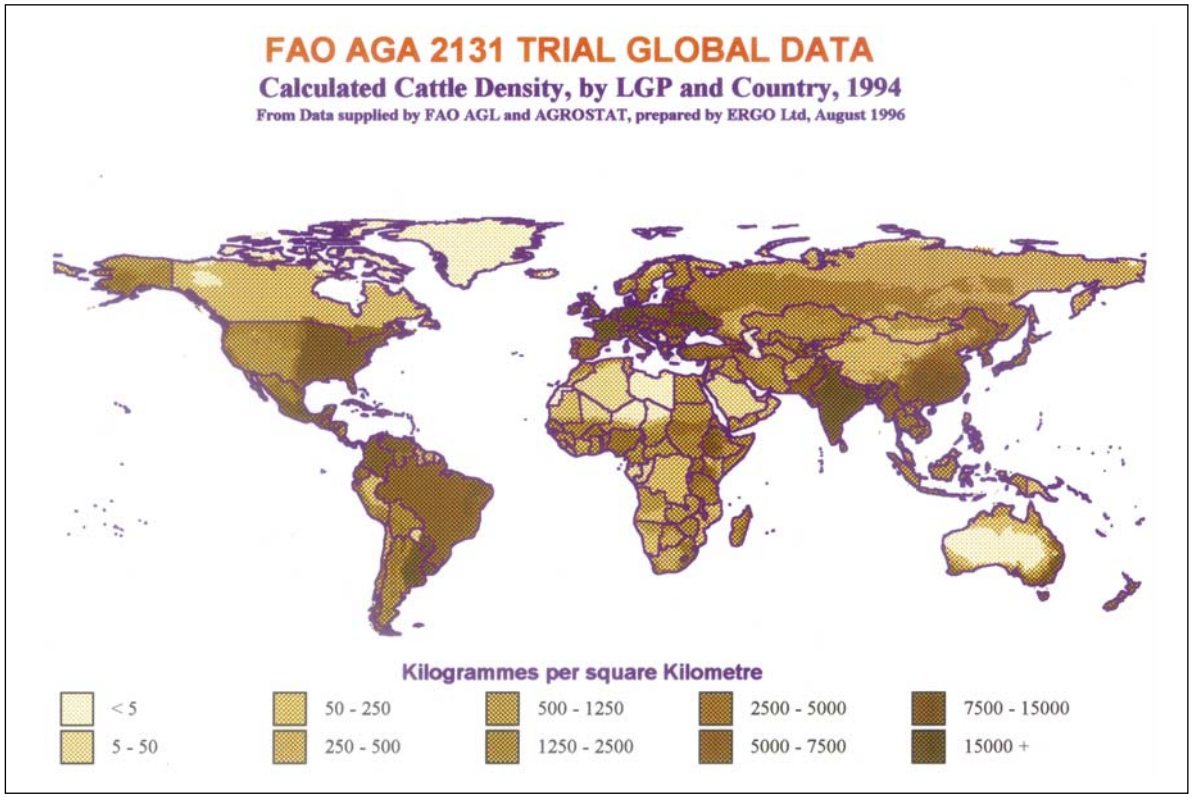

Figure 7. Calculated cattle density, by LGP and country (FAO 1996b)

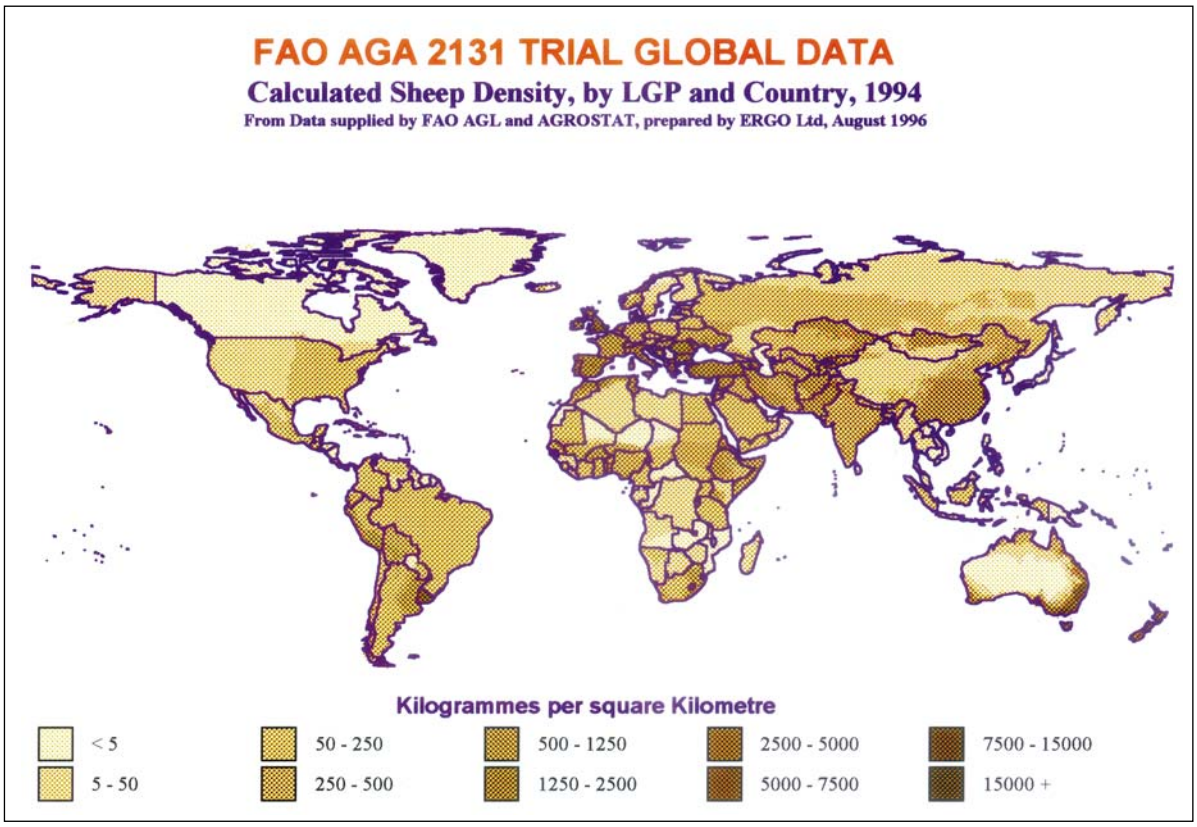

Figure 8. **Calculated sheep density, by LGP and country (FAO 1996b**

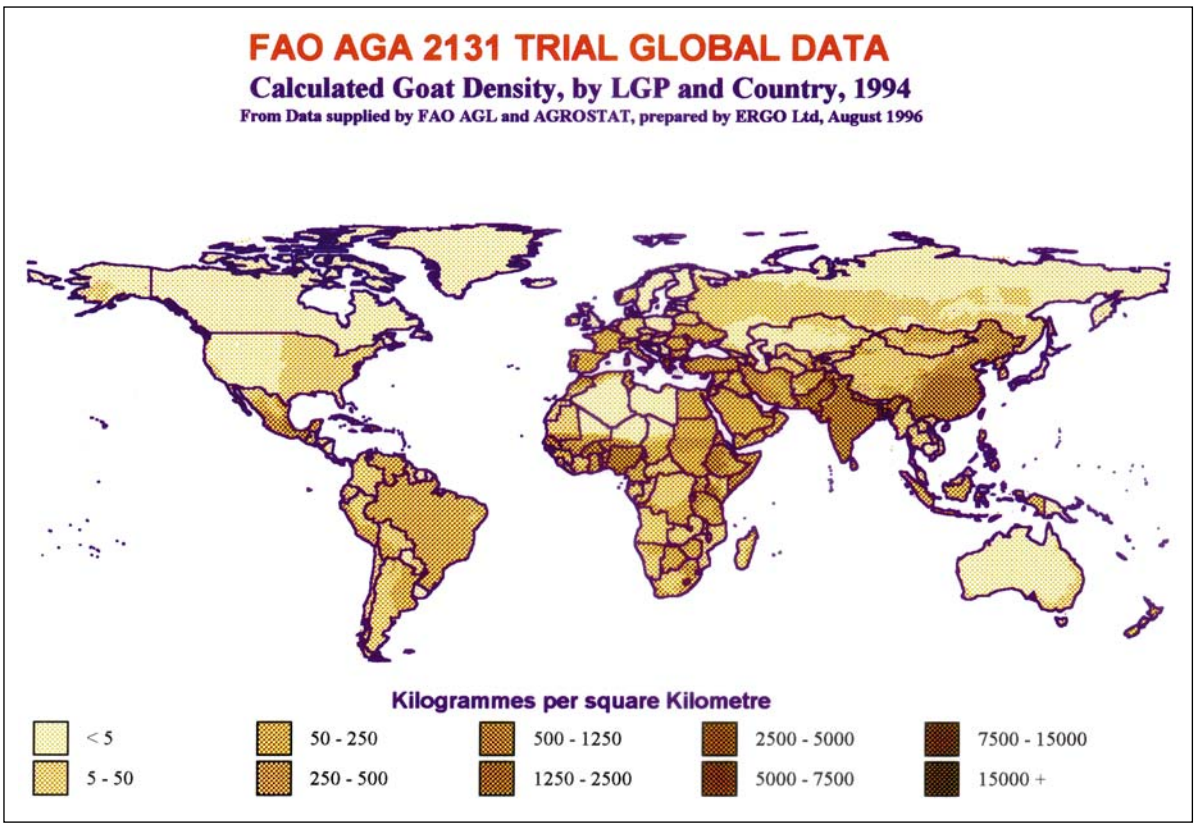

Figure 9. **Calculated goat density, by LGP and country (FAO 1996b**