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International post-graduate course in ecological approaches to resources development, land management and impact assessment in developing countries

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INTERNATIONAL POSTGRADUATE COURSE IN ECOLOGICAL APPROACHES TO RESOURCES DEVELOPMENT, LAND MANAGEMENT AND IMPACT ASSESSMENT IN DEVELOPING COUNTRIES (EMA)

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Centre for Protection and Improvement of Environment (Berlin) of the Ministry of Environmental Protection and Water Management of the German Democratic Republic in cooperation with the Technical University Dresden

Subject IV: Animal husbandry

STUDY MATERIAL
elaborated by a team of authors under G. Fenske

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IV.2. <u>Ecology and production technology of selected animals</u>

IV.2.1. <u>Ecology and production technology of cattle</u>

IV.2.1.1. <u>Demands of cattle production on the environment</u>

Scope and kind of demands on the environment result from the requirements for cattle and are closely associated with the organization of production. In the majority of developing countries experience is available in the production of cattle. But people know frequently only the traditional way of cattle breeding. In the majority of cases the development projects provide for a greater concentration of animals and for a more modern mode of production in farming. In preparation for and in implementation of the development projects it is decisive to consider the interaction and correlations between environment and production.

In this context it is not at all permitted to transfer the experience gained by the highly developed European countries about structure and operation of modern animal production facilities to the developing countries without making any reservations. But it is important and correct to utilize the knowledge available and the experience gathered in taking into account the local conditions.

Basically the idea is to create certain conditions for a greater concentration of animals in the wake of the establishment of development projects, which will decide on the success or failure of projects. Such conditions are:

a) Sufficient supply of fodder and water as to quantity and quality.
   Modern cattle production requires an <u>all-year and continuously sufficient supply with feed</u>. Cattle are in a position to utilize those feeds which are unsuitable for human nutrition and cattle can convert them into high-quality foodstuffs. Cattle cannot be regarded as a competitor to man, as regards to foodstuffs, as it is, e.g., the pig and the hen. Therefore the underlying idea is to feed cattle with crude basic feeds, and concentrates (e.g. grain) are added only to a limited extent. If green fodder (e.g. pasture, fodder maize, clover, alfalfa) is unavailable throughout the year, the feeding stuff has at any rate to be preserved for these periods (hay, silage).

One cow requires in one year about

green fodder (green fodder, silage, hay)	15 ... 20 t
concentrate	0.3 ... 1 t

In areas with crop farming , irrigation and fertilization and with good yields of crops it is calculated that an area of 1...1.3 acres (0.4 ...0.5 hectares) of fodder area is required for one cow. If on pastureland, e.g., the production of green mass is essentially lower, you need at least 2.5 to 3.5 acres (1...1.5 hectares) per cow. To reduce the distances for the transport of the large feed quantities per each cow it is convenient to have the common development of feed and cattle production in a territory.

Water supply is determined by the needs of the animals and the line of production intended. Cattle need drinking water (40 - 80 l/cow in 24 hours) which has to be always available. The optimum solution would be to provide water of a quality suited for human consumption, e.g. from deep water wells. If the decision is made in favour of milk production the water quality should be unobjectionable from a hygienic point of view because milk is a foodstuff intended for human consumption.

b) Provision of suitable animals

The diversified utilization of cattle has considerably contributed to its wide distribution. It is known that milk and beef are important suppliers of food for man. In many countries the existence of cattle to do work and to supply hides remains to be important. Cattle dung is re-used as a waste product from animal production as fertilizer in crop production, or as heating material or starting material for the generation of bio-gas in households. This application is largely excluded in this description.

In most countries there are indigenous breeds of cattle . In increase in performance is mostly aspired by cross-breeding with efficient foreign sub-species with a view to combining the benefits of indigenous and foreign breeds of cattle. But it has more and more frequently happened that breeds of cattle from other countries or continents have been imported for development projects. If it is at all possible to produce with such cattle, the animals of such breed have first to get accustomed to the new environmental conditions. They are more susceptible to pathogenic agents of the tropical and subtropical zones, so that the risk of infection increases in these cases. Therefore special attention has to be paid to the observance of the principles of animal hygiene and the protection of animals from diseases. Moreover, imported breeds of cattle have mostly higher demands on feed than indigenous breed.

c) Selection of suitable locations

The most important consideration in the selection of localities for development projects should be to produce low cost products for which is a real demand in the immediate vicinity. Thus milk production is closely related to the density of population of an area. In the close proximity of large settlements or towns the development of milk production is of importance because milk has a limited storing stability and, as a rule, cannot be transported over great distances. In dependence upon the daily requirements for milk and upon the experience gained by man in handling larger herds, the stock of animals per facility can reach 100 to 500, in exceptional cases even up to 1,000 cows. On the basis of a stock of animals of about 500 cows it is possible to provide for a dairy (e.g. for a processing capacity of 5,000 l/day) on the farm. In the case of smaller animal stocks the milk has to be transported to a central dairy, or to be directly sold to the dealer.

The reproduction of the stock of cows is mostly done from young animals bred in one's own farm. If all the calves on the farm remain as heifers for breeding, or as feeding bulls, we obtain the following stocks of animals (Table IV.2.1.).

Table IV.2.- 1 Total stock of animals in a cattle farm

	Example A	Example B
Cows	100	500
Calves up to 6 months	40	200
Heifers from 7 to 30 months	0	200
Beef cattle from 7 to 18 months	20	100
Breeding bulls	2	4 1/
Cattle altogether	202	1,004

1/ Semen extraction and artificial insemination

In the above example slaughter animals (feeding bulls, slaughter cows) are also produced aside from milk cattle. Beef cattle can be taken to a slaughter-house that can be located in a different territory.
Milk production is mostly predominant in those areas where high yields in fodder are obtainable. Pasture-land with low yields or little opened territory provides the basis for the production of slaughter cattle. Beef cattle are well adapted to low-grade pastures. Beef cattle form a great part of the herds of cattle in the countries of Africa, Asia and Latin America. Cattle which have been especially bred for beef production provide only the amount of milk just to feed the calf. These breeds are intended to produce meat rather than milk. If meat production has been accorded priority in your development projects it is possible with these breeds to produce exclusively slaughter animals for sale. The following factors have to be considered in selecting the location:

Prevailing temperature, amount of precipitation, humidity of air, prevailing winds, nature of the ground and the possibilities of its utilization (natural plant growth, agricultural use, phenomena of erosion, possibilities of irrigation, etc).

It is also of importance to consider the development of the area in question in terms of making it accessible to modern means of communication.

d) Availability of manpower potential

Labour available determine essentially the kind of management of development projects. Cowsheds have to be erected for the modern production of cattle with foreign breeds, but even for indigenous breeds. Sheds provide the cattle protection against heat (provision of shade), cold or rain. In tick-infested areas it is required to accommodate foreign breeds (e.g. from Europe) in sheds and to protect them from tick. In dependence upon the climatic zone and the kind of fodder storage it has to be reconsidered whether it will be necessary to build houses for the storage of fodder. The same applies to milk production and the storage of milk.

Traditionally the majority of operations are performed by hand in cattle production. A modern cattle farm is equipped with machines that are driven by electrical energy or fuel. In developing the territory the connections for energy supply and the access roads shall be considered.

Cattle have to be daily attended to by trained workers. They have to be provided with feed twice a day and have to be milked twice a day. Additional work for attendance has to be done. In dependence upon the daily working hours and the use of machines a different number of workers is engaged to attend to the same amount of cattle (Table IV/2. - 2). If required, a camp with all amenities for living will have to be put up for these workers in the vicinity of the farm.

Table IV.2. - 2 Number of workers for a cattle farm (7 hours of daily work)

Farm	Number of workers
A	12
B	41

Farm A: 100 cows as well as calves, heifers and feeding cattle; mostly manual work; milking by means of pipeline milking plant, no fodder production.

Farm B: 500 cows as well as calves, heifers and feeding cattle; mechanised feeding and fodder handling, milk production and manure removal; no fodder production and no dairy.

e) Safe removal of waste products

The waste products emanating from the stabling of cattle are dung, liquid dung and animal bodies. All these wastes are suited to degrade the environment, to pollute the water and to be the starting point for infections (notably fallen animals). Therefore a great importance has to be attached to their safe removal.

Dung and liquid dung have to be principally introduced to the soil for the promotion of humus formation. At the same time the fertility of soil is increased and the conditions are improved for adopting intensive forms of animal production.

Of course, the greatest danger emanates from fallen animal bodies. Counter-measures have to be taken to prevent the spreading of disease-causing agents via fowl, birds and rodents. The safest kind of carcass removal is burning. At those places where this kind of carcass removal is not permitted for energy reasons it is indicated to bury them sufficiently deep at hygienically unobjectionable places (not in drinking-water areas !). Even they will have a fertility-promoting effect on the soil. In the vicinity of towns it is also possible to consider the processing of carcass to protein feed in the event of the existence of suitable technologies.

IV.2.1.2. Processes for milk production, slaughter cattle and heifer calves

If the development project incorporates the production of milk, slaughter cattle and heifer calves in one farm, as it happens in many cases there are basically three different processes to be distinguished. They are different from each other in that

- calves require a different feed (e.g. milk, milk substitutes) compared with cows
- heifers continue to grow and the requirements for space increase also in the course of time (calf 0.8 m^2; heifer 1.5 m^2; cow 2.3 m^2 as a place of rest)
- the measures of treating animals are not identical between grown-up cattle and heifers (cows have to be covered, or inseminated. They are in need of obstetrics, or injections which are not required in heifers).
- cows have to be milked.

Below processes shall be described shortly for the production of milk. The point of departure is again a modern production in a farm.

For the sake of a better understanding we will subdivide the process according to the following scheme:

Fig. IV.2.-1

Main process
- Fodder handling, water supply
- Housing and treatment of animals
- Milk production
- Manure removal

Auxiliary process
- Preparation and storage (fodder, manure...)
- Power supply
- Veterinary treatment
- Maintenance

Fig. IV.2, -1: Structure of the process of milk production

Fodder handling, water supply

As a rule, cattle are fed daily, but above all seasonally with different feed over the period of the year, e.g.

Feeding period 1	Feeding period 2
green fodder	silage
straw	hay
concentrate	straw

The distribution of feed can be done manually or by machines. When using fodder distributers for conveying and dosing the fodder has to be cut to obtain chaff. The chaff-chopper which harvests the fodder on the field, or is stationed in the farm, chops the green fodder as well as the straw and the hay. Twice a day the cows are provided with fodder.

The water supply is done in the shed by way of drinking bowls Water has always to be available for the cow for reasons of lactation. Watering tanks have thus to be provided on the pastures or for longer stay in the run.

Housing and treatment of animals

The functions of the animal place are thought to be fulfilled when it permits the cow to stand up, to lie down, to eat or to drink. However, for these various operations the cows make different demands on the formation of place. The dimensions of the animal places are commensurate with the measurements of body and, accordingly, are specific of the breed. It is possible to fix (to tie up) the cow at the standing place, or to provide for the cow a chain-tying housing with a loose tying, or a loose housing. Loose housing has many benefits. It permits the animals a greater freedom of movement. It can also be combined with a run, or with the pasture. There are no problems involved in driving the cows for milk extraction which is done in a milking parlour. Fig. IV.2. - 2 shows the layout and flow chart of a loose housing arrangement with feedlots (32 cows per group). There is a bedding pen available for each cow in the feedlot.

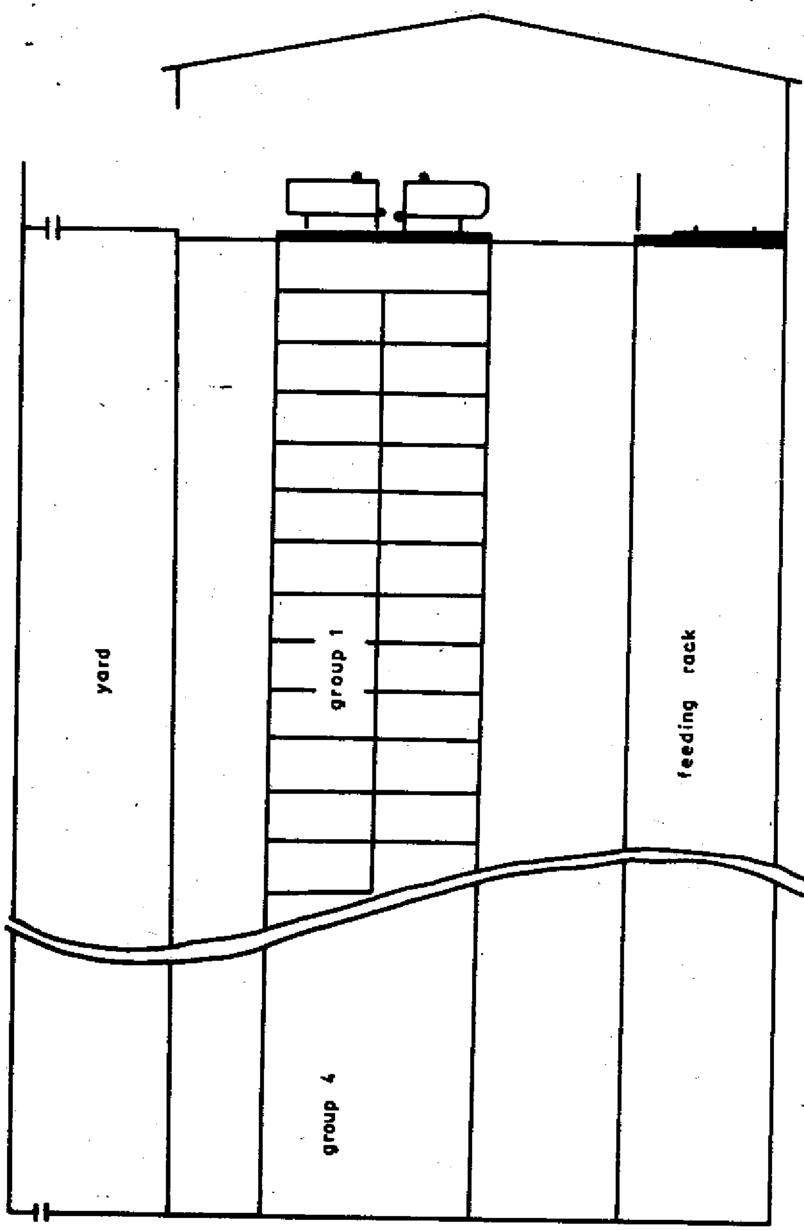

Fig.IV.2.2. Loose housing for cows

All cows are accommodated in a separate cowshed, the calving shed, shortly before ceasing calving up to a fortnight after it. The next gestation begins 80 to 120 days after the birth. The cow has to be covered by the bull, or to be artificially inseminated. Every cow is expected to give birth to a calf within a period of 12 to 15 months. In Europe a calf is expected per each cow and each year. If this period is prolonged there will be a reduction in the milk yield as well as a reduction in the number of calves. But the calves provide the basis for the production of meat and for retaining the stock of cows on the farm.

Milk extraction

The lactation period sets in after the birth of the calf. The length of the lactation period is dependent upon the breed of the cow and the state of nutrition. It amounts to 230 to 330 days. At least two months prior to the new birth the cow is no longer allowed to be milked. Thus milk is always obtained only from part of the cows (50 to 80 % of the stock of cows). Daily a lactating cow gives 8 to 12 litres in the case of a good milk yield, which corresponds to an annual milk quantity of 3,000 to 4,000 litres. As a rule, milking is performed by hand. If milking is done by machine, you can choose between a cow-to-cow milking plant, a pipeline milking plant, or a herringbone milking parlour.

In a modern farm cows are milked by machine. If the stock of cows reached 150 animals and more the use of a herringbone milking parlour brings about many benefits:

High quality of milk, good health of udder, good working conditions for man.

These benefits are especially effective when a milking parlour is used where milking proceeds in part automatic since many complicated processes are involved in milk extraction (Fig. IV.2.- 3). In this case the machine assumes the correct execution of these operations. It should be tried to obtain the milk by machine on account of the complicated processes and the high quality of milk attainable.

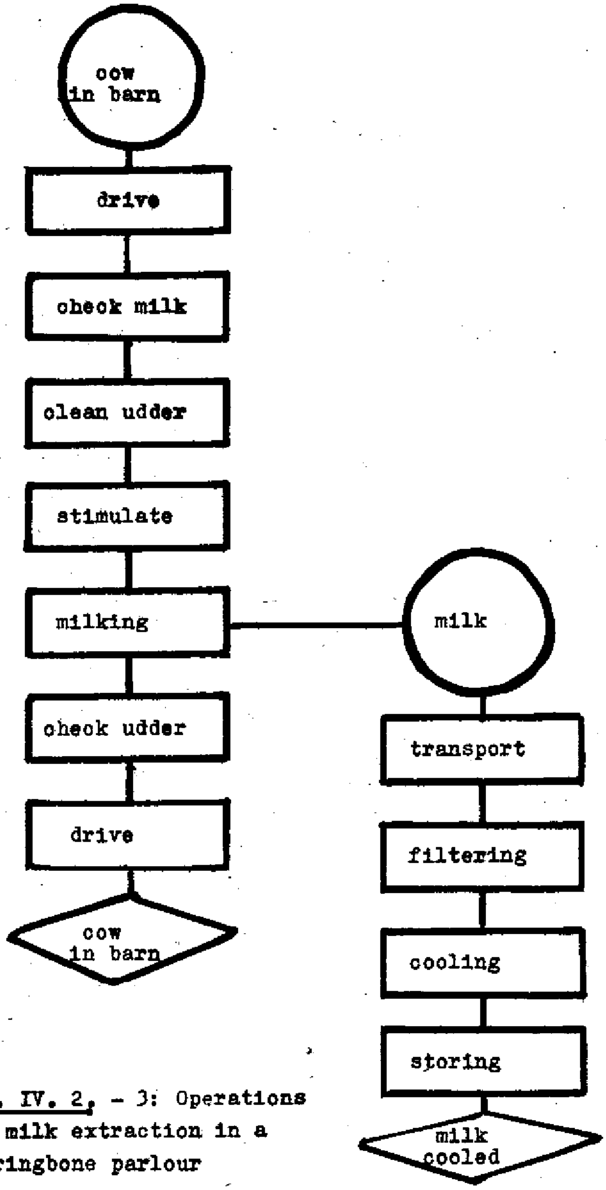

Fig. IV. 2. - 3: Operations for milk extraction in a herringbone parlour

Removal of manure

The manure may appear either as compact manure, or as liquid manure. In dependence upon the dry matter content there are 30 to 40 kg compact manure as well as 10 to 15 litres dung water, or 80 litres liquid manure. However, this applies only when the animals are kept in barns, or sheds. If the cows have a yard, above figures are smaller. When the animals are on the pastures day and night, the removal of manure is no longer necessary.

The manure can be transported out of the barn by using means of mechanization (e.g. tractor with front-end loader). Liquid manure processes are little suited for tropical and subtropical areas, since they require a special technology.

Auxiliary process

In periods where no green fodder is harvested it is necessary to make available preserved feeds. It is possible to dry green fodder during the period of vegetation and to make hay, or to ferment the green fodder as silage. Silos are required for the process of fermentation where the fodder is stored even after fermentation until it is fed to animals. It is possible to store hay and straw in the open air or under a roofing (protection against rain). Preserved feed has also to be stored under cover. Preserved feed for cattle consists of ground grain, milling products as well as residues of oil manufacture. But they have also minerals as ingredients. If the mixed feed is to be produced on the farm it is required to have a mixed-feed plant, a feed mill. The mill should be laid out for a capacity of 5 to 10 tons of mixed feed per hour if it is intended to supply also other farms in the territory.

The storage of manure is required only for a short-term period if it is used in crop production throughout the year. In dry and warm regions the humidity content in compact manure is considerably reduced so that it is only required to provide for small manure deposits. Liquid manure can be stored in pits at the barn side, or in special tanks for bio-gas extraction.

Veterinary methods of treatment have to be worked out according to breed and country. A veterinary surgeon should care for the animals in each farm. The protection against diseases is of extraordinary importance for larger stock of animals. Already in the stage of planning of plant provisions have to be made for restricting largely the mobility of foreign persons and vehicles and for not allowing foreign cattle to get on the farm.

As the treatment of animals has to be ensured from the onset of production, it should equally be provided that even machines and buildings have to be repaired. For this reason it is planned to provide for workers who are especially trained for maintenance works and to establish a workshop on the farm.

After this survey on the processes required for a cattle production facility the following layout plan shows the possible structure of a farm (Fig. IV.2. - 4).

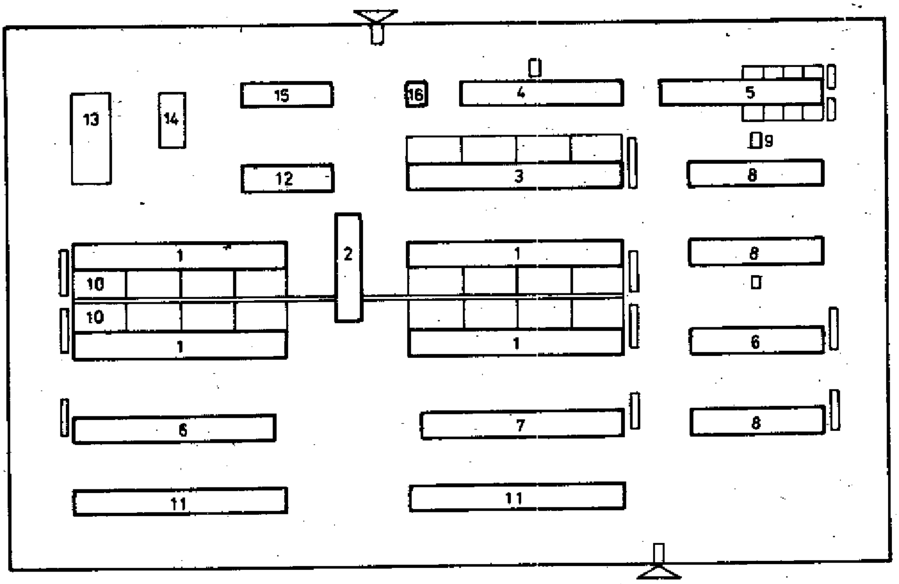

Fig.IV .2.4. Layout for a cattle farm

(1) Barn for lactating cows
(2) Milking house and store for concentrates
(3) Barn for dry cows
(4) Barn for calving and cattle treatment
(5) Barn for calves
(6) Barn for small heifers
(7) Barn for heifers
(8) Barn for fattening bulls
(9) Collecting basin for manure
(10) Yard
(11) Storage hall for hay and straw
(12) Dairy
(13) Feed mill - capacity 5 t/h - with storage hall
(14) Workshop - weigher
(15) Building for administration and services
(16) Transformer station

IV.2.2. Ecology and production technology of sheep and goats

IV.2.2.1. Introduction

About 60 % of the agricultural acreage on a worldwide level is natural grassland. In this region where tillage is not possible animal production with ruminants is the only alternative.

An example of this is the Sahel region in Africa (Tauscher 1982).

Table IV. 2.-3

Livestock of the Sahel countries in 1000

	Mauretania	Mali	Upper Volta	Niger	Chad
Pasture in % of agricultural acreage	99	94	71	75	?
Cattle	1,600	4,459	2,700	2,995	3,716
Goats	3,250	5,757	2,700	6,400	2,448
Sheep	5,200	6,067	1,800	2,500	2,400

FAO, Production Yearbook, 1980

Under these conditions a game management can additionally produce animal protein (Andreal 1982).
No other domestic animal is surrounded with so many controversial accounts as the goat. On the one hand, this animal is associated with the destruction of sensitive ecosystems, on the other hand, the ability of the goat to adapt to extreme conditions and to guarantee human existence on the borderline areas of deserts, in the steppes and savannah regions has to be considered (Peters 1980).

Camels and sheep and especially fat-tailed and broadtail sheep can store energy in the form of fat, which can amount to as much as 30 % of the body weight. Sheep as well as camels and goats are heat-resistant and their organisms have the ability to reduce water losses in arid regions.

Meat and milk represent the main products for human nutrition, but wool, skins, furs and hair are also considered to be suitable products of animal livestock.

The fact that the goat can assume the role of a dairy cow for a family should be viewed as an acknowledgement. The designation as the "small man's cow" is all too often misunderstood. The composition of the milk and its value is underlined by the following table.

Table IV.2. - 4. Proportional composition of milk

	Dry matter %	Fat %	Total protein %	Casein %	Albumin Globulin %	Lactose %
Goat	13.1	4.1	3.8	2.6	1.16	4.4
Sheep	16.4	6.2	5.2	4.2	0.98	4.2
Cattle, bos taurus	12.4	3.4	3.5	3.0	0.50	4.6
Zebu, bos indicus	16.2	5.2	4.2	3.3	0.86	5.1
Buffalo	17.3	7.9	5.9	5.4	0.53	4.5
Camel	13.6	4.5	3.5	2.7	0.80	4.9
Matt	12.3	4.4	1.1	0.4	0.39	7.1

The small ruminants, sheep and goats, serve the purpose of establishing a food depot for meat and milk, whereas cattle, as far as they can at all be kept under arid and semi-arid conditions, perform the function of assets to be retained and multiplied.

The skins are of considerable importance for personal use. The raw products, to a comparable extent, are of great economic relevance, notably those made from the coveted goat leather from Morocco, Somalia, Ethiopia, Uganda, Pakistan and India. The fine skin of certain goat breeds is exceptionally well suited for the production of fine leather goods, such as gloves.

It is generally recognized that the population of the majority of the tropical countries has grown rapidly in this century and is expected to increase further at least for some years ahead. The current food supply is frequently inadequate to meet the needs of the present population in various parts of the tropics. Farming is mainly undertaken by smallholders with small ruminants and rabbits who, althouth they may grow some cash crops, practise it mainly for subsistence, and they use traditional methods which give low yields and are often wasteful, or even destructuve, of natural resources.

There are differences in the grazing habits of cattle, sheep and goats, mixed grazing may be preferable to stocking with cattle alone. Sheep are very selective in their grazing. They prefer the finer grass and nibble the growing leafage. Cattle graze more uniformly, but disregard certain coarse and unpalatable grasses.

Goats are not very selective as regards plant species, but they have a strong preference for succulent shoots and leaves that are slightly above their normal head level. Granted the opportunity, they will browse mainly on trees and shrubs. Special attention has to be paid to the subject of adaptation of livestock to hot climates. In the past breeds of the temperate zone that were exported to the tropics encountered a disastrous failure. After a short period in the tropics the rate of productivity of many breeds decreased, their conditions deteriorated and they became susceptible to tropical diseases. The low level of performance of indigenous animals makes it absolutely necessary to take measures in breeding. On account of the great demands for imported animals, the establishment of a breeding centre within the framework of the project has become imperative.

The centre should have the task of making sire material or semen available for breeding measures aimed at raising the productivity in local populations through upgrading or cross-breeding.

In management and feeding the often obvious overgrazing necessitates frequently a drastic reduction in the number of grazing animals.

The restoration of natural vegetation will not be sufficient for promoting an efficient animal production. Measures to be taken for improving feed production have to be considered vital, too.

IV.2.2.2. Sheep population in the world

The sheep is an important domestic animal that is spread over all continents throughout the world. In 1982 world sheep populations reached about 1120 million heads of sheep. The sheep is very popular, since it is a multi-purpose animal.

The reasons for this are the following:

- Sheep provide the basis for nutrition for many people
- It is the supplier of animal protein, also for specialities, such as lamb and cheese
- Wool, an excellent raw material for wealthy clothes
- Skins and furs
- Good utilisation of the fodder
- Sheep is important for ecology and the preservation of landscapes
- Supplier of dung, a valuable organic dung for the fertility of the ground.

The purposes are different for rearing sheep in the various parts of the world.

Table IV.2. - 5 World sheep populations (1982, FAO) (in mill.)

Asia	341.60
Africa	187.45
U.S.S.R.	142,10
Australia	137.41
Europe	137.40
China	104.00 x/
New Zealand	70.00 x/
Total	1119.96

x/ FAO estimates

In 1982 the world sheep populations were by 1.7 % higher than in 1981.

World meat production (sheep and goats):
1981: 8.06 mill. tons
1982: 8.08 mill. tons

World milk production (sheep and goats):
1981: 7.93 mill. tons
1982: 8.03 mill. tons.

IV. 2.2.3. Sheep breeds

Division into type of wool (Grell, 1977)

1. Merino sheep and sheep of the Merino type
about 20 % of all sheep
2. Long wool breeds and crossbreeds (long wool)
about 20 % of all
3. Short wool breeds and crossbreeds (short wool)
about 4 % of all
4. Raw wool breeds about 50 % of all
5. Hair sheep breeds about 6 % of all.

To 1) Arid regions (Australia, South Africa, Argentina, U.S., Europe), wool very fine - fine
Merino long wool sheep, wool production
(New Zealand, U.S., South America

To 2) Meat and wool
(Lincoln, Leicester, Kent, Merino-mutton breeds, local breeds, white face - meat sheep in Europe, German Merino mutton sheep.

To 3) Meat and crossbred wool
(Southdown, Dorset Horn, Dorset Down, Oxfordshire, Hampshire, Suffolk, Ile des France, Berrichon du Cher)

To 4) Mixed wool
Meat and milk, hill or mountain breeds (Blackface, Welsh mountain)
Mixed wool sheep (originality)
Fat tail sheep.

To 5) Tropical and subtropical countries

1. Meat production
2. Milk production

African countries, India.

<u>Note:</u> World wool production:

75 % (by No. 1 - 3)
25 % (by No. 4)

The following table deals with sheep production in the tropics and subtropics as well as in the temperate climatic zones of the world.

<u>Table IV. 2. - 6 World population and production of sheep</u>
(FAO Production Yearbook 1975)

Climatic region	Temperate climatic zone 1.)	Tropical subtropical zone 2.)	World
Population in millions	534.354	508.516	1,042.870
%	51.3	48.7	100.0
Mutton in 1000 t	4,861	1,916	6,777
%	71.7	28.3	100.0
Washed wool	811.2	712.5	1,523.7
	53.2	46.8	100.0
Milk in 1000 to	4,985	2,339	7,324
%	68.1	31.9	100.0

1.) Europe, U.S.S.R., U.S., Canada, Greenland, Chile, Argentina, Urugway, Falkland Islands, Cyprus, Turkey, Japan, Korea, Mongolia, Nepal.

2.) Africa, Asia, Australia, Central America

<u>Merino mutton sheep</u>

Among the Merino breeds the Merino mutton sheep assumes a special place since it combines a number of different valuable properties. This breed is especially suitable for arid regions, but it also puts demands on feeding and housing (intensive use).

This breed is noted for its good staple formation. Therefore under dry climatic conditions, even under the impact of dust, the fleece can altogether be protected by a good closure of staples. The quality of wool is within the range of fine wool; meat production is also considerable. This intensive breed has found interested people in many regions of the world and there has been a brisk demand for it up to the present day. For this reason the GDR as an accepted trading partner for the export of high-quality animals for breeding has been prepared for this efficient breed. In many countries this breed has proved itself in the development of sheep-breeding and thus has acquired an important place in breeding activities.

Karakul sheep

Undoubtedly, the Karakul sheep is another important breed in tropical and subtropical countries.
The production of furs is the major contribution by this sheep. The lambs are slaughtered after birth to obtain the coat. After trimming the black or brown lamb-skins are processed to get the world-renowned 'Persian' skins. The production of meat, milk or wool is of minor importance (Matter 1977). The home of the Karakul sheep is Turkmenistan and Uzbekistan in Soviet Central Asia. After a trial period of breeding in Germany the Karakuls were exported from Germany to South Africa and at the beginning of this century an important breeding centre was established there, in addition to the original centre in Soviet Central Asia. The sheep prefers semi-arid climates. 80 % of lambs are slaughtered and 20 % serve for replacement and multiplication. A high rate of fertility is a necessity for a successful productivity.

In theory the Karakul sheep can lamb twice a year. In practice, however, there is only one reproduction time annually in both breeding centres.

The mating of the Karakul sheep is correlated with the course of climatic factors, such as daylight, air temperature, air humidity and precipitation.

The photoperiodic and the rainy period interfere significantly with conception and fertility.
Fertility can be enhanced through nutrition, flushing and other farm management techniques.

Awassi sheep

- Dominant types in Iraq, Syria, Jordan and Israel
- Unimproved Awassi is a robust and vigorous, medium-sized sheep of milk and mutton type;
- Improved dairy type is larger and more refined than the ordinary Awassi. The proportions of the body are affected by the size and weight of the fat tail that gives the impression of a lack of balance between fore- and hind-quarters;
- The ewes lamb for the first time at the age of two years or older (unimproved); improved ewes: 9 - 10 mon. ins.
  Oestrus 15 - 20 d, $\bar{\bar{x}}$ 18 d, length 16 - 59 h, $\bar{\bar{x}}$ 29 h
  Lambing season, typical: November, December, January.
  Gestation period: 150 days.
- Fertility: 70 - 80 lambs/ 100 ewes, in experiment:
  (Syrian) 110 - 120 lambs/100 ewes.
- Milk: 197 - 231 kg (till 406 kg)
  Turkey: 100 - 185 kg, Iraq 90 - 130 kg
  7.5 % fat content.
- Wool: long wool with an open, lofty and moderately lustrous fleece of carpet wool with distinct, wide crumps.
  30 μ (ideal carpet) (28 - 36 μ)
  Clean wool: 61 - 78 %
  Staple length: 10 - 16 cm

The wool is commonly used in the region and bamboo is extensively used in the Philippines. The roofing material, particularly in Indonesia, varies greatly and includes the use of cogon (I. cylindriea), attap, bamboo leaves, coconut fronds and even tiles.

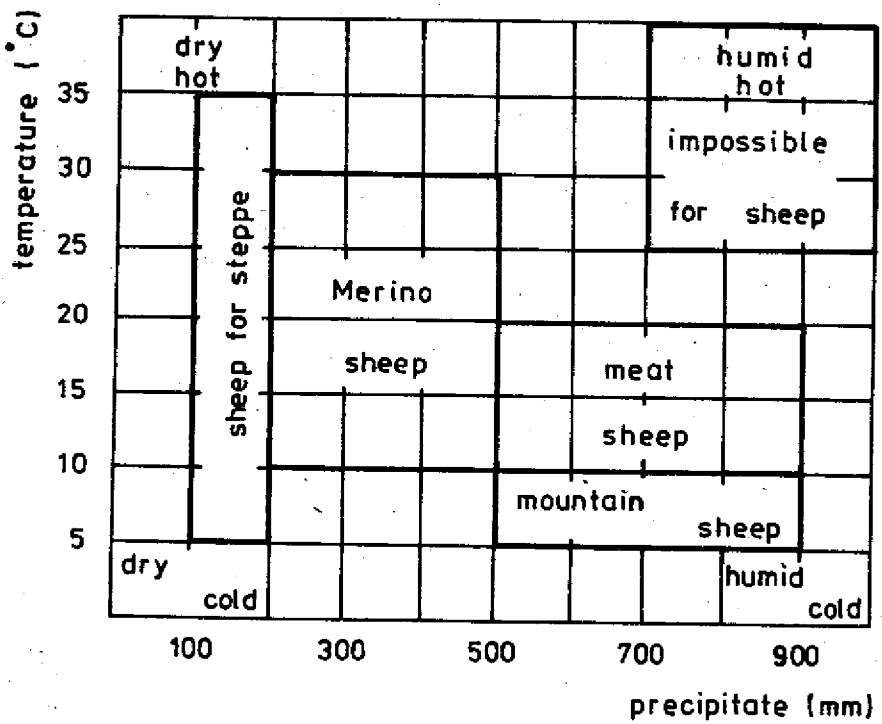

Fig. IV. 2.5. Climatic zones for the sheep-types

IV.2.2.4. <u>Sheep breeding, several methods to improve sheep</u>

- <u>Improving sheep by selection</u>

  Selection is an important method to achieve genetic changes. An essential incentive to improve sheep by selection is that the additive genetic gains from selection tend to remain permanent.

  Hence, apart from the idea of selection to eliminate problems due to disease, accidents, or age, a continued selection pressure is unnecessary, except for achieving additional genetic gains or offsetting undesired effects due to natural selection.

  By contrast, the costs of many non-genetic methods to improve production, such as improvements in management practices, have to be continued indefinitely if the resulting improvement shall be maintained.

  Disadvantage of selection: The genetic gains reached annually are small, especially if the trait is lowly inheritable; and there is the influence of environmental changes.

- <u>Importance of records</u>

  Records shall be kept for other economically important traits.
  Collection of data: birth, weaning, yearling, making weights, milking potential, type of birth (single, twice, triplets, etc.), semen characteristics of rams, numbers of lambs born, udder characteristics of mature ewes.

- <u>Environmental factors and accuracy of selection</u>

  . Estimation of environmental influence
  . Superiority of animal (genetic)
  . Reducing errors in choosing genetically superior animals
  . Influence of time of selection
  . Heritability of important features
  . Objective characteristics of selection

Environmental factors

rel. low infl.	rel. high infl.
face cover	body type
staple length	condition
fleece weight	type of birth of lamb
horn score	rate of gain over short periods
neckfolds	birth weight
yearling body weight	weaning weight

- <u>Improving sheep by cross-breeding</u>

. Possibility for rapidly increasing reproductive rates by cross-breeding

. Introduction of Finnsheep and other breeds

. Advantages and disadvantages of crossbreeding (wool production - reproductive rates)

. Once-a-year lambing
High lambing rates and high lambs weaned of ewes bred can greatly improve the efficiency of a sheep farm

. Twice-a-year lambing
A breed that can lamb twice a year without any hormone treatment can probably be developed within a reasonable period by careful selection concurrently with lambing in January and February and breeding in February and March and lambing again in July and August and breeding in August and September. This method would require a breed with a relatively short gestation period and a short postpartum interval (interval from lambing to conception) as well as a long breeding season.

. Lamb carcass investigations
This is a more important subject of a sheep farm.

- Dairy sheep breeding

Situation and perspectives for developing dairy sheep breeding:

For many years sheep have been raised as dual- or triple purpose animals in the different countries. Indigenous and unimproved breeds of sheep are kept for mutton, milk and wool production. The aims of sheep farmers are subject to changes in response to a change in the price relationship and economic conditions.
On account of the economic conditions sheep and goats can be considered the main source for milk production in the Mediterranean countries.
A somewhat similar situation can also be seen in the Balkans and in the East European countries. In Asian and African countries sheep milk is the main source of income for small farmers. In these countries sheep milk is usually sold at double the price of cow's milk and sometimes even more.

Situation of dairy sheep breeding in different countries

In the northern countries dairy ewes have been used in cross-breeding for lamb production (Finnish Landrace x Dorset Horn in Scotland, Finnish Landrace x Border Leicester in Great Britain, East Friesian milk sheep, Romanov sheep, Finnsheep with Merino (mutton), etc.).

Many countries interested in milk production have carried out experiments for improving milking capacity and lactation period. East Friesian sheep have been brought to several countries and crossed with native breeds with a view to improving litter size and milk production (Israel, Bulgaria, Spain, Italy, Greece, Cyprus, Soviet Union, Turkey).

In Middle-East countries fat-tailed native breeds of sheep are generally raised. Mainly because of unsatisfactory feeding conditions preference has been given to fat-tailed sheep. There are low-productive unimproved local breeds. The Awassi sheep only have been known to be high-yield milk sheep.

The improved Awassi in Israel and some Middle-East countries, such as Turkey and some Arab countries, have high yields of milk under suitable feeding conditions of the region. Under dry and hot climatic conditions Awassi is known to be a resistant breed.

Value percentage of milk, mutton and wool within the total income from dairy sheep:

Milk: 45 %
Mutton: 45 %
Wool: 10 %

- Perspectives of development for dairy sheep breeding

The Mediterranean basin is one of the main dairy sheep breeding regions. Below there is some information about this region. Dairy sheep breeder can be divided into three groups:

1. Large flock (300 to 400 heads)
2. Small flock (50 to 100 heads)
3. Family flock (5 to 10 heads)

For the future trend the following appears to be important:

- What is the carcass quantity and quality in dairy sheep ?
- Does the wool obtained from dairy sheep have any economic relevance ?

As to the view of Prof. Sonnez, the need for high milk-yielding sheep in Mediterranean countries will increase in future. The income elasticity in the demand for lamb and for quality cheese and yogurt supports this argument. People like and prefer yogurt and cheese made from sheep milk in this region.

The problem of breeders is how to feed dairy sheep during winter. Concentrates and silage are not regularly used. Cooperatives and some official organizations have been very successful in supplying feeds to small breeders.

Labour costs are an important factor that affects total costs. In keeping large flocks the labour costs make up for about 50 % of total milk income. Educated and careful shepherds are not easy to find in most countries. Special schools and courses are needed for sheep breeders and shepherds to be successful in this field. This is a very important aspect.

The major sheep and goat countries in the "Mediterraneum" (production and consumption) are Greece, Bulgaria, Turkey and the south-eastern coast of the Mediterranean basin (Syria, Lebanon, Israel and Egypt).

IV.2.2.5. Artificial Insemination (A.I.)

Artificial insemination (A.I.) is a very important method of animal breeding, particularly in modern animal breeding. The use of A.I. in practice increases continuously. Such countries, as the Soviet Union, Bulgaria, Roumania, GDR, France have achieved a high level in the practice of A.I. The following advantages can be derived from a wide use in comparison with natural mating:

- Greater breeding progress
- High utilization of valuable A.I. animals (male)
- Increased production of milk, meat and wool
- Reduction in the number of A.I. animals (male), high pressure on selection
- Reduction in venereal diseases, or total elimination (prophylaxis and hygiene are controlled by programmes)
- No problems with mating, easy possibility of crossbreeding
- Possibility of sperm preservation (liquid, deep freezing), effective use of semen, estimation and sperm import for semen to be freezed (for cattle already possible, for sheep still in experimental stage)
- Possibility of investigations into population genetics.

To have success in A.I. it is indispensable to take account of the varying conditions in the region.

IV.2.2.6. Aspects for development strategies

The state of development of sheep production, the rate of concentration of stocks as well as the qualification of man entrusted directly or indirectly with the care for sheep have reached a different level in the countries. Therefore there is no uniform model for breeding available for the developing countries. The point of departure for all considerations is to formulate a practicable objective within a surveyable period.

The following aspects shall play a role:

- How to achieve an increase in yield from the animal potential available by improving the fodder basis and the care of animals ?
- What are the possibilities for consolidating indigenous breeds of sheep, or upgrading well-tried breeds by cross-breeding with foreign breeds ?

In answering the second question it is necessary toconsider the following aspects:

- Is there any justifiable possibility of upgrading the indigenous breed/population by pure-line breeding ? Generally this way does not appear to be promising since the yield is low from many primitive breeds.
- If a decision is made in favour of a cross-breeding of proven foreign breeds the following should be considered:
  a) What are the breeds that have to be taken into consideration (objective) ?
  b) What kind of breeding programme shall be used (two- or three-race breeding) ?
  c) What is the share of the indigenous race in the improved breed (test programme) ?

To make the cross-breeding programme more effective it is reasonable to use artificial insemination.
To this end the following measures are required:

- Establishment of an insemination station for sperma extraction from suitable rams, training of expert personnel for sperma production, laboratory personnel and technical personnel for insemination. In line with regional conditions it is suggested that several stations will be established because of the need for liquid-preserved sperma required for artificial insemination (maximum period of preservation 12 hours).

- Establishment of a location insemination station if permitted by concentration of animals and breeding activities to be carried out initially one place.

To comply with these tasks it is required to train technical personnel. Adequate training facilities are available in the GDR.

In addition an assessment of the breeding value and the consideration of the indigenous share shall be carried out.

IV.2.2.7. Production of goats

World's goat population accounts for 373 millions of animals, two thirds of which are found in the tropics and subtropics.

Table IV.2. - 7 Distribution of tropical and subtropical goat populations (FAO, 1975)

Country	Numbers (millions)
Africa	100.0
India, Pakistan, Sri Lanka	77.0
South America	27.6
Central America and Caribbean	16.0
Asia (east of India)	13.5
Asia (west of India)	27.4
	261.5

Breeds of goats

The classification of domestic goat breeds distinguishes five major goat types, the European, Oriental, Asiatic, African and South American.

European type

a) Toggenburg

It is a large fawn, or chocolate-coloured goat, the home is Switzerland. A successful European breed that was introduced into the tropics.

b) Saanen, Netherland White, German White

Saanens have a short white coat and are generally polled. Often introduced to the tropic and subtropical countries. Good milkers, they are the main breed of milking goats: both sexes are polled, but it is reported that hermaphroditism can be a problem.

c) Alpine

It is a highly developed milk breed distributed in the Swiss, Austrian, Italian and French Alps. Alpine has been introduced to West India and Indonesia. They have been well acclimatized.

d) Old English

The breed is variously coloured and is related to the wild Welsh goat. Milk yield is lower than with the other European breeds.

Oriental type

a) Nubian

This goat is spread in the eastern Mediterranean, North Africa and especially in the Sudane. It is a large, long legged hard breed. Under harsh conditions the goat is capable of feeding fibrious and xerophytic vegetation. The milk and meat content is good, it is a fertile breed.

b) Angora

This breed is spread in Asia, Turkey, the tropical regions and in South Africa. It is a white-coloured goat, hair or wool is very valuable and has a good yield of mohair wool, meat and milk.

c) Damascus

The goat is spread in the Middle East, it is red or white and red in colour and well suitable for the Mediterranean environment.

d) Mamber

It is a black, long-haired goat of the Middle East, particularly Syria and Egypt. It is variable in size and shows good lactation yields.

Asian types

a) Kashmir or Kashmiri

It is a goat of Central Asia around the mountains of Tibet, India, Pakistan and Kurdistan. The colour is white, or black and white. The goat has long, fine hair, known as cashmere wool. It provides meat and wool and is used for drought. It represents a breed of goat still used for agricultural purposes.

b) Jumna Pari, Etawah

It is a large milk goat in India and south-east Asia with a high milk yield and a good butterfar content.

c) Cutch or Cutchi, or Malabar

It is a breed in southwest India and Malabar with black, brown, white, or mixed colours. It is a fertile goat for meat and milk production, the skin is very useful for leather goods.

d) Kambing Katjang

This goat is spread in Malaysia and Indonesia. It is a black animal with white patches. It is used for meat and milk production.

e) Ma Tou

It is a breed distributed in Central China. It is a large goat, fertile with a high annual birth rate. The female brings four lambs and lambs twice a year. 70 % are twins, or triplets and 8 % quadruplets (Devendra and Burns, 1970).

African type

a) Neneder

This goat is found in Somalia, it is a large animal in white or other colour.

b) Galla or Somali
This goat is spread in Kenya, Somalia and Ethiopia, it is of white colour and used for meat and skin production, but some local strains are occasionally milked.

c) Nigerian
It is a large breed in West Africa and is used for meat and milk production.

d) Small East African
The adult goat has a liveweight of about 15 – 30 kg. The breed is distributed in East Africa, the main products are meat and skin.

e) West African Dwarf
This goat has disproportionately short legs and is spread in Central and West Africa, particularly in East Africa. It is 50 cm in height and 20 kg liveweight. This breed is resistant to trypanosomiasis.

f) Southern Sudan Dwarf, or Nilotic Dwarf
This goat is truly a dwarf. The height of withers is 45 cm, the weight is 11 kg.

g) Boer
It is a South African goat of white and red colour. It is a good meat and milk producer with high fertility, mostly twins and triplets. The kids reach a liveweight of 40 kg in 12 months.

South American types

a) Moxoto, or Black Back
This breed is found in northeast Brazil. The colour is light brown, or fawn with black stripes along the back. It is a goat for milk, meat and skin production.

b) Marota
It is found in the Bahia state and resembles the Saanen goat. It is used for skin and milk production.

The capacities of goats in meat and milk production, the two forms of tein, are shown in the following table.

Table IV.2. - 8 Meat and milk production of goats in selected countries (according to Devendra and Burns, 1970)

Country	Goat popul. million	Contribution Milk % of total	Meat % product.	Mean milk yield kg/goat/year
Brazil	17.3	5	2	44
Cyprus	0.3	50	14	109
India	67.2	3	35	18
Indonesia	7.8	-	11	--
Iraq	1.8	58	12	135
Libya	1.6	50	36	42
Morocco	7.6	33	16	26
Pakistan	11.4	26	-	90
Sudan	6.9	23	-	64
Turkey	18.1	28	16	67

Table IV.2. - 9 Comparison of milk yield of tropical milk animals on the basis of yield per unit live-weight

Type of stock	Mean lactation yield (kg)	Mean live-weight (kg)	Yield kg/ 10 kg lw.
Goat			
Tropical type	200	40	50
European crossbreed	400	50	80
European type	600	60	100
Cow			
Unimproved zebu	400	300	13
Improved zebu	1000	350	29
European crossbreed	2000	400	50
Water buffalo			
Unimproved breed	1000	500	20
Improved breed	1500	500	30

A comparison of milk production by tropical milk animals on the basis of their average liveweights is presented in above table.

The productivity of goats in comparison with other animals per unit liveweight has shown that they are superior to all the other types of larger ruminants. Thus in tropical areas the goat is often able to lactate when for larger animals there is an insufficiency in feed.

IV.2.2.8. Sheep and goat nutrition

The quantity and quality of fodder affect the growth of sheep and goats. On good pastures the animals have a daily increase in liveweight of 40 to 60 g.
In 18 months, under these conditions, they reach a final weight of 40 kg. However, it would only take three to four months to reach this weight in case of an intensive lamb fattening management (Legel 1977).
When the quantity of fodder on tropical grassland pastures is no longer sufficient and all usable grass has been consumed in the form of 'standing hay' a migration will take place to more humid areas. A better quality of feed and a greater share of plants are necessary to ensure continuous animal production.

Table IV.2. - 10 Nutrient requirements of sheep (by Legel 1977)

Bodyweight	Average daily gain/g	Air dry feed (kg)	DCP (g)	TDN (kg)	DE (M)	Ca (g)	P (g)
Ewes							
45	30	1.2	54	0.59	10.6	3.2	2.5
55	30	1.4	59	0.86	12.3	3.3	2.6
65	30	1.5	68	0.77	14.0	3.4	2.7
Ewes lactating							
45	-	2.1	100	1.24	22.0	6.2	4.6
55	-	2.3	104	1.33	23.6	6.5	4.8
65	-	2.5	109	1.40	25.2	6.8	5.0
Lamb fattening							
27	160	1.2	82	0.68	12.3	2.9	2.6
32	180	1.4	86	0.82	14.7	2.9	2.6
36	205	1.5	91	0.95	17.1	3.0	2.7
41	205	1.7	91	1.04	18.8	3.0	2.7
45	180	1.8	91	1.09	19.6	3.1	2.8

Legend for page 38:
DCP = Digestible crude protein
TDN = Total digestible nutrient
DE = Digestible energy
MJ = Mega - Joule (4.1 Joule = 1 cal)

Table IV.2. - 11. Nutrient concentration of air dry matter

Body-weight (kg)	Average daily gain (g)	Daily air dry matter (kg)	Nutrient concentration of air dry matter DCP %	TDN %	DE MJ/kg	Ca %	P %
Ewes							
45	32	1.2	4.4	50	9.0	0.3	0.2
55	32	1.4	4.4	50	9.0	0.2	0.2
65	32	1.5	4.4	50	9.0	0.2	0.2
Ewes lactating							
45	-	2.1	4.8	59	10.6	0.3	0.2
55	-	2.3	4.6	58	10.6	0.3	0.2
65	-	2.5	4.4	56	10.2	0.3	0.2
Lambs fattening							
27	160	1.2	6.6	55	10.2	0.2	0.2
32	180	1.4	6.1	58	10.6	0.2	0.2
36	205	1.5	5.9	62	11.4	0.2	0.2
41	205	1.8	5.2	62	11.0	0.2	0.2
45	180	1.8	5.2	62	11.0	0.2	0.2
Requirements for ewes under range conditions							
Gestation		1.6	4.4	46	7.6	0.3	0.2
Lactation				57			
First 8 weeks		1.9	5.4	54	10.2	0.3	0.2
Last 8 weeks		1.8	4.5	54	9.4	0.3	0.2

Table IV.2. - 12. <u>Nutrient requirements of goats</u> (Devendra and Burns 1970)

Nutrient	Requirements
Dry matter	2.5 to 3.0 % of liveweight by meat goats up to 8.0 % of liveweight by milking goats
Energy	
for maintenance	725.8 g SE/100 kg liveweight/day
for liveweight gain	3.0 g SE/g liveweight gain
for milk production	300.0 g SE/kg milk
Protein	
for maintenance	45 - 650 g/DCP/100 kg liveweight
for milk production	70 g DCP/litre milk
Water	450 - 680 g/day for a goat weighing 18 - 20 kg
Dry matter: total water intake ratio	1 : 4
Minerals	
Calcium	147 mg/kg liveweight
Phosphorus	72 mg/kg liveweight

SE = starch equivalent, 1 kg SE ≅ 9.86 MJ

Table IV.2. - 13 Average water requirement in semi-arid tropics
(Bandelaire 1972 and FAO 1978)

Species	LSU per animal	Daily water requirem. kg/animal	Frequency of drinking days	Water requirements per week	
				kg/animal	kg/LSU
Camel	1.1	60-80	4-5	95-125	85 - 115
Cattle	0.8	30-40	1-3	105-140	130 - 175
Sheep	0.1	4-5	1-2	20-25	190 - 230
Goat	0.1	4-5	daily	30-35	300 - 350

LSU = livestock unit

Under tropical conditions the water requirement is considerably influences by a number of factors. These factors include air and water temperatures, air humidity, animal species and breed, nutrient and salt content of fodder, water quality a.o. (Legel 1977).

The ambient temperature is the dominating factor. The high consumption of water is considerable with goats.

Extensive grassland management

Extensive grassland management in steppes and savannas with their natural vegetation is the major livestock feeding in the tropics and subtropics. Seasonal rains produce plant growth within a very short time.

When the rainy season is over, water and nutrient contents drop very rapidly and the vegetation dries out to "standing hay". Nomadic grassland utilization provides a discontinuous supply of animal livestock with nutrients.

Intensive grassland management

It means fodder production in a rotational system with paddocks for grassing and other paddocks for the production of hay as a fodder reserve when food is short.
Improved pasture quality and green fodder crops or silage can further offset nutrient consumption of the animals.
In warm countries there are favourable conditions for the production of high biomass as fodder on grassland. Light, temperature and water determine the conditions of plant growth.

IV.2.2.9. Additional statistics and tables

Table IV.2. - 14. Stock of sheep (1978) FAO, in million

		share in grazing large animal units
Asia	299.1	9
Oceania	191.8	49
Africa	168.5	13
U.S.S.R.	141.0	19
Europe	129.3	15
South America	103.9	8
North & Central America	22.0	2
	1055.6	12
Dev. ping. all	549.1 million sheep	
Dev. ped. all	506.5 million sheep	

Table IV.2. - 15 Development of sheep stock, selected regions (FAO materials, 1,000 heads

	1969-1971	1979	1980	1981
South America	115 218	105 575	106 230	105 165
Asia	269 947	310 723	324 211	335 035
Europe	127 195	132 086	134 126	137 109
Oceania	236 968	197 754	204 764	204 601
U.S.S.R.	136 434	142 600	143 599	141 573
Dev. ping all	557 540		527 259	
Dev. ped all	519 415		592 833	

Table IV.2. - 16 Sheep and goat meat production structure 1980 and 2000
by Hrabovszky (1981)

Region	Animals	Carcass weight kg/animal	Meat product. (1000 t)	Share of sheep in total numbers 1975 %	
1980					
90 developing countries	791.5	12.6	3037	58	
of which					
Africa	222.8	10.5	747	50	
Far East	196.6	10.5	705	37	
Latin America	154.1	12.8	413	75	
Middle East	218.0	16.4	1173	69	
Low-income countries	357.9	11.3	1299	-	
				Growth rate 1980 - 2000 Animal number %	prod. %
2000					
90 developing countries	1172.9	14.7	6214	2.0	3.6
of which					
Africa	347.3	12.7	1787	2.2	4.5
Far East	297.3	12.4	1441	2.1	3.6
Latin America	225.5	15.8	862	1.9	3.8
Middle East	302.8	18.5	2124	1.7	2.0
Low-income countries	549.6	13.3	2781	2.2	3.9

Table IV.2. - 17. Goat and sheep production potential in ASEAN region (Devendra 1979)

Distribution of goat and sheep populations (1977)

	goats	%	sheep	%
Indonesia	6,112	77.1	3,286	96.2
Malaysia	377	4.8	46	1.3
Philippines	1,400	17.7	31	1.0
Singapore	2	-	-	-
Thailand	31	0.4	52	1.5
Total	7,922	100	3,415	100
1977 compared to 1961/65		- 6.1 %		- 5.5 %

Table IV.2. - 18. Sheep and goat production in the drought polygon of northeast Brazil (MASON)

	sheep	goats
Northeast Brazil: 1,548.672 km^2	5,290,000	6,045,000

per km^2 = sheep = 3.4 heads

per km^2 = goats = 3.9 heads

Table IV.2. - 19. Prominent goat and sheep breeds in the ASEAN region under development

Species	Breed	Location	Speciality
Goats	Kambing Kaljang	Ind., Mal., Phil., Sing. Thail.	meat, prolificity
	Kambing Etawah	Indonesia	milk, meat
Sheep	Priangan East Java fat-tailed	Indonesia	meat, prolificity coarse wool
	indigenous	Malaysia	meat
		Thailand	coarse wool

Table IV.2. - 20. Countries with highest stock of sheep (in 1,000 heads)

	1969-71	1978	1980	rel. world	rel. contin.
U.S.S.R.	136 434	141 025	143 599	12.8	—
Australia	177 491	131 445	135 706	12.1	
China	78 000	90 360	102 880	9.2	
New Zealand	59 468	62 163	68 653	6.1	
n = 4			450 838	40.25	
Turkey	36 470	42 708	46 026	4.1	
India	40 657	40 700	41 300	3.7	
Argentina	42 773	34 200	33 000	2.9	
n = 7			571 164	50.99	
Iran	32 000	33 600	32 000	2.9	
South Africa	35 585	32 002	31 641	2.8	
U.K.	26 332	29 686	31 392	2.8	
Pakistan	13 096	22 291	26 239	2.3	
n = 11			692 435	61.82	
Ethiopia	24 077	23 150	23 250	2.1	
Afghanistan	21 463	19 075	23 138	2.1	
Uruguay	19 906	16 161	19 980	1.8	
Brazil	17 768	17 200	18 500	1.7	
Sudan	11 419	17 358	17 800	1.6	
Morocco	17 087	15 272	16 100	1.4	
Roumania	13 984	14 463	15 820	1.4	
n = 18			827 024	73.84	
Spain	18 712	15 403	14 547	1.3	
n = 19			841 571	75.13	
Peru	16 698	14 473	14 473	1.3	
Mongolia	12 678	13 430	14 400	1.3	
United States	20 501	12 421	12 687	1.1	
Algeria	7 940	10 863	12 500	1.1	
n = 23			895 631	79.96	
France	10 023	11 415	11 799	1.0	
Nigeria	8 550	11 000	11 700	1.0	
Iraq	12 000	11 420	11 460	1.0	

Table IV.2. - 20 continued from page 46

	1969-71	1978	1980	rel. world	rel. continent
Bulgaria	9 518	10 144	10 536	0.9	
Somalia	8 967	9 900	10 192	0.9	
n = 28			951 318	84.93	
Italy	8 097	8 694	9 110	0.8	
n = 29			960 428	85.75	

Table IV.2. - 21. Production of meat, wool (washed) and skins of sheep (1978) (FAO)

			developed contr.	dep-ing c.	%
Meat from sheep	kt	5,502	3,182	2,320	42
Milk from sheep	kt	7,329	3,611	3,718	51
Pure wool	kt	1,638.3	1,230.3	408.0	25
Sheep hides	kt	1,026.8	556.8	470.0	46

Production per sheep:	Meat	Milk	Wool (pure)	Hides	Meat per head)
Developing countries all (kg)	4.58	7.34	0.806	0.93	1.3
Developed countries all (kg)	5.79	6.58	2.241	1.01	3.0

Table IV.2. - 22 Export and import slaughter sheep (FAO)

Export slaughter sheep		Import slaughter sheep	
Australia	4 mill. sheep	Iran	3 mill sheep
Somalia	1 mill. sheep	Saudi Arabia	2.4 " "
Bulgaria	1 mill. sheep	Kuwait	0.815 " "
Roumania	0.75 mill. sheep	Libya	0.561 " "
Mauretania	0.75 mill. sheep		

Export meat from sheep		Import meat from sheep	
Oceania	559 kt	Europe	260 kt
South America	33 kt	Asia	242 kt

Table IV.2. - 23 Sequence of absolute wool production (1980)

1. Australia (25.3 % of world production)
2. U.S.S.R. (16.2 % of world production)
3. New Zealand (12.8 % of world production)
4. Argentina (6.1 % of world production)
5. South Africa (3.5 % of world production)
6. Uruguay (2.8 % of world production)

Yield of wool per sheep (pure wool) (1976)

1. New Zealand 3.96 kg
2. Australia 3.40 kg
3. German Dem. Rep. 2.73 kg
4. Argentina 2.41 kg
5. Uruguay 2.12 kg
6. United States 1.88 kg
7. U.S.S.R. 1.83 kg

Table IV.2. - 24

Goats (numbers of goats in the years, 1,000 head)

	1969-71	1979	1980	1981
Asia	218 117	254 044	265 979	271 608
Oceania	196	299	354	401
South America	18 360	19 104	19 089	19 108
Europe	12 373	11 459	11 409	11 873
U.S.S.R.	5 355	5 504	5 824	5 914
Africa	134 948	144 220	146 552	148 936
North and Central America	13 992	11 711	10 858	10 865
World	403 339	446 340	460 065	468 705
Developing countries all	376 965	422 318	435 667	443 722
Developed countries all	26 375	24 022	24 398	24 983

Table IV.2. - 24

Countries with the highest stock of goats (1981), in 1,000

1.	China	82,284
2.	India	72,144
3.	Pakistan	32,808
4.	Nigeria	25,000
5.	Turkey	19,043
6.	Ethiopia	17,200
7.	Somalia	16,500
8.	Iran	13,709
9.	Sudan	12,825
10.	Bangladesh	11,800
11.	Brazil	8,000
12.	Indonesia	7,925
13.	Yemen, Arab Rep.	7,500
14.	Mexico	7,185
15.	U.S.S.R.	5,914
16.	Greece	4,650
17.	Mongolia	4,567
18.	Iraq	3,675
19.	Bolivia	3,050
20.	Afghanistan	3,000

Table IV.2. - 26 Important British sheep breeds subdivided into classes (and PALMER 1982)

Hill breeds	
Scottish Blackface +++	Welsh Mountain +++
Swaledale ++	Improved Welsh +
Dalesbred ++	South Welsh Mountain
Derbyshire Gritstone	Black Welsh Mountain
Lonk	Radnor +
Herdwick +	Beulah Speckleface ++
Rough Fell +	Hardy Speckleface ++
North Country Cheviot ++	Exmoor Horn +
South Country Cheviot	Shetland ++
Upland breeds	
Clun Forest ++	Greyface Dartmoor +
Kerry Hill	Whiteface Dartmoor +
Devon Closewoll ++	
Romney	
Kent or Romney Marsh ++	
Devon	
South Devon +	Devon Longwool ++
Lowland	
Dorset Horn +	Wiltshire Horn
Polled Dorset Horn	Lleyn
Improved Dartmoor	Llanwenog
Jacob	
Longwool	
Border Leicester	Leicester
Bluefaced	Colbred
Leicester	Improver
Teeswater	Finnish Landrace
Wensleydale	
Lincoln Longwool	
Down	
Suffolk ++	Southdown
Dorset Down +	Shropshire
Hampshire	Ile de France
Oxford Down	Ryeland

Remarks:
+ Breeds with more than 25,000 mother animals
++ Breeds with more than 100,000 mother animals
+++ Breeds with more than 1 million mother animals

Table IV.2. - 27

Regional distribution of total number+ of sheep (in 1,000)
(and PALMER, 1982)

	1970	1978
East England	845	926
Southeast England	1,213	1,386
Southwest England	2,481	2,802
Midlands	2,297	2,748
North England	4,792	5,897
Wales	5,992	7,601
Scotland	7,494	7,352
North Ireland	966	974
Great Britain	26,080	29,686

+ Results of June counts

Table IV.2. - 28

Analysis of size of herds in England and Wales (share in total stock, % (and PALMER, 1982)

Size of herds	1970	1974	1978
1 - 24	0.5	0.4	0.3
25 - 49	1.3	1.0	0.8
50 - 99	4.4	3.2	2.7
100 - 199	11.8	8.8	7.5
200 - 299	12.0	10.0	8.4
300 - 399	10.3	9.0	8.1
400 - 499	8.7	7.9	7.5
500 - 699	13.2	13.2	12.7
700 - 999	12.9	13.6	14.2
1,000 - 1,499	11.6	13.9	15.1
1,500 - 1,999	5.7	7.0	9.0
2,000 and more	7.6	12.0	13.7
	100.0	100.0	100.0

Table IV.2. - 29

Milked sheep breeds

Milk production level	Country	Breed
high	East Friesian, FRG, GDR	East Friesian milk sheep
	Israel	Awassi
	Italy	Sarda, Langhe
	Greece, Turkey	Chios, Skopelos, Kymi
	France	Lacaune
average	Bulgaria	Blackface, Pleveu, Stara-Zagora
	Italy	Sicilian, Comisana
	Spain	Churra
	Greece	Karagonuiko, Mytilene
	Cyprus	Cypriot
low	France	Préalpes, Manech
	Italy	Sopravissana, Abtamura Leccese, Bergmamasca
	Greece	Serres
	Turkey	Kivircik
	Spain	Manchega
	Portugal	Serra de Estrela, Bordaleiro
	Yugoslavia	Bardoka

Table IV.2. - 30

Meat sheep breeds

Crossbred race for meat production		
Shortwool- and Down-breeds	British	Southdown
	"	Suffolk
	"	Hampshire
	"	Shropshire
	"	Oxford Down
	GDR/FRG	Blackface-meat sheep
Longwool breeds	British/ Irish	Border Leicester
		Romnay Marsh
	"	Lincoln
	Holland	Texel
Meat wool race, including fertility		
Shortwool- and Down-breeds	British	Dorset Down
	"	Dorset Horn
	"	Clun Forest
	"	Colbred
Hill breeds	British	Cheviot
	"	Scottish Blackface
	"	Welsh Mountain
	"	Swaledale
Merino Longwool breeds	France	Ile de France
	"	Berrichon du Cher
	"	Blaue Maine
	FRG	Whiteface-meat sheep
	U.S.S.R.	Meat-wool race North Caucasus
	British/ New Zealand	Corriedale

Table IV.2. - 31

Local sheep and goat meat production (1977) (in 1,000 t)

Country	Meat			Approximate $\bar{x}$ sheep carcass weight (kg)
	Sheep	Goat	Total	
France	142	12	154	18
Italy	48	3	51	9
Greece	76	42	118	11
Spain	131	13	144	12
Portugal	23	4	27	10
Turkey	275	105	380	15
Yugoslavia	57	4	61	10
Bulgaria	65	4	69	13
Roumania	67	4	71	16
Europe (without USSR)	1027	92	1119	15
U.S.S.R.	960	40	1000	16
World	5586	1720	7306	15

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IV.2.3. Ecology and Production Technology of Poultry

IV.2.3.1. Poultry products

Eggs and poultry meat have a high nutritive value for human nutrition (cp. Table IV.2. - 32, 33).

Table IV.2. - 32: Composition of the hen's egg (%)

14 %	protein	egg protein digestibility: 97 %; favourable amino acid composition, egg protein is of high biological value.
11 %	fat	
0.6 %	carbohydrates	
0.9 %	ash	
73.5 %	water	

Table IV.2. - 33: Composition of poultry meat (%)

Variety	Water	Protein	Fat	Minerals	Energy
Ducks	63.7	18.1	17.2	1.0	1017 +/
Geese	52.4	15.7	31.0	0.9	1525
Broiler	72.7	20.6	5.6	1.1	603
Turkeys	66.8	20.7	7.7	1.0	846
Pigs	53.9	15.2	30.6	0.8	1500

+/ in kJ/100 g

Most of the poultry species have the excellent ability to convert feed protein and feed energy into eatable protein (Table IV.2 - 34,35).

Table IV.2. - 34:
Utilization of feed protein and energy for the protein rate of various animals

Animal	Protein rate (100 g feed protein produce	419 kJ UE in the feed produce
Meat type poultry	20 g protein rate	11 g eatable protein
Laying hens (eggs)	18 g protein rate	11 g eatable protein
Milk cow	23 g protein rate	10 g eatable protein
Pigs (meat)	12 g protein rate	6 g eatable protein
Cattle (meat)	6 g protein rate	2.6 g eatable protein
Lambs (meat)	3 g protein rate	1.3 g eatable protein

Table IV.2. - 35: Protein and energy conversion in animal feeds of various animals without regard to utilisation of the fat tissue

Animal	Crude protein (%)	Gross energy (%)
Broiler	23	11
Turkeys	20	8
Laying hens	25	17
Pigs	14	14
Milk cow	25	17
Fattened bulls	8	6

IV.2.3.2. Conditions for poultry production

All poultry species are well adapted to their environmental conditions. For this reason there are only a few places throughout the world where on account of climatic conditions it is impossible to keep poultry.

Laying hens or broilers, for example, may be equally kept in lowlands or in highlands, along the coast or even in desert and semi-desert regions, thus it is possible to keep poultry in modern layer or broiler houses with sufficient ventilation. Modern intensive poultry keeping systems permit to ensure an economical egg and broiler production at all places in the world if it is feasible to provide economically favourable microclimatic conditions.

Thus modern intensive poultry production systems operate independently of natural stations. Economic factors are exclusively relevant, and notably the infrastructure (feed production, feed mills, short transport ways for feed and products to the consumer, etc.) appears to be decisive for the transport of products to the consumer and the utilization of the manure.

Intensive poultry keeping systems are preferably suitable for large-scale commercial egg and meat production.

The reasons for the good suitability of laying hens, broilers and other kinds of poultry for commercialized egg and meat production are the following:

- In the last few centuries breeding hens and broilers of high performance have been successfully obtained by using new breeding methods;
- Great progress has been made in the line of poultry feeding and poultry housing (especially climatization), making it possible to adopt intensive keeping methods;
- On account of the short generation interval of poultry (compared with other domesticated animals) and in conjunction with the high reproduction performance it has become possible to ensure protein production for human needs on an economic basis (in many countries poultry meat is the cheapest type of meat) and within a relatively short time;
- Poultry can be kept in highly concentrated stocks on a small space;
- Almost all operations in large stations can be mechanized or made automatic.

Small-scale production is typical of poultry production by farmers.

IV.2.3.3. Egg production

Table IV.2. - 36 represents a survey on the major forms of management forms and keeping systems for egg production by laying hens.

Table IV.2. - 36: Survey on the kinds of hen management and keeping systems

Management	Keeping system
Extensive	Hen housing on limited range Hen housing on limited range
Half intensive	Hen houses with solaries Hen yards

Intensive at floors	Deep litter systems High intensity deep litter house Slat floors Special systems (open front houses etc.)
Intensive in cages	Flat deck cages California cages Hen batteries (multi tiers) Colony cages

IV. 2.3.4. Small scale egg production

Extensive management forms are characteristic of small-scale egg production by farmers. Keeping of hens is usually done in self-made cages, or in small units of industrially made cages.

Small-scale egg production - general features

- Self-sufficiency of farmer's family with eggs and poultry
- Egg and meat production for local market
- Cash income for farmers
- Hen houses and equipment are self-made using local material
- No investments required
- Great production reserves involved in small-scale production
- No environmental problems arise, in general, with small-scale egg production methods.

Characteristics of extensive hen keeping in unrestricted yards in villages

- Keeping hens on free range, hens are free to go anywhere;
- Great part of daily food uptake is searched by the hens themselves;
- Breeds of hens: mostly mongrel stocks of genetically low quality;
- Eggs are often lost, or when found they are too old to be of value;
- Low laying performance
- Killing and stealing of hens, killing by wild animals

- No proper feeding of hens
- No disease control possible
- Insufficient production methods.

Characteristics of extensive hen keeping in restricted yards in villages

- Hen keeping in a poultry run, or yard (area of land enclosed by a fence.
- Possibility of proper hen feeding
- Need for a higher level of care for hens
- Housing conditions for hens generally good
- Possibility to instal labour-saving equipment for hen house
- Possibility for higher hen concentration
- Need for higher degree of production organization
- Higher production level results in better laying performance
- Typical production method for advanced poultry farmers or plants

Natural conditions of small-scale egg production

Run size: It depends on the quality of grass growing, it covers 8 - 10 m^2/hen in general;

Run shape: Quadratic shape is the best one because it requires the smallest fence

Demands on run: It should be dry (endoparasites), wet places have to be drained;
feeder sites have to be changed every 2 - 3 days;
runs should be planted with trees or bushes (shade!)
'hen-tired' runs to be relocated.

Feed value of runs: Depending on the food quality of plant growth and the content of animal organisms it is possible for well-attended runs to save up to 10 % of daily feed consumption of hens.

Situation of poultry house in runs: Two thirds of the area of run to be located in front of poultry house.

Housing conditions in small-scale egg production

Type of hen housing: self-made poultry house,
open-front poultry house in the absence of night frost.

Size of flock: From a few hens up to max. 250 hens per flock, 2 flocks can be held in the same house separated from each other by a feeding room;

Flocking density: Flock size $<$ 100 hens - 2.2 to 2.7 hens/m^2
Flock size $>$ 100 hens - 3.6 hens/m^2

Deep litter: Suitable litter materials to be used, e.g.
soft-wood shavings from a plane
wheat straw
shredded material
sawdust and wood shavings (1/2 : 1/2)
oat straw
barley straw (beardless)
rice straw
corn cobs

Poultry house equipment:

Dropping pits - 1/3 of hen-house base to be covered with wire netting or wooden grating;

Feeding troughs, or feed hoppers - linear feeder space 12 - 15 cm/hen;

Waterers - simplest shape: bucket waterer in a trestle
- better design: waterers installed onto water supply system (2.5 cm/hen linear water space);

Laying nests - absolutely required for obtaining clean eggs;
5 hens/nest box
Litter in nest to be changed at least twice/week, suitable litter material, deep litter material.

Suitable hens for small-scale egg production

Mongrels are of low genetic quality. White Leghorn is the best laying race throughout the world. Especially the dwarf-type Leghorn hens are able to adapt themselves well to different environmental conditions. Under the same feeding and keeping conditions White Leghorn hens show a higher laying performance by 30 to 50 % compared with Mongrel hens.

Laying hens reach better laying performances under good feeding and management conditions than under bad ones. In general indigenous hen breeds do not surpass White Leghorn's laying performance and feed efficiency. But in many cases it would be better to use indigenous hens with good laying performances instead of Mongrels if Leghorns or their crossbreeds with native hens are unavailable.

Hen feeding in small-scale egg production

The prevailing feeding method: home preparation of feed.
Feed types mostly available (choice):

Cereals

- grains and by-products
- maize or corn
- grain sorghum
- wheat
- wheat shorts

Protein supplements

- noog oil cake
- groundnut or peanut oil cake
- horse beans
- chick peas
- fish meal
- meat meal
- milk and milk products

Mineral supplements

- Salt
- steamed bone meal
- limestone rock

Vitamin supplements

- green grass, or legumes
- legume, dried leaves and buds

Table IV.2. - 37 Rations for chicks, pullets and layers, or breeders (after Fields, 1978)

Ingredients	chicks %	growers %	layers/breeders %
Barley, wheat or rice	49.25	54.25	51.0
Wheat shorts	10	10	10
Peanut oil meal	20	15	5
Noog oil meal (cow peas, pigeon peas, horse beans	5	5	15
Meat or blood meal	4.5	4.5	4.5

Table IV.2. - 37: continued

Salt	0.25	0.25	0.5
Alfalfa hay	5	5	4
Limestone	1	1	3.5
Steamed bone meal	2	2	3.5
Fish meal	3	3	3

Green feed: at least 20 g/hen daily
Grit (or course sand from river bed): daily ad libitum
Salt portions can be dispensed with if fishmeal is used
Recommended crude protein content of feeds:
0 - 6 weeks of age - 20 %; 6 - 12 weeks of age - 18 %; 12 - 20 weeks of age - 16 %; 20 weeks of age till end of laying - 18 %.

Table IV.2. - 38: Mean feed requirements in different stages of age of hens (kg/hen)

Age stage	Laying-type hens	Meat-type hens
0 - 6 weeks	1.2	1.3
6 - 12 weeks	2.4	3.0
12 - 20 weeks	4.5	5.7
20 weeks till end of laying	50.0	70.0

Table IV.2. - 39: Minimum daily water requirements in different age stages of hens (l/100 birds)

Age stage	l/100 birds	
0 - 3 weeks	2	Water uptake depends above all on
4 - 9 weeks	8	the environmental temperature:
10 weeks	20	$21^{\circ}C$ - 5 g/h/hen
20 weeks	30	$37^{\circ}C$ - 30 g/h/hen
laying period	35	

Recommendations on how to improve the laying performance and efficiency of small-scale egg production

- Replacement of Mongrel hens by White Leghorn hens, or using crossbred hens (White Leghorn cock x native hen);
- Improvement of hens' environment by supplanting the method of hen housing in unlimited ranges by that in limited ranges and by supplying equipment for hen's housing and feeding requirements, as mentioned above;
- Keeping hens for only two laying periods because every hen has her maximum performance in the 1st laying period (Table IV.2. - 40);
- Education and training of poultry farmers especially in the field of poultry management and and poultry feeding.

Table IV.2. - 40: Relative laying performance of hens in various laying periods by different species

Species	1st period	2nd period	3rd period
Laying type, or meat type			
Hen	100	80 - 85	70 - 80
Duck	90	100	95
Turkey	100	50 - 60	-
Goose	80	90	100

Conclusions from above table: Laying hens should not be kept longer than two laying periods.
The limitation of hens' useful time to only two laying periods (two years) is one of the most important prerequisites to intensifying small-scale egg production in every developing country.

Benefits of a two-year useful time of hens:
- High laying performance in total of every hen
- Better feed efficiency
- Higher economic effectiveness of small-scale egg production.

<u>Economic preconditions for introducing the two-year useful time of laying hens in every country</u>

- Establishment of artificial chick incubation systems to be organized with parental hen stocks in main production areas; erection of incubation centres on a cooperative or state basis; sale of 1-day-old chickens to farmers.
- Organization of artificial chicken rearing in main production areas; erection of rearing centres on a cooperative or state basis; sale of 8-week-old pullets to farmers.
- The incubation and rearing centres can also be put up as combined incubation-rearing centres in the main production areas; the efficiency of such enterprises is raised, environmental degradation will be low.

IV.2.3.5. <u>Large-scale egg production</u>

Intensive hen keeping systems are characteristic of modern large scale egg production in cooperative and state enterprises. They operate on an economic basis and encompass egg production and marketing, keeping of parental stocks, incubation, chicken and pullet rearing. Large-scale enterprises are conveniently located close to consumer centres (capitals, district towns or other large towns of industrial relevance). They require sufficient water and energy, feed mills with short feed transports and a well established egg distribution system.
As to the utilization of hens' manure, especially in cage keeping enterprises, it is possible that there are environmental problems arising. Hen keeping systems on deep litter or floor gratings are suitable for small-scale egg production systems. Cage-keeping systems permit an enormous hen concentration in one poultry house, or in one egg production facility (up to 1 mill. hens).

<u>Three developmental tendencies to improve the effectiveness of large-scale egg production throughout the world</u>

1. Increase in laying performance by an appropriate air-conditioning and the use of lighting programmes in well-insulated hen houses.

2. Increase in the number of hens/m^2 ground floor in the poultry houses (deep litter ---> floor gratings ---> cage systems).
3. Reduction in building costs per hen by devising low-cost keeping methods in easy hen accommodations in climatically favourable areas.

Reasons for the introduction of large-scale egg production

- Increase in the demand for eggs and poultry meat
- Increased number of animal stocks
- Coercion to rationalize poultry production.

Benefits of large-scale (intensive) egg production vis-à-vis extensive production systems

- Higher laying performances by improved environmental conditions
- Better feed efficiency because of higher laying performance
- Mechanization or automation of working operations in poultry house
- No need for runs - thus lower risk of parasite infections in hens.

Benefits of deep litter systems vis-à-vis cage systems

- Lower investment expenses
- Easy bioclimatic house control
- Low technical expenses
- Easy maintenance and care of equipment

Benefits of cage systems vis-à-vis deep litter systems

- Higher productivity per m^2 ground floor
- Egg weights slightly higher
- Egg quality slightly better
- Reduced incidence of dirty eggs
- Reduced consumption of feed, thus better ratio feed : egg

Disadvantages of cage system vis-à-vis deep litter system

- Higher investment costs
- Possible incidence of broken bones, cage fatigue, fat-liver syndrome, dystrophia because of restricted hen movement

- Hens react susceptibly to low mean temperatures below the freezing point
- Occasionally reduced stability of egg shell.

Table IV.2. - 41: Protein and energy requirements of intensively kept layers

		Feed contents in climates moderate	hot
20 - 42 weeks of age	protein (%)	14.5 - 18	16.5 - 20
	kJ ME/kg	11050 - 13350 (for both climates)	
Nutrient intake	protein (g/hen/d	18 (both climates)	
	kJ ME/hen/d	1275	1150
42 weeks of age and more	protein (%)	13 - 15.5	14 - 17
	kJ ME/kg	11050 - 13350 (for both climates)	
Nutrient intake	protein (g/hen/d	16 (both climates)	
	kJ ME/hen/d	1300	1170

Table IV,2. - 42: Mean food consumption of intensively kept layers in cages

	Range	Average	
140 - 532 days old			Food consumption
Total consumption (kg)	34.8 - 48.3	42.6	depends on:
Daily intake (g)	98 - 126	115	ambient tempera-
Liveweight of hen:			ture,
532 days (kg)	1,516 - 2,055	1,766	live weight
126 days (kg)	1,088 - 1,451	1,243	laying performance

Efficiency of intensive egg production depends on the following factors:

- Microclimatic conditions existing in hen house
- Composition of feed and quality of feed
- Constitution, state of health and genetic origin of hens
- Capabilities, knowledge and dedication of hen-house workers.

Table IV.2. - 43: Manure production of cage-kept and floor-kept laying hens

Management	Consumption of feed (kg/hen/d)	Manure production (kg/hen/d)	(% moisture)	Egg production %
Cage	0.106	0.110	74.3	75
Floor	0.115	0.138 1/	70.2	70

1/ Based on 63.5 % excreted into pits, and 7.2 hens/m^2 floor space

Table IV.2. - 44: N, P and K-content in manure of poultry

Type of manure	Moisture %	N %	P_2O_5 %	K_2O %
Cage battery (fresh)	70	1.50	1.25	0.50
Deep litter (1 year old)	28	1.75	2,25	1.10
Broiler litter	15	4.00	3.35	2.10

IV.2.3.6. Chicken and pullet rearing

Chicken rearing (brooding) period: 0 - 8 weeks.
Pullet rearing period: 9 - 20 weeks, up to maturity.
Errors in the stages of rearing can hardly be corrected later and have adverse effects on the following laying period.
Rearing method: deep litter rearing has proved to be an all time well-tried system of rearing applicable to chicken and pullets. Cage rearing is an uneconomic system.

Deep litter systems of rearing are noted for:

- Equal suitability for small-scale and large-scale poultry production
- Good possibilities for mechanization of feeding and watering
- Rearing temperatures required are produced by brooders and room heaters
- Optimal pen size: 500 - 1000 chicken during brooding period, 5.000 pullets during rearing period
- Intensive keeping of chicken avoids losses through uncontrol-lable diseases and predatory animals and results in a better efficiency of feed

- No problems of degradation for human environment
- Deep litter, after being removed from the rearing station is a valuable feed for ruminants, especially fattened bulls during the brooding, or rearing period.

Chicken rearing

Table IV,2. - 45: Environmental requirements for chicken during the brooding period

Room temperature	20 - 22°C
Brooder temperature (in the first three days)	32 - 35°C
Brooder space/chick	50 cm^2
Relative air humidity	50 - 70 %
Minimum ventilation rate	1.5 m^3/kg/h
Maximum ventilation rate	8 m^3/kg/h
Size of flock	500 - 1000
Density of flock	14 - 15 chicken/m^2
Length of feeding trough	5 - 6 cm/chick
Number of chicks/feeder pan (35 cm Ø)	50
Side length of waterer	1.5 cm/chick
Number of chicken per two waterers (1 litre capacity)	50

Table IV.2. - 46: Protein and energy requirements for chicken and pullets

Age weeks	Type of feed	Form of food	Recommended content	
0 - 4	chick starter	mash or crumbs	crude protein (%):	19.5 - 23
			kJ ME/kg	11050 - 12900
5 - 14	growers mash	mash	crude protein (%):	15.5 - 18.5
			kJ ME/kg:	11050 - 12900
15 - 20	pullet developer	mash	crude protein (%):	12.5 - 14.5
			kJ ME/kg:	11050 - 12900

Table IV.2. - 47: Mean production parameters in rearing period (laying hens)

Feed consumption/bird	0 - 8 weeks	≈ 2 kg
	0 - 20 weeks	≈ 9 kg
Mortality	0 - 8 weeks	2 - 3 %
	0 - 20 weeks	5 %
Live weight/bird	8 weeks	500 g
	20 weeks	1500 g

Pullet rearing

Pullet rearing in runs is the most frequent method and is characteristic of small-scale production.
Accommodation is ensured in self-made transportable pullet shelters put up in the run.
Feeding - growers mash and grains.
Watering - simplest form: bucket waterer on racks,
optimum form: installation of water supply
Environmental requirements for pullets: similar to those for laying hens in runs.

Intensive pullet rearing: typical of large-scale enterprises.
Pullet rearing in deep-litter houses is a well-tried rearing method.
Cage rearing involves problems because of unresolved technological technique.
Intensive pullet rearing requires a higher rate of investments compared with pullet rearing in runs.
It is possible to mechanize essential operations.
Environmental requirements for pullets are similar to those for laying hens reared in deep litter houses.
Density of stocks: 8 - 10 pullets/m^2.

IV.2.3.7. Broiler production

Suitable animals:
Worldwide crossbreds have supplanted purebred animals since 1960. Usual crossbred: (WR ♀ x WR ♂) x Co ♂ - 3-way crosses.

In every breeding programme White Cornish (Co) is the father foundation because of great feeding results and the F_1-White Rock female is the mother foundation on account of the heterosis in parental flocks (greater economic effect in the production of broiler).

Production parameters

Duration of fattening period: 0 - maximum 63 days of life
Mean liveweight: 1500 g (♀ 1200, ♂ 1800 g)
Feed: ratio of gain 2.1 - 2.5
Mortality: $<$ 2 %
Carcass yield: $\geq$ 72 %

Keeping system

Broiler production on deep litter is the customary keeping system. The broilers are kept in an intensive system in home pens, or large halls without pens (10000 - 20 000 birds/hall). Deep litter: It is laid out shortly before broiler production starts. Depth of pile: 15 - 20 cm; litter is removed at the end of fattening period. Litter is used after removal of dung for vegetable gardening and field, or as feed for fattened bulls. Suitable litter material: Chapter IV. 3.2.

Broiler production on deep litter is suitable for small-scale and large-scale production. It is a well-tried and secure system of production, without any problems, and does not involve any environmental degradation. Large-scale broiler production requires the complete infrastructure of the production area (grandparents and flocks of parents, hatchery, feed mill, slaughter house, dressing plant, distributing system, roads, water and energy supply, motor trucks, etc). The offal should be dried, ground and re-used in the broiler feed.

Table IV.2. - 48: Environmental requirements for broiler chicken

Density of stocks	18 birds/m^2
Brooder space/bird	50 cm^2
Relative air moisture	
1st - 2nd week	30 - 70 %
3rd - 7th week	60 - 80 %

Ventilation rate	1 - 3 m^3/kg/h
Max. NH_3 concentration	0.003 Vol. %
Linear waterer space	1.5 cm/bird

Table IV.2. - 49: Temperature regime in the broiler production period

Age of birds	Brooder (°C)	Room (°C)
1st day	35	26
2nd day	34	26
3rd day	33	26
4th - 7th day	32	26
2nd week	30	24
3rd week	28	24
4th week	25	22
5th - 7th week	-	20

Table IV.2. - 50: Protein and energy requirements of broiler chicken

Age of birds (weeks)	Type of feed	Recommended content protein (%)	kJ ME/kg
0 - 3	broiler starter	20.5 - 25.0	11500 - 13800
4 - 7	broiler grower	17.5 - 21.0	11975 - 14275

Broiler lighting

1. Continuous light throughout the whole day with a dark period of only one hour (23 L : 1 D) - this is a simple and approved method to ensure maximum growth rates.
2. Intermittent lighting (2 L : 2 D) provides an optimum ratio of light and darkness for birds, a permanent flow of feed in birds, it minimized their locomotive activity (higher growth rates, better feed : gain ratio, lower mortality), but requires the exact control of the light-darkness cycles by using automatic timers.

Sex separation in broiler rearing

The different energy and protein requirements for male and female chicken result from a dimorphism of sex in broiler growth.

Therefore male and female chicken are reared separately in broiler houses and slaughtered at different times.
Benefits of sex-separated broiler production:

- Improved feed economy and nutrient utilization
- Higher weight gains in both sexes
- Lower mortality
- Greater uniformity of slaughtered carcasses.

Broiler production in cages

This method cannot be viewed as an improvement due to

- Higher investments
- Greater incidence of breast blisters and other carcass damage
- Frequent incidence of perosis, bone breaking and different forms of leg weakness
- Lack of experienced constructional solutions of cages and lack of knowledge about optimum broiler rations for cage fattening.

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IV.2.4. Ecology and production technology of pigs

IV.2.4.1. Importance of pig production

Pig production has assumed a great importance on a world-wide scale. At present the number of pigs is about 800 million. The areas and regions with the greatest populations of pigs and the highest concentration are to be found in the countries of Asia (especially China), Europe (notably northwest Europe) and North and South America. There are only a few stocks of pigs in the countries of Africa, Central America and in Oceania. Some 40 % of pigs are to be found in tropical regions (notably in southern China, the tropical regions of Asia and Latin America). The unequal distribution of pigs within the tropics has to be seen as the result of social and religious facts rather than that of climate and natural resources.

A highly developed pig production requires high-quality feed. In many tropical and subtropical countries there is an absolute shortage of food among the population and a sparsely developed production of plants. Under these circumstances man and pig are competing for the products under cultivation.

Pigs require energy-rich feed (grains, potatoes) and they need a certain amount of animal protein to grow. Therefore, under the existing conditions of each individual country it has to be considered whether it it possible to create the preconditions for pig production. In addition it has to be seen that the wastes of human nutrition (kitchen refuse and wastes, offal from large slaughtering houses) shall be taken into account.

In pig production the dominating aspect is the provision of meat compared with other domestic animals. On a worldwide scale the share of pork in the total consumption of meat is presently 38 %, thus taking the first place. In Europe the per-capita consumption of pork is especially high (up to 50 kg). The basic requirements for this development were the high rate of reproduction, the high rate of increase as well as the continuous availability of high-quality feed.

In the highly developed industrialized countries it is possible to process the entire pig carcass. Apart from the leather- and bristle-processing industry the bones and claws are used in the soap and glue industry, whereas the glands can be prepared especially for medical purposes. In dependence upon the state of industrial development and the initiatives it is possible to process the raw hides, bristles and intestines either in the country itself, or to export them as an agricultural raw material. The dung is another nutrient or side-product to be used as humus in crop production. In China, e.g. dung is used for intensive gardening work as well as for the stimulation of growth of microorganisms in fish and duck ponds. The latter aspect shall not be accepted without reflection because the excessive supply of nutrients into ponds and lakes results in eutrophication, so that it is possible to contaminate the water with pathogenic microorganisms. In the present time pig dung has become of interest in the generation of biogas especially in the tropical and subtropical countries.

The performance of pigs is determined by parameters referring to the principle: performance of animal stock per time unit:

- Number of breeding and fattened pigs produced per each sow, or the quantity of meat (pork) produced per annum and per each sow.

In the countries with a highly developed pig production an increased role is played by the quality of carcass in form of the daily fleshing as well as the share of meat to the animal body. However, in countries with an extreme lack of energy these problems are currently of secondary importance. The causes for the different meat-fat ratio in the carcass animal are, on the one hand, genetically conditioned and, on the other hand, are dependent upon the methods of fattening, the feed used, the age of slaughtering and the weight of carcass animal.

IV.2.4.2. Breeds of pigs and their importance

Pigs were domesticated mostly in Asia and in Europe (eastern part of Mediterranean) some 4000 years ago. The domesticated

breeds are derived in Europe from the European wild boar (Sus scrofa) and the Asian wild boar (Sus vitatus). It was especially the Asian wild boar that contributed several decisive properties to the development of the present breeds of pigs, such as fertility, frugality and early sexual maturity, while the European boar contributed its great height and the share of meat. The first breeds originated in England (Large White, Large Black, Tamworth, Berkshire) and in Denmark (indigenous breeds). In breeding meat pigs the bacon-type of the Danish native breed became dominant. But also in other countries with a highly developed pig production the breeds with a high fat production are seen to be decreasing.
This trend of production requires high-quality feed (rich in protein and highly digestible). In the countries of the tropics and subtropics suffering often from a general lack of nutrition it is conceivable that such an extreme goal is presently out of the question. These countries, in developing their own pig production, should, as a rule, take recourse to their own plain breeds of pigs. Out of the 45 different breeds of pigs which are currently known a great part of them are to be found in the Asian and Latin American countries. These indigenous, often extremely old breeds are usually marked by a low body weight and a carcass weight of less than 60 kg. Extreme fertility, frugality and resistence against the customary infectious diseases are the characteristic features of these breeds that have to be emphasized. In the PR of China there is the world's largest pig population with some 320 million animals. These animals have found increasing international interest among animal breeders because of their high fertility. Contrary to the high fertility there is the low birth weight (0.4 - 0.7 kg) and the slow growth of the animals. Table IV.2.-51 includes several Chinese breeds with their performances. The animals are slaughtered below a weight of 100 kg, with a pronounced fatty infiltration being available. In the Asian region there is still the Thai pig and two Vietnamese breeds to be found. These breeds are also fertile, short and rich in fat.

Table IV.2. - 51: Performances of Chinese pig breeds

Breed	Number of teats	Piglets/farrow live born	Piglets/farrow reared
Mai Shan	16.8	14.0	12.2
Fea Ying	17.4	13.9	11.9
Jia Ying	16.4	13.0	10.9
Da Min	--	13.8	10.5

Throughout Africa there are only some 10 million pigs. While only a very few animals are kept in the Islamic countries, the stock is about 1 animal/ha in the other countries. Pig breeding has reached a high level in the south of Africa where the so-called 'Kalbruck pig' is readed, a small and quickly fattening swine of early sexual maturity. It is slaughtered at a weight of 40 to 80 kg and is preferably kept by the native people. In Latin America the indigenous breeds that are pigmented and with an excessive development of fat and of late sexual maturity have a decreasing importance and are being supplanted by imported breeds and their crossbreds. Brazil with about 70 million pigs has the largest swine population of this continent. Many of these indigenous breeds could be improved solely by a change of the feeding regime as well as by the existence of a technically better trained personnel without great expenditures. The foremost requirement and the first step for an increase in efficiency would be the breeding, or crossbreeding of indigenous races of swine. In dependence upon the conditions of farm operation and the provision of feed it may be possible to reach a qualitative progress to a growing extent by way of breeding (e.g.crossbreeding with imported species. Initially it would be appropriate to use rather plain and simple breeds for it. Especially suitable for crossbreeding would be Berkshire and Large Black as well as other suitable races, especially those of early sexual maturity and suitable for slaughter from 60 to 70 kg, with the former breeds being noted for a convenient meat-fat ratio.

Both breeds can be easily acclimatized due to their pigmentation. Also of great interest are the races Poland-China, Duroc, Tamworth and Wessex-Saddleback, i.e. pigmented, robust and adaptable breeds, with the Wessex-Saddleback being noted for its high fertility and the excellent mother characteristics. Duroc has proved to be excellently suitable for crossbreeding.

IV.2.4.3. Breeding systems

The task of breeding is to develop animal material with a high genetic potential and its uniform distribution in a population. The basic requirement for each systematic breeding is to have an objective in breeding which is supposed to include all economically important production parameters. There are two methods available for the breeding and distribution of the genetic potential, first, the selection of the breeding partner within a closed population (purebred) and second the selection within an open population by the addition of boars that stand outside this population (combination breeding). If in tropical countries economically important pig populations are already available it should be attempted by a purposive pure-line breeding to consolidate the typical and desired performance characteristics within this population. This is done by finding out the dispositions of performance in the progeny of father animals. These animals can be used as the basis for further breeding activities. At the same time properties are acquired which are needed with a view to implementing further more complicated breeding operations for developing its own indigenous lines or breeds. The import of highly developed foreign breeds should always remain the second step because of the unavailability of the material preconditions required for the preservation and further treatment of this animal material (conditions of keeping, provision of feed, operating technology).

Combination breeding is carried out in order to increase the diversity of genetic material within the population, or to retain this diversity in a systematic way in specific lines.

The lines with the specific properties are used as a starting material for purposive breeding.
A variety of the process indicated here is increasingly used internationally as a hybrid breeding programme for the production of fattened hybrids with the aim of utilizing the additive and non-additive genetic variants.

IV.2.4.4. Performance tests

An indispensable precondition to reach the goal of breeding is the consistent use of a system of performance tests. The problem involved is to find out the performance parameters that determine the breeding value of the animal material.
The value of breeding can be determined by the performance testing of the animal's capacity and progeny. The performance test of the animal and the progeny test are relatively low-cost, instant and safe methods for determining such parameters, as the growth rate, feed utilization and the carcass quality.
In consideration of the existing possibilities the fertility, feed utilization and the body weight growth are required to be used as easily determinable properties. To determine the carcass quality at the living animal by ultrasonic devices there is needed the availability of adequate technical and scientific facilities which only a few countries of these regions are able to comply with.

In progeny testing boars are mated with different sows and their inheritability is tested. This test needs a larger time, but it is the only possibility of selecting parameters with a lower inheritability. The consistent application of the performance test makes it advisable to accentuate especially those animals which had been identified as efficient. In the case of parental animals this is done in the form of an institutional recognition with document. It is recommended to furthermore use exclusively such recognized paternal animals for breeding with a view to achieving quick breeding successes nation-wide.

IV.2.4.5. The keeping of pigs

The breeding, fattening and slaughtering properties of pigs are determined not only by genetic factors, but also by a wide scale of environmental factors, such as keeping, climate and feeding. Only when the animals are kept in an environment approaching optimum conditions it is possible to reach fully the genetic potential of the pigs.

The major cause for the unsatisfactory performance of pigs in the tropics and subtropics is essentially the existence of the relatively large desolate and arid areas.
Grown-up pigs are relatively susceptible to heat. Upon very high outside temperatures (up to 30°C and more) the intake of feed and the growth decrease. The thermally neutral zone of the pig is dependent upon the body weight. It is lowered with increasing body weight. Table IV.2.-52 shows the thermally neutral zone of different age groups.

A production facility for pigs can be erected, by and large, by using indigenous building materials.

Table IV.2. - 52: Thermal-neutral zone of pigs of different age with a relative humidity of 60-80 %
KOLB, 1978

Piglet at the time of birth	35 - 33 °C
Piglet of 2 days - 2 weeks	33 - 28 °C
Piglet, 2 - 4 weeks	30 - 24 °C
Piglet, 4 - 8 weeks	26 - 20 °C
Piglet, 8 - 12 weeks	22 - 18 °C
Fattened pig, 40 - 80 kg	22 - 18 °C
Fattened pig, 80 - 110 kg	18 - 15 °C

The following considerations shall determine the choice for the location of a pigsty:

- Microclimate. In tropical and subtropical regions the sheds for pigs (pigsty) should be build on a plateau (more intensive movement of air);

- Provision of feed. In addition to energy-rich feed it is essential that animal protein is made available in the form of skim milk, fish-meal, carcass meal and grain wastes.
- Provision of energy
- Supply of water
- Sales of pork (regions with a great density of people in the vicinity of cities)
- Slaughter house, or sale to smaller slaughtering enterprises.

The location should be surrounded by a double fence. The area within both the fences has to be cleared from growth with a view to denying any shelter to wild animals.

The sheds should be erected in a semi-open mode of construction with the possibility of covering the openings with simple means against cold, or in special regions with gauze against insects. The aim should be to create a convenient climate with low expenditure of energy. In general the flooring, the runs and the ways should be provided with a hard surface to offer good conditions for cleaning and disinfection. Solidly burnt bricks are well suitable as a cover in shed floor provided that they are used with edges uppermost, or with the narrow side uppermost.

Within the plant the sheds have to be subdivided according to the various stages of keeping:

- Farrowing pen
- young-pig pen
- porker pen
- reproduction pen
- fattening pen
- boar pen.

Basically there are only two kinds of pens required for construction. One kind of pen is the farrowing pen, and the second one is suitable for all the other kinds of keeping, with the boar pen to be built more solidly depending on the size of boar. However, the farrowing pen has to be built with nests and slides to the sow to be accessible from outside for the personnel and to be covered against the sudden onset of cold weather. All pens have to be provided with separate watering troughs that allow the water also to be drained off. Fig. IV.2.-6. show the two types of pens and Fig. IV.2.-7. shows the arrangement of the various pigsty pens and adjoining buildings. The ducts for liquid manure should not be covered in order to prevent rodents and other animal species from hiding in them. In addition to the original buildings for animals the following buildings are recommended to be put up:

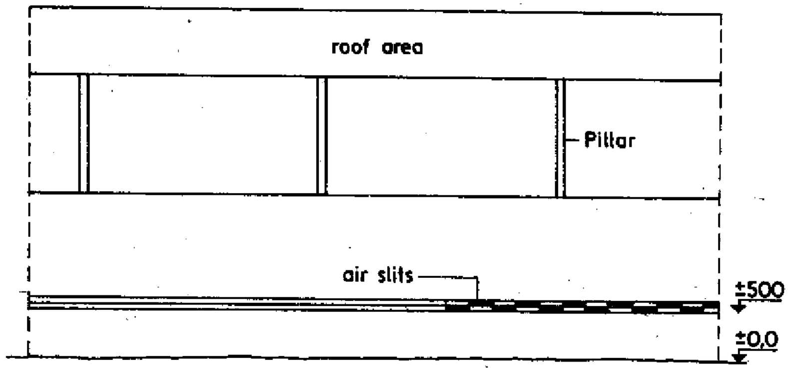
Social building (social amenities)
Building for animal feed
Dung depot } covered
Loading platform } covered
Water depot
Liquid manure tank

From the point of view of epidemic hygiene the animal stocks should not exceed a concentration of 100 productive sows (about 500 animals in total) together with offsprings. The stocks represent enclosed production units, within which only the necessary exchange of breeding animals is allowed. The distance between the individual units should at least be five kilometers.

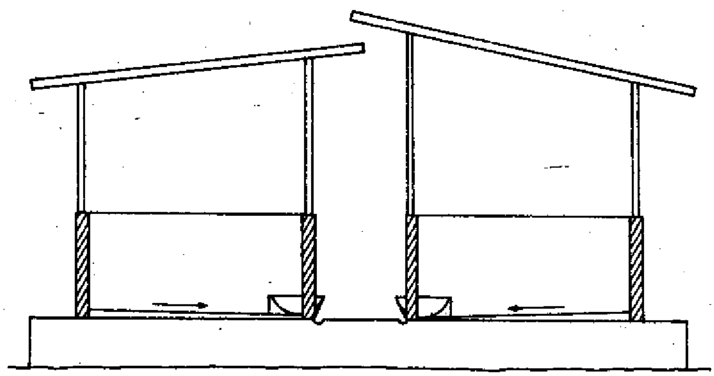
IV.2.4.6. <u>Feeding</u>

In the tropics there are two main problems in pig feeding that apply also to the subtropics. First, feed is available only intermittently on account of seasonal vegetation. Second, the pig is the food competitor of man.

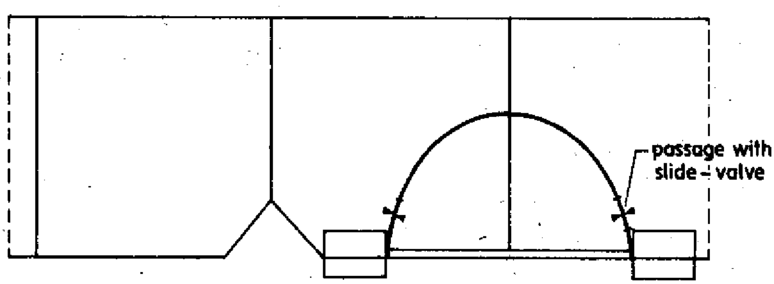
Thus an intensive arable farming and cultivation of plants is the basic requirement for the continuous provision of feed. However, this is incompatible with the conditions existing in the majority of the countries of these regions. Therefore, aside from the planned development of arable farming and crop cultivation greatest attention should be paid to the side of feed production. The pig as a monogastric animal demands digestible feed rations which should contain not more than 10 % of raw fibre matter. To produce a certain amount of meat a minimum amount



Front view of the stable



Cross section of the stable, scale 1: 50



Base view of the farrowing pen, scale 1: 50

Fig. IV.2.-6.

Pilot unit in Western Afrika

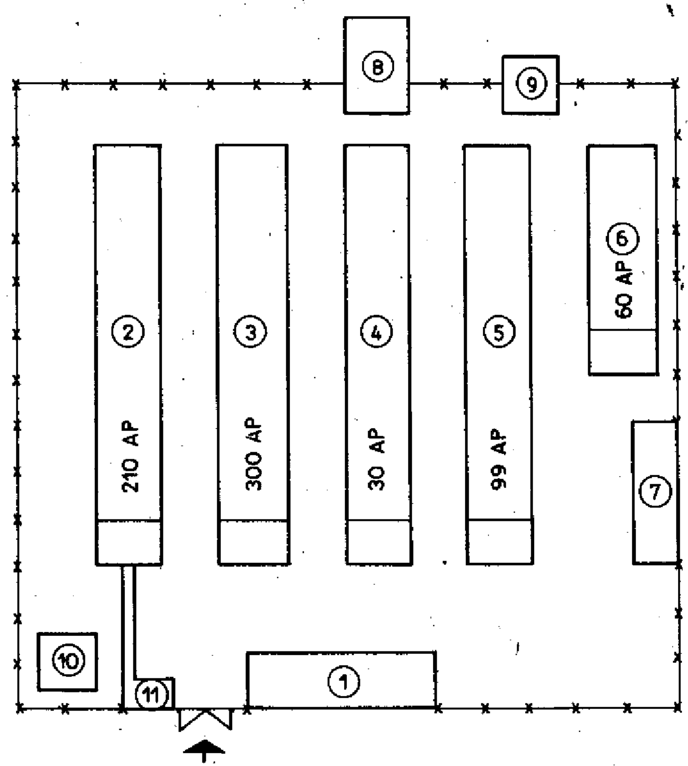


Fig. IV.2.-7.

Key of the figure:

1. Social and administration house
2. Fattening stable
3. Weaned piglet
4. Farrowing room
5. Sow house and boar house
6. Reproduction
7. Feed processing room
8. Dung pit (roofed)
9. Dungwater pit (covered)
10. Water depot and generator
11. Animal loading platform

— House

x—x Fence

AP Animal places - capacity

<u>Pig breeding and fattening unit for 60 sows</u>

Layout, scale 1:500

of digestible raw proteins is required. For this reason the feeding stuff available has to be judged in terms of its digestibility, protein content and energy content.

It is suggested to use feeding material from the grain-processing industry (wastes from mills), oil-plant-processing industry (peanuts, coconuts, soybeans, etc.), the fish-processing industry and, if available, the foodstuffs industry (breweries, dairies, meat-processing, kitchen wastes). In the event of an intensification of pig keeping attention has to be paid to the provision with mineral substances and trace elements that have to be supplied via imports, if required.

IV.2.4.7. Additional basic requirements

Apart from technical consultations to be provided by specialists a qualified veterinary service is necessary in the wake of the erection of a large-scale pig production facility. Apart from epidemics involving heavy losses of animals in the tropics and subtropics importance has to be attached to zoological problems. For the protection of human health the animals have to be examined by a veterinary surgeon prior to slaughtering and after it,it is necessary to carry out an examination of the meat for trichinosis in particular.

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Subject IV: Animal husbandry

STUDY MATERIAL
elaborated by a team of authors under G. Fenske

Volume One

1. Range management

Volume Two

2. Ecology and production technology of selected animals (cattle, sheep, poultry, pigs)

Volume Three

3. Processing and marketing

4. Unconventional sources of protein, game management (management of reserve areas and other game habitats)

5. Environmental impact of animal husbandry
   - Overgrazing, soil erosion and desertification
   - Animal feedlots and processing plants (water, soil and air pollution)