DRAUGHT ANIMAL SYSTEMS AND MANAGEMENT: AN INDONESIAN STUDY

Editors: E. Teleni, R.S.F. Campbell and D. Hoffmann

The Australian Centre for International Agricultural Research (ACIAR) was established in June 1982 by an Act of the Australian Parliament. Its manate is to help identify agricultural problems in developing countries and to commission collaborative research between Australian and developing country researchers in fields where Australia has a special research competence.

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FOREWORD

Farming methods based on draught animals are among the most significant agricultural systems in the world. In the production of rice and other crops in the tropics these systems remain critical to the food security of expanding populations. They are a major contributor to employment and a major source of income from crop products, calves, animal rental and animal by-products.

The concept of a multidisciplinary study of draught animal power arose in 1985 from discussions between Dr John Copland of ACIAR in Canberra, the Graduate School of Tropical Veterinary Science at James Cook University and CSIRO, Townsville, the University of Melbourne and colleagues in several Southeast Asian countries.

The project was brought into sharper focus at an International Workshop held at James Cook University in 1985 which set out, in a proceedings volume, the major criteria for improving the production of draught animal systems in Asia and Africa. As a result the ACIAR Project in its first phase concentrated on the total farming system, including ruminant nutrition and the economics of draught animals. Some of the findings of this research were distilled in a further conference held in West Java in 1989. Detailed results from subprojects were reported in the DAP Project Bulletin series also published by ACIAR. The coordination of this complex study was the work of Dr John Petheram, Dr Putu Kompiang and his successor and Dr Benny Gunawan.

The second phase of the Project being reported made further advances in the knowledge of draught animal nutrition. It also compared draught animal production in different ecological systems and gave some attention to reproductive performance which emerged as a key factor in production and economic output. Aspects of animal health, especially among calves, were now identified as problems. Dr E. Teleni and Dr M. Sabrani coordinated these activities.

This manual contains a comprehensive account of the draught animal systems in representative areas of Indonesia whose characteristics simulate many other areas of Southeast Asia.

GHL Rothschild
Director
ACIAR, Australia

S Hadiwigeno
Director
AARD, Indonesia

PREFACE

This manual is intended to be a source of information and a guide for field advisers who are involved in the development of improved draught animal systems in Indonesia and elsewhere. It is the first attempt at integrating research results for practical implementation in draught animal systems in this country. The manual does not pretend to be the definitive statement on the subject as there are still important areas to be clarified through further research. It is anticipated that its usefulness will improve with time as further information and its critical evaluation by users become available.

Much of the information used here has been published in some form or other in the ACIAR Draught Animal Project publications: DAP Project Bulletin, Nos. 1-10, Draught Animal Bulletin, Nos. 1-3 and in the ACIAR Proceedings Series No.27 entitled Draught Animals in Rural Development. The manual presents descriptions of draught animal systems in selected agroecosystems; highlighting problems unique to each. Tillage implements used in these areas are also described. Feed resources, feeding and breeding, health and management and economic strategies which field advisers could use as guides when assisting smallholder farmers develop their own respective strategies are discussed.

The use of this manual as a guide must be emphasised. Field advisers must adapt the guidelines provided here to the particular conditions of their areas.

E Teleni R.S.F. Campbell
Department of Biomedical and Tropical Veterinary Sciences James Cook University

D Hoffmann
ACIAR

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ACKNOWLEDGMENTS

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List of ACIAR Draught Animal Project members

Australia

ACIAR

Dr D Hoffmann	Animal Science Research Coordinator

James Cook University

Professor R Campbell	Project chairman
Professor P Summers	Head, Biomedical and Trop. Vet. Sciences
Dr E Teleni	Project leader/coordinator
Dr M Murray	Nutrition
Ms D Martin	Nutrition
Mrs K Griffiths	Project secretary

CSIRO

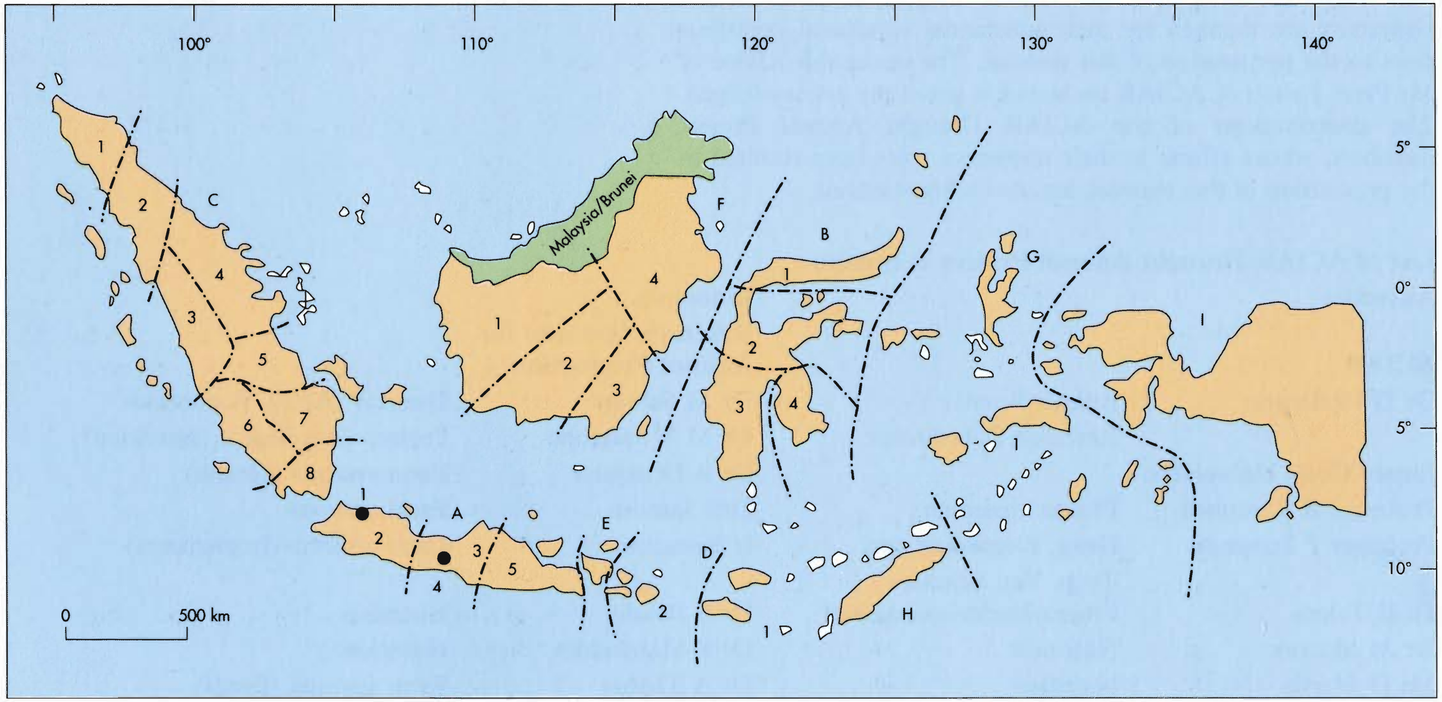
Dr J Hogan	ex Head, Davies Laboratory, Townsville
Dr P Kennedy	Nutrition

Indonesia

Research Institute for Animal Production

Dr M Sabrani	Director (BPT), Economics
Dr M Winugroho	Project Coordinator (Nutrition)
Dr R Dharsana	Farm systems (Health)
Drh Santoso	Farm systems
Ir Sumanto	Farm systems (Implements)
Dr B Bakrie	Nutrition
Dr P Mahyuddin	Nutrition
Dr A Thahar	Farm systems (Feeds)
Dr T Chaniago	Farm systems (Reproduction)
Ir Komarudin-Ma'sum	Site Coordinator (Animal Production)
Ir M Ali Yusran	Farm systems (Animal Production)
Drh D B Wijono	Reproduction
L Affhandy	Nutrition

Figure 1.1.1
The Indonesian islands.
Source: ACIAR Draught Animal Bulletin 2 (1991)



A: Java
1. DKI Jakarta
2. W. Java
3. Central Java
4. DI Yogyakarta
5. E. Java

B: Sulawesi
1. N. Sulawesi
2. Central Sulawesi
3. S. Sulawesi
4. SE. Sulawesi

C: Sumatera
1. DI Aceh
2. N. Sumatera
3. W. Sumatera
4. Riau
5. Jambi
6. Bengkulu
7. S. Sumatera
8. Lampung

D: Nusa Tenggara
1. E. Nusa Tenggara
2. W.Nusa Tenggara

E: Bali

F: Kalimantan
1. W. Kalimantan
2. Central Kalimantan
3. S. Kalimantan
4. E. Kalimantan

G: Maluku

H: Timor

I: Irian Jaya

1.1 INTRODUCTION

1.1.1 The Indonesian climate

Indonesia consists of more than 1600 islands which are located close to the equatorial belt (see Figure 1.1.1). The tropics are characterised by a uniform climate with respect to air temperature, solar radiation, humidity, wind speed and evaporation. However, the seasonal fluctuation of rainfall is an important climatic variable as it will influence cropping systems if no additional water sources are available.

Solar declination causes heating and cooling of large land masses. Cooling of the Eurasian continent and heating of the Australian continent, cause a broad north-westerly monsoon over eastern Asia, including Indonesia. The climate of Indonesia is called 'monsoon-type' and the monsoon marks the beginning of the rainy season in this region. The movement of the equatorial low pressure belt, following the solar pattern, causes rainfall peaks in August and September at the northern limit, and rainfall peaks in January and February in the southern limit of the equatorial belt. The area south of the equator has a less pronounced seasonal change, due to the buffering effect of the vast oceans surrounding the Indonesian archipelago. Hence the northern coast of Java is affected more by the seasonal variations than is the southern coast which is exposed to the Indian Ocean. East Java and islands to the east have a more pronounced dry season than West Java, because they are more directly exposed to the Australian continent.

Crop growth and cropping patterns are in part determined by interactions among climate, soil, plants and management. Any plant will grow when minimum requirement levels of factors are available, but it requires an optimal arrangement of these factors for maximum plant production. In Indonesia the annual air temperature fluctuation is not a problem for growing plants, but water availability may be a major constraint. Irrigation systems have increased agricultural productions, but the areas with fully controlled irrigation are still generally limited.

Farmers traditionally adapt their crop or cropping pattern to the existing rainfall pattern. In most parts of Indonesia, rice is the main food crop and the system used there is known as a 'rice-based (wetland) cropping pattern'. Elsewhere, in dryland areas there are secondary cropping patterns.

1.1.2 Agroclimatic systems

A wet month is defined as one with enough rainfall to grow a crop of lowland rice. It has at least 200 mm of rain. A dry month of less than 100 mm will not support the growth of most of the economically important upland crops. According to Oldeman and others, the rainfall patterns in Indonesia may be classified into five main zones:

A: more than 9 consecutive wet months
B: 7–8 consecutive wet months
C: 5–6 consecutive wet months
D: 3–4 consecutive wet months
E: less than 3 consecutive wet months.

These main zones are then subdivided according to the length of consecutive dry months.

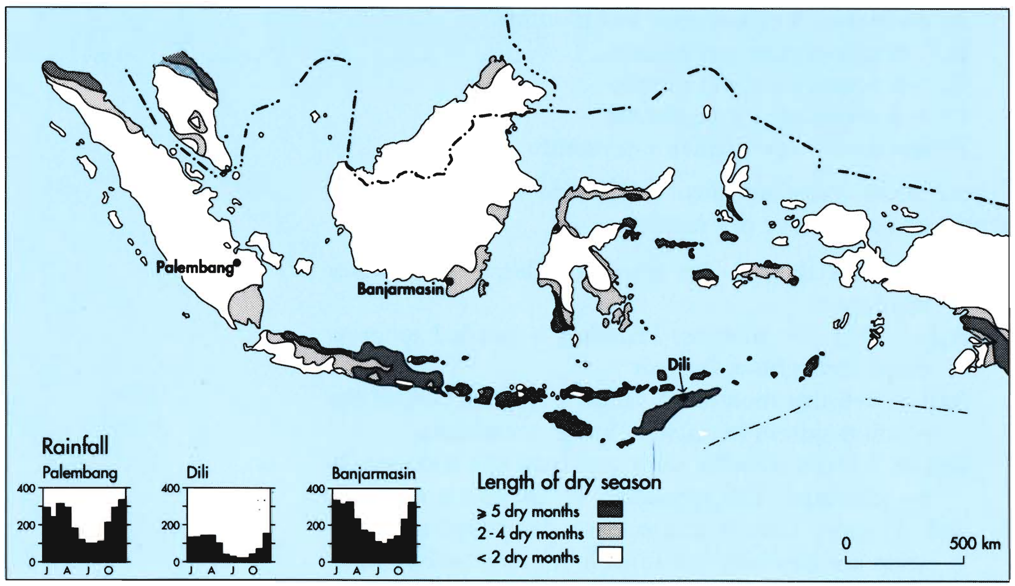
Sub 1: less than 2 dry months. There is no water restriction.
Sub 2: 2–3 dry months. Planning is needed to grow crops throughout the year
Sub 3: 4–6 dry months. A fallow period is part of the rotation system because of water constraints
Sub 4: 7–9 dry months. Only one crop can successfully be cultivated. The remainder of the year is too dry
Sub 5: more than 9 consecutive dry months. These areas are generally not suitable for any cultivation of arable crops.

These subdivisions lead to 18 agroclimatic zones, of which 14 are recognised in Indonesia. The percentage occurrence of the 14 agroclimatic zones are:

A1 (29%)	C2 (9%)	D3 (4%)	E3 (2%)
B1 (29%)	C3 (2%)	D4 (1%)	E5 (1%)
B2 (1%)	D1 (6%)	E1 (4%)	
C1 (8%)	D2 (2%)	E2 (2%)	

A broader classification of agroclimatic zones of Indonesia is presented in Figure 1.1.2 for the purpose of discussion in this Manual.

Figure 1.1.2
A broad classification of agroclimatic zones of Indonesia into dry (5–8 consecutive dry months), intermediate (2–4 consecutive dry months) and wet (< 2 consecutive dry months) zones.
Source: IRRI (1978)



Agroclimatic classification in Indonesia is based on a concept in which rainfall patterns are considered as the most important variables affecting cropping except where irrigation systems are developed. In addition to the monsoon which primarily governs rainfall, the mountainous nature of many parts of Indonesia also results in great variation of rainfall patterns and intensity.

Topographic classification of land in this Manual is confined to:

- low altitude which is land < 100 m above sea level (52%)
- medium altitude which is land 100–500 m above sea level (23%), and
- high altitude which is land > 500 m and < 1000 m above sea level (16%).

1.1.3 Soils

While rainfall is a major influence in cropping patterns, the quality of fodder harvested is also greatly influenced by soil types. In this Manual, Indonesian soils are classified broadly into acid (pH < 5.0) and non-acid (pH > 5.0) soils. The non-acid soils are further divided into intermediate (pH > 5.0 < 6.0) and lime (pH > 6.0 < 8.0) soils.

Acid soils consisting mainly of red-yellow podzolic and red-yellow podzolic complex account for approximately 60% of the land area of Indonesia (Figure 1.1.3). The acid swampy and tidal lands, which are non-podzolic, occupy an area of approximately 25 million hectares or 13% of the total land area of Indonesia especially in Sumatera, Kalimantan and Irian Jaya. Intermediate soils with an average pH of 5.5 can be found in Java, while lime soils are found on the islands in Nusa Tenggara Timur.

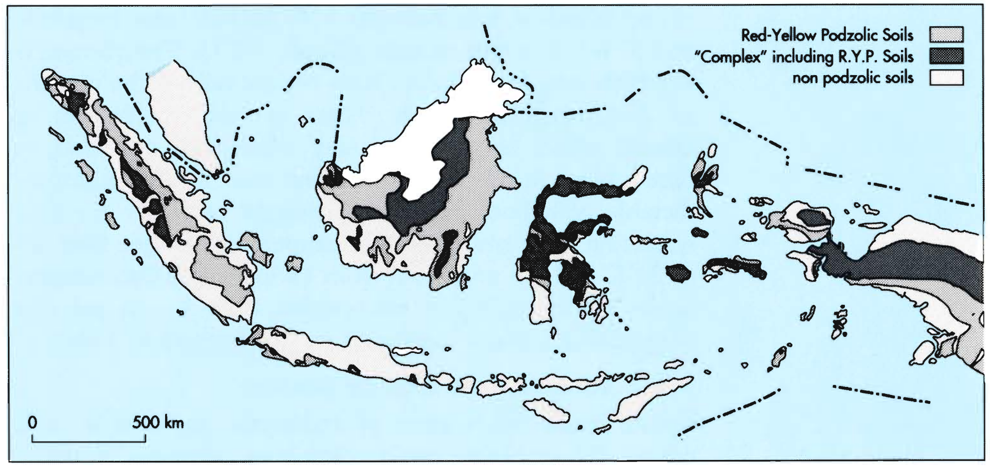
In the following sections, draught animal systems are described for some selected areas which differ in agro-ecosystems as influenced by climate. These extend from the relatively dry tropic of Timor through East Java to the high rainfall zones of West Java and South Sumatera.

Suggested reading

Oldeman L R (1975) An Agroclimatic Map of Java. Contribution No. 17, 1975. Central Research Institute for Agriculture, Bogor, Indonesia.

Oldeman L R, Irsal L A S and Muladi (1980) The Agroclimatic Map of Kalimantan, Maluku, Irian Jaya and Bali, West and East Nusa Tenggara. Contribution No. 60, 1980. Central Institute for Agriculture, Bogor, Indonesia.

Figure 1.1.3
Distribution of red-yellow podzolic soil and red-yellow podzolic soil complex in Indonesia.
Source: Soil Research Institute (1978)



1.2 NUSA TENGGARA TIMUR

Thamrin D Chaniago, A Bamualim and C Liem

1.2.1 Location and agroclimate

The province of Nusa Tenggara Timur (East Nusa Tenggara) consists of many islands, the largest of which is Timor. As the name suggests, the province lies to the east of the island of Java between 118° to 125° east longitude and 8° to 12° south latitude (Figure 1.1.1). The climate is dry with very low rainfall. Rain mainly falls in the months of November to March. There is wide fluctuation in rainfall which in one day may reach 100 mm and in others none at all. During the wet season, rain is unpredictable with both periods of drought or heavy flooding occurring. The maximum air temperature ranges from 28 to 32°C and the minimum from 19 to 25°C. High temperatures cause significant evaporation of 4–9 mm per day constituting a major constraint for the farmers in Timor.

1.2.2 Land use and crop production

Unlike many other parts of Indonesia the land is used mainly for extensive cattle rearing and dryland cropping (Table 1.2.1). The bulk of dryland crop production is for family subsistence while livestock provide the main source of income. The considerable livestock population in the province is shown in Table 1.2.2.

Table 1.2.1 Landuse in Nusa Tenggara Timur

Landuse	Area (km^2)
Grazing land	7878
Dryland crops	6163
Rainfed ricefield	313
Irrigated ricefield	401

Table 1.2.2 Livestock population in Nusa Tenggara Timur

Livestock	Numbers	Percentage of National herd
Cattle	641400	6.3
Buffalo	176400	5.4
Horses	187200	27.4
Goats	457600	4.2
Sheep	91600	1.5

The increase in livestock numbers over the years has put pressure on land availability for cropping. This trend has led to the practice of constructing fences around cropping lands. The major dryland crops are maize and upland rice, based mainly on shifting cultivation with a fallow period which is influenced by soil fertility and human population pressure.

1.2.3 Draught animals

The main species in Nusa Tenggara Timur is Bali cattle which make up almost 70% of the total population (641400 head) of the province. Draught animals, to the extent to which they are used in agriculture in the province, are mostly Bali type. The remaining 30% is dominated by Ongole and Ongole crosses better known as *peranakan* Ongoles or PO for short. Cattle are most concentrated on the island of Timor in the districts of Kupang, South Central Timor and North Central Timor (Table 1.2.3).

Table 1.2.3 Cattle and buffalo population in each district of Nusa Tenggara Timur

District	Cattle	Buffalo
West Sumba	11100	46900
East Sumba	35500	24800
Kupang	153300	29900
South Central Timor	201200	2400
North Central Timor	101200	2100
Belu	98000	17500
Alor	5100	–
East Flores	2600	–
Sikka	5600	500
Ende	5700	2700
Ngada	17500	13800
Manggarai	4600	30800
Total	641400	176400

There are 176400 buffalo, most of which are located on the islands of Sumba and Timor (Table 1.2.3).

Because of the dominant role of Timor in Nusa Tenggara Timur, discussion in this Section will focus on this island (Figure 1.2.1).

1.2.4 Draught animal enterprise

Climatic conditions are a major constraint to cropping. The risks associated with cropping enterprises have been used as a reason for not investing in expensive draught oxen. In comparison the fattening of beef cattle is a lucrative enterprise compared with food crops.

On Timor, approximately 50% of the island is covered by grassland savannas. These are communally owned and are used for grazing as well as for swidden (slash and burn) agriculture. In the past, large cattle herds were owned by elite groups, representing only 2 to 10% of the population, who monopolised these grazing lands. More recently semi-intensive fattening systems for cattle have developed.

As previously mentioned, because of the high risk of crop failure, there is a general reluctance to invest in draught animals and consequently no animals are used in dryland crop production. In wet ricefields, land is prepared by trampling the soil (*merancah*) using groups of animals (Photograph 1.2.1).

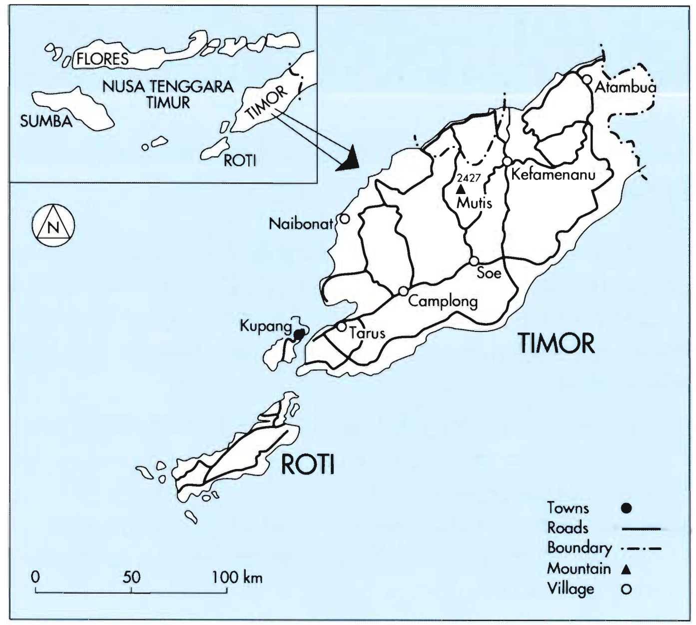


Figure 1.2.1
The locations of the island of Timor in Nusa Tenggara Timur and of the ACIAR Draught Animal Project *village sites on the island.*

Photograph 1.2.1
Trampling (merancah) of wet ricefields by a herd of Bali cattle driven by men and boys on horseback.

Merancah is the main use of cattle and buffalo in crop production in Nusa Tenggara Timur. This method of land preparation has the advantage that it can be used by small-holder farmers 'on credit'. The disadvantages are that *merancah* is:

- expensive; the hire fee is one-third of the rice crop produced by the smallholder farmers to be paid to the larger cattle rearers,
- dependent on sufficient rain to saturate the soil, and
- usually starts too late in the year to obtain maximum rice production.

The greatest benefit from the use of *merancah* goes to the larger cattle rearer who hires out his animals for land preparation.

In a few areas of rice production (mainly irrigated ricefields), animal-drawn metal ploughs have been used for 10 to 15 years (Photograph 1.2.2). Ploughs were originally introduced by protestant missionaries and later by Yayasan Indonesia Sejahtera. The use of these implements has not spread because of their cost (Rp 70000) and their tendency to sink in the deep clay soils. The use of simple wooden ploughs as used in East Java for example (Section 4) was unknown in Timor until recently when our *Draught Animal Project* introduced the technology for evaluation on farms in the Kupang district.

Photograph 1.2.2
A pair of Bali bulls pulling a metal plough in the village of Tarus, Kupang, Timor.

1.2.5 Work activities

Work type

Most land preparation for dryland crops is achieved in Timor by human labour, although the method varies with area and soil type. The most common implement used is the metal-tipped digging stick or *linggis* (Photograph 1.2.3). In some areas hoes are used on some crops but this is usually after the rains have started.

Land preparation using the *linggis*, although highly labour intensive, does not usually cause a labour shortage, because it is conducted in the dry season. The clods are turned over and the weeds inverted. By contrast, in the small but important rainfed rice growing areas, there is a serious shortage of labour for land preparation, which leads to late planting of rice and often reduced yield. The use of *merancah* can also result in late planting. Under such conditions, the case for a much greater role of draught animal power in land cultivation is clear. The time available for land preparation using the traditional *merancah* system is limited to three to four weeks. Since draught methods can be carried out in drier conditions, the time available for conventional ploughing is estimated at six to eight weeks.

Lack of labour for weeding is considered to be the major constraint to improved production of dryland crops. At present weeding is done using a trowel (*tofa*), but could be improved by developing animal-drawn weeding implements together with the training of animals to work between rows of crops.

Work season

The work season for animals is necessarily tied to the cropping pattern in an area. In Timor, most food crop production is based on subsistence, with shifting cultivation of dryland crops of which maize is the major staple.

Photograph 1.2.3
*The traditional digging stick (*linggis*) in use on very heavy clay soil in the dry season in West Timor.*

This is supplemented with beans and cassava. In the traditional cropping system, farmers usually plant and weed their dryland crops and then move to lowland areas to cultivate rainfed or irrigated rice. Dryland crops are normally planted in December and harvested in April and May. Land preparation and planting of rice are normally carried out from late January to the end of March. Harvesting of rice occurs in the period from mid May to the end of June (Figure 1.2.2).

Only in rainfed or irrigated rice cultivation is animal power used for land preparation by the traditional *merancah* method. The planting season for dryland crops and rainfed rice indicate the period in which draught animals could work, if introduced.

Work period

A herd of Bali cattle may be used for *merancah* from 20 to 30 days per year with an average working period of 25 days. This occurs normally in the period from later January to end of March depending on rain (Figure 1.2.2). In areas where irrigation is available, the period of work is more concentrated.

Work rate

A herd of cattle may service from one to seven farmers per season. The *merancah* herd is normally large averaging about 70 animals but may vary from as few as 10 to as many as 150 animals.

The animals traditionally are herded across flooded rice fields for three to four hours per day to puddle the soil into a suitable condition for transplanting rice. This operation can only be carried out when heavy rains have produced swamp-like conditions in the ricefields.

The number of *merancah* operations to achieve conditions suitable for transplanting rice varies from three to four; with intervals between *merancah* varying from a few days to a few weeks depending on the condition of the soil and availability of cattle. According to our recordings a herd of 130 cattle could prepare a hectare of land in 5.5 working days. Labour required for this herd size is five to six people.

1.2.6 Feeding practices

Cattle are normally grazed all year round. During the rainy season, feed is abundant and cattle gain weight. However, during the long dry season supply of feed is very scarce and cattle lose condition. Changes are due to fluctuation in feed quality as well as supply.

In some areas, the animals are allowed to graze only during the monsoons and are hand-fed during the dry season. Elsewhere, cattle are tethered on pastures or fallow

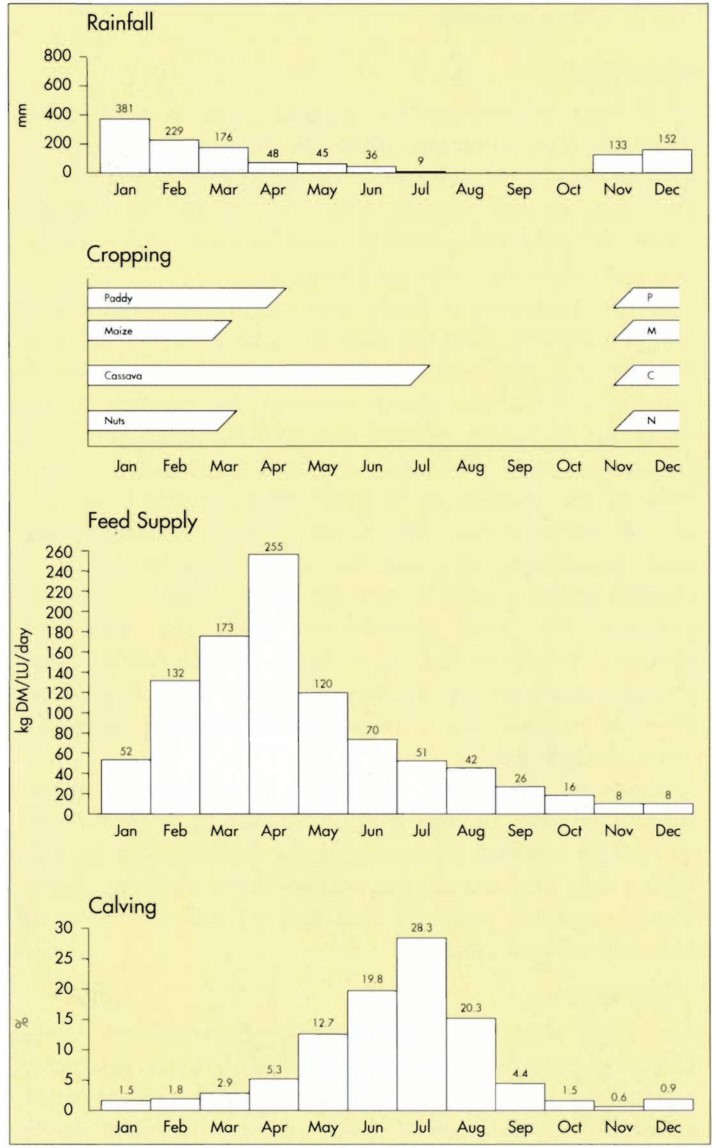


Figure 1.2.2
The monthly pattern of rainfall, cropping, animal work, animal feeding and calving in the village of Naibonat, Timor.

Agroclimate: Dry (≥ five consecutive dry months)
Land use: Dryland cropping (rainfed rice)

lands and moved from one place to another as appropriate. A system of fattening male cattle (*paron*) for sale is practised when animals are hand-fed mainly on *Leucaena leucocephala* leaves (Photographs 1.2.4 and 1.2.5). The recent arrival of a leaf hopper (psyllid or kutu loncat) has devastated *Leucaena* plants, highlighting the need for a range of resistant shrub or tree species of similar quality or, in the longer term, resistant strains of *Leucaena*.

1.2.7 Breeding

Heifers are usually mated around 24 months of age and have their first calves between 30 and 40 months. The majority of calves are born between May and August (Figure 1.2.2) when pastures progressively deteriorate. Natural mating of heifers and cows is the normal practice. The farmer's own bull or one which is on loan from a neighbour is normally used for mating. At present weaning occurs naturally. The reproductive performance of cattle in Timor is summarised in Table 1.2.4.

Photograph 1.2.4 A farmer carrying tree leaves (mainly Leucaena) to feed paron cattle in Kupang, Timor.

Mortality of livestock during the end of the dry season is reported to be quite high, especially among young stock and calves. This is marked in Bali herds in which calving peaks in the dry season when feed supply becomes limited.

Table 1.2.4 The reproductive performance of cattle in Timor

	Rearing system		
	Grazing dryland	Tethered	Grazing wetland
Age at first calving	35 months	33 months	32 months
Calving season	March to September	April to October	June to November
Calving interval (month)	14	13	13
Mating:			
Artificial Insemination (%)	9	5	8
Own Bulls (%)	82	76	81
Borrowed Bulls (%)	9	19	11
% survival rate to weaning	91	81	68

1.2.8 Housing

Animals are seldom housed as in other parts of Indonesia since herd size could vary from 10 to 150 animals. Herds are generally kept in corrals at night and grazed during the day.

Photograph 1.2.5 A Bali bull being fattened under the paron system in Kupang, Timor.

1.2.9 Training

Farmers in Timor were generally unfamiliar with methods of training cattle or buffalo for draught work since the draught system for crop production is almost non-existent. It was not until 1988 that some farmers from selected villages in the Kupang district were taught some training methods for cattle. The program was organised by the *ACIAR Draught Animal Project* which sponsored an experienced draught animal trainer from West Java to travel to Kupang and spend two weeks with volunteer local farmers, teaching them the art of introducing cattle to the system.

The training program involved three stages:

Holing the nose A hole is made in the nose of the animal and a rope is inserted through it to allow the trainer to facilitate handling. The trainer and the animal become accustomed to each other after a period of time.

Pulling logs The animal is then yoked with another in a similar disposition. The pair is encouraged to start pulling logs of various weights, starting with the lightest, then gradually increasing the load. During this time the animals are also trained to follow spoken commands. At first four people are used as assistant trainers. Two assistants are positioned in the front of each animal to help restrain them while the other two handle the ropes from the rear of the animals. After about an hour, one assistant positioned in front of the animals and another at the rear are removed. Training proceeds for another hour using only two assistants.

Pulling implements When the animals become accustomed to pulling logs and following commands after training sessions of two hours per day for two days, they are introduced to pulling a plough.

The above procedure, using two people, is repeated. Eventually the pair of cattle can be controlled by one person.

1.2.10 Health

All farmers interviewed in our village studies consider that disease control is very important in maintaining and increasing animal production in Timor. Diseases may kill animals or reduce their productivity. Pasteurellosis [septicaemia epizootica (SE)] is considered to be the major problem causing about 60% of mortalities. This disease is thought to occur every year. Other reported disorders include thelariasis which can cause blindness, difficulty in consuming feed, loss of weight and even death. Diarrhoea of uncertain aetiology is sometimes common. The status of other parasitic diseases remains unclear.

Suggested Reading

DAP Project Bulletin No. 10 (1990). James Cook University Townsville, Australia.

Statistical Book on Livestock (1991) Directorate General of Livestock Services, Jakarta

1.3 EAST JAVA

Komarudin-Ma'sum, M Ali Yusran and E Teleni

1.3.1 Location and agroclimate

The province of East Java is located between 111° to 114° east longitude and 7° to 8° south latitude (Figure 1.1.1).

Although there are three agroclimatic categories in East Java, namely, the dry, intermediate and wet; the dominant categories are the dry and intermediate (see Figure 1.1.2). Of the total of 29 Kabupaten (districts) in the province, 22 (76%) are predominantly dry and 7 (24%) are in the intermediate group. The wet season is normally from November to April, while the dry months (<100 mm rainfall per month) extend from May to October.

1.3.2 Land use and crop production

Although the province of East Java includes about 47 922 km^2 (2.5%) of the land of Indonesia, it is one of the main agricultural areas and contributes a significant proportion of the national food crop production. For example it produces approximately 20%, 45% and 30% of the national output of rice, maize and cassava respectively. Draught animals play a very important role in the production of these crops. Approximately 50% of the province is under agriculture, and of this, about 50% is used for dryland crops (Table 1.3.1).

Table 1.3.1 Land usage of the agricultural area of East Java

Land use	Area (km^2)
Irrigated ricefield	9022
Rainfed ricefield	2698
Dryland crops	11608

1.3.3 Draught animals

There are about 1 315 000 draught cattle and 74 000 buffalo in East Java. Farmers prefer rearing draught cattle to buffalo because they consider them to be more tolerant to heat, work more quickly in the field and are easier to sell. In addition cattle are more suitable for working in dryland cropping.

Breeds include the *peranakan* Ongoles, Madura and Bali cattle. The *peranakan* Ongoles are the most populous in the province followed by Madura and then Bali animals (Table 1.3.2).

Table 1.3.2 Non-dairy cattle population of East Java

Breed	Numbers	Percentage of total
Ongole	2197789	75
Madura	672654	23
Bali	42234	2
Total	2912677	100

From our village and research station studies, it has been shown that the *peranakan* Ongoles (Photograph 1.3.1) are superior in work capacity to the other two breeds. In general, female cattle are preferred by farmers for draught because they can also produce calves and are easier to handle than males. Although the exact proportion of the total cattle population used for work is not known, our studies in selected village sites in East Java (Figure 1.3.1) indicate that over 70% of the female population provide draught power. As yet, there is no accurate information about the sex and the proportion of buffalo which are used for work in East Java, but it is considered that almost all working buffalo are female as in the case of cattle.

1.3.4 Draught animal enterprise

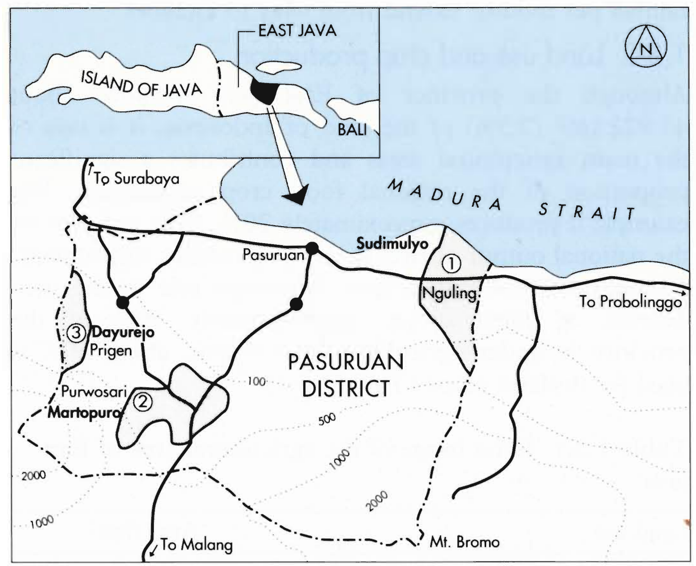
The size of draught animal enterprises, involving either cattle or buffalo, is generally of two to three head per rearer. Farmers always work their animals in pairs.

Photograph 1.3.1
A pair of peranakan Ongole cows ploughing land for rice in East Java.

Data from village studies (Figure 1.3.1) in East Java show that most cattle kept by farmers are owned (Table 1.3.3). Only a small proportion is in shared rearings where the farmers may work and rent out the animals, and also receive half of the number of offspring produced. This situation can be applied to East Java in general. Cows are usually worked for the first time at about two years of age. Farmers tend to replace their animals when the animals are unable to perform their task satisfactorily which usually occurs after they have had as many as 8 to 10 calves. They may also be sold when cash is required urgently.

Table 1.3.3 Percentage of rearers of cattle in various livestock ownership categories

Ownership categories	Village		
	Martopuro	Sudimulyo	Dayurejo
		(%)	
Own all stock	60	80	75
Share-in all stock	10	7	5
Own + share-in stock	30	13	20



0 50 km

Road
District Boundary
Sub-district
Contour in metres
Town
Study Village Sites ① ② ③

Figure 1.3.1
The location of the ACIAR Draught Animal Project study village sites in East Java.

1.3.5 Work activities

Work type

Work by draught cattle and buffalo in East Java mainly involves the cultivation of agricultural land. This includes wetland ploughing, using the *singkal*, levelling using the garu, and dryland ploughing using the *brujul* (Section 4). Only a small proportion of the total draught cattle population is used for transportation.

The total number of working days per year and the proportion of the types of work activities undertaken by draught animals depend on the main land use of an area which over a large part of East Java is in dryland cropping (Table 1.3.1). Land preparation may involve only one operation (ploughing) or two or three operations which would include a second ploughing and then levelling. The number of operations depends on such factors as farmer preference, season and field conditions.

Work season

The work program for draught cattle and buffalo on agricultural land is in accordance with crop planting seasons in areas of wetland or dryland (Figures 1.3.2 and 1.3.3). Planting in non-irrigated areas depends on the rain pattern and therefore draught cattle come into work at a difficult time at the end of the dry season or in the early wet season when available feeds are normally low in quality as well as quantity (Figures 1.3.2 and 1.3.3).

Work period

Our village studies show that the work periods for draught cattle vary widely from 10 days to 110 days per year (Figures 1.3.2 and 1.3.3), depending on cropping patterns, animal availability and land ownership categories (Table 1.3.3).

In irrigated areas or in areas with a longer rainy season or higher average annual rainfall animals have longer work periods per year. Periods also appear to be longer in areas where availability of draught cattle is low and farm sizes are smaller (Table 1.3.4). Sessions of work per year are normally three in which the longest period occurs in November for wetland crops and in December for dryland crops (Figures 1.3.2 and 1.3.3).

Work rate

The work rate of draught animals is illustrated by the area of land they prepare in a given time. This can be influenced by land and soil type, soil moisture content and crop types (Table 1.3.5). It has been reported by farmers that a pair of buffalo working in an irrigated ricefield could take 35 hours to plough and level one hectare. This is slower than the corresponding time we have recorded for cattle (Table 1.3.5).

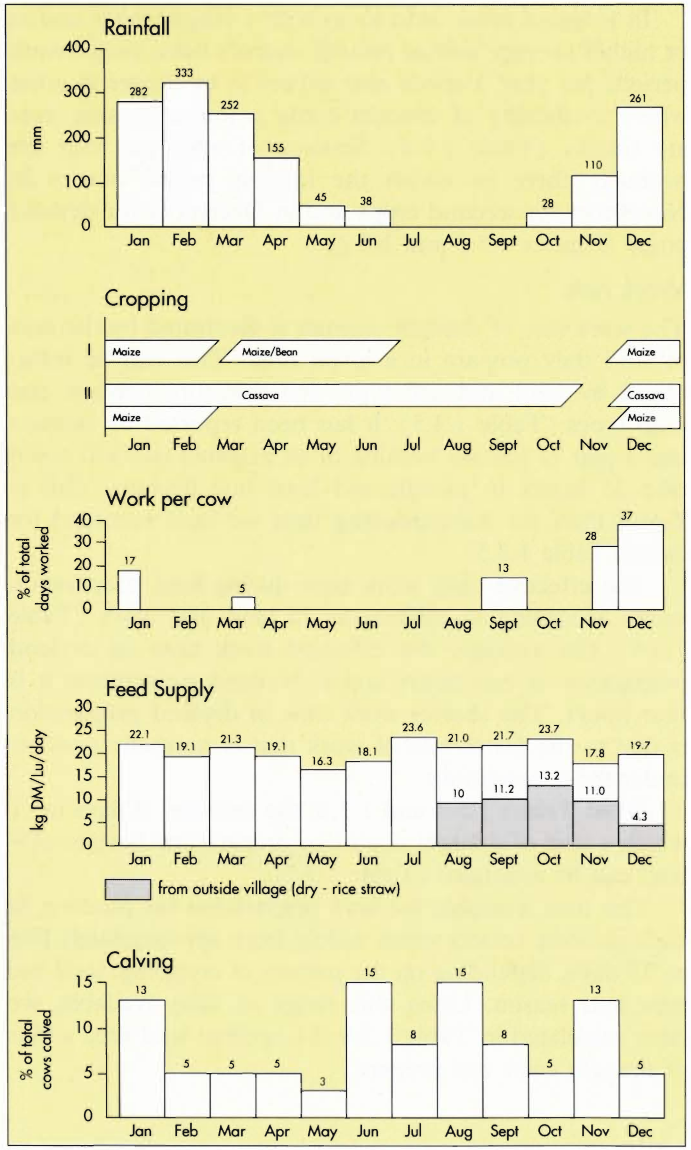
The effective daily work time during land preparation varies according to differences in land and work (Table 1.3.6). On average, the effective work time in dryland preparation is two hours and in wetland preparation it is four hours. The shorter work time in dryland preparation is due to the faster rate of work that is normally possible under those conditions.

From Tables 1.3.5 and 1.3.6, the number of days in which a pair of draught cows can prepare one hectare of land can be estimated (Table 1.3.7).

The time available for land preparation for planting in each planting season varies widely from approximately five to 23 days, depending on the pattern of cropping, land use type and season. Using this range of time available, we have calculated in Table 1.3.8 the optimal land area a pair of draught cows can prepare.

Figure 1.3.2
The monthly pattern of rainfall, cropping, animal work, animal feeding and calving in the village of Sudimulyo in the district of Pasuruan, East Java.

Agroclimate: Dry (≥ five consecutive dry months)
Altitude: Lowland (< 100 metres above sea level)
Land use: Dryland cropping



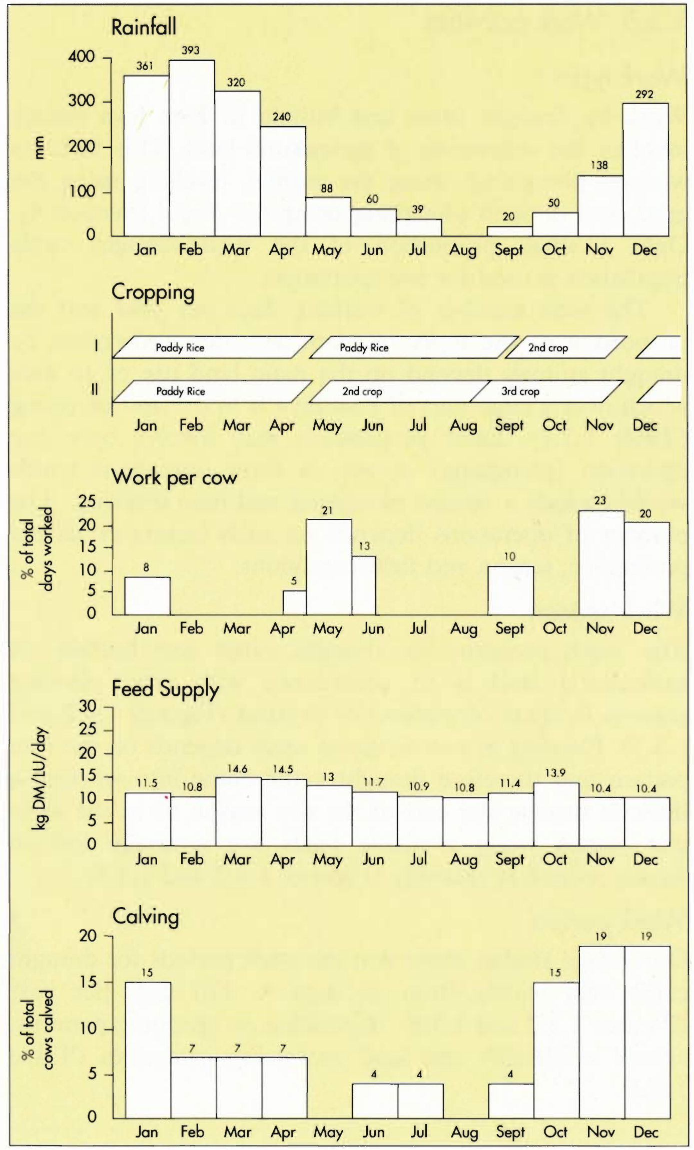


Figure 1.3.3
The monthly pattern of rainfall, cropping, animal work, animal feeding and calving in the village of Martopuro in the district of Pasuruan, East Java.

Agroclimate: Dry (≥ five consecutive dry months)
Altitude: Medium (100–500 metres above sea level)
Land use: Wetland cropping (irrigated rice)

Table 1.3.4 Average days and types of work during the main work season (November to May) in two categories of farm sizes (1: <1 ha; 2: >1 ha)

	Martopuro village		Sudimulyo village	
	Farm size		Farm size	
	1	2	1	2
Wetland ploughing (days)				
On own land	4	22	4	3
Rented out	50	6	6	0
Percentage of all types of work	82	72	23	23
Levelling (days)				
On own land	1	8	5	2
Rented out	11	3	3	0
Percentage of all types of work	18	28	19	15
Dryland ploughing (days)				
On own land	<1	0	11	6
Rented out	<1	<1	2	0
Percentage of all types of work	<1	<1	30	46
Pulling carts (days)				
On own land	0	0	10	2
Rented out	0	0	2	0
Percentage of all types of work	0	0	28	15
Total (days)	66	39	43	13
On own land	5 (8%)	30 (77%)	30 (70%)	13 (100%)
Rented out	61 (92%)	9 (23%)	13 (30%)	0

Notes: Martopuro village - dominated by irrigated ricefield, longer wet season with lower cattle availability
Sudimulyo village - dominated by dryland crops, shorter wet season with higher cattle density

Table 1.3.5 Rate of land preparation by a pair of *paranakan* Ongole cows working on different land type and season in East Java

	Land type		
		Dryland	
Season	Irrigated ricefield	Rainfed ricefield	Dryland crops
	hours/ha/pair of cattle		
Wet season	28.5	14.5	9.5
Dry season	28.5	8.0	-

Table 1.3.6 Total work and idle times during land preparation by a pair of *peranakan* Ongole cows in East Java

		Ploughing (hours/day)		Levelling (hours/day)
Activity		Ricefield	Dryland	Ricefield
Total work + idle time	Means	5.5	2.5	5.0
	Range	5.0–6.0	2.0–3.0	4.0–5.5
Idle time*	Means	1.0	0.5	1.3
	Range	0.8–1.2	0.3–0.7	0.8–1.8
Effective work time	Means	4.5	2.0	3.7
	Range	4.0–5.0	1.8–2.2	3.5–3.9

* Including cattle husbandry

Table 1.3.7 Number of days in which a pair of *peranakan* Ongole cows can prepare one hectare of land

Season	Days		
	Irrigated ricefield	Rainfed ricefield	Dryland crops
Wet season	6–7	7–8	5–6
Dry season	6–7	4–5	–

Table 1.3.8 Optimal land size which a pair of *peranakan* Ongole cows can prepare in a given available time

Available time (days)	Irrigated (ha)		Not irrigated (ha)		
			Rainfed rice		Dryland crops
	Wet season	Dry season	Wet season	Dry season	Wet season
5	0.8	1.2	0.7	1.2	1.0
8	1.2	1.9	1.0	1.9	1.5
11	1.7	2.6	1.5	2.6	2.1
14	2.2	3.3	1.8	3.3	2.7
17	2.6	4.0	2.2	4.0	3.3
20	3.1	4.8	2.6	4.8	3.9
23	3.5	5.5	3.0	5.5	4.5

1.3.6 Feeding practice

In East Java, fodder for draught animals is mainly cut-and-carried from cultivated land in the form of native grasses, weeds, tree leaves and crop residues. Rice bran and other concentrates are not normally fed to draught cattle. Cattle are nearly all hand-fed throughout the year, and are seldom grazed (Photograph 1.3.2).

The time taken by rearers to gather grasses from roadsides and field bunds varies, due to differences in seasons and agroecosystems. Rearers in villages with a ricefield system as a base, take a shorter time to gather field grasses than those in villages with dryland crops (Table 1.3.9). The differences in agroecosystems can also cause differences in the composition of the feeds fed to the animals (Figures 1.3.2 and 1.3.3). Differences in quality can be quite significant especially between the middle of the dry and early wet seasons.

Table 1.3.9 Time spent by rearers in gathering feed for their cattle (2–3 livestock units)

Village	Hours/day	
	Wet season	Dry season
Martopuro (ricefield)	2.1	3.1
Sudimulyo (dryland crops)	2.7	3.6

Photograph 1.3.2 Peranakan Ongole cows and a calf being hand-fed in their open-sided housing in the village of Sudimulyo, Pasuruan, East Java.

Shortage of fodder in regions with ricefield agro-ecosystems is less severe than in regions with dryland crops (Photograph 1.3.3).

Photograph 1.3.3
Tethered peranakan *Ongole cows given access to a stack of rice straw during the dry season, in Sudimulyo village (dryland cropping) in the Pasuruan District, East Java.*

1.3.7 Breeding

In East Java, few of the draught animal areas are supported by an artificial insemination (AI) program, thus breeding of cows occurs 'naturally'. However, as there is little or no free grazing allowed, mating is commonly arranged when cows are in oestrus.

The mature bulls available may be sufficient to serve cows, because the ratio of bulls to cows is about one to eight. However, lack of bulls of good quality may create a problem for improving draught cattle production. In spite of this, the average calving percentage of draught cattle available in non-AI program areas in East Java is 50%, while that of buffalo is 55%. In the AI program areas it might reach 80%. Poor mating management and lack of feed are thought to be major causes of low calving percentages.

As can be seen in Figures 1.3.2 and 1.3.3 there is no particular calving season in East Java. Calving can occur at any time during the year, whether there is a shortage or abundance of feed and whether it is the working or non-working season. Farmers never plan the mating and calving times of their animals. In the irrigated ricefield areas, calves are usually weaned at about five months of age, and at about three months in the dryland cropping areas. Almost all male calves are sold after weaning in either area.

1.3.8 Housing

In East Java, there are two types of accommodation for draught cattle, namely the open-sided and closed-sided housing which generally depend on the altitude of the farm. A building for open confinement is essentially a roof carried on poles or pillars (Photograph 1.3.4), mainly used by farmers in the lowland areas, except on Madura Island. In addition, almost all such housing for draught animals is separated from farmers' dwellings and from each other by distances ranging from 5 to 20 metres. There is no exact location for animal housing in relation to the farmers' homes.

A building for closed confinement has essentially a wall, surrounding all or only a part of the building (Photograph 1.3.5). The closed housing type is generally used by farmers in the colder medium to high altitude areas. In addition, almost all animal housing in these areas backs on to the farmers' accommodation.

Photograph 1.3.4
An open-sided housing for cattle in the village of Sudimulyo, Pasuruan, East Java.

Photograph 1.3.5
A closed-sided housing for cattle, attached to the farmer's house, in the village of Martopuro, Pasuruan, East Java.

The materials commonly used for constructing animal houses are shown in Table 1.3.10.

Table 1.3.10 The construction materials of draught animal housing in East Java

Part of the building	Materials
Roof	Roof tile, hay, straw or reed
Poles/pillars	Bamboo and/or wood
Wall	Bamboo
Floor	Earth, wood

On average, a housing unit is designed to accommodate animals in a floor space of 1.5 metres by 2.0 metres per animal. The shed is not divided into functional spaces, such as for calving, weaning, growing and so forth. Few houses in East Java have individual feed containers (see Photograph 1.3.2).

1.3.9 Training

Young heifers are usually trained for the first time at the age of 12 to 18 months or when they reach the appropriate body size for work. They are trained by their rearer during the dry season. There may be other ways of training heifers to become draught animals in East Java but the method described below is the only one recorded in our village studies. The program is divided into three steps:

Yoking and walking

The first step is to control the speed and the direction of walking of the heifer being trained. This is achieved by pairing the untrained heifer with an older trained cow using a yoke. The pair is driven on a road or open field while spoken commands are given. This routine takes two to three days and one to three hours per day.

Harnessing and walking

The second step is the introduction of an appropriate implement such as a plough which the pair of animals are made to pull in a field or on a road. The plough does not enter the ground but is dragged over the surface. Sometimes the animals are made to pull a specially constructed implement called the *keleles* (Photograph 1.3.6) instead of pulling a plough. This routine is conducted for one to three hours per day for three to seven days.

Pulling implements

In the final step of training, the young heifer is encouraged to plough. Its work duration is increased gradually from one hour to three or four hours per day for six to seven days after which the heifer is considered trained.

Photograph 1.3.6
A keleles which is sometimes used (instead of a plough) by farmers in East Java in training their heifers.

1.3.10 Health

In general, farmers in the non-irrigated areas take inadequate care of animals and their housing, so ticks (*Boophilus microplus*) and cattle flies, are common. According to farmers' recall and results of direct observations in village studies, the diseases which are most frequently observed in draught cattle are diarrhoea, bloat, injuries of the hump and foot rot. Parasitic eggs found in the faeces of draught cattle in the region have included those shown in Table 1.3.11.

Table 1.3.11 Helminth genera according to faecal egg examinations

Nematoda	Trematoda
Trichostrongylus	*Fasciola*
Strongyloides	*Paramphistomum*
Cooperia	
Neoascaris	
Haemonchus	

A range of other diseases is known to occur in East Java from veterinary investigations. They include scabies, trypanosomiasis (surra), pasteurellosis (haemorrhagic septicaemia), malignant catarrhal fever and ephemeral fever. Jembrana disease may also be present especially among Bali cattle. Medicinal treatments other than traditional methods are rarely carried out by farmers who claim that their calves rarely die before weaning at the age of three to six months.

1.3.11 Development needs

Improved productivity might be achieved in a number of ways. Synchronisation of calving to coincide with optimal feed availability would reduce stress on cows and improve calf nutrition as well as cow fertility. There is a need for improved selection of bulls to increase calving rates. In the field of nutrition both feed conservation and supplementation deserve further research and are particularly important in dryland cropping areas where low body condition scores of draught cows (Photograph 1.3.3) result in low productivity. There is scope for the improvement of implements.

Suggested reading

Yusran M A and (the late) Yudi P A (1991) Draught animal work practices in two agro-ecosystems and two land ownership classes (of farmers) in East Java. *Draught Animal Bulletin* No. 1, 1–8.

Yusran M A, Komarudin-Ma'sum and Yudi P (1989) Profiles of draught animal rearing in two villages in East Java. *DAP Project Bulletin* No. 9, 2–17.

1

1.4 WEST JAVA

Santoso, Sumanto and Rini Dharsana

1.4.1 Location and agroclimate

The province of West Java is located between 105° to 109° east longitude and 5°50' to 7°50' south latitude (Figure 1.1.1).

Only about 16% of the province can be classified as dry while the remainder can be divided equally into intermediate and wet categories. Overall the rainfall is higher in West Java than in either Central or East Java. Of the 20 *Kabupaten* in the province, only 3 (15%) are predominantly dry but 17 (85%) are in the intermediate and wet areas.

The wet season normally extends from November to April while the drier months are from May to October.

1.4.2 Land use and crop production

The total land area of West Java is approximately 46 300 km^2 or 2.4% of the land area of Indonesia. About 73% of the land area of the province is under agriculture, with as much as 42% under dryland crops (Table 1.4.1).

Table 1.4.1 Land usage of the agricultural area of West Java

Land use	Area (km^2)
Irrigated ricefield/Rainfed ricefield	11945
Dryland crops	14331
Others	8177

West Java produces approximately 23%, 4%, 13% and 23% of the national production of rice, maize, cassava and sweet potato respectively. While some tractors are used in the province, particularly in irrigated rice areas of the north, animal power is still of greatest importance in rice cultivation.

1.4.3 Draught animals

Among the draught animals in West Java there are 154 600 cattle and 494 500 swamp buffalo. Their density, however, is quite variable, ranging from 5 LU to 10–25 LU/km^2 for cattle and 2–5 LU to 20 LU/km^2 for buffalo. The breed of cattle in West Java is mostly of 'local type' which probably originated from *Bos indicus* crosses of Ongoles.

As in most other parts of Indonesia, farmers prefer to keep female animals for draught work since they can also produce calves. Thus in villages in West Java cattle and buffalo populations may be made up of 70 to 80% of females. This proportion is even higher (above 90%) when only the adult population is considered. Our studies in selected village sites in West Java (Figure 1.4.1) indicate that approximately 64% of the cattle and buffalo population are used for work (Photograph 1.4.1). Of these about 91% are females.

Photograph 1.4.1
A pair of swamp buffalo ploughing land for rice in West Java.

1.4.4 Draught animal enterprise

Draught animal enterprises are small, ranging from one to three animals per farmer due to the limited size of holding. For example, in the villages of Tanjungwangi and Padamulya in the Subang district of West Java (Figure 1.4.1) the average land area operated per farmer is only 0.31 hectare. Most rearers own their cattle and buffalo while smaller numbers of total rearers either share-in all stock or both own and share-in stock. Examples of these are illustrated by data from two villages in the Subang district (Table 1.4.2). Sharing appears to be more common among cattle rearers than owners of buffalo.

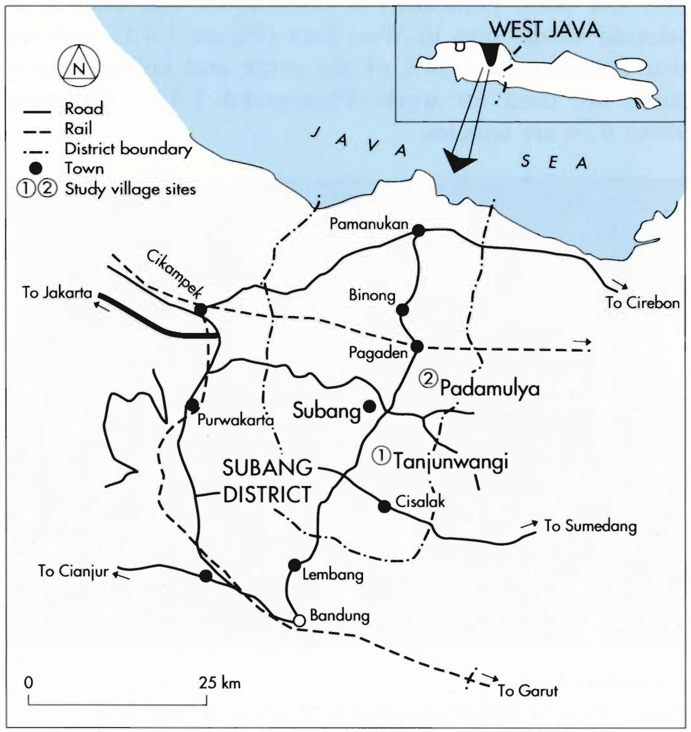


Figure 1.4.1 Map of West Java showing location of the ACIAR Draught Animal Project village study sites.

Table 1.4.2 Percentage of rearers of cattle and buffalo in various livestock ownership categories in Subang, West Java

Village Ownership categories	Tanjungwangi	Padamulya
Own all stock	77	98
Share-in all stock	17	2
Own + share-in stock	5	0

Cattle and buffalo start their working life at about two years of age but the exact age depends on the month in which they were born. For example, animals born in the dry season from June to September are usually trained at approximately two years of age for work in the main ploughing season in October and November. Animals born in the wet season usually start their working life in April and May in the third year. They also may be used with older animals for work two wet seasons later before they are two years old. Farmers tend to retain their draught animals until they are relatively old, that is, eight years or greater. The socioeconomic circumstances of the farmer and his family usually cause the sale of animals at an earlier age.

1.4.5 Work activities

Work type

Draught cattle and buffalo in West Java are used for land cultivation but seldom for other purposes, such as pulling carriages. Most cultivation involves wet ricefield preparation while dryland cultivation is uncommon. The implements involved in ploughing, levelling and raking are called the *bajak*, *garu* and *bugis* respectively (Section 4).

The type and pattern of tillage work vary between farmers, seasons and field locations and also depend on water availability, soil conditions, work costs, the time available and local customs. Some variations of land preparation pattern in Subang for example, are illustrated in Table 1.4.3 for two main planting periods in the year. Due to the less effective irrigation system at Padamulya village, the percentage of rearers working is less than at Tanjungwangi, particularly during the dry season planting.

Work season

The work season for draught cattle and buffalo on farms is in accordance with crop planting seasons (Figures 1.4.2 and 1.4.3). Rice is the main food crop, particularly on the lowlands of West Java. Other commodities such as corn, peanut, green pea, soyabean, sweet potato and cassava are commonly grown as intercrops.

The cropping systems adopted by farmers depend on the availability of irrigation water. Farmers will grow rice two to three times a year in areas with sufficient controlled irrigation. Where there is no irrigation and low water availability, an annual rice crop may be followed by a secondary crop or a fallow period.

Agricultural systems vary with altitude. Most of the upland areas are used for more temperate produce (e.g. vegetables, horticulture) and sometimes estate crops. Farms at medium altitude are generally involved in mixed croppings with rice grown once or twice a year followed by secondary crops (*palawija*). The lowlands are dominated by rice particularly in areas with controlled irrigation or other water sources. The different cropping patterns in West Java and their relationship with the rainfall are shown in Figures 1.4.2 and 1.4.3.

As is customary in Indonesia, the main work occurs in the early wet season from November to December. A second work period may occur towards the end of the wet season in March and April when another crop of rice or a secondary crop is planted (Figures 1.4.2 and 1.4.3).

Table 1.4.3 Variations in work activities of draught animals during land cultivation in villages in Subang district, West Java

Pattern of land preparation	First planting * (Nov–Dec)		Second planting ** (April–May)		Third planting *** (July–Aug)	
	Percent of all rearers working					
	†	††	†	††	†	††
Ploughing 2x, levelling 2x	42*	8	33*	3	–	–
Ploughing 2x, levelling 1x	20*	18	22*	8	3	–
Ploughing 1x, levelling 2x	–	3	–	3	–	–
Ploughing 1x, levelling 1x	38*	60	42	35	15	–
Ploughing 2x	–	–	–	–	5	–
Levelling 2x	–	–	–	5	–	–
Ploughing 1x	–	–	3	–	23	–
Levelling 1x	–	–	–	5	–	–
Total	100	89	100	59	46	–

* Early wet season (see Figures 1.4.2 and 1.4.3)
** Towards end of wet season (see Figures 1.4.2 and 1.4.3)
*** Dry season (see Figures 1.4.2 and 1.4.3)
†: Tanjungwangi village
††: Padamulya village

Work period

The average period worked by animals per year is short, being less than 40 days, though riceland may be cropped throughout the year in some locations (Tanjungwangi). The average number of days worked in the drier village of Tanjungwangi, for example, in the first ploughing period during October and November, is only 26 days and for the second, is 21 days. Respective periods for the drier village of Padamulya with irrigation are 19 and 8 days. The shorter period for cultivation recorded for the drier season reflects the smaller area of rice cultivated as well as the fact that some farmers use zero tillage (*mencacah* or *balik jerami*).

Naturally, the smaller the size of land owned by a farmer, the shorter the period of work per season. The period of work is increased if the farmer is also involved in renting out his draught animal(s) and/or is involved in 'mutual-aid' work (*gotong royong*) when farmers help each other in the preparation of their lands. In villages surveyed in West Java, cattle and buffalo may work on average from 3.7 hours to 4.9 hours per day.

Work rate

Most animals are worked in pairs (*pasang*). A few are worked singly, when there is no second animal available or if the soil is not too hard or heavy for a single animal to plough. Working single animals (*pegon*) depends to a large extent on their body size, the bigger they are the more likely it is that they will be able to plough heavy or rocky soil. In areas where soils are softer, single animals are commonly used.

The work rate of draught animals can be measured by the area of land they cultivate per unit of time and is affected by:

- the species or size of the animals,
- the number of animals used, that is, as singles or pairs,
- land and soil type,
- soil moisture content,
- type of crop, and
- type and pattern of tillage operation.

The various work rates discussed below refer to animals working in a pair with at least one operator who is usually a rearer. Standard *bajak*, *garu* and *bugis* (Section 4) are used. Differences in work rate between species (viz. cattle and buffalo) are unclear at this stage. Buffalo rearers in the Subang district at least, consider that buffalo work faster than cattle. Many cattle rearers, however, disagree with this and suggest that their animals move faster. It is said that the rate of work is slower when farmers are preparing their own land than when their animals are being rented out. Farmers say that animals on hire must appear to be 'working hard'.

From farmer recall data on time taken to prepare each of their blocks of land, it appears that cattle and buffalo work rates may vary from 28 to 40 days per hectare (Table 1.4.4).

Table 1.4.4 Rate of land preparation by pairs of cattle and buffalo working in villages in Subang, West Java

	Villages	
	Tanjungwangi	Padamulya
	(days/ha/pair of animals	
Cattle	28.4	40
Buffalo	30.6	40

When animals are rented out work rates may be reduced to 15 to 30 days per hectare. According to non-rearers, the preparation of one hectare of wetland for rice requires from 14 to 22 days of animal work plus 54 to 77 days of human labour.

The great variations in pattern of land preparation which occur between farms and seasons within a village and between villages are demonstrated by the data in Table 1.4.3. These result in differing rates of work by animals. Ploughing usually represents harder work and is more time-consuming than levelling. Levelling itself may

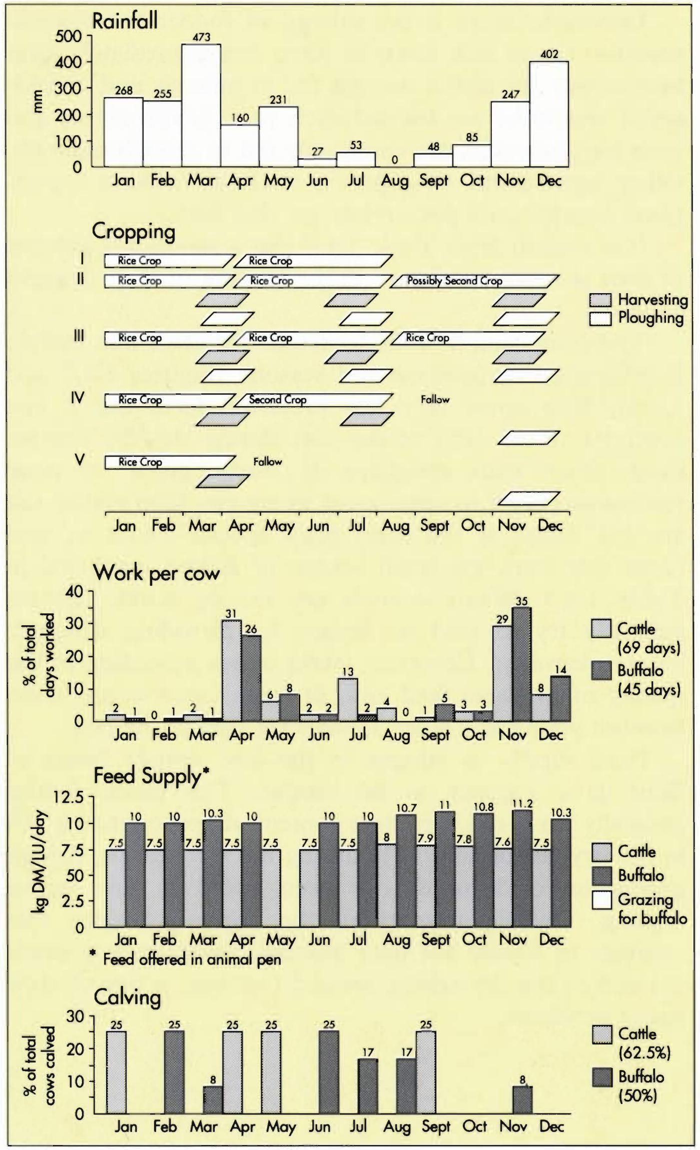


Figure 1.4.2
The monthly pattern of rainfall, cropping, animal work, animal feeding and calving in the village of Tanjungwangi in the district of Subang, West Java.

Agroclimate: Dry (≥ five consecutive dry months)
Altitude: Medium (100–500 metres above sea level)
Land use: Wetland cropping (irrigated ricefield)

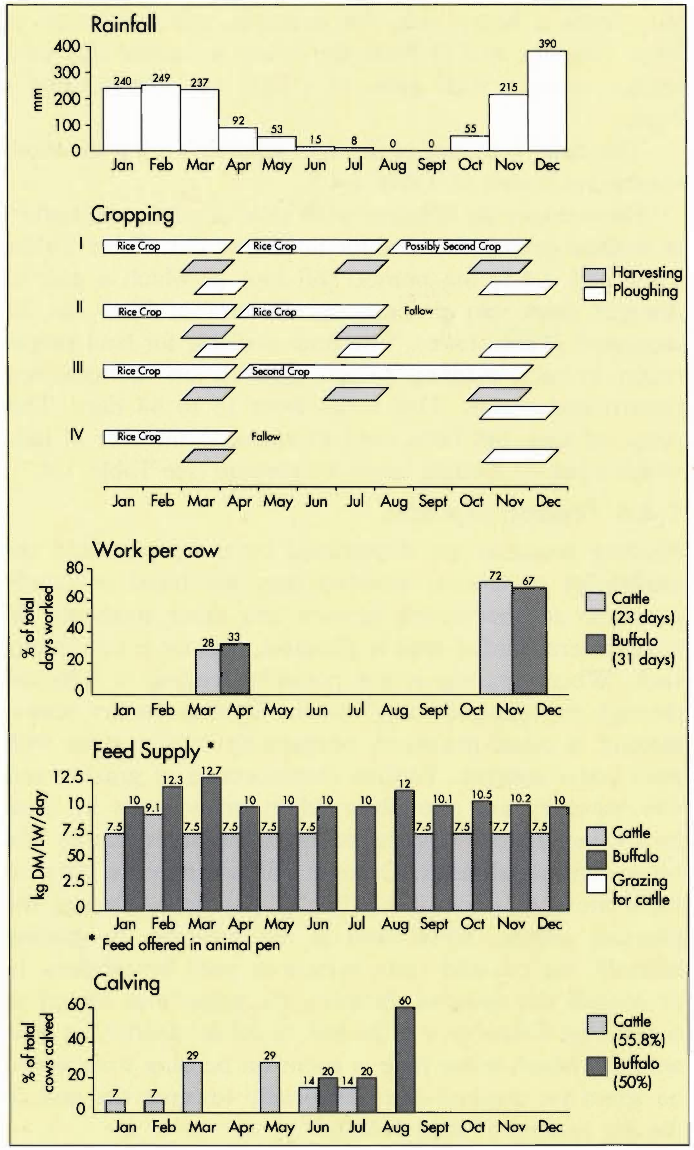


Figure 1.4.3
The monthly pattern of rainfall, cropping, animal work, animal feeding and calving in the village of Padamulya in the district of Subang, West Java.

Agroclimate: Dry (≥ five consecutive dry months)
Altitude: Lowland (<100 metres above sea level)
Land use: Dryland cropping

vary from a heavy task, for example, the movement of large volumes of soil from the lower to upper side of a terrace using a wide *garu*, to a light cultivation using a *bugis*.

The daily activities of draught animals during the work season are shown in Table 1.4.5.

On average, the effective work time of cattle and buffalo in wetland preparation is three hours per day. From Tables 1.4.4 and 1.4.5, the number of days in which a pair of draught cows can prepare one hectare of land can be estimated (Table 1.4.6). The time available for land preparation in each planting season depends on the cropping pattern and season. This varies from 15 to 44 days. This range of time has been used to calculate the size of land which a pair of draught cows can prepare (see Table 1.4.7).

1.4.6 Feeding practices

Feeding practices are determined by the supply and the availability of labour, whether they are hired or family members for harvesting grasses and other nutrients. In areas where rainfed land is plentiful, grazing is commonly seen. Where grazing is not possible, feeding is achieved through the 'cut-and-carry' system. During the dry season grazing is often practised, particularly in the areas with poor water sources. Various combinations of grazing and cut-and-carry are also observed in many areas in West Java where fodder is gathered from roadsides, canals and other communal lands. Draught animals may be taken to these areas to graze if herding is practised. During the planting season, when land is not available to grazing animals, the cut-and-carry system is used by farmers. In prolonged dry seasons, farmers are sometimes forced to travel long distances, e.g. 20 km, to collect fodder for their animals. Much more time is spent on herding than would be spent on cut-and-carry especially towards the end of the dry seasons (Table 1.4.8).

Generally, there is no storage of fodder for draught animals. Green rice straw is often fed immediately after harvest but dry straws are not fed to animals and considerable quantities are burned each year. Maize stover and bean hay, however, are commonly fed to draught animals. Other agricultural by-products such as cassava leaves, sweet potatoes and peanut hay are also used.

It is evident from Table 1.4.8 that a significant amount of time is spent by rearers in the feeding of their draught animals.

The composition of the feedstuffs for cattle and buffalo is influenced by location and seasons (Figures 1.4.2 and 1.4.3). Rice straw is a less preferred feed, but it can comprise up to 60% of the diet during the dry season. Feed other than roughage is rarely given to large ruminants except in some areas where rice bran and/or salt are fed. Some of the main plant species found in land types that form the main source of fodder are listed in Table 1.4.9. When animals are fed by hand, farmers generally try to feed *ad libitum* by providing adequate forage overnight. However, intake varies according to the quality of available feed and, in some cases, competition between young and older animals for feed in the pen.

Feed supply in villages in the low altitude zones of West Java appears to be similar. The green fodder generally has a crude protein content of approximately 9% in the dry season and 11% during the wet season. A high proportion of legumes has been noted in dry season grazing. Overall, farmers in the region consider that shortage of fodder for their animals, particularly towards the end of the dry season around October, is one of their major problems.

Table 1.4.5 Mean total work and idle times during land preparation by cattle and buffalo in West Java

	Ricefield	
	Ploughing	Levelling
Activity	(hours/day)	(hours/day)
Total work + idle time	3.6–5.0 (4.8)	3.9–5.1 (4.1)
Idle time	0.7–1.4 (1.3)	0.8–1.9 (1.0)
Effective work time	3.5	3.1

Means are in parenthesis

Table 1.4.6 Number of days in which a pair of draught cows can prepare one hectare of land

	Days	
Season	Wetland rice	Dryland crops
Wet season	35	–
Dry season	–	–

Table 1.4.7 Land size which a pair of draught cows can prepare in a given available time*

			Not irrigated (ha)		
	Irrigated (ha)		Rainfed rice		Dryland crops
Available time (days)	Wet season	Dry season	Wet season	Dry season	Wet season
20	0.18	–	–	–	–
24	–	0.10	–	–	–
(25)	0.13	–	–	–	–

* – Data not available

Table 1.4.8 Labour use in the cut-and-carry and grazing systems of feeding cattle and buffalo during the wet and dry seasons in the villages of Tanjungwangi and Padamulya in Subang, West Java

	Hours/day			
	Wet season		Dry season	
Feeding systems	Cattle	Buffalo	Cattle	Buffalo
Tanjungwangi				
Cut-and-carry	2.2	2.5	2.6	3.0
Herding	5.6	5.0	6.6	6.4
Padamulya				
Cut-and-carry	4.6	3.2	4.4	2.7
Herding	8.3	5.0	9.1	8.3

Table 1.4.9 Examples of forages fed to draught cattle and buffalo in West Java

Land type/forage source	Main species	Quality
Roadsides and canal banks (handfed and/or grazed)	*Polytrias amaura*	Fair
	Ischaemum timorense	Poor
	Brachiaria sp	Fair
	Chrysopogon acicularis	Poor
	Cynodon dactylon	Good
	Calopogonium sp	Good
	Imperata cylindrica	Poor
Fallow ricefields (grazed)	Dry rice straw	Fair
	Polytrias amaura	Fair
	Digitaria and *Paspalum* sp	Fair
Ricefield banks (handfed and/or grazed)	*Polytrias amaura*	Fair
	Ischaemum timorense	Fair
	Digitaria sp	Good
	Desmodium spp	Good
Under forest trees and forest edges (handfed)	*Imperata cylindrica*	Fair
	Axonopus compressus	Fair
	Paspalum conjugatum	Fair
	Polytrias amaura	Fair
	Setaria and *Panicum* sp	Fair
	Centrosema sp	Good
Weeds of mixed gardens (handfed)	*Eleusine indica*	Good
	Brachiaria sp	Fair
	Amaranthus and *Bidens* sp	Fair
Crop residues	Green rice straw	Poor
	Green maize leaves	Good
	Whole maize stover	Fair
	Sweet potato leaves	Fair
	Bean or ground nut hay	

1.4.7 Breeding

There is no tradition of controlled cattle and buffalo breeding in West Java. Bulls, when available, run with the herd which mixes freely in the common grazing ground. Mating occurs mostly after the harvest period when all animals are let loose on pasture. Our studies revealed that one of the most important factors causing low productivity is the lack of breeding bulls. A similar observation was made in East Java. Most male cattle and buffalo are under two years old but in fact there are several small villages in Subang which have no bulls. Unfortunately many good healthy bull calves, which grow quickly, are sold for meat at a very young age while those that grow more slowly are retained and later used at random for mating.

In-breeding is common and could be another contributing factor to the small size and low productivity of draught animals in the area. In villages where there is no common grazing ground, the animals are housed throughout the year. If farmers notice their cows to be in oestrus they either take the cows to the bull or vice versa. The owner of the bull sometimes charges a minimal amount for this service so that he could buy medicine or poultry eggs for the bull. If a cow does not conceive after several services, the farmer usually sells the cow and buys another one. However, the percentage of males sold from villages is always higher than that of females.

Some farmers keep bulls for draught power and these are used as much as possible. When the animals complete work for the owner, they are rented out to other farmers for ploughing. Bulls are worked hard during the day and kept in isolation in their own shed at night. This practice minimises the opportunity for bulls to come into contact with cows. To date bulls are never examined for fertility but greater attention must be given to male capacity in future if calving rates are to be improved.

Under village conditions sexual maturity of heifers is attained at the age of 2.5 to 3 years and age at first calving is 3.5 to 4 years. Calving intervals are more than 450 days (18 months for cattle and around 24 months for buffalo). Calving percentages are 65% (cattle) and 50% (buffalo) and calves are weaned naturally at the age of five to seven months. Animals start working at the age of 1.5 to 2.3 years.

1.4.8 Housing

Apart from individual experiments, housing has until recently been confined to traditional designs. Houses are constructed from locally available materials; the pillars and crossbeams consisting of sapling or bamboo cut from the jungle and nailed together. The roof is made from palm fronds or clay tiles. Ventilation is usually good with no solid walls around the unit. A cattle shed is supposed to protect animals from extreme weather, wild animals and thieves. It should be kept clean otherwise it may predispose to disease.

There are two kinds of housing in West Java:

Individual farmer units A cattle shed is built under, attached to or near the farmer's house, usually to accommodate one or two animals. The floor area of the shed may vary from 4 to 50 m^2 (average 17 m^2). This type of housing provides security for the animals from thieves and also allows the farmer to keep a close watch on his animals for any abnormalities or oestrus. Because animals of different farmers are isolated from one another this system of animal housing assists in infectious disease control. However, the system may be a disadvantage to productivity because heat detection may be less efficient since signs of oestrus are sometimes less obvious when animals are kept individually. The average density of animal sheds are around 7.5 m^2 per animal. The distance of animal sheds to the farmer's homestead varies from 0–8 m (average 5.2 m).

Communal farmer units In this system, several farmers build their animal sheds in an area usually near a river to accommodate up to 100 animals. The housing area is not necessarily located near homesteads so security for the animals is provided by either hired guards or the farmers and their family on a roster basis. If mature bulls are present in this system, mating of receptive cows can be more easily achieved.

Most of the traditional animal houses do not have a drainage system. Farmers collect the manure from the shed into a heap outside the building. The animal houses are usually far from clean and hygienic. Animals are individually tied in wooden or bamboo stalls with a feed trough made of timber or bamboo and water is provided individually to the animals in buckets. Some of the housing characteristics in West Java are compared with those in South Sumatera in Table 1.4.10.

Table 1.4.10 Animal housing

Data	West Java	South Sumatera Betung IIB	South Sumatera Karang Agung Ulu
Size of pen (m^3)	4–50	10–24	8–45
Density (m^3/head)	7.5	8.0	7.6
Distances from family house (m)	0–8	3–12	0–15
Construction			
Roof	Tiles of palm leaves (plaiting), rumbia leaves	Alang alang grass or plaiting, palm leaves, rumbia leaves	Plaiting rumbia leaves or lalang alang
Floor	Ground	Ground	Ground
Wall	No wall (wooden bar)	No wall (wooden bar) or bamboo plaited wall	No wall (wooden bar) or in the kitchen (indoor)

1.4.9 Training

Untrained animals are first trained at one and half to two years of age. They are trained by their rearers on site in the morning from 0600 to 0900 hours. The main training activity is divided into three steps:

Putting on and accepting the yoke and training for walking

The aim is to train the animals to accept the yoke and to walk smoothly. Animals are prepared by putting a rope around their horn or their nose so that trainers can encourage them to be calm.

The second activity is to train them in the direction of walking and to control the speed. Animals are also taught to stop walking, move in a straight line, and to turn in the paddy. Generally this activity is achieved by using a trained animal along side the trainee. Their acceptance of the yoke takes two to three hours. As soon as the animals accept the yoke, the next activity is to start walking. This is commonly managed by two trainers in which the first (in front), holds the nose rope while the second (at the back) keeps close to the flanks of the animals so that both trainers can control the direction and speed animals walk. The pair is driven on a road or open field with special commands. This routine takes two to three hours per day for three to five days.

Adaption to implement

The final step is the introduction of an appropriate implement such as a plough which the pair of animals pull in a field. Sometimes the plough is not directly entered into the ground but is pulled over the surface. For ploughing, the pair of animals need to be taught again in terms of straight line, left and right turn, stop and turning. This routine is achieved in two to three hours per day for five to ten days. The animals ought to be used for regular work as soon as they are trained. During a long period of inaction after training, they will tend to lose the habit of daily contact with the implement.

1.4.10 Health

There are no accurate data on the prevalent diseases in West Java. Information on the occurrence of diseases in villages is usually derived from the answers of farmers in questionnaires and from the Direktovar Jendral Peternakan (Directovate General of Livestock Services). Among the abnormalities mentioned by farmers are: diarrhoea, harness sores, poor appetite, eye disorders, weakness/thinness, skin diseases, poisoning, bloat, hoof problems, abortion and nasal discharge. In Subang, the occurrence of ascariasis in buffalo calves, lice infestation, wounds, burns, trypanosomiasis, malignant catarrhal fever, red urine and eye disorders have been reported by the Balai Penelitian Veteriner (Research Institute for Animal Health) at Bogor. For the last two conditions no causes have yet been determined though babesiosis and Moraxella infection ('pink eye') are possible candidates. In the same location a survey by the *ACIAR Draught Animal Project* on endoparasitic diseases in buffalo and cattle was conducted in January (wet season) and June (dry season) of 1987. Results showed a high incidence of fascioliasis in January and June in about 70% in buffalo and 40–60% in cattle. The incidence of ascariasis in buffalo calves in January and June was 7% and 4% respectively.

Our data indicate that some diseases in West Java can be controlled by prophylactic management and treatment.

When farmers see their animals sick, but not acute, they call for the district veterinary assistant (*mantri hewan*) for service. If the disease, however, is acute and the District veterinary office is relatively inaccessible, farmers try to use traditional medicines such as herbs, spices, tree legumes, roots or even cow faeces as remedies. The practice of these traditional treatments has been passed from generation to generation and from one farmer to another who candidly state that they sometimes work well but sometimes do not. If a farmer thinks an animal cannot be cured, he will slaughter it and sell the meat. Emergency slaughtering should not be necessary if there are adequate local veterinary services in terms of qualified personnel, diagnostic facilities and reporting systems.

1.4.11 Conclusions and recommendations

- Cattle and buffalo are critical to farmers as the animals are used for draught power, as a capital asset and for manure production.
- A common problem in DA rearing in densely populated areas of West Java is feed shortage during the dry period. More intensive use of appropriate feed and food conservation technologies is needed to overcome the problem.
- Variations in pattern and intensity of DAP use are associated with different agro-ecosystems. Types of implements used and methods of land preparation should be designed according to local land conditions to improve the work productivity.
- Greater attention should be paid to breeding methods including the supply, status and management of bulls to increase calving rates and thus the income of farmers.
- More accurate information on the incidence and distribution of local disease including those affecting bulls and calves is urgently required. Methods of prevention and control are available for many problems.

Suggested reading

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Sumanto, Santoso, Petheram R J, Perkins J, Nana and Rusastra W (1987) An agro-economic profile of Padamulya village, Subang, with emphasis on draught animal rearing. *DAP Project Bulletin* No. 4, 4–28.

1.5 SOUTH SUMATERA : TRANSMIGRATION AREAS

Santoso, Sumanto and R Dharsana

This Section deals specifically with two transmigration areas; namely Betung II-B and Karang Agung Ulu, which are located in the north east of the province of South Sumatera (Figure 1.5.1).

1.5.1 Location and agroclimate;

The province of South Sumatera is located between 102°20' to 108°30' east longitude and 1°30' to 5° south latitude (Figure 1.1.1). None of the province belongs to the dry agroclimatic category while 24% and 76% are intermediate and wet respectively.

The geographic position and the topography of the huge island result in great variation in rainfall distribution in the province. The Bukit Barisan mountain chain, which stretches in a northwesterly to southeasterly direction along the western side of the island, blocks the humid air from the Indian Ocean from reaching the province whilst the Malaysian Peninsula serves as a barrier to humid air from the China Sea. As a result, the entire east coast, particularly the northwest portion, receives less rain per year than the west coast. Rainfall may vary over short distances, e.g. from 6000 mm per year on the western slope of the Bukit Barisan to less than 1500 mm in secluded valleys on the eastern side.

The rainfall in South Sumatera ranges from 1500 mm to 3200 mm per year, with an average of approximately 1600 mm. The wet season is normally from September to May while the only dry months are June to August (Figures 1.5.2 and 1.5.3). The agroclimatic category under which the transmigration areas of Betung II-B and Karang Agung Ulu are classified is C2 (Section 1.1) that is, five to six consecutive wet months and two to three dry months. They are lowland areas with Betung II-B having an altitude ranging from 15 to 219 metres above sea level and Karang Agung Ulu only 3 to 5 metres.

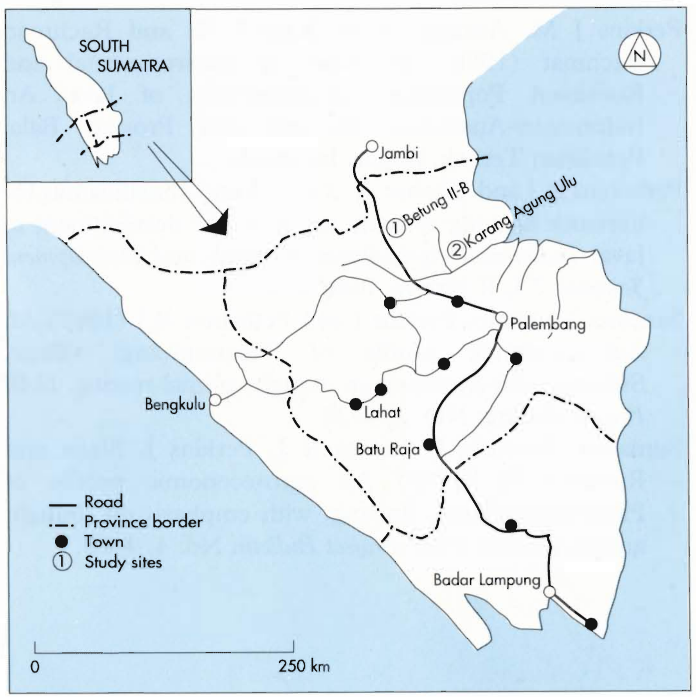


Figure 1.5.1 Map of South Sumatera showing the locations of the transmigration areas studied by the ACIAR Draught Animal Project.

1.5.2 Land use and crop production;

The total land area of South Sumatera is 103 688 km^2 or 5.4% of the land area of Indonesia. Approximately 48% of the province is under agriculture; of this only 19% is used for dryland crops (Table 1.5.1).

Table 1.5.1 Land usage of the agricultural area of South Sumatera;

Land use	Area (km^2)
Irrigated ricefield/Rainfed ricefield	4579
Dryland crops	9435
Others	36303

Of national production the province of South Sumatera produces rice (3%), maize (1%), cassava (2.5%), soyabean (1%), peanut (2%) and sweet potato (2%) respectively. Land usage in Betung II-B and Karang Agung Ulu is summarised in Table 1.5.2.

Table 1.5.2 Land use in transmigration areas Betung II-B and Karang Agung Ulu

Land use	Betung II-B (ha)	Karang Agung Ulu (ha)
Irrigated ricefield		5026*
Rainfed ricefield	49	
Dryland crops	3786	
Estate or forest land	34	2538
Swamp	19	
Residential	542	1436
Public facilities	34	
	4464	9000

* Both irrigated and rainfed ricefields

1.5.3 Draught animals

The predominant animals used for draught work in South Sumatera are cattle which number approximately 315 000. Of these approximately 7% are Bali breed but in transmigration areas imported Bali cattle make up the bulk of the population due to Government policy which promotes the distribution of the species. In Betung II-B and Karang Agung Ulu, for example, Bali cattle make up 75% and 59% of the population respectively. More than 85% are female and working cattle (Photograph 1.5.1).

1.5.4 Draught animal enterprise

The greatest limiting factor in the development of land in the transmigration areas is the lack of power for cultivation. With available cattle, the ownership in Betung II-B varies from one to seven head per rearer, with an average of two per unit. According to farmers on this site, Bali cattle are strong and fast enough to work under local conditions. They also have good reproductive performance. However, local cattle are regarded as more docile, easier to work and more heat tolerant. Buffalo are not popular as they are not considered suitable for use in land preparation for dryland crops. The population density of cattle is very low (6.7 hectare per head) compared with most areas in Java. Draught animal numbers at Karang Agung Ulu is still inadequate at an estimate of approximately 54 hectare per head. Animal numbers, however, are increasing steadily.

Farmers generally prefer to keep cows rather than bulls, since they produce calves. Bulls, according to some rearers, can be a liability if they become aggressive when used for work. The preference of farmers for female cattle is shown by the increase in female to male ratio as the age of animals

Photograph 1.5.1
A Bali cow in Karang Agung Ulu, South Sumatera.

increases. It should be noted also, in relation to this, that the Indonesian Government, through its Smallholder Cattle Development Project, supplies one bull for every 10 cows distributed by the Project to the farmers. Bali cattle are very popular among the transmigrants, more than 70% of whom express preference for them over the local breed.

The rate of change in cattle ownership in the two areas is quite rapid with animals bought, sold or exchanged. The most common reason given by farmers for buying animals is that they would like to increase their capacity to cultivate land. A much smaller proportion of farmers buy in cattle as a means of saving or for profit when sold at a later date. The number of cattle per owner varies from one to four head, with an average of two. The size of land operated by rearers is approximately 1.6 ha while non-rearers operate approximately 1.4 ha.

Table 1.5.3 Percentage of rearers of cattle in various livestock ownership categories in transmigration areas in South Sumatera

	Transmigration areas	
Ownership categories	Betung II-B	Karang Agung Ulu
Own all stock	46	78
Share-in all stock	9	18
Own + share-in stock	45	4

In Karang Agung Ulu, animals are used for work at a relatively younger age (1.5 years) than in some areas of West Java because of the urgent need for animal power. Survey data show that most rearers (70%) have used their animals for land preparation but the remaining rearers have not started to work them. More than 50% of animals over 1.5 years have not been used. The proportion of adult working cattle in Betung II–B is much higher.

The reasons given by rearers for lower usage of draught animals in the cultivation of land in Karang Agung Ulu include:

- the heavy condition of the clay soil and the abundance of residual tree stumps and roots which makes ploughing so difficult that they have resorted to manual labour and hoes for land preparation;
- the lack of a second animal with which their animal could form a pair of working team; and
- the fact that a farmer may have just bought the animals.

These factors constrain the rearers' ability to develop and maintain a greater area of land.

The high percentage of rearers involved in the mutual aid system of land preparation in Betung II-B, may indicate a shortage of capital and/or labour. The average time of cattle work is approximately four hours per day, but hours may be increased if rearers want to complete the work more quickly. A contract system also leads to more work hours per day.

The number of trained adult cattle owned by farmers matches the land size operated. Most rearers work areas ranging from one to 1.5 ha (average 1.09 ha) per family per season which is about half of the total allocated land per family. Constraints which limit the area of land cultivated may include:

- a shortage of labour and capital,
- abundance of predators (wild pigs) and pests, and
- the heavy soil condition due to clay and residual tree stumps and roots.

It should be emphasised however that the major limiting factor to land cultivation is still the overall lack of draught animals.

1.5.5 Work activities

Work type

Draught animals are worked in pairs almost exclusively for ploughing using *bajak Jombang* or *Betung* (Section 4) and levelling. Examples of the activities which they engage in during the work season are shown in Table 1.5.4.

Table 1.5.4 Work activities of draught animals during land cultivation in Betung II-B and Karang Agung Ulu

Pattern of land preparation	First planting (Nov)		Second planting (Feb)*		Third planting (July)	
	Per cent of all rearers working					
	†	††	†	††	†	††
Ploughing 2x, levelling 2x	–	–	–	–	–	–
Ploughing 2x, levelling 1x	–	–	–	–	–	–
Ploughing 1x, levelling 2x	–	48	–	32	–	–
Ploughing 1x, levelling 1x	–	10	–	10	–	–
Ploughing 2x	100	23	100	16	100	–
Levelling 2x	–	–	–	–	–	–
Ploughing 1x	–	19	–	6	–	–
Levelling 1x	–	–	–	–	–	–
Manual labour only	–	–	–	36	–	–
Total	100	100	100	100	100	0

† Betung II-B: Predominantly dryland cropping
†† Karang Agung Ulu: Predominantly irrigated rice
* April/May in Karang Agung Ulu

An important problem of arable land in tidal areas in Karang Agung Ulu is the high soil acidity (low pH) and an acidic soil layer. Farmers are advised to prepare their land carefully to avoid pulling the acidic layer to the surface where it would be oxidised, producing substances which adversely affect plant growth. Better implements (including types of ploughs and levellers) should be considered further.

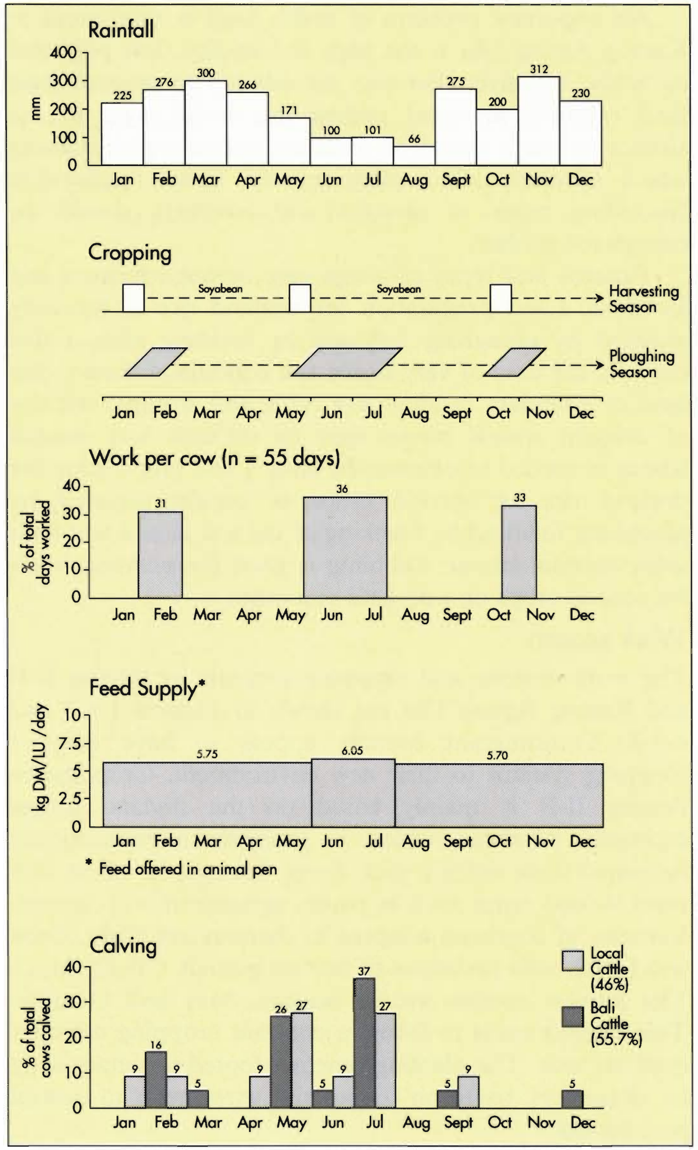
Patterns and types of tillage vary between farmers and locations. Land preparation for wetland rice is generally initiated by ploughing followed by levelling after a few days. In the case of very heavy soil conditions (heavy clay land or abundant residual tree roots and stumps) the use of draught animal power may be difficult and manual labour is needed to operate the land. Land preparation for dryland rice or second crops is usually initiated by ploughing followed by breaking of the soil after a few days using manual labour. Dibbling is used for planting seeds for second crops or a dryland rice crop.

Work season

The work seasons and cropping patterns in Betung II-B and Karang Agung Ulu are shown in Figures 1.5.2 and 1.5.3. Transmigrant farmers appear to have adapted cropping systems to their new environment. Cropping in Betung II-B is mainly based on the dryland crops, especially soyabean which is generally a monoculture harvested three times a year. Some farmers, however, also plant second crops such as maize, groundnut and cassava. Varieties of soyabean adopted by farmers are Wilis, Orba and Local, with variations of harvest periods (70–85 days). The harvest seasons are in January, May and October. This pattern tends to follow a constant cropping calendar over the year. The planting time is adopted simultaneously by all farmers, based on cooperative agreements to control pest attacks.

Figure 1.5.2
The monthly pattern of rainfall, cropping, animal work, animal feeding and calving in the transmigration area of Betung II-B in the province of South Sumatera.

Agroclimate: Wet (< two consecutive dry months)
Altitude: Medium (100–500 metres above sea level)
Land use: Dryland cropping



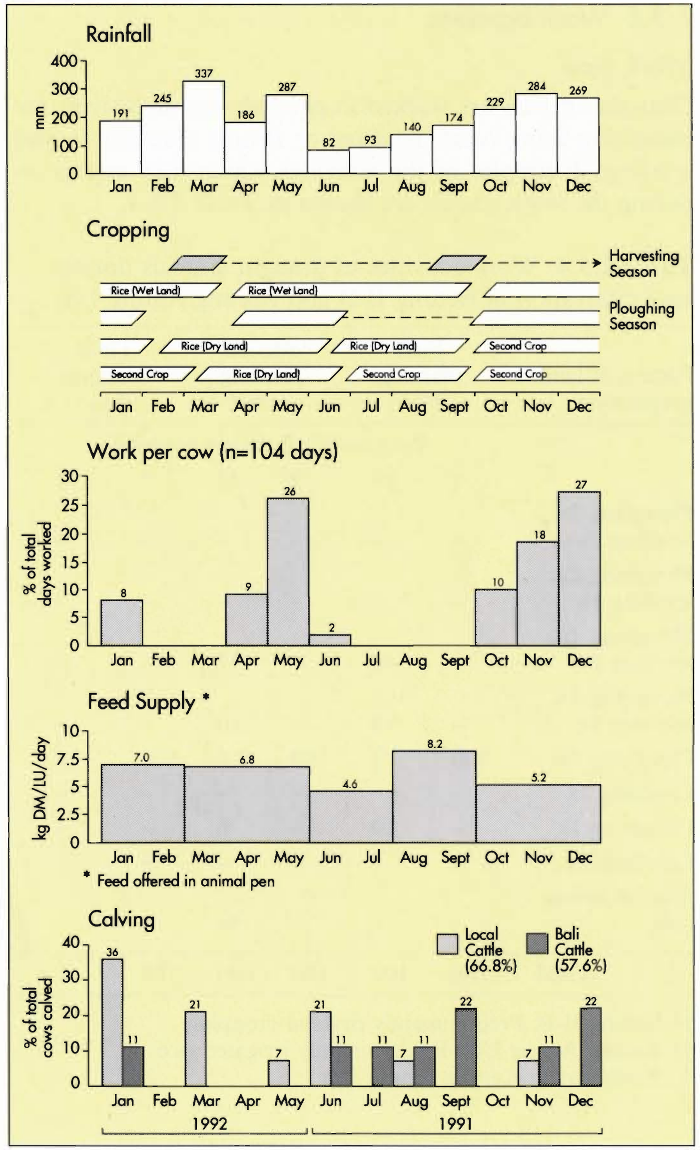


Figure 1.5.3
The monthly pattern of rainfall, cropping, animal work, animal feeding and calving in the transmigration area of Karang Agung Ulu in the province of South Sumatera.

Agroclimate: Wet (< two consecutive dry months)
Altitude: Lowland (<100 metres above sea level)
Land use: Wetland cropping (irrigated rice)

In Karang Agung Ulu wetland and dryland rice are the main crops. Second crops include maize, soyabean, ground nut and cassava. Fruits (pineapple, rambutan, etc) and other species are found at some locations.

In general, water for the arable lands in West Java, particularly for rice crops, is supplied by irrigation from mountain streams and to a lesser extent by rain. Irrigation systems at the Karang Agung Ulu site in South Sumatera, however, are affected by tidal water systems (up and down stream) and by rainfall. Based on the degree of land elevations which are affected by flood tide, the land units are divided mainly into three types: B, C and D. Type B is only affected by high flood, while type C and D are never flooded but are characterised by shallow soil water.

A new cultivation system introduced to improve diversification of cropping systems uses sunken and raised beds in an attempt to overcome water and soil problems. The rice crop is planted in the sunken furrows and second crops planted on the raised beds.

Work period

The total work period per year varies from approximately 98 days in Karang Agung Ulu to 56 days in Betung II-B. In the wet planting season in Karang Agung Ulu, animals are worked for approximately 57 days while in the dry season they are worked for 41 days. In Betung II-B the number of days worked per season ranges from 17 to 21 days and 24 to 124 days per year respectively. On average draught cows are worked for four hours per day but the range varies quite widely, from three to seven hours. Rented animals tend to work longer periods.

Work rate

Where possible draught animals are worked in pairs due to the fact that Bali cows, generally of smaller body size, are mainly used for draught in transmigration areas. In Betung II-B, land is prepared at the rate of approximately 10 days per hectare; 5.6 days per hectare for the first ploughing and 4.6 days for the second. At Karang Agung Ulu the average number of days taken to prepare a hectare of land is 12 days. The effective work time of cattle during land preparation is shown in Table 1.5.5.

From the data above, and in Table 1.5.5, it can be estimated that the preparation of a hectare of land in Betung II-B and Karang Agung Ulu would take 27.5 hours and 45 hours respectively.

Table 1.5.5 Mean total work and idle times during land preparation by cattle in the transmigration areas of Betung II-B (BII-B) and Karang Agung Ulu (KAU) in South Sumatera

	Hours/day			
	Ploughing		Levelling	
Activity	BII-B	KAU	BII-B*	KAU
Total work + idle time	4.25	5.75	–	4.2
Idle time	1.50	2.00	–	1.9
Effective work time	2.75	3.75	–	2.3

* Levelling work is not commonly used

If the time available for land preparation during each season was accurately known, the area which a pair of draught cows can prepare during that time could be estimated using the above information.

1.5.6 Feeding practices

Animals are fed by a combination of hand-feeding and grazing during the year. The average time for labour spent on herding is slightly longer than on hand-feeding (Table 1.5.6). The labour spent in the dry season is naturally greater. The majority of rearers do not appear to have any problems with fodder supply during the year (Figures 1.5.2 and 1.5.3) but others who encounter shortages in their immediate surround during the dry season, are required to cut-and-carry fodder as far as 1 km from their homestead.

Native grass is the predominant feed in the area but other feed such as *Setaria* sp, corn and cassava leaves, sweet potato leaves, fresh rice straw, peanut leaves, some weeds, tree leaves and rice bran are sometimes fed. Salt and local 'livestock medicine' are also commonly provided by rearers. Because pesticides are intensively applied on crops in the area, particularly soyabean, their straw has not been used as feed for cattle.

Table 1.5.6 Labour use in the cut-and-carry and herding systems of feeding cattle during the wet and dry seasons in the transmigration areas of Betung II-B and Karang Agung Ulu, in South Sumatera

	Hours per day	
Feeding systems	Wet season	Dry season
Betung II-B		
Cut-and-carry	2.1	2.0
Herding	2.3	3.4
Karang Agung Ulu		
Cut-and-carry	2.3	1.4
Herding	3.4	4.3

Observation during the ploughing season showed that up to 34 fodder species are fed by rearers. The principal species fed to cattle in Betung II-B are listed together with their composition in Table 1.5.7.

1.5.7 Breeding

Mating of cows in Betung II-B occurs whenever appropriate during the year. Rearers who have no bulls have their cows mated by neighbours' animals. There are occasions when rearers have to travel some distance from their homestead with their cows. The calving rate at Betung II-B is around 56% (Bali cattle) and 46% (local cattle) and the calving interval is about 21 months (Bali cattle) and 26 months (local cattle). The calving rate could be increased by improved management. Bull quality should also be examined more carefully.

In Karang Agung Ulu the ratio of male to female over two years of age is 1:15 but this figure gives no indication of the availability of bulls for breeding purposes. Other factors such as distribution of animal housing, herding and hand-feeding practices and proximity of animals to neighbouring herds are also important determinants of opportunities to mate. Preliminary data collected from this site indicates calving rates of 58% for Bali cattle and 67% for local cattle and calving intervals of 20 months (Bali cattle) and 18 months (local cattle). Farmers, in the main, take their cows to be mated by their neighbours' bulls. Although all rearers are keen to have their cows calve as frequently as possible, they have little understanding of some important aspects of reproduction of their animals.

1.5.8 Housing

Animal housing in Betung II-B is constructed from locally available materials. The roofs are built with nipah/palm fronds or alang alang (Imperata cylindrica) (Photograph 1.5.2). Very few rearers use tiles. The pillars of the houses

Table 1.5.7 Chemical composition of eight species of roughages fed to the animals

Biological name	Common name	Local name	Ash	Crude protein	NDF	Crude fat	Energy	Ca	P
Clibadium surinamense		Angrung	23.7	22.2	65.0	2.92	14.6	1.3	0.52
Boreria alata		Kentangan	16.5	23.2	33.1	3.48	14.3	1.82	0.23
Eleusine indica	Crows foot grass	Lulangan	13.1	16.6	68.8	1.93	15.5	0.71	0.32
Digitaria setigera	Finger grass	Merangan	8.7	16.6	77.4	2.11	18.2	0.24	0.19
Paspalum conjugatum	Sour paspalum	Paitan	15.4	11.9	72.3	1.20	16.4	0.40	0.09
Axonopus compressus	Broadleaf carpet grass	R. Tanah	8.7	14.3	70.3	1.62	17.1	0.26	0.18
Mikania cordata	Mile-a-minute	Rawatan	14.9	19.4	43.5	4.03	17.0	0.84	0.56
Cyperus polystachios	Cyperus (nut grass family)	Teki	7.4	10.0	79.5	2.55	17.3	0.31	0.17

Photograph 1.5.2 An open-sided cattle house with a roof constructed with alang alang in Karang Agung Ulu, South Sumatera.

Photograph 1.5.3 A closed-sided cattle house with bamboo-plaited walls in Betung II-B, South Sumatera.

and the cross beams are constructed from wood. Most housing is closed-sided, using plaited bamboos as material (Photograph 1.5.3). The floor area of the houses averages 18.8 m^2 (range: 9–23 m^2) which allows for an average stocking rate of 8.0 m^2 per animal. Rearers collect the manure just outside the houses for use as fertiliser for their crops. Distance of the sheds from the farmer's homestead varies from 3–15 metres.

The animal houses at Karang Agung Ulu are similarly constructed. The distance of these units from the homestead varies from 2 to 20 metres. A few rearers keep animals inside their kitchens to protect them from mosquitoes by smoke generated from firewood or dried feed residues. They also feed their animals at night.

A comparison of housing in South Sumatera and West Java is presented in Table 1.4.10.

1.5.9 Training

Animals are older in Karang Agung Ulu than in West Java (two to three years old vs one and a half to two years old) when trained for the first time. Training is conducted by special trainers or sometimes by the rearers themselves. Rearers would have to pay a trainer around Rp 50000 for a complete training program.

Training methods are the same as in West Java because the transmigrants are usually from that island. There is a difference in the length of training, as the routine of putting on and accepting the yoke and training for walking takes five to ten days while the adaptation to an implement is conducted over ten to fifteen days.

1.5.10 Health

The most commonly observed symptoms of ill-health of cattle in Betung II-B involve the digestive system, e.g. poor appetite, bloat and diarrhoea. Harness sores and skin disorders are sometimes observed. Nasal discharge, stiffness and some abortions have been reported by rearers. Veterinary services are available at each location and rearers are becoming familiar with the benefits of this facility for sick animals.

Karang Agung Ulu reports also indicate the common occurrence of diarrhoea, bloat, loss of appetite, skin disorders including harness sores, and diseases of the eye. Abortion has not been noted and retention of the afterbirth post partum was reported only by one farmer. Due to poor access to this site, limited veterinary service is available so the detection and identification of diseases and their control are difficult to carry out. Rearers usually treat their sick animals by traditional medicines (*Jamu*) with uncertain results. There is clearly a need to improve animal health services in the area and much work is required to determine the causes and epidemiology of the more common problems.

Suggested reading

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Santoso and Sumanto (1991) Draught animal (management) systems in transmigration areas, Betung-IIB, South Sumatera. Draught Animal Bulletin No.3, 9–19.

Bakriv. B. (1990). The management or rearing and productivity of Bali cattle as draught animals in a transmigration area of South Sumatera. Proceedings National Seminar of Bali cattle. Faculty of Animal Husbandry. Utayana University Denpasar, Bali. p E19–E23.

Bakriv. B. (1991). An observation on the feeding management of the draught animals in the transmigration area of Betung IIB, South Sumatera, Indonesia. Draught Animal Bulletin. 1: 32–38.

2.1 FEED RESOURCES

A Thahar and P Mahyuddin

2.1.1 Fodder supply

The diet of the ruminant animal in Indonesia consists almost exclusively of plants and plant products. These include:

- a range of native grasses and creepers and some weeds,
- leaves of leguminous and non-leguminous shrubs and trees, and
- crop residues.

For the purpose of this manual, these plants and plant products will be collectively referred to as fodder. In specific cases, fodder will be specified as ground fodder, shrub or tree fodder and crop residues respectively.

A particular problem with fodder is its high variability, both in quality and quantity. Feeding can also be very demanding in labour requirements. Usually high quality fodder is rare while low quality material is common. Mineral deficiencies are also widespread, particularly in the acid soils which are dominant in more than 60% of the total land area of Indonesia. Deficiencies can also occur in lime soils, particularly during the dry season.

Availability of fodder is a limiting factor to draught animal productivity in densely populated islands such as Java and Bali. It is also a major problem during the dry season in more arid agroclimatic regions like Timor and the surrounding islands where there is abundant food during the wet and early dry seasons. The supply decreases as the dry season progresses toward the start of the wet season when animals are required to work.

Feed requirements

Farm level

Green fodder is eaten by the ruminant animal in amounts equivalent to 10%–15% of its live weight. The percentage of dry matter (DM) may vary from 20% to 25% and the amount eaten, is expressed on a DM basis, equivalent to 2.5% to 3.0% of the live weight of the animal.

Cattle are considered to be partial browsers while buffalo are heavy grazers. The amount of feed eaten by a partial browser is normally less than that eaten by a grazer. Thus a 100 kg steer may eat 10 kg of green fodder while a 100 kg buffalo steer may eat 15 kg of the same feed.

Regional levels

Estimation of feed requirement in a given area is based on Livestock Units (LU). One LU in Indonesia is taken to be equivalent to an animal weighing 250 kg in live weight. The minimum requirement per year of one LU, 1.14 t of digestible dry matter (DDM), is estimated using the following equation:

$$DDM = (365 \times 2.5\% \times 250 \times 50\%)kg/1000 = 1.14\ t$$

where DDM is digestible fodder dry matter in tonnes
365 is days per year
2.5% is the amount of fodder dry matter eaten expressed as percentage of live weight of the animal
250 is live weight in kilograms per LU
50% is the average digestibility of the fodder dry matter eaten.

The population of the grazing animals (including horses) in a given region is converted to LU using a conversion factor of 0.8 per head for buffalo, 0.7 per head for cattle or horse and 0.06 per head for sheep or goat. The estimated LU and corresponding minimal feed requirement in Nusa Tenggara Timur, Java and South Sumatera are presented in Table 2.1.1.

Table 2.1.1 Total Livestock Units (LU) and estimated minimal fodder digestible dry matter (DDM) requirement in Nusa Tenggara Timur (NTT), East Java, West Java and the transmigration area of Karang Agung Ulu in South Sumatera

	NTT*		East Java		West Java		Karang Agung Ulu	
Animals	Number	LU	Number	LU	Number	LU	Number	LU
Cattle	614721	430304	2891000	2023700	1616900	1131830	120	69
Buffalo	183452	146762	223000	178400	989500	791600	5	4
Horses	182449	127714	81857	57300	319131	223392	0	0
Sheep	86274	5176	2359000	141540	5407960	324478	0	0
Goats	395047	23702	490000	34300	378000	26460	563	54
Total LU		733659		2435240		2497760		127
Fodder DDM required (t/yr)		836372		2776174		2847446		145

* NTT comprises Flores, Sumba and West Timor

Feed availability

Production

Fodder is obtained from fallow and grazing lands, farm border strips, roadsides and public lands. The total DM production in an area is estimated using information in Table 2.1.2 which has been compiled using data from publications or obtained through personal communication with crop scientists together with results of field research by the authors in the *ACIAR Draught Animal Project*. The contents of Table 2.1.2 will be reviewed as more information becomes available through research. Dry matter production of feeds used in West Timor, East and West Java and Karang Agung Ulu are shown in Figure 2.1.1.

Carrying capacity index

Carrying capacity index is the amount of DDM of feed produced in a given area divided by the total feed requirement of the resident LUs.

The carrying capacity indices are classified into four categories of adequacy. These are:

Carrying capacity indices	Adequacy
1 to 2	Severely critical
2 to 3	Critical
3 to 4	Marginally satisfactory
Greater than 4	Satisfactory

In terms of livestock population, the island of Java may be broadly classified into two regions. The Western region, which also includes Central Java and Yogyakarta, is classified as the less highly populated region while the Eastern region is considered to be heavily populated.

Table 2.1.2 The productivity of fodder plants

Food crops	Plant parts	HI* and Ratio of parts	DM** production
Rice			
Wet land	*Local Varieties*		
	HI	0.2	
	Unhulled : Straw + Roots	1 : 4	
	Unhulled : Straw	1 : 3	3.5 : 10.5 t/ha
	New varieties		
	HI	0.4	
	Unhulled : Straw + Roots	2 : 3	
	Unhulled : Straw	1 : 1	4 : 4 t/ha
Dry land	*Old varieties*		
	HI	0.2	
	Unhulled : Straw + Roots	1 : 4	
	Unhulled : Straw	1 : 3	1 : 3 t/ha
	New Varieties		
	HI	0.4	
	Unhulled : Straw + Roots	2 : 3	
	Unhulled : Straw	1 : 1	2 : 2 t/ha
Corn (Maize)			
Arjuna	HI	0.2	
	Grain : Straw + Roots	1 : 4	
	Grain : Straw	1 : 3	1–2 : 6 t/ha
Madura	HI	0.2	
	Grain : Straw + Roots	1 : 4	
	Grain : Straw	1 : 3	0.25–0.5 : 0.75–1.5 t/ha
Soyabean	HI	0.3	
	Grain : Straw + Roots	3 : 7	
	Grain : Straw	1 : 3	0.75–1.0 : 2.25–3.0 t/ha
	(The straw consists of stem mainly, hulls and minimal leaves)		
Dolichos lab-lab	HI	0.2	
	Grain : Straw + Roots	1 : 4	
	Grain : Straw	1 : 3	0.5 : 1.5 t/ha
Other leguminous crops	HI	0.3	
	Grain : Residues (feed)		0.5–1.0 : 1.0–2.0 t/yr
Sweet potato	HI	0.85	
	Tuber : Residues (feed)	5 : 1	1.5 : 0.3 t/ha or 7.5 : 1.5 t/ha (fresh)
Cassava	HI	0.25	
	Tuber : Residues (include leaves, pells, small tubers)	3 : 1	2 : 0.7 t/ha or 10 : 3 t/ha (fresh)
Sugar cane	Raw sugar : cane tops		1 kg : 0.45 t
Banana trees			
Dry lands (including homestead gardens)	Any elevation		
	Trees		75 trees
	Leaves		0.30 t/yr
	Stems		0.15 t/yr

* Harvest Index ** Dry matter

Food crops (con't)	Plant parts	Ratio of parts	DM production
Banana trees cont.			
Wet lands (sawah)	<100 m above sea level		0
	100–500 m above sea level		
	Trees		25 trees/ha
	Leaves		0.10 t/yr
	Stems		0.05 t/yr
	500–1500 m above sea level		
	Trees		50 trees/ha
	Leaves		0.20 t/yr
	Stems		0.10 t/yr

Trees	Plant Parts	Ratio of Parts	DM Production
†	Banana tree leaves : Other tree leaves	1 : 4	See banana trees for estimation of production values
††	Leaves		10 t/ha/yr

Grasses			DM Production
In wet lands			
Banks	<100 m above sea level		0.5% total lands at 2 t/ha/yr
	100–500 m above sea level		1% total lands at 3 t/ha/yr
	500–1500 m above sea level		2.5% total lands at 4 t/ha/yr
Fallow	One rice crop/yr		2.5–5.0 t/ha/yr
	Two rice crops/yr		0.5–1.0 t/ha/yr
In dry lands			
Banks	<100 m above sea level		2.5% total lands at 2.5 t/ha/yr
	100–500 m above sea level		5.0% total lands at 5.0–7.5 t/ha/yr
	500–1500 m above sea level		10% total lands at 10 t/ha/yr
Fallow	One cropping/yr		2.5 t/ha/yr
	Two croppings/yr		0.5–1.0 t/ha/yr
In plantations *(estate crops)*	Under young (2 yr old) oil palm		12 t/ha/yr
	Under mature plants		0.6 t/ha/yr
On road sides, river sides, premises, cemeteries and other communal lands	<100 m above sea level		0.25% total village lands (not including forestry, estate crops, grazing areas) at 5 t/ha/yr
	100–500 m above sea level		0.5% total village lands at 7.5 t/ha/yr
	500–1500 m above sea level		1% total village lands at 10 t/ha/yr

Grasses (con't)	Plant parts	Ratio of parts	DM production
On grazing lands			5 t/ha/yr
On critical lands			0.5 t/ha/yr
Native grasses			5–10 t/ha/yr
New species/varieties	Traditional management		204–0 t/ha/yr
	Good management		40–60 t/ha/yr

† This is a method using banana trees as production indicators of other tree leaves fed to animals. Twenty percent of the total tree leaf diet is the maximum proportion of banana leaves which could be fed.

†† This method is the preferred one and is based on the following estimations:

- Canopy cover
  - Premises 30–70%
  - Dry lands 10%
  - Forest 100%
- Feed sources
- Probability of use
  - Fruit trees 20%
  - Fodder trees 100%
  - Other trees 20–50%

The carrying capacity index of the Western region indicates a satisfactory situation in which the real carrying capacity index is 11.5. On the other hand, with a carrying capacity index of 2.1 (derived from our DA Project data) East Java has a critical level. These data suggest that the animal population of West and Central Java could be increased to more than two times the existing numbers. Any increase however, should be supported by improved technical and feed management strategies as well as sound programs of feed resource development.

East Java has less opportunity to increase livestock population, unless successful developmental programs to increase feed resources and/or more efficiently utilise current feed can be set up. It is important therefore, that programs of livestock research and development place a high priority on feed resources and their utilisation. Silvipasture practices in Dayurejo village (one of our study sites in the Pasuruan district, East Java) is a good example of village feed resource development.

The estimates of carrying capacity indices presented in Figure 2.1.1 are based on calculations using secondary data.

The data on the LU carrying capacity of Karang Agung Ulu suggest that the LU could be increased to 1550 [more than the current population (69% LU)]. The current production of crop residues in that area is estimated to be able to support an increase of 330 LU. An increase in LU must also be accompanied by an expansion of feed resources with an emphasis on the establishment of multipurpose fodder shrubs and trees.

The carrying capacity of LU in Nusa Tenggara Timur (NTT) is similar to that of West Java, but seasonal variability in fodder DM production is a major limiting factor to animal production. Overstocking during the dry season, and understocking during the wet season are common. During the peak of the dry season, shrub and tree fodder (for browsing or cutting) is the major feed for ruminants. The stem of the *Corypha utan* (Photograph

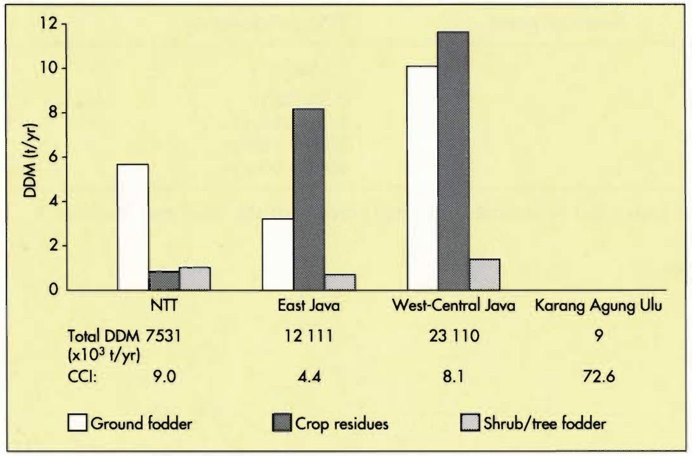

Figure 2.1.1
Estimated amounts of digestible dry matter (DDM) from ground fodder, crop residues and shrub/tree fodder and respective carrying capacity indices in Nusa Tenggara Timur (NTT), East Java, West-Central Java and Karang Agung Ulu in South Sumatera.

2.1.1) (also called *putak*) is a major feed for all the home yard livestock including ruminants and non-ruminants on the island of Timor.

Programs for the development of feed resources should include methods of fodder production and preservation, cultivation of conventional and non-conventional fodder species, increasing feed quality and the diversification of uses of existing fodder species and their management. Improvement of feed resources should be undertaken regionally as one of the priority objectives.

Types of Feed

On the island of Java, sources of fodder for draught animals are mainly from cultivated land whereas on the other islands, grazing lands are also important sources of feed (see Figure 2.1.1).

Photograph 2.1.1
Corypha utan *tree, West Timor.*

Fodder may be classified as conventional or non-conventional. Conventional sources include ground fodder and crop residues which are normally fed to animals. Non-conventional feeds include a number of plant species and crop residues which are not well known and are seldom considered. Some of these have high potential for livestock as well as having other characteristics which would be of advantage to animal production. Examples include *Samanea saman* (Photograph 2.1.2), *Azadirachta indica*, and *Acacia leucophloa* which have nutritious leaves of high palatability and which may also be used as shade trees capable of tapping into deeper underground water.

Fluctuation

Climate is the primary factor which influences patterns of fodder production and the LU carrying capacity of an area, while soils significantly affect fodder quality.

The cutting management of shrubs and trees, particularly in the dry agroclimatic regions, is very important to the productivity of those species. The recommendations, for example, for cutting *Glyricidia maculata* and *Lannea grandis* to optimise their DM production during the dry season are:

Grati, East Java	: April–May (end of wet) and October–November (end of dry season) or February, June and October.
Kupang, West Timor	: April and November (end of wet and end of dry seasons) or March, July and November.

The length of dry season is a major limiting factor to the availability of feed. For the purpose of this discussion the agroclimatic categories as defined in Section 1.1 are appropriate.

Photograph 2.1.2
A Samanea saman tree

Examples of monthly feed dry matter production in the three agroclimatic zones are shown in Figure 2.1.2.

2.1.2 Fodder quality

The quality of a fodder is determined largely by its intake which depends on the availability, its physical and chemical composition, and on the nutrient requirements of the animals. While factors which influence fodder digestibility may be related to those affecting intake, the relationship between digestibility and intake in tropical fodder is not always consistent. The digestibility or metabolisability of the diet eaten may vary by a factor of about two, but the intake of fodder by an animal may vary by a factor of four even under conditions in which the animal can choose the amount of fodder it eats. Factors which influence fodder intake by the animal and the means by which intake may be manipulated to advantage should be clearly understood.

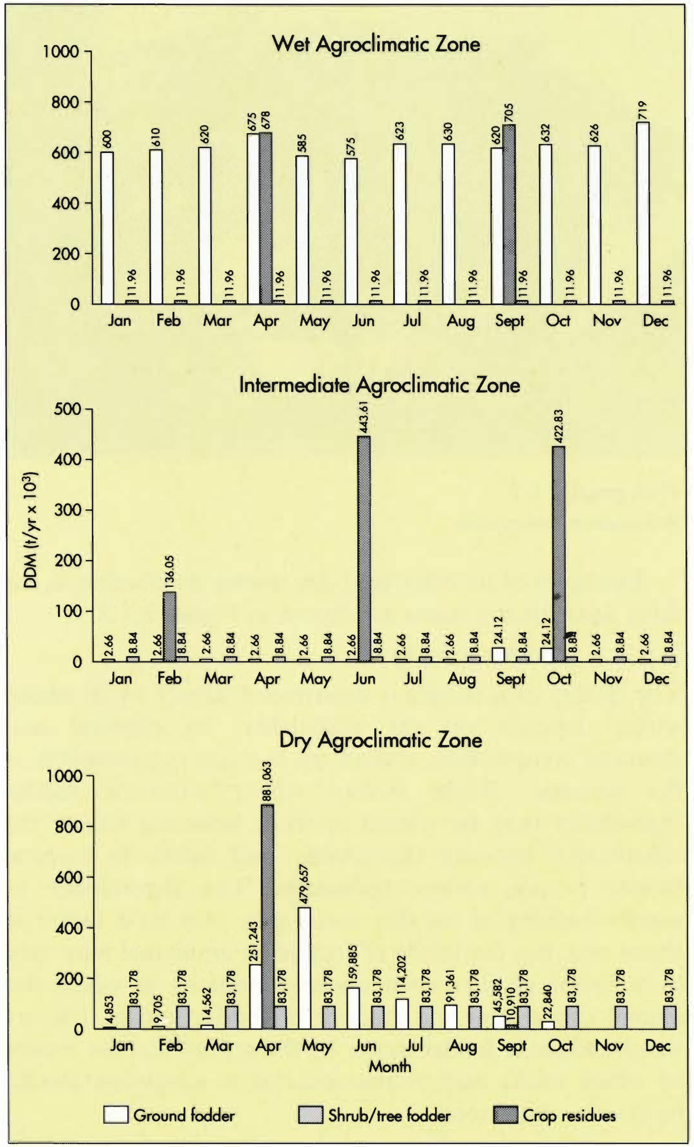

Figure 2.1.2 Examples of amounts of digestible dry matter (DDM) available each month from ground fodder, crop residues fodder, crop residues and shrub/tree fodder in wet (Karang Agung Ulu, South Sumatera), intermediate (Subang, West Java) and dry (Kupang, Nusa Tenggara Timur) agroclimatic zones.

Fodder intake

Cattle and buffalo usually prefer leaf to stem, young green fodder to mature green fodder, and fresh to wilted green feed. The intake of a plant by the animal also depends on the species or variety of the plant. In the cut-and-carry feeding system, animals are allowed to select the most palatable part of the plant, provided the amount fed is greater than the animals can eat. With a single diet, such as an agricultural by-product which is relatively homogeneous in composition, animals are forced to eat whatever is offered. In this case, care must be taken to make certain that voluntary intake of the feed is not less than the amount that is required to satisfy the animal. The appetite of an animal fed such a diet may be improved by the addition of common salt at 1% of the DM of the diet.

The most important physical plant factor to influence intake is the rate at which the material is broken down in the rumen to particles small enough to leave that organ. Smaller particles will pass through the rumen faster permitting more feed to be eaten. Thus pelleted or ground feed will usually be eaten in greater amounts than those which are fed whole. However, this is not always the case as the total dynamics depend on the quality of the unpelleted or unground fodder. A large increase in feed eaten usually occurs with low quality fodder which has been pelleted, while little improvement in intake occurs when good quality fodder is pelleted. Since pelleting is unlikely to be practical under village conditions, the next best option is to reduce the size of the low quality fodder by chopping. The mechanism which explains the difference in the intake of leaf and stem fractions similarly explains the differences in the intake of pelleted and unpelleted low quality forages.

Most tropical legumes are eaten in larger amounts than are tropical grasses of similar digestible energy. This difference is due to the fact that tropical legumes tend to reside in the rumen for a shorter period. It also can be more densely packed in the rumen than grass. The differences in the amount eaten of different varieties or species of fodder plants are mostly caused by the differences in their leafiness.

Younger fodder plant feeds are eaten in greater amounts than are mature ones. As fodder plants mature, the proportion of fibre in it is increased, as indicated by the high value of the NDF (neutral detergent fibre) of the plant. In addition, the protein content of the plant declines. These changes cause a reduction in digestibility and intake of the fodder by the animal. A high fibre content causes a slow passage of the digesta through the rumen and reduces the amount of the feed which the animal can eat. When the NDF content is above 50%–60% of the feed, both digestibility and intake will be affected. In most cases crop residues have NDF values greater than 60% (see Table 2.1.3).

If protein in the diet is less than 7–8% of the feed DM, the growth of the bacteria in the rumen will not reach its maximum rate. In such a situation, it would be expected that digestion of the feed would be inefficient and the total amount of the feed which the animal could eat would be lower. Feed intake may also be limited by the nitrogen status of the animal, and may increase as the nitrogen status of the animal increases. Once the requirement of the rumen bacteria for nitrogen is satisfied, additional nitrogen made available by dietary protein which is easily degradable in the rumen would be wasted. The aim at this stage therefore, is to provide dietary protein which is not degradable in the rumen and which will be digested together with microbial protein in the small intestine. Normally, protein contained in feeds has proportions which are undegradable in the rumen (Table 2.1.3). Knowing the proportions of degradable and undegradable ruminal protein in a feed would allow the use of combinations of available fodder to the best dietary effect.

The intake of fresh fodder plants may be higher than the intake of wilted ones. An example of this is *Calliandra* which is preferred by sheep and cattle when it is fresh rather than when it is wilted.

The rate of decline in digestibility may vary between species or variety. Most legumes (except Desmodium species) and many grass species from the genera *Brachiaria*, *Setaria*, *Digitaria*, *Panicum* and *Chloris* have relatively low rates of decline in digestibility in contrast to species from the genera *Hyparrhenia* (Table 2.1.3).

Table 2.1.3 Rates of decline in digestibility values of fodder species from some genera

	Rate of decline of digestiblity values
Genera	Digestible dry matter per day
Hyparrhenia	0.004
Brachiaria	0.002
Digitaria	0.006–0.0065
Panicum	0.0013–0.0034
Chloris	0.0013–0.0027
Setaria	0.0016–0.0021

The fibre content of a feed is more strongly related to its intake than to its digestibility. In tropical fodder plants the relationship between their digestibility and intake is quite inconsistent. The mean digestibility of DM of tropical legumes and grasses is about 56%, though some tree legumes and cassava leaves have higher digestibility values.

2.1.3 Fodder as feed

It is important that the farmer is aware of the feed requirements of his animals. Cattle and buffalo may eat, on average, an amount of fresh green fodder equivalent to 10 to 15% of their live weight. The amount of metabolisable energy required by an animal would depend on whether the animal is growing, pregnant, lactating or working, or working while in any of the other physiological states. Additionally, the farmer should be aware of the types of feed which can meet the ME requirements of his animals.

Most fodder plants used in the cut-and-carry system contain reasonable amounts of protein, i.e. greater than 10% (see Table 2.1.4). Legume tree leaves such as *Leucaena, Gliricidia, Sesbania* or *Calliandra* and cassava leaves which have higher protein content than grasses could serve as energy supplements in the cut-and-carry feeding system. In rice-straw based diets where protein is normally deficient, these leaves could serve both as protein and energy supplements. The leaves can increase the digestibility and the intake of a basal diet such as rice straw. They can also increase the yield of microbial protein thus resulting in a better balance of protein and energy absorbed from the gut.

Example

An animal weighs 250 kg. Its maintenance ME requirement may be calculated from the equation:

$$Mm = 8.3 + 0.09\ LW$$

where Mm is maintenance ME requirement of the animal in MJ/day
and LW is live weight of the animal in kg.

The value for Mm for the 250 kg animal is 31 MJ/day. This amount of ME can be met by the consumption of 30 kg of fresh fodder or 4.5 kg of the dried fodder which has an ME value of 7 MJ/kg (see Figure 2.3.2).

If the animal is working the ME requirement becomes 53 MJ/day (i.e. 1.7 x M). This amount can be provided by feeding the animal 50 kg of fodder. However, this amount of feed is unlikely to be all eaten by the animal. Hence the animal would probably lose weight during the working season. Inclusion of tree legume or cassava leaves (approximately 8 kg fresh) will meet the energy requirement of the working animal.

On a rice straw diet in which the ME content of the straw is 6 MJ/kg DM, the intake of DM would be equivalent to approximately 1.5% of the live weight of the animal. This level of straw intake would not be able to meet the ME which is required for maintenance, let alone for working. Feeding legume or cassava leaf supplements can increase the DM intake of rice straw to 2% of live weight. This is equivalent to 5 kg of rice straw or 30 MJ of ME. The remaining 23 MJ can be supplied by giving 8.5 kg legume or cassava leaf (containing approximately 30% DM). An alternative energy supplement which is relatively easy to get is rice bran. A good quality rice bran may contain approximately 11 MJ/kg DM. Approximately 2.5 kg rice bran (86% DM) can be given to meet the remaining energy required for the working animal.

The feeding of a protein or energy supplement with a basal diet may also provide the animal with additional minerals which are low in the basal diet. The practice of giving fodder consisting of a mixture of plants is to be recommended. However, because of limitations in fodder availability, farmers normally collect whatever material is locally available for feeding to their draught animals.

Most tropical fodder plants are deficient in some mineral elements. This is largely due to the soil type in which the plants grow. Indonesian soils may be broadly classified into acid soils (pH <5.0) and non-acid soils (see section 1.1.3)

Our Project study of fodder plants grown in the fertile medium soils of Java, the less fertile acid soils of South Sumatera and the lime soils of West Timor indicates that sodium is the mineral most commonly deficient in fodder species in Indonesia. In addition, fodder species in Sumatera are likely to be deficient in phosphorus, copper and zinc and these elements can be marginally deficient in species in Java. Tree leaves, generally, are good sources of calcium while grasses can be marginally deficient.

On the lime soils of West Timor phosphorus, magnesium and zinc can be marginally deficient in fodder species, while potassium, sodium, zinc and copper are deficient in the dry season but are adequate in the wet season.

From the above, it would be prudent to select protein or energy supplements on the basis of their capacity to also supply elements which are low in the basal diet. For example, rice bran is a good source of phosphorus (18 g/kg) while most tree leaves and cassava leaves would supplement the diet with calcium. Sweet potato leaves which have a reasonably high concentration of ME (10.4-MJ/kg DM) can also provide copper (12.2 mg/kg). Legume leaves such as *Sesbania grandiflora* are a good source of sodium (Photograph 2.1.3). The leaves from this tree are widely used as a supplement during the dry season in Timor.

Other trees which are potentially useful as fodder sources, particularly during the dry season, include *Acacia leucophloa* and *Corypha utan*.

Further details of the nutritional characteristics of the more common Indonesian fodder species are provided in Table 2.1.4. Values are derived from analyses undertaken in laboratories in Indonesia.

Photograph 2.1.3
A Sesbania grandifola tree, Kupang, West Timor.

Table 2.1.4 Some common fodder species in Indonesia and their content of dry matter (DM), digestible DM (DDM), metabolisable energy (ME), neutral detergent fibre (NDF), ether extracts (EE), ash, total protein and rumen undegradable protein (RUP) as analysed in Indonesia

Names				Composition							
										Protein (%)	
Botanical	Common	Local	Parts	DM (%)	DMD (%)	ME (MJ/kg)	NDF (%)	EE (%)	Ash (%)	Total	RUP
Legumes											
Pasture creepers											
Calopogonium mucunoides	Calopo	kalopo	Leaf		47.0	7.3	67.0		9.2	14.0	
Centrosema pubescens	Centro	sentro	Leaf/Stem	27			47.0	3.2	5.6	19.9	
Delonix regia	Poinciana	flamboyan	Leaf				25.3	4.1	5.2	21.6	
Mimosa pigra	Giant mimosa	putri malu	Leaf				44.2	4.8	10.0	23.4	
Parbia sp	Petai	petai	Leaf				62.5	4.2	3.6	18.0	
Stylosanthes scabra	Shrubby stylo	stili	Leaf/Stem				53.5	3.1	4.6	13.7	
Shrubs/trees											
Acacia auriculiformes	Acacia	akasia	Leaf				41.7	3.3	7.7	11.4	
Acacia villosa	Acacia	akasia	Leaf				19.6	3.8	2.8	27.6	
Albizia falcataria	Albizia	Jeungging/albisia	Leaf	33	52.7	9.3	34.4	5.0	6.0	25.2	
Calliandra callotyrsus	Calliandra	kaliandra merah	Leaf	39	44.8	7.0	41.2	3.2	4.5	24.8	
Gliricidia sepium	Gliricidia	Gamal	Leaf	37	65.7		35.1	3.8	10.8	24.7	45.8
Leucaena leucocephala	Leucaena	Lamtoro	Leaf	35	59.6	9.5	37.3	4.0	7.0	25.8	47.3
Samanea saman	Raintree		Leaf				53.9	4.3	4.7	20.7	
Sesbania grandiflora	Sesbania	Turi	Leaf	36	78.6	9.2	23.3	4.7	6.9	24.3	33.1

Grasses/Other shrubs/trees											
Ageratum hostonianum	Goatweed		Aerial	12	54.2		52.7		14.6	17.0	
Alocasia macrorhiza	Paragum taro	sente	Leaf				25.3	6.9	11.3	18.5	
Amhersia nabilis			Leaf				41.9	3.9	6.5	11.9	
Artocarpus heterophyllus	Jackfruit	nangka	Leaf			6.2	32.9	4.4	12.4	13.3	
Brachiaria decumbens	Signal grass	BD	Leaf		51.2		71.2	2.4	12.5	8.1	
Bridelia sp		kanyer	Leaf				29.8	8.7	11.1	19.6	
Brownea sp			Leaf				51.6	2.2	5.7	8.8	
Eupatorium odoratum	Siam weed	rumput merdeka	Leaf/Stem				35.7	7.4	8.3	19.1	
Gnetum gnemon		melinjo	Leaf				36.9	3.2	6.4	19.7	
Hibiscus tilaceous	Hibiscus	waru	Leaf				47.5	4.5	9.7	13.3	
Imperata cylindrica	Blady grass, cogon	alang-alang	Aerial	10	29.3	5.4	83.7	4.4	8.5	5.3	
Ipomea batatas	Sweet potato	ubi jalar	Leaf				27.8	4.7	11.6	15.8	
Ishaemum timorense	Lcuntu grass	sukut raket	Aerial				66.5	2.4	8.7	8.2	
Lannea grandis		kayu jaran	Leaf/Stem				43.1	4.3	12.0	11.3	5.0
Limnocharis falvus		genjer	Leaf				33.6	1.6	28.4	10.4	
Manihot utilissima	Cassava	singkong	Leaf	21	65.4	9.5	35.1	6.7	7.7	28.3	46.0
Melia azederah	White cedar	mindi kecil	Leaf				28.7	3.5	10.5	13.5	
Panicum maximum	Guinea grass	rumput benggala	Leaf		54.9	7.4	70.0			8.3	
Pennisetum purpureum	Elephant grass	rumput gajah	Leaf	20	68.9	8.4	57.8			17.7	
Peronema canescens		jati sabrang	Leaf				57.6	4.4	8.5	4.5	
Phyllanthus sp		meniran	Leaf/Stem				33.7	5.0	7.9	13.9	
Pisonia sylvestris		pahan sayur putih	Leaf/Stem				30.8	3.4	18.7	25.0	
Pseudoelephantropus spicatus			Aerial	20	47.1		52.6		18.4	11.4	
Pterocarpus indicus	Rosewood	angsana	Leaf				39.3	3.2	6.0	19.3	
Roadside grass	Mixed grass	rumput lapangan	Aerial		51.6	7.5	71.3			6.6	46.5
Saccharum officinarum	Sugar cane	tebu	Leaf			7.8	66.0	2.6	11.7	10.8	
Setaria plicata	Setaria	setaria	Leaf/Stem			8.7	63.0	3.1	15.1	16.2	
Sida rhombifolia	Sida	Sadagori	Aerial	30	52.4		56.3		9.2	14.2	
Synendrella nudiflora		Babadotan lalaki Jotong kuda	Aerial	10	54.8		48.8		18.7	17.7	
Themeda sp	Kangaroo grassmindi kecil		Leaf				69.2	2.6	11.6	8.9	

Table 2.1.4 (Cont'd)

Concentrates											
Ceiba petandra	Kapok	kapok	Kapok seed meal	90.0	50.0	10.4	58.0	8.0	7.1	32.9	
Cocos mucifora	Coconut meal	bungkil kelapa	Coconut meal	88.0	58.0	12.0	17.7*	8.1	6.7	20.2	
Glycine max	Soyabean	kedele	Soyabean meal	90.0		14.2	5.0*	4.0	6.6	37.0–48.0	
Manihot esculenta/utilissima	Cassava tuber	singkong	Cassava tuber	40.0		13.0	3.5*	0.7	2.2	2.1	
Orbigaya cohane	Palm kernel	kelapa sawit	Palm kernel meal	88.2	71.9		23.0*	10.5	3.3	14.3	
Oryza sativa	Rice, polished bro	menir	Broken rice	87.8	81.1	16.3	0.8*	1.3	1.5	10.0	
Oryza sativa	Rice, polishings	bekatul	Rice polishing	88.8	76.9	14.1	4.3*	17.2	10.3	13.4	
Oryza sativa	Rice bran	dedak	Rice bran	86.0	43.0	7.9–10.9	15.1–26.0*	3.7–8.8	13.0–16.0	7.7–13.0	
Tritinum aestivum	Wheat	gandum	Wheat pollard	87.8	75.1	13.6	8.5*	4.6	3.6	15.4	
Zea mays	Corn meal	bungkil hagung	Corn meal	85.0	65.5	12.5	9.0*	4.7	1.8	9.1	
Agricultural by-products											
Glycine max	Soyabean leaf	daun kedele	Leaf/Stem	28		11.1	20.8*	2.1	9.6	23.0	
Ipomea batatas	Sweet potato leaf	daun ubi	Leaf/Stem	11		10.4	27.8	4.7	11.6	13.0	
Manihot esculenta/utilissima	Cassava leaf	daun singkong	Leaf	21	69.2	12.3	15.7*	7.1	8.4	27.0	46.0
Manihot esculenta/utilissima	Cassava peelings	kulit singkong	Peelings	87		12.9	4.8*	2.9	4.1	4.9	
Musa paradisiaca	Banana leaves	pisang	Leaf	24	45–66	10.0	51.5	5.9	12.0	14.0	56.0
Oryza sativa	Rice straw	jerami padi	Leaf/Stem	33–95	38–55	6.0–7.5	33.0*	1.6	18.3	4.0–6.0	
Saccharum officinarum	Sugar cane top	pucuk tebu	Leaf/Stem	28	62.0	7.8	43.0*	1.7	7.6	6.0	
Sorghum vulgare	Sorghum straw	jerami sorgum	Leaf/Stem	85	42–48	7.7	6.6–44.6	1.6–7.5		7.9–11.0	
Zea mays	Maize stover	jerami jagung	Leaf/Stem	58	54.0	7.2	33.9*	0.8	8.7	6.0	

* Crude fibre

Suggested reading

Forages in Southeast Asian and South Pacific Agriculture. *ACIAR Proceedings Series* No. 12 (1985).

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2.2 ENERGY EXPENDITURE OF ANIMALS

B Bakrie and Komarudin Ma'sum

The amount of draught force required to pull a plough through different types of soil, depends to a large extent on soil shear strength, which in turn affects the amount of energy expended by the animals pulling the plough. The relationship between soil types and the energy expended by animals working on them are discussed in this section.

2.2.1 Work and workloads

Soils

The physical characteristics of the soil in Indonesia vary greatly even over short distances. Such variations may be due to differences in the formative processes of the soil, climate, rainfall, ambient temperature and also to the usage of the land, i.e. wetland or dryland cropping. For example, the soil used extensively for wetland cropping (*sawah*) has changed from its original characteristics because of the formation of a special 'ploughing layer' on the top of the soil. On the coast, areas of soil affected by the tides are commonly referred to as tidal or swampland. The colour of the soil, affected by its physical and chemical characteristics, is also variable even for the same type of soil. Hence soil shear strength in many cases may be differentiated by soil colour, e.g. soil in the transmigration area of Betung II-B, South Sumatera.

The two types of work involving draught animals in land preparation are ploughing and levelling. Ploughing is carried out before levelling, but the combination between these two activities may differ between villages (e.g. Tables 1.4.3 and 1.5.4).

Ploughing

Ploughing represents harder work and is more time consuming than levelling, especially for the first ploughing when the soil is harder since it has settled during the period of crop growth or fallow. Subsequent successive ploughings become progressively lighter work.

Plough

The type of plough used varies with soil type and village tradition. The wetland plough (*singkal*) may be made of metal or wood with a metal tip. The dryland plough (*brujul*) on the other hand, may either be similar or different in mouldboard type to the singkal. The singkal in East Java is usually made of wood with a narrow mouldboard and a pointed metal tip (Section 4). The plough is designed for use on soil which is relatively harder and where the ploughing depth required is shallow. Farmers in the transmigration area of Betung II-B, South Sumatera, use ploughs similar in design to metal ploughs used for wetland ploughing in Java.

Draught force

The draught force required for ploughing is mainly dependent on the soil shear strength and the plough type. The values of draught force we recorded during ploughing in different soils and locations are shown in Table 2.2.1.

The draught force is measured using a load cell placed on the rope connecting the yoke and the draw bar. Details of the method of measurement has been described by us in the *ACIAR Draught Animal Bulletin*, No. 2, 1991. The draught force required for ploughing on dry land is strongly related to shear strength of the soil, but for wetland this relationship is not so obvious. Obtaining a reliable average shear strength of soil in wetland is difficult to achieve due to the variable level of water and mud during ploughing. In addition the *sawah* conditions affect the rate of walking of the draught animals during ploughing and this in turn affects the draught force. This effect is clearly shown in Figure 2.2.1.

The draught force values recorded in Table 2.2.1 varied from an equivalent of 10 to 16% of the total live weight of the animals used. The upper limit of draught load which an animal can comfortably sustain for three to four hours while walking at the speed of 0.7 to 1.0 m/sec has been recorded by others in our Project to be equivalent to 11% of the live weight of an animal.

The speed of walking during ploughing is strongly related to the draught load. Animals tend to adjust their walking speed according to the draught load they are required to pull. The heavier the load the slower the walking speed. This is not always the case in the field, however, as other factors such as animal temperament and operator attitude can be important. Thus draught power, which is calculated using values of draught force and walking speed can be quite variable under field conditions.

Table 2.2.1 Soil shear strength, draught force, walking speed and draught power (Horse Power: HP) during ploughing on different soil in three locations in Indonesia

	Soil shear strength (kN/m^2)	Draught force (kg)	Speed (m/sec)	Draught power (hp)
South Sumatera				
Dryland				
Black soil	27	40	0.71	0.39
Red-yellow soil	44	50	0.56	0.39
Red soil	51	65	0.53	0.48
West Java				
Wetland				
Cattle	28	60	0.55	0.44
Buffalo	27	59	0.50	0.39
East Java				
Wetland				
1st plough	15	78	0.61	0.63
2nd plough	23	73	0.57	0.56
Dryland				
1st plough	33	62	0.95	0.82
2nd plough	33	67	0.95	0.90

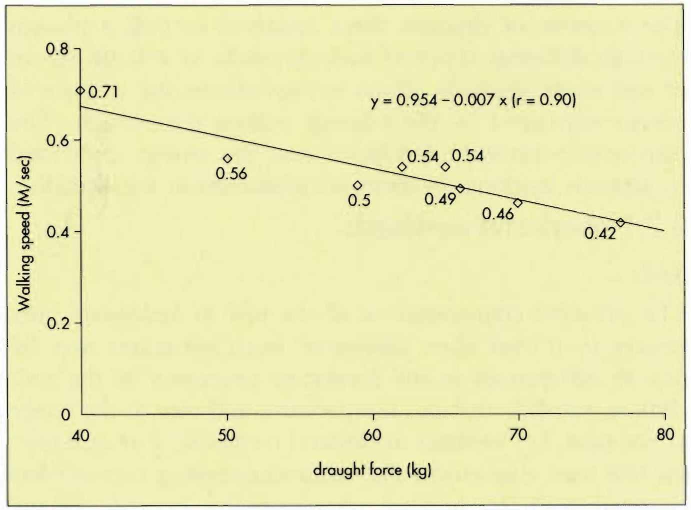


Figure 2.2.1
Relationship between draught force and walking speed of cattle working on dryland cropping areas.

Levelling

Levelling follows ploughing and is mostly undertaken in wetland cropping only. While such an operation is normally classified as light work, it is heavy work in cases where it involves the movement of large volumes of soil from the lower to upper side of a terrace, for example.

Leveller

The type of leveller used depends on the work to be done. The *garu*, a two-metre-wide boom with relatively short vertical spikes, is used for transferring large volumes of soil, and the *bugis*, which is smaller than the *garu*, is used for lighter tasks (see Section 4). Some farmers in the dryland areas may also use levellers without spikes for very light work. The use of harrows (relatively long spikes) may be more effective than levellers for the dryland areas, but this is not practiced by Indonesian farmers.

Draught force

The measurement of draught force exerted during levelling is more difficult to perform. Although the load cell is hooked to the rope connecting the yoke and the draw bar, as for the measurement of draught force during ploughing, the values recorded can be grossly underestimated. During levelling, the operator at times, is required to put some weight on the leveller by either sitting on the handle or by pushing it by hand. The pushing action causes the draw bar to touch the yoke occasionally, resulting in misrecordings of force by the load cell. Despite this problem some measurements have been taken with cattle and buffalo during levelling operations in villages in Subang (see Section 1.4). The results are shown in Table 2.2.2.

The measurement of walking speed during levelling is easier to undertake as it is achieved by recording the time taken to travel a given distance. Any underestimations of draught power (calculated from the draught force and the speed) therefore would largely be due to measured values of draught force.

Table 2.2.2 Draught force, walking speed and draught power by cattle and buffalo during levelling at three villages in Subang, West Java, Indonesia

Villages	Animal	Draught Force (kg)	Speed (m/sec)	Draught Power (hp)
Tanjungwangi	Cattle	49	0.59	0.38
Padamulya	Cattle	31	0.75	0.31
Wanareja	Buffalo	37	1.09	0.63

2.2.2 Energy expenditure during work

Information on the amount of energy expended by animals during work in the field is useful for the development of feeding strategies. Unfortunately such information is very scarce because there is no easy way of measuring energy expenditure of cattle or buffalo in the field. It is difficult enough in controlled laboratory conditions. Methods for measuring the energy expenditure, published in the literature, are mainly for the non-working animals. Methods developed for working animals are few and according to an evaluation undertaken by the *ACIAR Draught Animal Project* the most suitable for use under field conditions is the factorial method developed by Peter Lawrence from Edinburgh. The method requires measurement of the live weight of the animal, its walking speed and draught force exerted. Calculations involved are outlined below.

Calculations

The amount of energy used by an animal during work in the field is considered to comprise energy for walking, energy for carrying loads, energy for pulling loads and energy for walking up hill. This may be expressed as:

$$E = aDM + bDL + W/c + 9.81HM/d$$

where E = energy used for work (kJ)
D = distance travelled (km)
M = liveweight (kg)
L = load carried (kg)
W = work done in pulling a load (kJ) = Draught force (N) x Distance travelled (km)
H = distance moved vertically upwards (km)

These factors have been derived from controlled laboratory studies:

a = energy used to move 1 kg of body weight 1 m horizontally, the value is 2.0 for cattle and 2.09 for buffalo

b = energy used to move 1 kg of applied load 1 m horizontally, the value is 2.6 for cattle and 4.24 for buffalo

c = efficiency of doing mechanical work, the value is 0.3 for cattle and 0.38 for buffalo

d = efficiency of raising body weight, the value is 0.35 for cattle and buffalo

Field application

In most cases, fields used for cropping are quite level. Hence the value for H generally is zero. It remains therefore for one to measure the distance travelled (D) and to calculate the draught force (DF) and the load carried (L). The DF and L can be calculated from the measurement of angle force (AF) and angle of pull (α) (see Figure 2.2.2) using the following equations:

$$DF\ (kg) = AF\ (kg) \times \cos \alpha$$
$$L\ (kg) = AF\ (kg) \times \sin \alpha$$

As a load cell unit is usually not widely available, one may measure AF using a spring balance. A large number of AF values will need to be taken to account for the variations of AF over short distances. The α can be easily measured using a protractor. The value for this does not deviate too much from the average of 12° as most mature animals of the same breed are of similar height at withers.

Field results

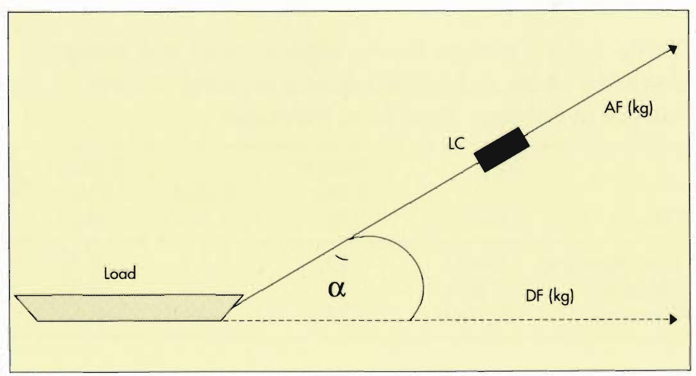
The energy expenditure by animals used in our field studies (Table 2.2.1) have been estimated (Table 2.2.3) using the above calculations. It is assumed that animals are worked for a total of three hours a day and the maintenance energy requirement is calculated based on the equation:

$$Mm\ (MJ/d) = 8.3 + 0.09\ LW\ (kg)$$

where Mm is maintenance energy requirement and LW is live weight.

There is no clear relation between work locality and the energy expended by the working animal. It appears that the amount of energy expended may vary from 1.2 to 1.8 x Mm depending largely on soil shear strength. A reliable way of obtaining the average shear strength of soil in a field could provide an easier way of estimating energy expended in ploughing it. While this is highly feasible in dryland cropping where soil shear strength varies with soil moisture content, it may not be in wetland cropping areas (e.g. *sawah*) where other factors such as variable walking

Figure 2.2.2
The angle force AF) measured by the load cell (LC) or spring balance attached to the line linking the load to the pair of working animals. Draught force (DF) and load carried (L) or the horizontal aid vertical force components respectively are calculated using AF and angle of pull α.



speed and draught force and also the difficulty in obtaining a reliable average soil shear strength significantly affect any prediction of energy expenditure.

Table 2.2.3 Energy expenditure (EE) and its value expressed as a multiple of the maintenance energy requirement (Mm) of animal ploughing different soils in different localities in Indonesia

	EE (kJ/kg LW.Hour)	(EE/Mm)
South Sumatera		
Dryland		
Black soil	13.7	1.36
Red-yellow soil	12.7	1.40
Red soil	14.5	1.42
West Java		
Wetland		
Cattle	11.9	1.37
Buffalo	8.3	1.24
East Java		
Wetland		
1st plough	15.0	1.51
2nd plough	13.4	1.44
Dryland		
1st plough	19.3	1.71
2nd plough	20.5	1.76

2.2.3 Summary

The draught force exerted in ploughing (heavier work) and levelling (lighter work) varies from 30 to 80 kg with an average range of 40 to 60 kg. The estimated energy expended by animals undertaking such work varies from 1.2 to 1.8 x Mm but could go as high as 2.0 x Mm. It might be assumed that for light work and heavy work the energy expended would probably be 1.25 and 1.7 x Mm respectively.

Suggested reading

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2.3 FEEDING AND BREEDING STRATEGIES

M Winugroho and E Teleni

2.3.1 Introduction

In this Section we present some approaches which Field Advisers might consider when assisting the smallholder farmer develop a feeding and breeding strategy for his draught animals. Information has been drawn from our own and other scientists' studies undertaken within the *ACIAR Draught Animal Project.* We focus on the draught cow because it is the most commonly used class of working animal in Indonesia and because we think that future developments, in other parts of the developing world, will move towards an increasing use of the cow for draught work. Any feeding strategy of such an animal must be developed around feed resources which are locally available and those which potentially can be successfully produced in the locality. Because smallholder farmers generally are very reluctant to spend money on proprietary feeds or feed supplements, we have opted not to include such feeds as part of possible feeding strategies for draught cows.

In order to develop a sound feeding strategy it is necessary to know the level and pattern of production of locally and potentially available fodder and the farmers' purpose for rearing the animals. A farmer may keep animals for draught work only or to get calves as well as work from them.

2.3.2 Rearing for work only

Where a farmer is interested mainly, if not only, in getting work out of his draught animals, there should be fewer problems involved in developing a feeding strategy for them. To do this the farmer will need to know:

- the range of draught loads which the animals are required to pull,
- the daily work duration, and
- the live weight of the animals.

Draught loads

The range of draught loads which might be expected in ploughing and levelling of land of different soil type are discussed in Section 2.2. Draught loads may vary from 30 kg in one location to 80 kg in another. An average range would probably be 40 to 60 kg.

Work duration

With regard to daily work duration, the farmer is best placed to provide that information as well as the number of days the animals are worked in a year. From surveys conducted by our Farm Systems studies (Section 1.1-1.5), the work duration may vary from 3 to 6 hours/day and from 20 to 60 days/year. On average, animals work effectively for approximately 3 to 4 hours/day.

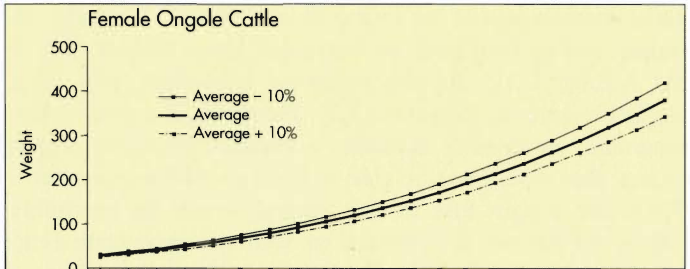
Live weight

In the absence of a weighing balance, a farmer could estimate the live weight of his animals by measuring their chest girths (Photograph 2.3.1). Information on the relationship between chest girth measurement in centimetres and live weight in kilograms for *peranakan* Ongole and Bali cattle is presented in Figure 2.3.1. The data used to plot the graphs in the Figure were recorded by our *Draught Animal Project* personnel from measurements on 115 Ongole and 115 Bali cattle in East Java. The predicted live weight ±10% from given chest girth values are presented below each graph in the Figure for ease of use. Similar reliable predictive equations for Madura cattle and swamp buffalo have not been developed yet.

Work capacity

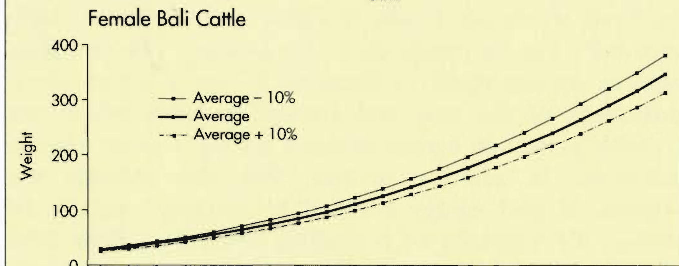
We know from our research that a draught cow, for example, can sustain pulling a draught load equivalent to 11% of its live weight while it is walking at a speed of 0.7 to 1.0 m/sec (or 2.5 to 3.6 km/hour) for a duration of 3 hrs/day. Therefore for a draught load of 40 or 60 kg, a

Figure 2.3.1
The relationship between chest girths and live weights in female peranakan Ongole and Bali cattle (J M Perkins and A Semali, unpublished data).



Girth	70	80	90	100	110	120	130	140	150	160	170
Av - 10%	26	38	54	73	97	125	158	197	241	292	349
Average	29	42	60	81	108	139	176	219	268	324	387
Av + 10%	31	46	66	90	118	153	194	241	295	356	426

Girth



Girth	70	80	90	100	110	120	130	140	150	160	170
Av - 10%	24	36	50	68	89	115	144	179	218	263	313
Average	27	40	56	75	99	127	161	199	242	292	348
Av + 10%	30	44	61	83	109	140	177	219	267	321	382

Girth

Photograph 2.3.1
Chest girth measurement being taken on a Bali cow in East Java

draught animal pair with a combined live weight of 364 or 545 kg respectively should be able to cope with the work load. Obviously, a single animal weighing 360 kg or 540 kg should also be able to undertake the work.

Live weight is the most critical factor determining the work capacity of a draught animal. For example, an animal which has a poorer body condition score (e.g. 4, see Photographs 2.3.2) but has a live weight in excess of 360 kg should be able to sustain pulling a draught load of 40 kg. On the other hand, an animal with a good body condition score (e.g. 7, see Photographs 2.3.2) but a live weight of 300 kg would not be expected to be able to sustain pulling the same draught load.

The information discussed above is very important to the approach a farmer might take to the feeding of his draught animal. If he has an animal with a larger body frame such as the peranakan Ongole, then feeding it well to achieve a good body condition score before the work season starts might not be as critical as it would be in the case of an animal with a smaller body frame such as the Bali or Madura (see Photograph 2.3.2). The feeding strategy for an animal reared for the purpose of draught work only should therefore be aimed at attaining and maintaining the live weight of the animal above the critical value for a given range of draught loads.

2.3.3 Rearing for work and calf production

Where the farmer wishes to use his animals for work as well as for producing calves, developing a feeding and breeding strategy for his animals becomes more complex; particularly where feed supply in both amount and quality is critical for a large part of a given year (e.g. in East Java; Photograph 1.3.3).

Feed requirement

We have tabulated estimated ME requirements of draught cows in different physiological states (Table 2.3.1) and consuming different amounts of fodder ME (Table 2.3.2). These should be useful to a Field Adviser assisting a farmer develop a feeding management strategy for his draught cows.

The feed energy required to meet the demand by the working animal has been estimated to vary from 1.25 times to 2.0 times the feed energy which is required to maintain an animal at a stable live weight (maintenance energy requirement). In Figure 2.3.2 we show the total ME which is required by the animal:

- to maintain itself,
- to sustain work by expending energy at a level equivalent to an average of 1.7 x maintenance,
- to sustain the above level of work as well as the development of the pregnant uterus in late pregnancy, and
- to sustain the above level of work as well as an average production of 10 kg of milk daily in early lactation.

We have also shown the amount of ME which an animal is likely to obtain from fodder ranging in quality from 6 MJ ME/kg DM to 9 MJ ME/kg DM. The assumption made is that an animal would eat an amount of feed DM equivalent to 2% of its live weight. On a low quality fodder such as rice straw (e.g. 6 MJ ME/kg DM) an animal would not be able to eat enough of the feed to meet the extra energy required for heavy work (i.e. 1.7 x maintenance). For example, a 250 kg and a 350 kg working cow would be short of feed ME by 23 MJ and 26 MJ/day respectively (Figure 2.3.2 or Tables 2.3.1 and 2.3.2). On such a diet therefore, the animals would be expected to lose weight. If a shortfall in dietary ME of about 28 MJ would result in a liveweight loss of 1 kg then these animals would be losing from 0.8 to 0.9 kg/day. A higher quality feed such as harvested green fodder (e.g. 9 MJ ME/kg DM) should minimise liveweight loss to a negligible amount (Figure 2.3.2). However, if a cow in late pregnancy or in early lactation is worked, even this higher quality diet would not be able to meet its ME requirement. Therefore weight loss in this animal would be inevitable unless the farmer is prepared to feed it concentrate (e.g. 13 MJ ME/kg DM) which is likely to be very expensive.

2.3.4 Feeding and management strategy

The feeding strategy developed will obviously depend on the feeds which are locally available and on those which potentially can be produced in the locality. The cropping patterns as illustrated in Sections 1.2 to 1.5 give some indications of the type and amount of feeds which are available in certain agroecosystems during a given year in Indonesia. In addition to this, they also indicate the patterns of feed energy demand by working animals. In Section 2.1 methods of estimating available fodder DM and LU carrying capacity of a given area are presented. The quality of the commonly available fodder is discussed together with a number of promising shrub/tree legume species in relation to their feeding potential and areas in which they are likely to grow well.

Although a farmer is locked into a cropping pattern and therefore work pattern by climate, the following might be manipulated to advantage:

- shrub/tree legumes as feed supplements,
- pattern and intensity of demand for feed, and
- body nutrient reserves of his draught cows.

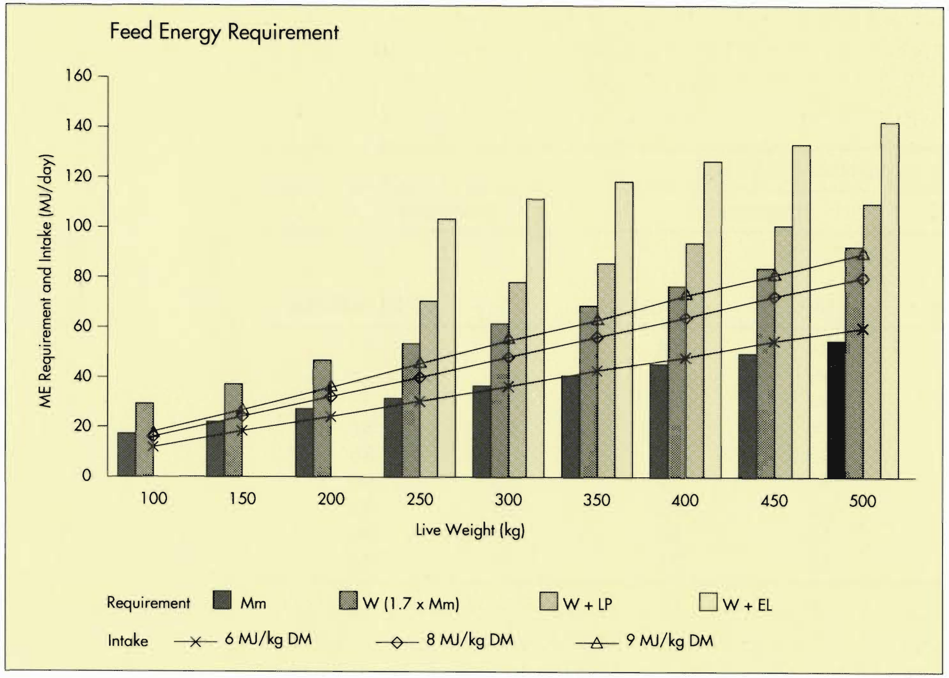


Figure 2.3.2
The metabolised energy (ME) requirement of cattle of different live weights for maintenance (Mm), work (W) at 1.7x Mm, W + late pregnancy (LP) and W + early lactation (EL). (E. Teleni 1993)

Shrub/tree legumes

A good strategy would be for a farmer to plant some of the shrub/tree legumes suited to the particular locality (see Section 2.1 and ACIAR Forage Project publications). These might be planted around the homestead, as fence lines and on borders of crop fields. Feeding such feeds with harvested grass fodder could provide a diet of 10 to 11 MJ ME/kg DM. The estimate of feed DM eaten (i.e. 2% of live weight) which we have used in Figure 2.3.2 is on the conservative side; particularly for feeds containing 9 MJ ME/kg DM. As the feed value is increased from 9 MJ to say, 11 MJ ME/kg DM it might be expected that the amount of the feed DM eaten would also be increased to a level equivalent to 2.5 - 3.0% of the animal live weight. The increase in dietary ME concentration and in the amount eaten would therefore result in a greater total ME consumed.

Pattern and intensity of demand for feed

Results of our studies indicate that any significant negative effect of work on production parameters such as calf and milk is likely to be a result of competition for nutrients between the productive tissues (viz. the working muscles and either the pregnant uterus or lactating mammary gland) rather than of work per se. The most intense demand for feed energy by the productive animal occurs during the last three months of pregnancy and during the first month of lactation. Working a cow in late pregnancy or in early lactation runs the risk of the animal losing live weight to a body condition score which is not compatible with an early return to oestrus after calving. In early lactation, a reduced milk yield by the working cow would reduce calf growth rate. It would be a good strategy therefore to avoid either of these events occurring during the work season. It would also be advisable to avoid working the animal within the month of its mating in order to ensure implantation and survival of the embryo. An idealised draught animal production scheme is shown in Figure 2.3.3. This should be a useful aid in developing a production pattern which optimally integrates with a given cropping pattern and available feed resources.

In a farm system where land preparation and planting of seedlings are undertaken in November, for example, the draught animal production system might involve the cow being mated in August and calving in May (Figure 2.3.4).

Table 2.3.1 The estimated metabolisable energy requirements of cows of different live weights, at maintenance, at different levels of work, at different stages of pregnancy or producing different amounts of milk

		Metabolisable energy requirement (MJ/day)						
		Work			Pregnancy		Lactation	
Cow live weight (kg)	Maintenance (Mm)*	1.25 Mm	1.7 Mm	2.0 Mm	180	260 days	5	10 kg milk/day
100	17	21	29	34	24	34	42	67
150	22	27	37	44	29	39	47	72
200	27	34	46	54	34	44	52	77
250	31	39	53	62	38	48	56	81
300	36	45	61	72	43	53	61	86
350	40	50	68	80	47	57	65	90
400	45	56	76	90	52	62	70	95
450	49	61	83	98	56	66	74	99
500	54	67	92	108	61	71	79	104

* Estimated from the equation Mm (MJ ME/day) = 8.3 + 0.09 x Live weight (kg)

Table 2.3.2 The estimated metabolisable energy intake of cows of different live weights fed different quality diets which are eaten in different quantities

	Metabolisable energy intake (MJ/day)							
	6 MJ ME/kg DM		8 MJ ME/kg DM		9 MJ ME/kg DM		11 MJ ME/kg DM	
Cow live weight (kg)	DM intake*: 2.0%	2.5%	2.0%	2.5%	2.0%	2.5%	2.5%	DM 3.0%
100	12	15	16	20	18	22	27	33
150	18	22	24	30	27	34	41	49
200	24	30	32	40	36	45	55	66
250	30	37	40	50	45	56	69	82
300	36	45	48	60	54	67	82	99
350	42	52	56	70	63	79	96	115
400	48	60	64	80	72	90	110	132
450	54	67	72	90	81	101	124	148
500	60	75	80	100	90	112	137	165

* Dry matter intake equivalent to 2.0%, 2.5% or 3.0% of a cow's live weight

The cow goes through the work period when it is two to three months pregnant and it calves in the earlier part of the dry season and close to the crop harvesting period when the supply of feed should be relatively high.

Body nutrient reserve

It is inevitable that a farmer's draught cow will lose live weight on certain occasions. There should be no problem in this if the farmer is aware of the limits to which body reserve nutrients can be depleted without compromising the productivity of the cow. In fact, the use of body reserve nutrients, i.e. liveweight and body condition loss, can be usefully a part of a farmer's feeding strategy for his draught cow. For this reason we have put together photographs of cattle and buffalo (Photographs 2.3.2; see following Sections on Body condition score and Scoring for details) showing different body condition scores (body reserve nutrients) to assist in identifying the type of animal which might have problems in producing a calf every 12 to 15 months. We have used a scoring scale of 1 to 10. The extreme ends of this scale are generally not seen in the field.

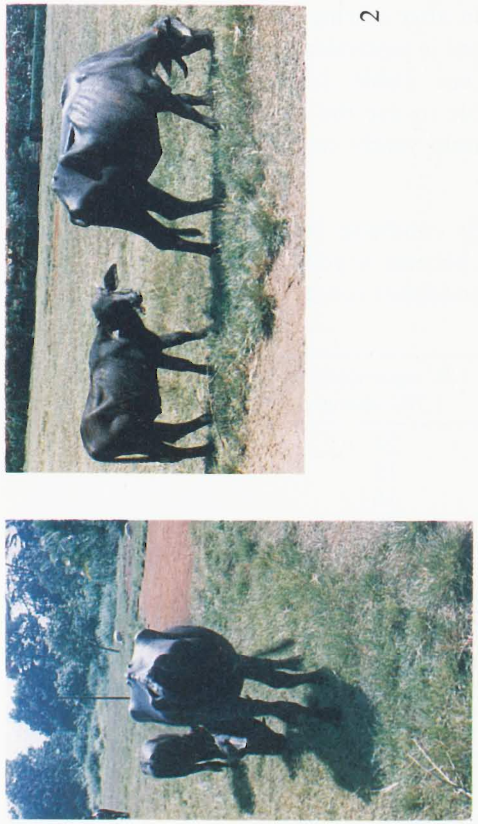
From our recordings of changes in body condition scores and live weights of cattle and buffalo, we have estimated the equivalent in live weight of one body condition score in the different species of draught animals. The live weights and body condition score at which these animals showed problems with their cyclic activities were also recorded. These data are summarised in Table 2.3.3.

To achieve an earlier return to oestrus in a cow after calving, good body condition before calving together with feeding a good quality diet post partum would be a better feeding strategy than feeding a high quality diet post partum to a cow with a low body condition score. The nutrients supplied by diets fed to cows in the first three months of lactation are likely to be diverted towards milk production than towards building up of body reserves or condition. Hence the farmer should try to have his cow calve in body condition scores greater than those listed in Table 2.3.3 for the different species. A cow may lose an average of 0.2 to 0.5 kg/day in live weight after calving, i.e. about 18 to 45 kg over 90 days. This loss is equivalent to one or more body condition scores (see Table 2.3.3). Depending on feed situation it is possible to use the data in Table 2.3.3 to assist the farmer to attain yearly calving of his draught cow.

Table 2.3.3 Live weights (LW) and body condition (BC) scores at which mature cows losing LW become acyclic and live weight equivalent of one body condition score change

Cows	Critical LW (kg)	Critical BC score	LW equivalent to 1 BC change
Ongole	≤260	≤4	24
Bali	≤230	≤5	15
Madura	≤220	≤4.5	16
Buffalo	≤350	≤5	30

Cows have been shown to return to oestrus more quickly if their calves are weaned early (e.g. at 90 days). This early weaning, with attendant problems of feeding of the young animal, can be part of an overall feeding management strategy of draught cows. In the village of Sudimulyo in East Java (see Section 1.3) calves are weaned early and sold at a profit (see Section 3 on Economics) to specialist calf rearers (Photograph 2.3.3).



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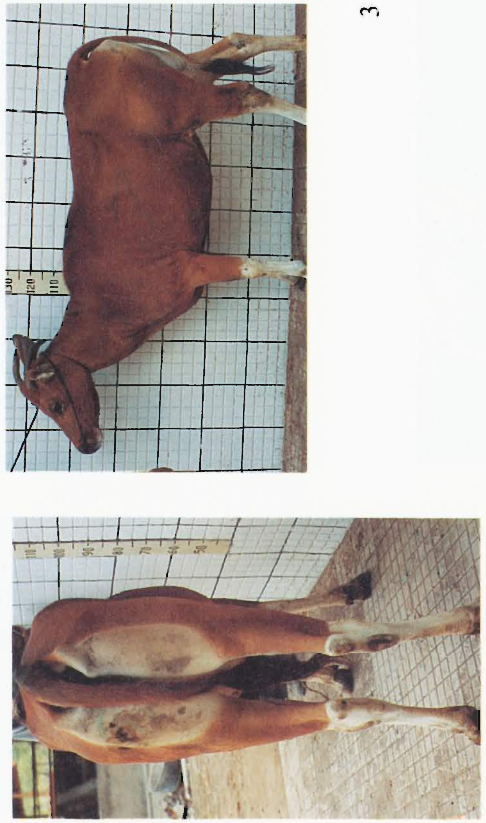
Buffalo
Photographs 2.3.2

2



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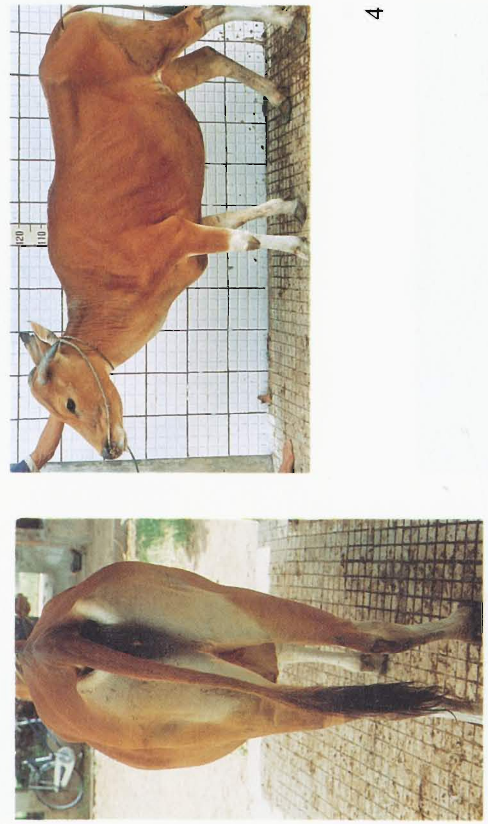

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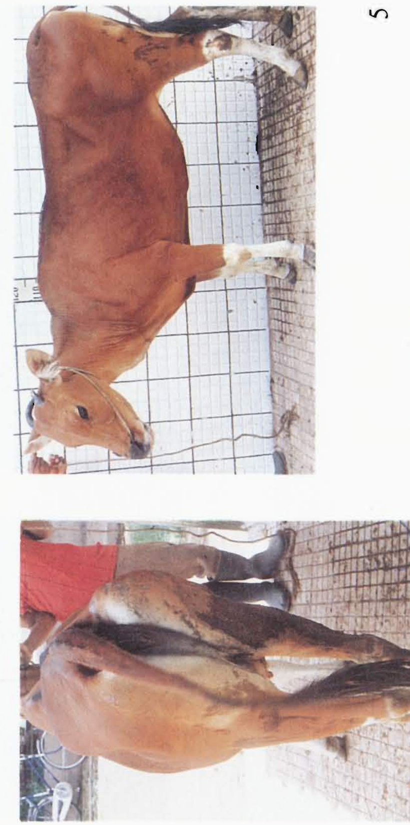

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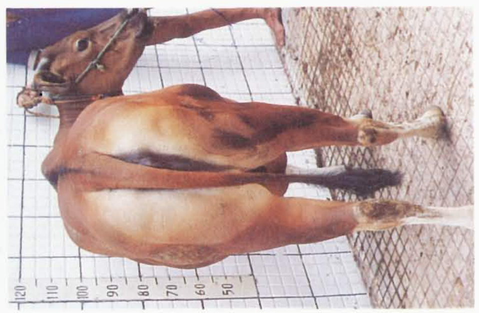

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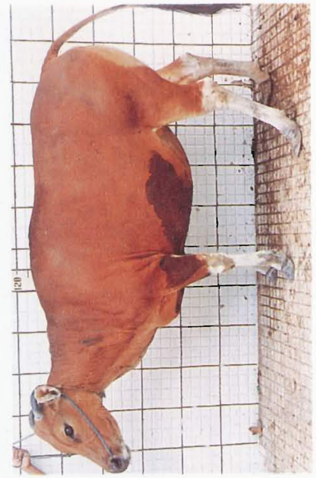

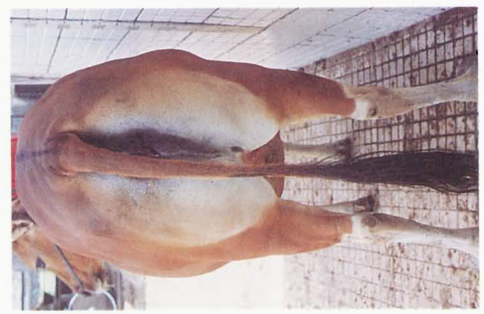

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Bali

Photographs 2.3.2 (cont'd)

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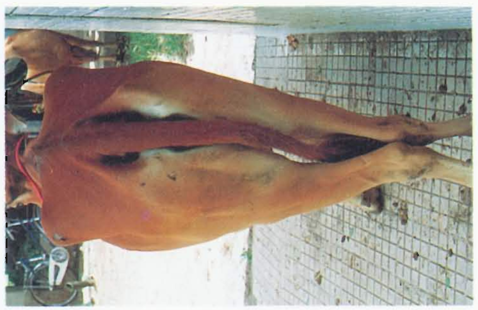

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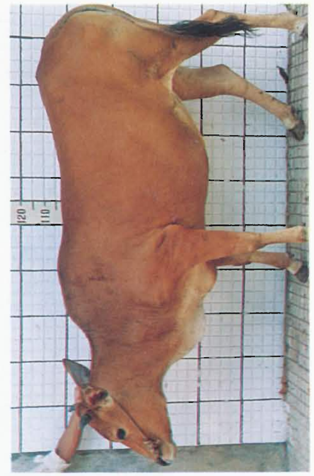
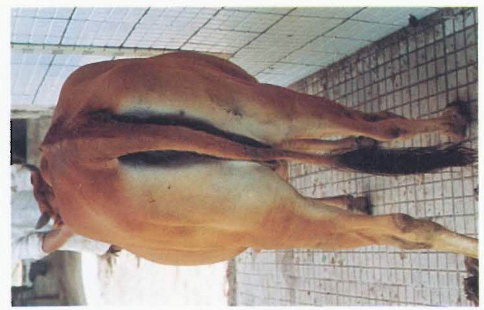

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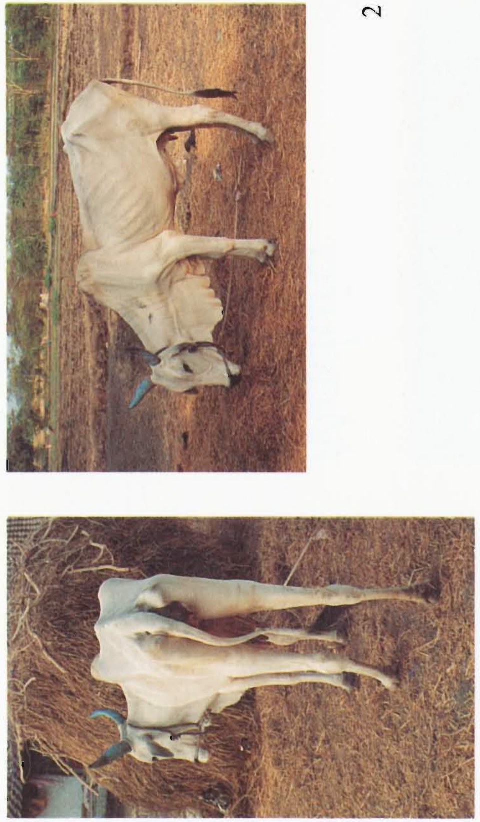
Madura

Photographs 2.3.2 (cont'd)



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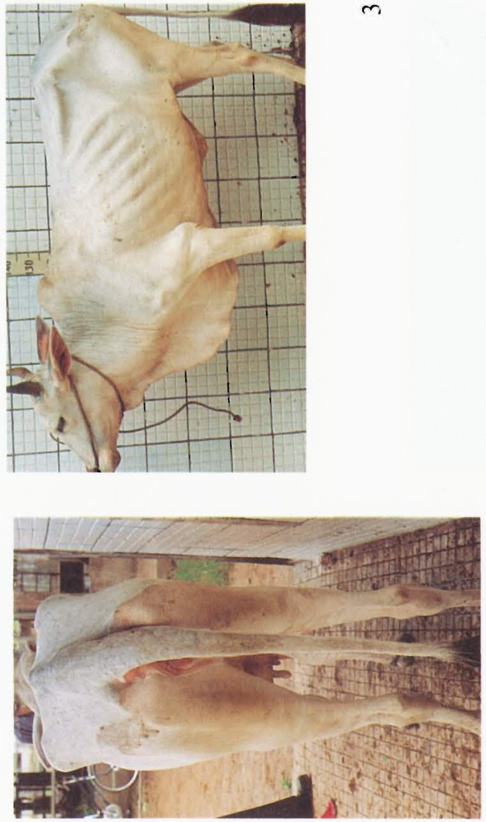

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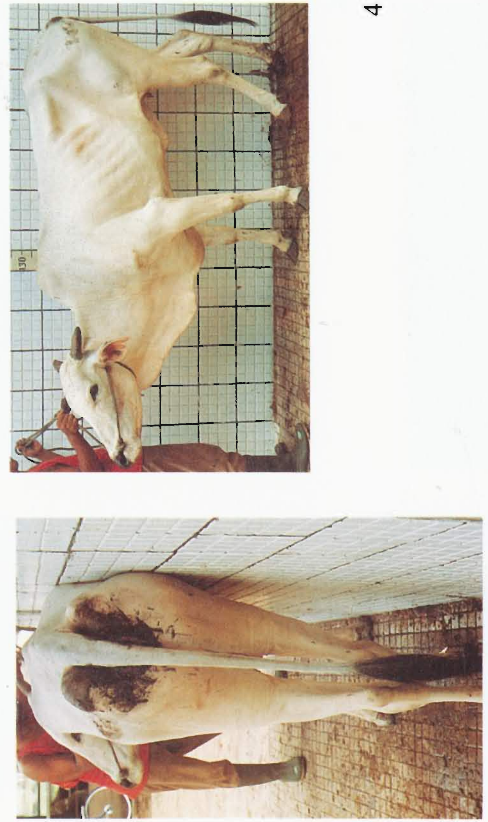

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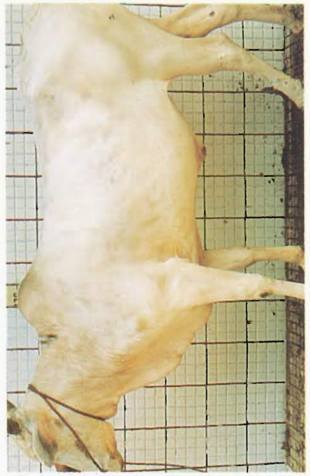


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8

Ongole

Photographs 2.3.2 (cont'd)

Photograph 2.3.3
A specialist calf rearer in Pasuruan, East Java.

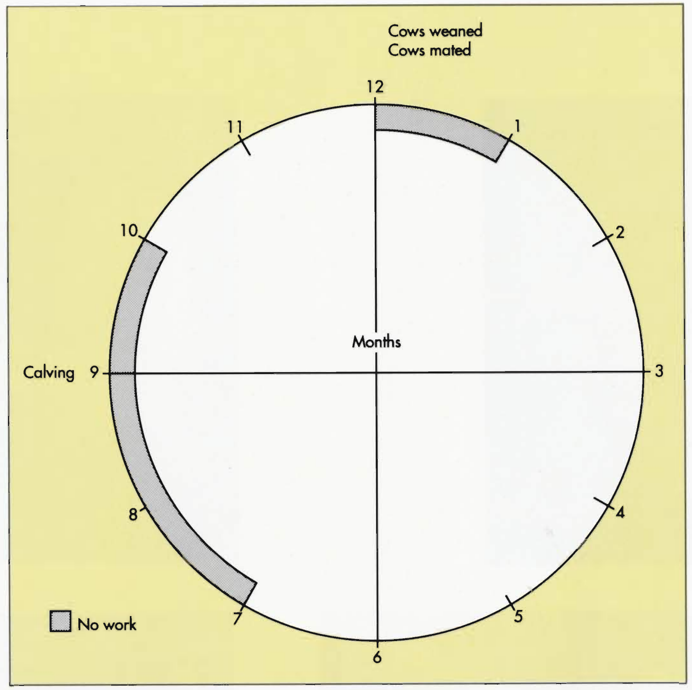


Figure 2.3.3
An idealised draught animal production scheme.

		Dry Season									
Jan	Feb	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	Nov	Dec
		Crop harvesting	Calving				Mating			Work	

Figure 2.3.4
A draught animal production strategy which minimises intensity of feed energy demand (adapted from E. Teleni and R.M. Murray, 1991).

Body condition score

In relation to the draught cow, body condition score is a better indicator of nutritional status and productivity than is live weight. Condition scoring is easy and quick to carry out but it is a subjective assessment and therefore could suffer from inconsistencies. However, it should become quite reliable with practice and with constant reference to a set of standards as presented, for example, in Photographs 2.3.2. As with any scoring system, the scoring scale and standards should be clearly defined. Body condition scoring can vary from a 5, 8, 9 or a 10 point scale. In the standards presented in Photographs 2.3.2 we have used a 10 point scoring scale starting from the most emaciated (1) to fattest (10) draught cows. The type of draught cows illustrated (scores 2 to 8) are those which one might see on a farm but the more common types are those with body condition scores of 3 to 6.

Scoring

Scoring should be undertaken (e.g. morning) before an animal has consumed a large quantity of feed and/or water as these can bias the assessment. The more specific anatomical parts of the cow used in assessing its body condition are shown in Figure 2.3.5. The broad divisions of body scores based on the shape of the back thigh muscles (*Semitendinosus* and *Biceps femoris*) viewed from the side [Figure 2.3.5(a)] include:

(a) Side view of back thigh muscles
(b) Side view (Ongole cow)
(c) Rear view (Ongole cow)

(a)

(b)

(c)

Figure 2.3.5 The anatomical parts of a cow relevant to body condition scoring.

- scores 1 to 4 in which the muscles are wasted and give a concave appearance,
- scores 5 to 7 in which the muscles have a straight appearance, and
- scores 8 to 10 in which the muscles bulge to give a convex appearance.

The individual scores are made by assessing (visually and by feel) the amount of fat cover over:

- the lower back bone (*lumbar vertebrae*) and its horizontal "wings" called the transverse processes,
- the lower rib cage,
- the hooks (*tuber coxae*),
- the hips (*trochanter major*),
- the pins (*tuber ischii*),
- the tail-head, and
- the back thigh

Score	Description
1	Emaciated animal. No apparent subcutaneous fat. Condemned.
2	Marked emaciation. The back bone, ribs, hooks, hips, pins and tail-head are sharply visible.
3	The lower back bone still has a sharp feel but less so than in score 2.
4	The ribs and back bone are less protruding than in scores 2 and 3.
5	The transverse processes are less obvious than scores 2 to 4.
6	Ribs are still visible, back bone barely visible, little fat cover.
7	Animal is smooth and well rounded, back bone cannot be seen but easily felt, hooks not visible.

8 Animal is well covered with flesh and some fat. Back bone can be felt with firm pressure but feels rounded rather than sharp.
9 Animal is well covered with fat.
10 Heavy deposits of fat; fat cover around tail-head very prominent.

2.3.5 Summary

The steps that a Field Adviser might follow in assisting the farmer develop a feeding and management strategy for his draught animals are outlined below:

(i) Know the farmer's exact purpose for rearing draught animals.

(ii) Know the cropping pattern (and therefore draught work pattern) on the farm. Chart the patterns as illustrated in Figure 1.3.2 for example. This will make things clearer.

(iii) Estimate the monthly available fodder DDM on the farm and immediate surrounds and estimate LU carrying capacity for the farm. At this point the Adviser should be able to inform the farmer of the optimal number of LU he can carry on his farm.

(iv) Using information in Figure 2.3.3 and on cropping and work patterns in (ii), optimise the breeding pattern for the farm.

(v) Using information in Tables 2.1.4, 2.3.1 and 2.3.2 estimate the monthly ME requirements and consumption by the draught cows.

(vi) Determine using information from (v) whether the feed resources available are able to maintain the draught cows in body condition which is compatible with good productivity. Use Table 2.3.3 and Photograph 2.3.3 to help you make this judgement. Note that a feed energy deficit of about 28 MJ ME/day would result in a liveweight loss of about 1 kg/day.

(vii) Assess the need and potential for introducing shrub/tree legumes to add to the farm's feed resource.

(viii) Keep in mind that:

- If the farmer's purpose for rearing a draught animal is for draught only then the primary aim of feeding is to achieve or maintain a target liveweight.
- If he rears a draught cow for work as well as frequent calf production then the primary aim of feeding is to achieve or maintain a target body condition score.

Suggested reading

Teleni E and Hogan J P (1989) Nutrition of draught animals. In: D Hoffmann, J Nari and R J Petheram (eds) Draught Animals in Rural Development. *ACIAR Proceedings Series No. 27*, pp 118-133. ACIAR, Canberra.

Teleni E and Murray R M (1991) Nutrient requirements of draft cattle and buffaloes. *Recent Advances on the Nutrition of Herbivores* 12, 113-119.

Teleni E. Energy expenditure and nutrient requirements of working animals In: W.J. Pryor (ed.) Draught Animal Power in the Asean-Australasian Region. *ACIAR Proceedings Series No. 46.* ACIAR, Canberra

3.1 INTRODUCTION

J Perkins and M Sabrani

Each specialist looks at draught animals from a different perspective. Nutritionists are concerned with the range of feeds available and the effects of different feeding systems; engineers may look at the relationships of animal, equipment and lands, seeking the efficient transfer of power to achieve work; veterinarians evaluate the effects of changes in health status on the animal's capacity to perform. Economists, and especially those interested in farm management, try to determine the contribution of draught animals to the farm as a business. This evaluation is often posed as a question, for example: Are draught animals profitable? What are they worth? What is their value to the farmer and the farm? This chapter seeks to answer such questions in two ways. Firstly, we discuss the most important factors which influence the economic analysis of cattle and buffalo enterprises; secondly, we provide a format for the evaluation of draught animals on smallholder farms, plus some examples.

It is important to acknowledge — right at the outset — that we can only provide the guidelines for analysis. There are more than twenty million farm families in Indonesia. Each is different in some way with regard to the resources they control and the goals they strive to achieve. These differences can be large even within one *desa* but may vary enormously between different locations. Many of these differences will have been fundamental to the development of local farming systems: the area and type of land available; climate; topography; markets; social and individual attitudes and preferences.

The people who can best interpret and integrate these local conditions are the people who live there. It is up to people such as you — extension staff with access to local farmers and with knowledge of local conditions — to **adapt our guidelines to your situation**. In particular, add important factors which we have not included; exclude things which do not apply in your area; use current levels of input and output prices; change our assumptions to fit your circumstances. There is no single farm budget that can stretch to fit all the conditions of Indonesian agriculture. General techniques and methodologies of evaluation are useful in assessing agriculture as a business but clear thinking on how to apply these techniques to your area is the best method of all.

There are some important general points that should be kept in mind throughout this chapter. Three deserve particular attention.

3.1.1 Cash, money, profit and economics

For many people, economic terms such as 'cash', 'profit', 'costs' and 'money' are considered to be interchangeable or, at least, different parts of the same thing — economics and economic analysis. They believe that economics is the study of money (or cash); profit is what is left when we deduct the cash costs of an activity from the cash income earned; the activity with the biggest cash profit must be the best. This is not the case. Cash and money are only part of the story.

Economics is the study of resources (of all types) and the results that will come from allocating these resources to different uses. For example, what if a farmer can use his or her labour to plant either a crop of rice, or cassava, or look after cattle? How can we choose between these alternatives? Economists are particularly interested in the efficient allocation of resources where efficiency is defined as the outcome which has the great utility, or value, to the user. It is these concepts of utility or value that many economists consider 'profit' – what is the best outcome that I can get from the resources available? In the case of the rice, cassava or cattle example we cannot provide any answer until we know the value of each crop to a particular farmer. Cassava may yield the heaviest output so, if production is the criterion, we would choose that option. But the farmer might prefer the taste of rice, or cattle might have the highest value at the market. Cassava for weight? Rice for taste? Cattle for cash? Which one – or how much of each? Until we have a better idea of what the farmer is trying to achieve we cannot determine which are the better options to select. The problem is how to measure the different possible outcomes and select the 'best' alternative.

Many people believe that the best outcome is the one that yields the largest profit in terms of cash. This can be a fairly straightforward process for farm management decisions in countries such as Australia or the USA where farmers sell most of their output and buy all their inputs. Multiplying the farm outputs (e.g. wheat, cattle, eggs) by the prices received for each will provide an estimate of total farm income. The cash value of the inputs (e.g. fertilizer, fuel, feed) purchased to produce these commodities will give an estimate of total farm costs. Deducting costs from income will give us a forecast of net profit in cash terms. Adjusting the land areas devoted to different enterprises will show which combination, and size, of farm activities might provide the largest cash profit, or 'best' outcome.

The analytical process for smallholder farms is not that easy. Much of their output is not converted to cash. Farmers might harvest two tonnes of rice, keep one tonne for home consumption and sell the other tonne for money. Family labour is one of the largest inputs on a village farm but the family do not pay each other cash for the hours that they put into planting or harvesting or cutting feed for cattle and buffalo. Non-cash inputs and non-cash outputs are a common feature of village production and it is extremely important that we do not ignore them. They are just as important when making decisions as are those other items which can be measured in terms of money.

It is a common mistake to equate cash profits with economic sense, particularly for cattle and buffalo enterprises. A three-year-old animal may be sold for Rp 500 000 and the farmer may have spent only Rp 20 000 cash on the animal during that time. It looks like a 'profit' of Rp 480 000 but .... what about the hundreds of hours that have gone into collecting feed, or tending the animal while it grazes? Can we put 'time' into our budget? That labour is worth something to the farmer or the family. Do they feel that, overall, it was worth the time and effort spent on cattle? Was it truly 'profitable' to them? Or would it have been better to have spent those hours doing something else?

We shall touch on these points and also suggest ways by which you can incorporate non-cash items into your analysis. But — don't forget — money is only part of economics. Keep asking yourself, 'Can I explain what a farmer does by cash alone? If not, what else is to be taken into account?'

3.1.2 Muscle or meat

If you ask farmers why they keep cattle or buffalo, they will often give three reasons – work, income and savings. The answers may vary only in their ranking. Some farmers nominate work as most important while others choose income or savings as their first preference. This variation is important as it emphasises, firstly, that cattle and buffalo are kept for a number of reasons and, secondly, that the draught ability of the animals is often not their most valuable feature. Indonesian Government statistics display this point neatly. When classifying cattle the statistics distinguish between *sapi perah* (dairy cattle) and *sapi potong* (beef cattle). No classification is made on the basis of working animals.

The draught functions of animals are obviously important. Land must be prepared for cropping and this has to be done quickly at the appropriate time. Many farmers keep cattle and buffalo to ensure that their land tillage needs are met when required. These are 'draught animals' because they are kept to do that essential work. However, the length of time that draught animals actually work at ploughing or levelling is often relatively short.

The 'average' figure for draught work is around 35 days per year for farmers who rear draught animals but this does vary widely (e.g. Section 1.3.5). If we use that average estimate of 35 working days in a year a quick calculation soon shows that these 'draught animals' are not working for 330 days of the year. However, they require feed and attention for all the days of the year. It is obvious that, for most farmers, the value of draught work alone is an insufficient reason to keep them on the farm. Their total contribution to the farm comes from a number of things which cannot be ignored in the economic evaluation of so-called draught animals.

One suggestion is that we bias our own perceptions by calling them draught animals and assessing them on their draught ability (or muscle). The non-draught aspects — which we could summarise as 'meat' — might be the clinching reasons for a farmer who is judging the value of an investment into buffalo or cattle. It may be better to think of them as 'draught-capable' animals or, simply, cattle and buffalo.

The many reasons for raising ruminants on farms is confirmed if we look at the patterns of ownership in Indonesia. All Indonesian farmers plant field crops of some type and all such crops require that land be prepared in some way prior to planting. If animals were kept only for draught purposes we could forecast that the large ruminant population would be distributed in similar proportion to the areas of arable land. However, this is definitely not the case. Cattle and buffalo populations are 'lumpy' in their spatial distribution. In some parts, such as East Java and Madura, cattle are common on farms; in many others, large ruminants are relatively rare. This raises a question worth considering for your own area – why do some people choose to rear cattle or buffalo while others prefer not to so do? Madurese people are known as cattle farmers and it is common for 95–100% of farm families to rear cattle. A study in Subang, West Java, showed that 95% of farmers did not rear cattle or buffalo and there will be many parts of Indonesia where no large ruminants at all are kept. These are deliberate choices – the Madurese farmers definitely believe that it is 'worth' keeping cattle but most Subang farmers obviously do not. There are a number of reasons that might explain these differences but the main lesson for us is that different circumstances bring forth a different response, particularly:

- Cattle and buffalo are multi-purpose animals.
- Draught is only one of the functions they can provide.
- Draught is certainly important but, for many farmers, it may be a function of minor importance.
- Different farmers have different attitudes towards cattle and buffalo.

3.1.3 Cattle and buffalo

The main providers of draught animal power (DAP) in Indonesia are cattle and buffalo. Horses are used in some areas but are relatively insignificant. This chapter does not differentiate between cattle and buffalo, assuming that either type makes an equal contribution. The most important differences from a farmer's viewpoint relates to sex – females can bear offspring, and males can be sold young without legal complication.

Weight is the main factor affecting the total pulling capacity of a draught animal. Animals can overcome a draught force of 11–14% of bodyweight on a regular basis, thus a heavier animal can pull a heavier plough or work more difficult soils regardless of whether that animal is a bull or cow. There are some important minor differences: cattle are more heat-tolerant and might work a longer day. But most of the arguments on which is the 'better' animal — cattle *vs* buffalo or Ongole *vs* Bali — are arguments which come from the passion of the individual owner, 'Mine is better than yours!' Our general approach and budgets must be simplified but it is up to you to adapt these to local conditions. If you work in an area where buffalo are highly prized but cattle are not, then use buffalo prices and buffalo costs. The general methods of evaluation need not distinguish between cattle and buffalo but the details certainly should if they are important in local circumstances.

The next sections of this chapter discuss the contributions made by cattle and buffalo to the farm business and what is required to maintain them on the farm. For convenience we label these **outputs** and **inputs.** Outputs cover items that might contribute directly to other activities **on** the farm (e.g. ploughing the land to prepare for a crop of rice) and also items that go **off** the farm (e.g. the sale of a calf at a market). Similarly, inputs include items that come from the farm's resources (e.g. the use of family labour to collect feed) and those that are brought in from outside the farm (e.g. purchase of veterinary medicines).

We have to concentrate on the most important inputs and outputs, which are listed below, and will probably leave out some minor items that could have local significance. Two criteria have been applied in compiling the list. First, what are the most valuable outputs that a draught animal produces? Second, what are the most significant costs of production? In Section 3.4 we shall reduce this list even further, selecting those items which are most essential to incorporate in the evaluation of a cattle or buffalo enterprise.

3.2 INPUTS

This section discusses some outputs from cattle and buffalo, particularly those outputs which might contribute income to the farm:

- draught work
- sale
- offspring (from female animals only)
- manure
- store of wealth
- status
- other outputs.

3.2.1 Draught work

Figure 3.2.1 summarises the position of draught animals in Indonesian smallholder systems. As horses are not widely used only cattle and buffalo are considered in our analysis.

Animal power can be applied to many tasks. Apart from preparing land for crops (ploughing, harrowing, levelling) draught animals can pull carts and sledges to transport people or cargo; power pumps for irrigation water; power machinery for grain milling; provide recreation and sport. However, we have to limit ourselves. Carting and haulage tend to be the work of specialists who use animals trained for these purposes. Few farmers use the same animals for both ploughing land and hauling carts. We can ignore these activities for our purposes and concentrate only on the use of cattle and buffalo on farmer's fields.

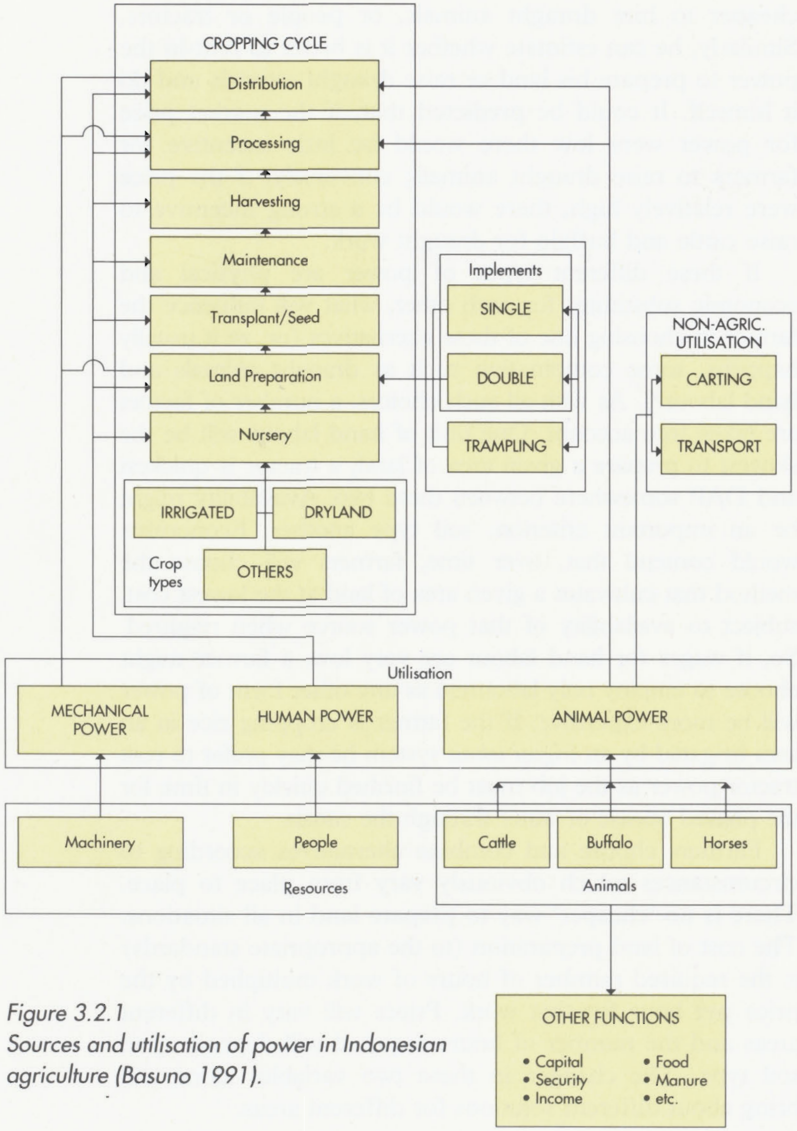


Figure 3.2.1
Sources and utilisation of power in Indonesian agriculture (Basuno 1991).

Alternative sources of power

Preparing land for crops requires energy applied as power. Draught animals are only one of the many alternative sources of power that can be used for land cultivation. This point is critical to our assessment of the value of draught animals.

Land must be cultivated before a crop can be sown or transplanted. Preparation of that land can be supplied in a number of ways – human labour, animal power, mechanical power. Land prepared by any of these methods should produce the same yield (i.e. at the one location – yields will obviously vary at different places and at different times, for many reasons). Thoroughness of land preparation is a factor that will affect yield but, if land is tilled to an appropriate extent, similar yields will occur whether that land is tilled by hand, by draught animals or by a tractor.

It is a small but important point that there are no intrinsic benefits from using DAP for land tillage. It may relieve some people from the drudgery of digging land and free them for other tasks. It may reduce the use of fossil fuels to power tractors, but — in terms of crop production — draught animals can be substituted equally effectively by alternative sources of power.

Some farmers will strongly prefer a particular method but this preference usually springs from their long experience and traditional values. They feel more comfortable with what they know. One example came to us from Lombok, where traditional land preparation through trampling (*merancah*) was compared with the use of DAP and implements on adjoining village fields. There was no difference between yields that could be attributed to one method or the other and the costs of land preparation were very similar. Yield differences (which were large) appeared to relate more to the timeliness of planting. Farmers planting late in the season received less rain on their fields and, generally, recorded the lower yields. Yet some farmers still insisted that *merancah* was better. They believed that it produced more rice and total production was greater in the old days when everybody used it. People who preferred DAP similarly felt that theirs was the better method but the measured results showed that neither system affected rice yield. What was of particular interest was the gradual replacement of *merancah* by DAP on the island. This is probably because DAP is 'cheaper' than *merancah*. Although the two methods cost the same to prepare a given area of land the DAP unit comprises only two animals whereas a group of *merancah* buffalo numbers ten to fifteen animals. It obviously costs more in terms of labour and management to look after a group of fifteen animals than only two, once the land preparation period is finished for the year.

The market for power

Human labour, DAP and mechanical power are physical substitutes in land preparation. The same is true in economic terms. In many parts of Indonesia, DAP is only one of the competitors in the market for power and, particularly, power for land preparation.

This is an especially important point for economists. The existence of a market for a resource tells us that prices will be formed in that market by competition between participants to provide a service or commodity. Further, the price in that market will reflect the value of that commodity or service both to the people who use it and those who supply it. In simple terms, farmers will recognise that price and adjust their use of resources to that price (and many others) when determining what is the best strategy for them to follow. For example, if a farmer can hire a DAP unit and a ploughman for Rp 3000 per day this information enables him to estimate whether it is cheaper to hire draught animals, or people or tractors. Similarly, he can estimate whether it is better to rent-in the power to prepare his land or raise draught animals and do it himself. It could be predicted that, if the market price for power were low there would be little incentive for farmers to raise draught animals; conversely, if the price were relatively high, there would be a strong incentive to raise cattle and buffalo for draught work.

If these different types of power are physical and economic substitutes for each other, what will influence the farmer in choosing one of these alternatives (or, as it usually happens, some combination such as draught animals and hand labour?). As with all such choices, a number of factors are taken into account. One unit of hand labour will be the slowest to prepare a given area of land, a tractor is quickest and DAP somewhere between these two. Availability might be an important criterion; soil type another. Economists would contend that, over time, farmers will choose the method that cultivates a given area of land at the lowest cost, subject to availability of that power source when required. So, if wages for hand labour are very low, a farmer might choose to employ only labourers as any other form of power will be more expensive. If the farmer is cropping rice in an area irrigated by an *irigasi teknis* system he may prefer to rent tractor power as the job must be finished quickly in time for the phased release of water through the canals.

Farmers choose and combine alternatives according to circumstances which obviously vary from place to place. There is no 'cheaper' way to prepare land in all situations. The cost of land preparation (to the appropriate standards) is the required number of hours of work multiplied by the price per hour for that work. Prices will vary in different areas and the number of hours required will depend upon soil type. The changes in these two variables alone will bring about different solutions for different areas.

However, because there is a market for power and a number of potential suppliers we find that competitive prices develop for using these suppliers. The prices that you should use when estimating your budgets are the prices that have developed in your area such as the wage rates for hiring day labour, the rates for hiring a DAP unit or the costs of renting a tractor. There are no 'official' prices for these activities. They have been formed in the market for power and reflect, to a large extent, the value placed on these types of work by those people actively involved in the system.

Draught work as an output

We have already said that draught work away from farm fields will not be included in this general analysis. If you are involved in the analysis of a system where the same animals are used for both land tillage and hauling carts then the off-farm activities should also be included for that particular budget.

The most common use of draught animals on Indonesian farms is the preparation of flooded ground for rice production. In some areas cattle and buffalo are also used for land tillage on dryland crops, e.g. maize or groundnuts (see Section 1.3.5 and Figure 1.3.2). Very little use of draught animals has been recorded for other cropping activities such as inter-row weeding.

Three main categories of tillage work are common: ploughing, harrowing and levelling. Of these three the use of the plough and the leveller are most widespread. The harrow is popular in some areas and not found in others. There are many variations of these three types of equipment, including their design, the materials from which they are constructed and their utilisation on the field (see Section 4).

From an economist's viewpoint, the key variable is **the number of days (or hours) that the draught animals, their associated equipment and the ploughman require to complete land preparation to the standards expected, and accepted, at any defined location.**

Total usage of a farmer's draught animals will be determined by the area of land that is to be covered, the work rate of the draught unit and the preferred condition of the soil after tillage is completed. These last two factors — work rate and preferred soil condition — are very important and highly variable.

Work rate

This will be determined, firstly, by the crop and soil types and, secondly, by a host of other factors, including the number and weights of the draught animals used; suitability of equipment; skill and efficiency of the ploughman; level of urgency to complete the task. Just considering crop and soil variations alone shows how complex the problem can become. Wetland rice production and dryland maize production provide very different working environments for draught animals. The work rate on a dry field for maize will obviously be much faster than on flooded *sawah*. Variations will continue within the one cropping type: heavy clays are harder to work than light clays; the presence of sub-soil stones will slow down work in one field compared to another than has light, well-worked soils (see Section 2.2).

Preferred end result

It is difficult for farmers to specify the condition in which the soil should be at the end of tillage and even more difficult for outsiders to judge. Some farmers might prefer their soils to be more heavily-worked and free of all stones and trash. Others are willing to accept a less intensive treatment, perhaps because they lack the resources to complete the job to that standard or feel that there is no great benefit in doing the job very thoroughly. For them, *cukup baik* or 'good enough' might be quite appropriate.

One example of the variations in tillage practices is shown in Table 1.4.3. Summarised in that table are responses to questions regarding tillage practices – how many times do you use the plough or leveller to prepare *sawah* for irrigated rice production?

Many variations were recorded and none could be said to be 'better' than any other without a lot more research. The results came from farmers in one *desa*. Imagine the increase in complexity if we examined the work practices and efficiencies at more places and with more people. For these reasons, it is better to ignore problems such as work rate, speed, depth and management and ask farmers in your area the really important questions:

- How many days do your draught animals work on your land?
- How many days do your draught animals work on other people's land?

These answers will be improved further by relating the number of days worked with season or crop. This will show the pattern of work over the year, i.e. is work concentrated all at one time of the year or is it spread across a number of sequential crops (e.g. Figures 1.3.2 and 1.3.3)? The **area** of land worked during those days is largely irrelevant. It is of no significance for our analysis whether the land is easy or difficult to plough or whether the farmer is an efficient ploughman or not.

A necessary subsidiary to the second question is the **price** for one day's work on another person's land, 'What is the price for renting a DAP unit for one day?'. To this could be added, 'Does this price vary during the year?' If the answer is 'Yes' to this last question we need to know both the number of days for each period and the appropriate price per day for each period. All this information will definitely be used in your evaluation.

Of the two categories of output listed, B (below) is easier to quantify. For example, if the farmer's draught animals are rented out for six days to plough another farmer's fields and the price for renting those animals is Rp 3000 per day, the value of that work is 6 x Rp 3000 = Rp18000.

For A (below), working on the farmer's own land, the procedure is not so easy. A farmer might use his own cattle for a total of twenty days in the year to plough and level his land. He uses his own labour but – how do we value the benefits of the draught animals' work? There are two useful things to consider.

A. DRAUGHT ANIMAL WORK ON OWN FARM

- Period 1* ____ days
- Period 2* ____ days
- etc

Total work on own farm/year ____ days

B. DRAUGHT ANIMAL WORK ON OTHER PEOPLE'S FARMS

- Period 1* (____ days x Rp ____ /day) Rp ______
- Period 2* (____ days x Rp ____ /day) Rp ______
- etc

Total value of work on other people's farms/year Rp ______

* Period 1, Period 2, etc refer to different cropping periods of the year, e.g. main rice planting period; second rice planting period; *palawija* preparation, etc.

First, by using his own animals the farmer has avoided the cost of hiring DAP (or human labour, or tractors) from another person. He has had to devote twenty days of his own labour to plough the fields with the animals (and we must remember to treat those days as a cost in later sections) but the benefit — to the farmer — is **not** having to employ someone else to do the work.

Second, we can put money values on this saving (if we so wish to do) by using the market price for DAP. If the farmer did not have draught animals it would cost him about Rp 60000 to prepare his land (20 days x Rp 3000/day). By using his own draught animals he has, thus, saved those Rp 60000 less the value of his own labour. If we put these items together the direct draught-related benefits can be expressed as:

- the number of days worked on the farmer's own fields (cost-saving benefit)
- income earned from renting-out the draught animals to plough other farmers' fields (income-earning benefit)

It is completely wrong to attribute the whole value of a crop to the fact that the land was prepared by using draught animals. Some people might say, *'The draught animals prepared 0.5 ha of ground. That land produced four tonnes of rice worth Rp 800 000. Without those animals the land would not be prepared therefore those animals benefited the farm by Rp 800 000.'*

This is not correct. The land certainly needed preparation but, similarly, seed was also needed plus rain, sunshine, fertilizers, human labour and much more. The use of DAP was no more critical to the production and harvesting of that rice than any other input. We cannot assign the whole value of the crop to just one preferred variable.

Limits to rental income

If we consider the two main draught-related benefits it is obvious that the first (working on the farmer's own land) is limited. Land area for most farmers is usually 0.5 ha or less. Once the land has been ploughed there are few other contributions that the draught animal can make until the next ploughing season. However, the prospects for ploughing on other peoples lands for cash do not look limited as there are many other farms. It looks easy, and inviting, to maximise draught income by spending a lot of time renting-out draught animals to other people.

In practice this option is limited. Remember we said that informal markets for power have developed in many Indonesian villages. This means there are many other people willing to supply power for rental at the prevailing local rental price, either through hand labour, draught animals and — in some areas — tractors. For any one farmer to increase his share of the local power rental market he must displace other competitors. This will be difficult. In addition, the periods of land preparation tend to occur at about the same time at any one location. There will be peaks of tillage activity when every farmer is trying to get fields prepared and all operators of draught animal units will find work. Then, the planting season is over and there is little ploughing work for anyone. These troughs and peaks of activity will work to limit the number of days that draught animals can be rented-out and so limit the amount of income that can be earned from DAP rental.

In general, there is more DAP available in rental areas where cattle and buffalo are relatively few in number. Conversely, where the ownership of cattle and buffalo is common — as in parts of East Java — animals tend to work less, simply because more are available to do the required work. This was well illustrated in a study that asked farmers from different areas how many days per year they used their animals for draught work (Figure 3.2.2).

The general trend is clear. In areas with relative low numbers of large ruminants, such as Pandansari, some farmers used their cattle or buffalo for up to 200 days/year. In the high density areas, such as Sudimulyo, farmers said that about 15 working days per year was the average.

For our purposes the lesson is that there are effective limits on the number of days that draught animals will be used for land preparation. This reinforces the importance of those simple key questions that you need to ask people in your area:

- How many days per year will your draught animals usually work on your land?
- How many days per year do you rent-out your draught animals to work on other people's land?

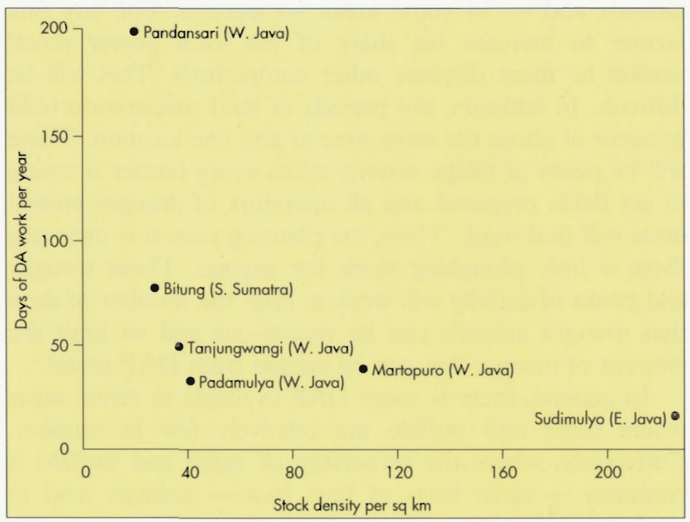


Figure 3.2.2
Comparison of days of draught work and cattle + buffalo densities at five village sites in Indonesia (Petheram et al. 1989).

3.2.2 Sale value

The sale of an animal will give a farmer the single greatest cash return to the total investment of money and effort made in cattle or buffalo. For most farmers, **sale is also the most 'profitable' part of the investment.** For this reason alone it is the factor that can never be overlooked when assessing the economic performance of cattle and buffalo enterprises.

Consider a hypothetical example. A farmer owns two cows which are used for ploughing on his farm and are also rented-out to work on other people's land in the village. The cows are each worth Rp 600 000 and, in that village, he can earn Rp 3000 per day for renting the draught animals to work for other farmers. If he sells one of the cows he will receive cash equivalent to the income earned from 200 days of draught rental (200 x Rp 3000). If he usually rents his draught animals for forty days per year (which is quite a high rental level), the sale value of just one cow is the same as the draught rental income (for two cows) from **five years** of draught work. You do not have to be an economic genius to understand where the economic value of that animal lies. Of course, raising the animals involves costs of many kinds which will dilute the size of this gross return but the important point is that, for most farmers, it is the sale value of cattle and buffalo which represents the real strength of their economic performance.

Why should farmers sell their animals? It is an obvious question and has an equally obvious answer. Farmers sell their animals because other people want to buy them. When we go to the next questions — who are these people and why do they want to buy cattle and buffalo — the picture becomes more complex. Many people want to buy large ruminants and for many reasons. Sometimes the purchasers might be other farmers. They want to buy animals because they need them for draught work; they buy young animals and fatten them to sell later; they want to increase the capital assets on their farm. Frequently, however, animals are sold because other people want to eat them. It is reasonable to suggest that the market, and prices, for cattle and buffalo are largely driven by the market for meat.

The relationship between sale by the farmer and final consumption is often a very protracted one in terms of time, location and transfer of ownership. A calf born today might be slaughtered two, ten or twenty years later. It may end up at an abattoir hundreds of kilometres from its birthplace; it will probably have passed through a long chain of owners; it may have been a draught animal for some of its years. However, it is safe to say that most cattle and buffalo in Indonesia will end up as soup, steak or *satay*; some sooner and some later. A few animals are not consumed because they have been affected by disease or illness but the rest — young or old, tender or tough — are slaughtered to satisfy the demand for meat (and by-products such as bones, horns and leather). It is the demand for meat which creates the prices, and values, for cattle and buffalo in Indonesia. These ideas are reinforced if we look at some population statistics for Indonesia over recent years, shown in Table 3.1.

Table 3.1 Human, cattle and buffalo populations, Indonesia (1975–1990)

	1975	1980	1985	1990
		millions		
People	135.7	151.0	167.3	184.3
Cattle	6.2	6.5	6.5	10.3
Buffalo	2.4	2.5	2.9	3.4
		head		
Cattle and buffalo per 1000 (people)	63	60	56	75

Population statistics: FAO Production Yearbooks (various)

An unusual jump in cattle numbers was recorded for 1990 but, generally, the proportions have stayed fairly constant. In 1975 there was a total of 63 cattle or buffalo for each 1000 people. In 1990 this ratio stood at 75:1000. These figures indicate a relatively static population of cattle and buffalo expressed in either absolute and relative terms. If the population remains fairly static, where do the offspring go? Obviously some will be used to replace the animals on farms but the balance will have been slaughtered. Farmers have not increased the number of cattle or buffalo on their farms (they prefer to keep some 2–4 head) so the output from these farms is, in total, going for meat.

If we accept the importance of sale value in our total assessment, the next step is to look at the most important factors that affect the particular value of an individual animal. This is necessary because the values of similar animals at the same location can vary enormously. One study at the Purwodadi livestock market, West Java, estimated that liveweight prices for cattle of the same sex and weight can vary by ±30 per cent. This is a huge range, with many implications for the evaluation process.

The main factors affecting sale value can be summarised as

- weight (and age)
- sex
- body condition
- training
- reasons for sale
- reasons for purchase
- price
- marketing systems.

Weight and age

As cattle and buffalo grow older they become heavier. As the weight of these animals increases so does their total value. In general, older heavier animals are worth more than younger lighter animals. It must be kept in mind that older heavier animals will have used more inputs (mainly labour and feed) to reach this weight than younger and lighter animals.

The general relationship of increasing value with increasing weight (or age) holds true for most circumstances. There may be a fall in value in the last years of an animal's life, e.g. cows which have had many calves may become thinner, lose condition and have a fairly low slaughter value. More important is the **variability** that can be expected in age and weight relationships.

One source of variability is the type of animals. Ongole cattle, for example, will nearly always be heavier than Bali cattle at any given age. Variation within type is a feature of all animal populations. Individual animals have different genetic potentials for growth, regardless of the management systems used. This makes it difficult to predict the likely changes in weight over time. Most Ongole calves, for example, have reasonably similar birth weights but, three years later, may display weight differences of ±75 kg or greater. These differences may reflect different growth potential, different feeding practices or different management. Whatever the cause the important consideration from our point of view remains the effect on total value: heavier animals, in general, are worth more money; animals will display a range of weights and values even at the same age.

Sex

If you conduct a census of cattle and buffalo in an Indonesian village you will usually find that mature cows (e.g. four years and older) will be the largest single group. Farmers prefer to rear cows for a number of good reasons. Cows can pull draught implements, bear calves and can be sold.

Male cattle tend not to remain long on village farms. They are grown as 'beef' cattle and sold at relatively early ages, which results in a lack of mature bulls. There are also legal complications such as restrictions placed on the sale of females in an attempt to build the size of the national herd. These regulations reinforce the 'meat' value of young males.

Male cattle tend to grow a little quicker than females and have a higher price per kilogram reflecting the likelihood that they will be slaughtered within their second or third year. In total, this means a price premium for younger males over younger females. Older male cattle and buffalo are usually heavier than females of the same age and would have a correspondingly higher sale value but there are relatively few such animals in most villages.

Cows that are pregnant will be more valuable than dry cows of a similar age and condition – after all, the buyer is virtually getting two animals rather than one. There is also some evidence to suggest a small jump in the value of female animals around two years of age as they approach sexual maturity. This increase may reflect their enhanced potential at that time. They have survived to maturity and can now conceive and raise calves.

Condition

The size of an animal is the main determinant of its sale value but the general condition of that animal has a strong effect. Cattle and buffalo that are thin, ill, or showing signs of neglect or poor treatment (e.g. poor coat, skin sores, diarrhoea, etc) will be worth less than healthy animals at the same weight. The condition of an animal is not easily incorporated into a general budget so we tend to assume that animals will be of average weight and in reasonable health. However, it is obvious that, in a budget for a particular farmer, the general condition of his animals will have a major effect on their value at any specific time.

Training

Prior training of animals may affect the value of animals that are being purchased for draught work. If a farmer is choosing between two animals, one of which is trained whereas the other is 'wild' and requires breaking-in, the first animal should get a higher price.

Reasons for sale

The personal circumstances of the seller can influence the price, or value, of the animal being sold. Most sellers are keen to obtain cash from the sale of their cattle or buffalo. It is likely that, the more urgent the requirement for cash, the lower the price that will be accepted. A farmer who needs to repay a loan in a hurry or meet urgent medical expenses will be in a less favourable bargaining position, something about which most traders are very aware. Conversely, a wealthy farmer is in a position where he can afford to wait for a good offer. In his case, a price premium may be obtained.

Reasons for purchase

The position here is similar to those mentioned above, although the effects are reversed. Anyone who is keen to make a quick purchase may have to pay a premium; anybody with enough time can afford to wait for a bargain.

There are more generalised patterns of price peaks and troughs throughout the year that will also affect prices paid and received. The most obvious examples relate to public festivals. The prices of all foodstuffs tend to rise during *lebaran*, for example, and the prices for large and small ruminants (and poultry) will always be much higher at *Idhul Haj* than at any other time of the year. Both buyers and sellers are well aware of these rises and falls and adjust their marketing strategies to suit.

For our purpose the most important points with respect to the many reasons for selling or buying cattle and buffalo are, firstly, that there is a reasonably predictable annual cycle of price variations (e.g. higher at festival times; lower at other times) and, secondly, there will be additional variations at any particular time, dependent upon the personal circumstances of buyer and seller. All such variations should be taken into account only if we are considering the circumstances of a particular farmer. For general budgets, use the average or conservative values that apply in your area. Avoid the high values associated with *Idhul Haj* for example and, similarly, avoid the low values associated with a forced or desperate sale.

Marketing systems

One problem associated with determining the sale values of livestock is the typical secrecy within the Indonesian marketing systems. The result is a lack of public information which makes it difficult for the farmer (and even more difficult for you!) to estimate the cash values of animals.

Most cattle and buffalo are sold from the farm to a trader, or *blantik*; some are taken to livestock markets (again, usually to be sold through a *blantik*); a few may be sold directly to abattoirs or butchers. Whatever happens, you all know that the negotiations are conducted in quiet privacy. There are no livestock scales available so no one knows how much the animals weigh. The *blantik* appraises the animal by eye and physical inspection. Money may, or may not, change hands at the end of the negotiation. The final result (e.g. how much did the animal weigh; what was the price) is never publicised nor recorded. A sale takes place but few people will know the details of what really happened.

Such a marketing system is not necessarily bad (although it could be easily improved) but it certainly does not provide much information to the agricultural public.

This has the effect of increasing uncertainty about prices and values of livestock. Most farmers have a general idea of current prices but only those who have recently traded will have a better appreciation. Such uncertainty, of course, aids the traders. If farmers are unsure of current prices it puts the traders in a more powerful position.

This uncertainty contributes to a wide range of values for similar animals of similar weights. One study of cattle (and buffalo) at Purwodadi market, West Java, recorded the weights of animals offered for sale. Sellers and buyers were asked to provide estimates of the sale value for each animal. The resulting value:weight relationships for 51 cows are shown in Figure 3.3.

There is a definite relationship in the graph — heavier cows are worth more than lighter cows — but equally obvious is the range of values at any weight. For example, at the 100 kg level, values ranged from Rp 170 000 to Rp 300 000; at the 200 kg level, cows were valued between Rp 200 000 and Rp 550 000. The weights were accurate

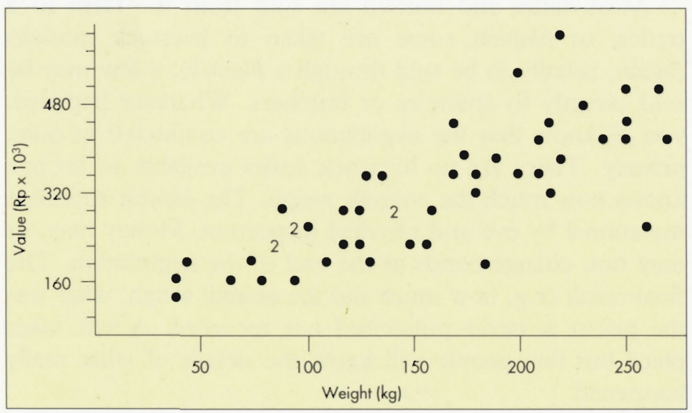


Figure 3.3
Value:weight relationships for 49 female cattle, Purwodadi market, West Java, 1988–89.

(livestock scales were used) but the values were estimates, which would account for some of that range. The physical condition of the different animals could also explain part of the variability but some of the variation would stem from the negotiating skills of the farmers and *blantik* involved in each negotiation, and the fact that such negotiations are conducted in secrecy. If you want to know what an animal is worth you have to rely on the information grapevine. The informant will probably tell you what he wants you to know – it is almost impossible to determine what actually happened.

Value, weight, age and price relationships

Thus far we have concentrated on the total sale value of cattle and buffalo – their cash value in terms of Rupiah per head. This value comes from two variables, Weight x Liveweight Price, where Liveweight Price is the price in Rupiah per kilogram. We have used total value as our reference point because the liveweight price (Rp/kg) is a statistic that is not used or recorded in most Indonesian agriculture. Livestock scales are rarely available at markets and never available on farms, so weights are not recorded and a Rp/kg price is, thus, irrelevant to most people. However, the relationships of weight and price are important and very revealing. In particular,

- heavier animals are worth more than lighter animals;
- the price/kg liveweight is higher for young animals and lower for old animals.

The last point is critical in assessing the value of individual cattle or buffalo. Their price/kg declines as they grow older. Although total sale value is still rising, it rises at a progressively slower rate. This means that it is incorrect to estimate value through applying a 'standard price' in Rp/kg to all weights of animals. For example, if someone said that the current price is about Rp1500/kg live weight, this would give a total value of Rp150 000 for a 100 kg animal and Rp 450 000 for a 300 kg animal. This is unlikely to be the situation in practice. The 100kg animal will probably be worth much more than Rp150 000 and the 300kg animal somewhat less than Rp450 000.

These general relationships were tested in a study near Grati, East Java. A large number of Ongole and Bali cattle were weighed and farmers' estimates of their age and sale value were recorded. The results are summarised in the figure below.

The study confirmed what had been long suspected but never tested, that is, young animals have a higher value per kilogram live weight than older animals. This explains, in part, why it is more 'profitable' for many farmers to sell their animals when young and not keep them on the farm.

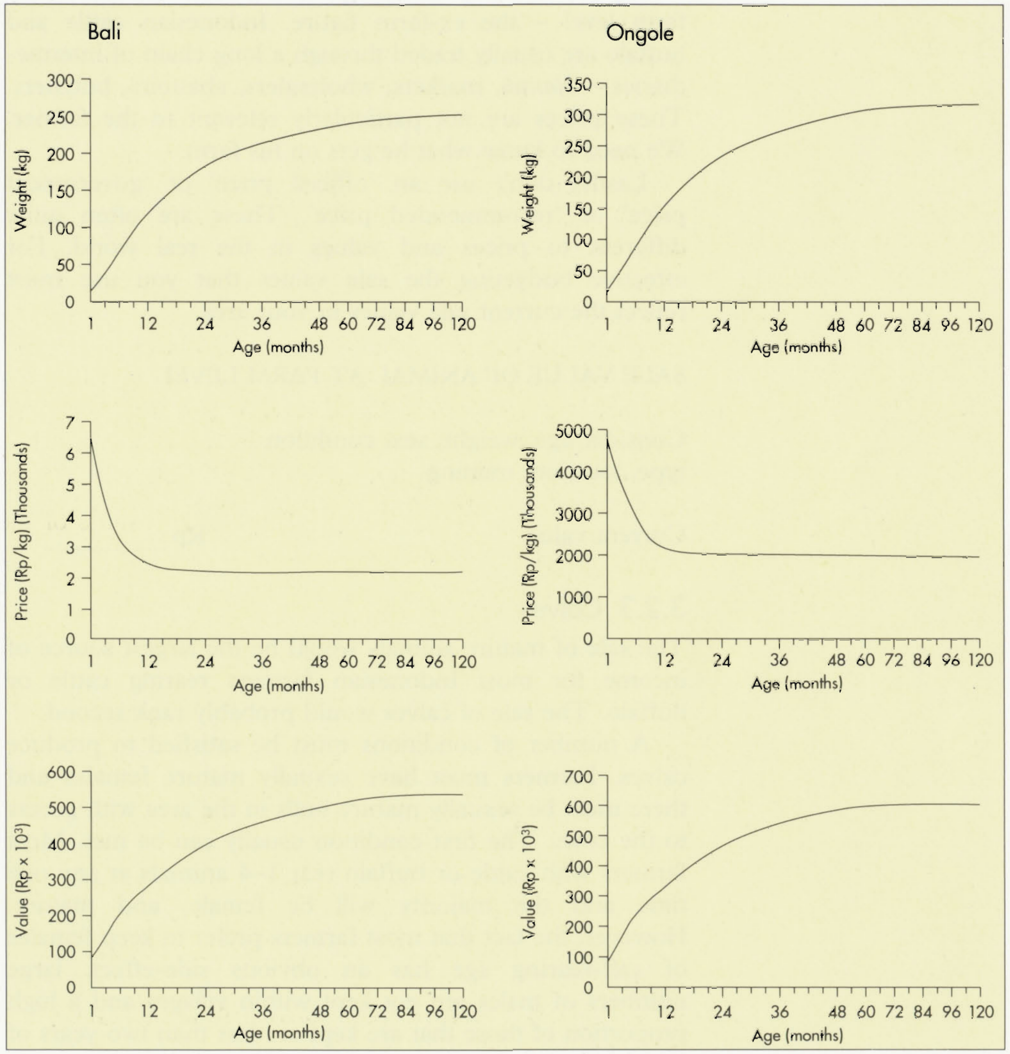
Tables based on this study are given later in this section as a guide to assessing the values of animals. Elsewhere in the manual is listed the relationships of girth (in cm) and live weight (in kg) that were also measured (see Section 2.3). You might not have access to scales but you can buy tape measures cheaply and use them to obtain good estimates of the weight of Indonesian cattle. A better idea of weight will help to build a better estimate of value. All these things relate in important ways.

Summary

The factors affecting the value of cattle and buffalo have been discussed at some length because — in our opinion — it is this value which determines the overall profitability of these livestock in Indonesian farming systems.

In terms of preparing budgets and assessments the key figure to use is the **sale value of cattle and buffalo at the farm.** There is no single value that covers all cases. A healthy male Ongole calf in North Sulawesi will obviously have a very different value to a twenty-year-old Madura cow in East Java. Your valuation must be relevant to your

Figure 3.4
Age, weight, price and value relationships; female Ongole and Bali cattle, East Java, 1990.



own location, and cognisant of age, weight, sex, condition and those other factors that affect value.

Equally and importantly, your valuation must be at the farm level – the ex-farm figure. Indonesian cattle and buffalo are usually traded through a long chain of intermediaries – *blantik*, markets, wholesalers, abattoirs, butchers. These prices are not particularly relevant to the farmer. We need to know what he gets on his farm.

Lastly, don't use an 'official price' or 'government price' or 'recommended price'. These are often quite different to prices and values in the real world. For effective budgeting the sale values that you use must reflect the current sale values in your area.

SALE VALUE OF ANIMAL AT FARM LEVEL

Consider age, weight, sex, condition
type, location, training

Current value Rp ________

3.2.3 Calves

The sale of mature animals would be the largest source of income for most Indonesian farmers rearing cattle or buffalo. The sale of calves would probably rank second.

A number of conditions must be satisfied to produce calves. Farmers must have sexually mature females and there must be sexually mature bulls in the area with access to the cows. The first condition usually can be met. Most farmers with cattle or buffalo rear 1–4 animals at any one time and the majority will be female, and mature. However, the fact that most farmers prefer to keep females of calf-rearing age has an obvious side-effect: large numbers of males are not kept within villages and a high proportion of those that are kept are less than two years of age. Males tend to be slaughtered young and relatively few continue to breeding age.

Frequency of calving

More frequent calvings mean more animals available for sale. It is possible for females to calve every twelve months and there is a strong temptation to use this figure in budgets as it makes the livestock enterprise look very attractive. In practice the typical calving intervals are much longer in Indonesian village systems. An eighteen-month interval would be considered good; 2–2.5 years as average and three years or longer as not unusual.

One of the main reasons has already been mentioned: relatively low populations of sexually mature bulls (e.g. Section 1.4.7). Added to this would be general feeding and management practices (see Section 1.3.7). Most farmers can recognise the symptoms associated with ovulation but may be unable, or unwilling, to seek out a bull in the short time available for service. Many females are kept in pens for much of the day, again reducing the opportunities for mating. The net result is that most females will be served intermittently, often by a bull of low fertility and not at the time best suited for conception. Add to these factors the lack of early weaning (calves may suckle for 12–18 months) and we can expect fairly long intervals between calves.

You should be guided by the situation that exists in your area. If cattle or buffalo are plentiful and graze in herds for long periods in the year then shorter calving intervals might result. If there are not many animals about and cut-and-carry feeding systems are common, then longer calving intervals might occur. Above all, be realistic. When preparing a budget you should use figures that reflect what happens rather than what is possible. One advantage is the ease of adjusting the length of calving interval within your budget. It does not take long to estimate the changes in income that will occur if the average calving interval is changed from three years to eighteen months.

Replacement or sale

Calves will usually have two uses within the farm, i.e. either to replace one of the cattle held by the farmer or to be sold at some later stage. There is an additional use – to expand the total number of livestock and increase the family's wealth. However, most farms raise only a few cattle and this figure stays fairly constant. This implies that most calves that are born are used either for replacement (and the animal that they replace is sold) or sale.

Experience indicates that the sale of young stock is a very common practice. Some farmers will keep their cattle and buffalo on the farm for a long period and especially older, mature females but many more are fairly active traders. They will buy and sell cattle of all ages. Calves, in particular, tend to be sold within twelve months of birth.

It is not possible to recommend a 'best' strategy for choosing a final use for calves born on the farm as many factors will affect each individual's situation. The previous section on 'sale value' (Section 3.2.2) illustrated the rationale in selling young animals. With regard to our economic evaluation the key criterion is the sale value of that calf at the time that it leaves the farm. Obviously the longer it stays, the heavier it gets and the more valuable it will become. Against this must be balanced the costs (usually labour) of maintaining that animal for longer periods.

Other factors

Age at first calving

Cattle and buffalo in Indonesia tend to be fairly slow in developing. Cows will become sexually mature at around two years of age. Add to this the required gestation period and it is unlikely that many heifers (young females) will deliver their first calf within their third year from birth. It is more realistic to assume first calving in the fourth year. It is a small point but an important one. Early calving is attractive in economic terms but it is an unrealistic assumption to use if it does not occur often in your area.

Small herd numbers

The small number of animals typical of Indonesian farms raises problems for orthodox farm management techniques. One such problem is the **assumed sex of the calf.** If we are dealing with a situation in which, for example, the farm has a herd large enough to produce twenty calves each year it is easy to assume that about ten will be male and ten will be female. However, when the farm has only 2–3 animals and one new calf every two years or so it makes some difference if we assume the calf to be male or female. The male will usually be sold off for meat. A female, potentially, can be retained and produce more calves (and, thus, more income) in later years. The easiest way out of this dilemma is to assume that all calves will be sold within two years. Differences in weight (and value) will still be fairly small and young females would not have produced any calves.

The other problem of small numbers concerns **mortalities**. The highest level of mortalities tends to occur in young calves (up to six months of age). One study of communally-reared buffalo in West Java indicated that farmers expected to lose up to one-third of the calves born each year through poor health and nutritional problems. Again, if one farm is producing twenty calves per year we can predict the economic effect of poor calf health by assuming that six of these twenty will die (20 head x 30 per cent annual mortality rate). But most farms rearing large ruminants will get one calf every two years or so and we cannot use a mortality figure of 30 per cent (or any other). The calf will either survive or die. Seventy per cent of a calf is just not possible!

There are a number of ways to get around the mortality problem. If we calculated a model budget for all farmers the overall income from calves can be reduced by allowing for mortalities at the chosen level. But this is not a satisfactory answer for the individual farmer as his calf will be either alive or dead – he will gain income for it or he will not. For this reason it is easiest to assume a zero rate of calf mortalities in small farms. Indonesian cattle and buffalo rearers are well aware of the risks involved and fully appreciate that a dead calf means no income.

Summary

The questions most relevant to the valuation of the output from calves are:

- How often are calves produced?
- How long will they stay on the farm?
- What is their total sale value when they leave the farm?

CALF OUTPUT AND UTILISATION

- Calving interval __________ months
- Period calf retained on farm __________ months
- Value of calf at sale Rp __________

3.2.4 Manure

Cattle and buffalo produce large quantities of manure per head per year. In some situations manure is collected (usually from animal houses) and may be sold as a fertilizer. This has led people to question whether all of the manure output should be given a cash value.

On balance the best option is to ignore the output of manures when preparing an evaluation. Some cattle are penned for long periods. Their manure is accumulated and then spread over crops by the farmers. Most such manure goes onto vegetables or *palawija* crops. Few farmers would use cattle or buffalo manure on main crops such as flooded rice, which they would usually treat with proprietary fertilizers. To the extent that the vegetable crops yield more it can be said that the manures produce a direct benefit. Further, if the use of manure means that the farmer purchases less inorganic fertilizer for use on vegetables or *palawija* it could also be said that the use of manure saves money and, hence, produces an additional benefit.

In practice such changes are small and almost impossible to measure or evaluate. The replacement of inorganic fertilizer by manure can only be valued when it occurs. Many farmers use the manure because it is available but would use inorganic fertilizers if manure could not be obtained. Lastly, much manure is not deliberately collected for use on crops. Animals will dung while they are grazing, with material deposited at random over the fields.

As always, adapt your budget to local conditions. If farmers **do** bag and sell manure, then count it as an income-earning output: how many bags are sold per year; how much is a bag of manure worth? In most cases though this output can be acknowledged but left out of an economic assessment.

3.2.5 Wealth and security

Cattle and buffalo are a store of wealth for village families, often referred to as 'walking banks'. Economists would classify them as assets, similar to other capital assets of the farm such as land, houses, animal pens, small ruminants (sheep and goats), farm equipment (ploughs, tools, machinery) and the like. Economists would further classify cattle and buffalo as 'liquid assets', i.e. they are a form of capital that can be converted to cash relatively easily. Other examples of liquid assets would include any items that can be sold quickly — e.g. sheep, goats or gold. Some of the farm's assets are less liquid. They would include those things that are less easy to sell, e.g. animal pens as these structures must be physically dismantled and removed, or those which may find a ready market but which the farm family would be very reluctant to sell, e.g. land or even the family house. To sell these types of capital asset is usually an indication that the family is in desperate trouble.

Farm families are keen to increase total wealth or total capital stock. It increases their sense of security and provides a better outlook for their future and those of their children. All families would like to have more land, more buildings and more gold. Unfortunately an increasing number will never reach this goal. Many rural households are landless and it is this lack of wealth, or lack of capital, that adds to their feeling of insecurity and hopelessness.

Cattle and buffalo are used as both short-term and long-term stores of wealth. It is a common practice for farmers in some areas to invest in livestock immediately after the main harvest period when a relatively large amount of cash may be available. Some families prefer to keep this as cash to meet daily needs; others might put it into a bank or savings group. Some farmers invest in livestock. They purchase cattle or buffalo (or sheep or goats) after harvest and hold them for some weeks or months during the dry season when there is little work to be done in the fields. The animals may gain weight and can be resold when required, perhaps before the next planting season starts when cash is needed to buy seed or fertilizer or to hire labour.

This use of animals as a short-term store of wealth is really a trading strategy, taking advantage of a particular situation. It is not easy to cover this within a general budget. A farmer will make money if the classic business principle applies, i.e. *'buy cheap – sell dear'*. Some farmers may just as easily burn their fingers on such a deal, buying when prices are high and selling when they are low. For our purposes short-term wealth storage can be ignored. It is just one of the many ways of trying to park cash safely for a short time.

Using large ruminants as a long-term store of wealth is a matter of retaining them on the farm until cash is needed. Livestock can be kept for years. Once mature their weight (and value) will be fairly stable. The farmer is not going to earn any 'interest' on the investment but, against this, they are a good hedge against inflation. All things being equal, the Rupiah price of livestock will keep roughly in line with the general rate of inflation so, when the time comes for sale, the farmer may not have gained much but he is also unlikely to have 'lost' any value over that period.

If cattle and buffalo are a good way to store wealth and increase family security you might ask why farmers don't increase the number of animals they rear. After all, it has been mentioned before that most farmers who rear livestock only keep 2–4 animals. Why do they not expand numbers to six, eight or more? Two main reasons explain this – effort and risk. It requires labour and skill to rear animals and the labour that goes into cutting grass or cleaning pens could be used for other tasks. Many farmers believe that the rewards are not worth the effort involved. Families with 2–3 animals would probably like to have more but find that they do not have the resources to look after additional animals. Risk is an equally potent factor. Cattle and buffalo are expensive to purchase. They must be cared for with skill and constant attention. A field of crops can be left unattended for two weeks and little will happen but cattle and buffalo need daily care. Neglect, ill-health or theft can remove a very valuable capital asset at a stroke. The risks involved in animal management are of a high level.

The contribution of cattle and buffalo to total wealth and security of a farm is clear. Our problem now is how do we reflect these values in an economic analysis? Two possibilities are discussed below.

Sale

The difference between income and wealth is that the former is a flow and the latter a stock. Income represents a flow of cash (or goods) such as comes from selling crops or renting-out draught animals to other people. Wealth is a stock of **potential** income that is only realised when that asset is actually sold (or swapped, or bartered). A farmer who dies owning three buffalo will never have enjoyed all the income benefits of those assets. It is often said that many farmers *'live poor and die rich'* simply because a large part of their potential income is locked into their capital assets. We can express this potential in a budget by assuming that the farmer sells them at some point. This enables us to compare the relative benefits and costs, for example, of growing cassava or raising cattle over a five-year period. Whether the farmer sells the cattle at the time that we have assumed is quite irrelevant. All we are seeking is some standard method to compare very different things.

Inventory change

Another alternative is to look at the changes in the farmer's inventory of animals over a period. 'inventory' is simply another word for 'list'. For cattle and buffalo we list the number at the start of the period and again at the end of that period (while noting some important characteristics). What we are looking for is any changes that might have occurred that would affect the valuation of these assets.

An example here will help. Let us assume that, on the 1st January 1993, we list the buffalo on a particular farm:

- One eight-year-old cow, worth Rp550 000. She is pregnant. The calf will be born at the end of March. The farmer does not intend to sell the calf during the year.
- One two-year-old heifer, worth Rp300,000. She is still growing and not pregnant.

During the year one calf is born. By 31st December 1993 it is nine months of age and worth Rp130 000. The eight-year-old cow has become nine years of age but, because it has stopped growing, is still worth Rp550 000. The heifer has gained weight and is now worth Rp-400 000. These items are listed in Table 3.2.

As indicated in the table, the farm's wealth has increased by Rp230 000 during the year due to the growth in the heifer, plus the birth and growth of the calf. But it is important to stress that only the **wealth** has changed. No animals were sold thus the farm received no income.

Table 3.2 Inventory changes, smallholder buffalo, example A

	Opening inventory (Jan 93)	Closing inventory (Dec 93)	Change (Jan–Dec)
		Rupiah	
Cow	550 000	550 000	0
Heifer	300 000	400 000	+100 000
Calf	0	130 000	+130 000
Total	**850 000**	**1 080 000**	**+230 000**

What if an animal had been sold? Let us extend that same example but, this time, assume that the heifer was sold in July 1993 for Rp350 000 (she has grown for six months since January 1993). How will this affect the inventory values? (Table 3.3).

This time the value of the inventory has fallen by Rp-170 000 over the year. There has been a reduction in the capital assets of the farm due to the sale of the heifer. Of course, the farm's income has benefitted by gaining Rp350 000 from the sale of the heifer whereas, in the first example, the farm sold no animals and received no direct income from animals in 1993.

Table 3.3 Inventory changes, smallholder buffalo, example B

	Opening inventory (Jan 93)	Closing inventory (Dec 93)	Change (Jan–Dec)
		Rupiah	
Cow	550 000	550 000	0
Heifer	300 000	0	–300 000
Calf	0	130 000	+130 000
Total	**850 000**	**680 000**	**–170 000**

These issues are raised again later when we provide some examples of different evaluations. However, they do underline the importance of distinguishing between wealth and income and some of the problems we face in trying to locate the position of wealth (or capital or assets) when evaluating the farm as a business.

3.2.6 Other outputs

There are a number of other outputs that we could attribute to cattle or buffalo but are not discussed in detail. **Status** is one such output. In some parts of Indonesia ownership of cattle or buffalo — or particular types of each — can confer important status on the owner. Madura is well known for its racing bulls. The owners of these animals will spend many hours and much money on the training and care of their animals. Success in the races will mean a lot for the owner. He may not win much cash in terms of the value of the prizes but the bulls will have a very high value and he gains prestige and respect among his peers, which may mean a lot in terms of influence over village matters. Buffalo in Tanah Toraja are particularly valuable if they have attributes such as pale or spotted coats, pronounced cervical humps or horns of a particular shape. Again, ownership of such animals and their contribution to particular festivals confer enormous prestige upon the owners. But all such qualities — speed or shape — are largely abstract and very difficult to quantify in economic terms. Who would wish to, anyway? They are usually specific to a particular location and culture, part of important traditional values.

Cattle and buffalo are also potential producers of **by-products** – milk, hides, bones, horn. These can be safely ignored in most situations. Dairy cattle, e.g. Friesians, are special breeds developed for a particular purpose. Few are used for draught work (although some slip through the net) and draught work may have a significant effect on their milk yield. All the other by-products mentioned are part of the total sale value. The farmers get a price for the whole animal, not its component parts. For our purposes all these minor items can be set aside.

3.3 INPUTS

In this section we cover inputs – those items required to maintain cattle and buffalo and to enable them to work in the field. In farm management, inputs are usually called costs to cover all those things that must be bought and used for the animals. One problem for us is that many of the items we cover are not purchased with cash. Family labour is the most obvious example. Decisions must be made on when, and how, the non-cash items should be incorporated in our evaluation. This is discussed in the section and some examples are given in Section 3.4 of the chapter.

- purchase
- feed
- labour
- equipment and housing
- other inputs

3.3.1 Purchase

Cattle and buffalo arrive on the farm through a variety of means. A large number will have been born on farms and thus come 'free' in terms of initial capital cost (although a substantial amount of work is required to maintain the cow) but many others arrive by other means. One of our *DA Project* studies in Subang, West Java, listed how animals came onto the farm in one village (Figure 3.5).

Overall, births accounted for more than half the entries of new animals on to the farms. It is interesting to note that, when farmers can choose the sex of their animals, the preference for females is confirmed: more than half the new female cattle or buffalo came to the farms through purchase or some sharing arrangement. The number of animals that entered through exchange arrangements was quite unexpected. A number of farmers swapped animals with other farmers. Sometimes these were swaps of relatively equal value (a young female for a young male) at other times the swap appeared relatively unbalanced – two sheep for a cow. It is likely that cash was paid to balance the value of the swap between participants, or that some other obligation was entered. Whatever the reasons and methods for swapping animals we will ignore them for purposes of general evaluation.

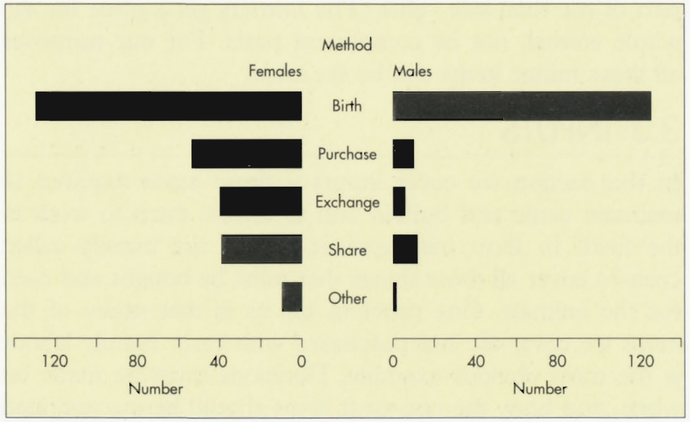


Figure 3.5
Method of arrival on farm, Tanjungwangi, West Java

Purchase

The purchase of cattle or buffalo is the largest single expenditure that most farmers will make for their animals. Over time the value of labour that goes into the care and maintenance may well be a greater total but purchasing an animal requires a large sum of money to be paid at one time. *'I can't afford them'* is the reason most commonly given for **not** rearing animals, which indicates the significance of such a transaction.

The factors that determine the purchase price of any particular animal are exactly the same as those that have already been discussed – age, weight, body condition, training, reasons for purchase and sale, marketing systems. There is no reason to discuss these further. The purchase of an animal is the mirror image of its sale. What is important is that you use values for animals that are consistent with conditions in your area.

One additional factor that may affect the purchase of an animal is the period of time over which payment is made. A farmer might pay only part of the cash required at the time of the transaction with the balance due later. Again, there are particular circumstances for particular conditions. For the purposes of our evaluation we shall assume that **all** money is paid at the time that the transaction is completed.

Gift

A number of animals come onto farms through some gift-giving process. A family might wish to help their older children (or relatives) through donating an animal at no cash cost. Economists do not include such gifts in the evaluation process because it biases the outcome. A cattle or buffalo enterprise looks much more profitable if the animals are received 'free of charge' but those conditions simply do not apply for most people. It is better to treat such gifts as though they were purchases, placing a value on that animal consistent with their sex, weight and condition, etc.

Credit

Cattle or buffalo may come as part of a credit package, as in some transmigration projects. They arrive on the farms 'free', i.e. without a cash cost, but the farmer will incur some obligation to meet all, or part, of the costs involved. The most appropriate treatment in such circumstances is to look at the effect of meeting these obligations on the farmer's cash flow. There are two common methods of repayment.

Repayments through cash

A situation similar to any credit, or loan, obtained through a bank. The farmer is asked to meet a schedule of repayments so that the purchase of the animal is completed within some time limit (e.g. two years) and may include some allowance for interest on the purchase price. The budget simply treats these as cash costs over time. For example, a farmer receives a cow worth Rp 550 000 and is asked to repay Rp 600 000 over three years (Purchase price + Rp 50 000 interest). The capital value of the cow is **not** entered into the budget as a first-year cost (since no money was paid) but repayments are entered at the time which they fall due, e.g. Rp 200 000 per annum for Years 1 to 3.

Repayments through calves

It is a common practice for loans to be repaid in kind, i.e. with physical things, rather than in cash. A number of credit schemes provide the farm family with, say, a cow or two and then get repaid with one or more of the calves that are produced. For the farm budget this means that the farmer does not receive the benefits of those calves. Repayment conditions vary between different projects but, for an example, let us assume that the family receive one cow and must repay by giving the first two calves back to the project. Assuming that she calved in Years 2, 4 and 6, the first two calves (Years 2 and 4) would go off the farm and no cash income would be recorded for them – that is the 'cost' of the cow to the farmer. However, if the calf from Year 6 is sold then the cash received from that sale would be properly recorded as income.

Sharing arrangements

Many farmers in Indonesia rear cattle or buffalo which they do not own. These sharing (or rental or loan) arrangements are simply another form of credit and should be treated by the same means as given in the section above.

The arrangements are many and complex in nature. They range from fairly loose, informal agreements between relatives or friends to much tighter and more restrictive deals. If you want to incorporate such schemes in your analyses, the critical questions that you must answer are:

- How much of the initial purchase price (or value) is paid by the farmer;
- How many of the inputs (cash and non-cash) are supplied by the farmer?
- What happens to any calves born during the period of sharing? Any that go to the owner **would not** count as income; any that go to the farmer **would** be counted as income when the calf is eventually sold.

- What happens when the animal leaves the farm? For example, when the original animal is sold does the farmer get any share of that sale price?

Summary

The most convenient way to deal with new animals on the farm is to assume that all those which arrive by **any** means other than being born on the farm **have been purchased**. This avoids the complications of sharing, credit or loan arrangements. Assuming that animals are purchased also makes good economic sense as it usually will provide the scenario for the most expensive option. Anything else should be less expensive.

PURCHASE PRICE OF ANIMAL, AT FARM LEVEL

Consider age, weight, sex, condition, type, location
training
Value at purchase Rp ____________

3.3.2 Labour

Labour is the most important variable input, or variable cost, involved in rearing cattle and buffalo on Indonesian farms. There are some areas in the country (e.g. parts of South Sulawesi) where animals are left to graze unattended and fences are built around the cropping areas to keep animals away (including pigs) and prevent damage. In these circumstances total labour use will be relatively small but, at most other locations, intensive labour inputs are a feature of Indonesian animal systems. They are one set of costs that we cannot avoid in the economic evaluation of cattle and buffalo as a farm business.

The section looks at the use of labour from two viewpoints. Firstly, what is the labour used for and how much is required? Secondly, we concentrate on who supplied the labour. This is an area significantly affected by non-cash inputs as it involves both family labour, and cash costs when the farmer actually employs someone to do part (or all) of the tasks of animal management.

Labour for feed management

Most of the labour devoted to cattle and buffalo enterprises is used in feed-related matters, either supplying feed to the animals or supervising them while they graze in the fields. Four basic divisions of feeding system are often defined. These are listed below, together with the implications for labour use.

Cut-and-carry

This is a zero-growing system. Farmers, family or hired labour collect forages through cutting or collection and bring them to the animals confined in pens or by tether. The animals select the feeds they want and the cycle of collection and feeding is repeated every day or so. The range of materials that can be collected and offered is enormous and beyond the scope of this chapter. Briefly, it will encompass native grasses and weeds; fresh and dried crop residues; shrub and tree leaves. Composition of the material will vary from season to season — even from one day to another — dependent upon local cropping patterns, weather and availability.

Cutting or collection requires time covering both the gathering of material and walking (or cycling) from the farm to the day's site and back. How much time? The answers are obviously highly variable. Here is a subject where talking to farmers *in your area* is absolutely essential. At minimum you need to get their opinion on:

- The times of the year when they use cut-and-carry, and for roughly how many weeks or months for each period;

- The approximate number of hours per day **for each period** that would be required to cover walking, cutting, collection and transporting back the amount of feed needed to maintain their cattle or buffalo.
- The frequency with which they would make such trips during the cut-and-carry period. Do they collect every day? Every two or three days?

What you are trying to estimate is the proportion of the year when cut-and-carry is used and the average time required for total collection and transport. These are key figures that will be of use in a number of budget situations.

An example may help. Let us assume that you talked to a group of local cattle farmers. Their general responses were:

- Cut-and-carry is used for two periods each year, January–April (four months) and August–September (two months). In total, cut-and-carry provides all or some of the cattle's feed requirements for 50 per cent of the year.
- In January–April about three hours per day is required, to cover walking, cutting and transport. (Four months = 122 days; 122 days x 3 hours per day = 366 hours).
- In the August–September period about two hours per day is required. (Two months = 61 days; 61 days x 2 hours per day = 122 hours).
- In total, this means that the cattle farmers each expect to use 366 + 122 = 488 hours per year to cut-and-carry feed. If we say that the 'average' working day is eight hours, this indicates the investment of some 61 days' labour into cut-and-carry feeding.

In practice, how much time will be used for cut-and-carry feeding? There is a tendency to underestimate the time involved – outsiders often say, *'It doesn't take long'*. Let's look at some examples.

In the *ACIAR Draught Animal Project* study at Subang, West Java, farmers were asked to estimate the 'average' time that they spent walking to forage sites, cutting the feed and delivering it back to the pens. Their responses covered two villages. Tanjungwangi is situated at a slightly higher elevation, with some access to irrigation water all year round. Padamulya is lower, flatter and has a longer dry season with little supplementary irrigation. The results of the study (40 farmers in each village) is given in Table 1.4.8 in Section 1.4.

The average labour use is high, ranging from two to five hours per day on those days that feed was collected for herds of 2–4 cattle per farmer. The variation is quite striking, too. Padamulya farmers spent almost twice as much time on collecting feed, probably because they had to travel greater distances. The farmers indicated that some 30–40 per cent of their animals' feed was supplied by hand-feeding throughout the year. If we use an average of 33 per cent this would indicate some 120 days x 3 hours per day each year, a total of 360 hours. If we also assume an average eight-hours working day, the annual labour input per farm is equivalent to some 40–60 days for cut-and-carry feeding. This represents a major investment of time for the farm family.

The figures from other areas are similar. A study conducted near Malang, East Java, showed that cattle farmers required 2.5–3 hours per day for cut-and-carry feeding. Perkins and Semali (unpublished data) questioned farmers near Grati, East Java, who estimated that some two hours of cut-and-carry per day was needed to feed a two-year-old heifer or bullock.

These figures will vary from place to place and season to season. During harvest there may be plenty of feed available for collection close to the farm. In the dry season a collection may cover many kilometres and take most of the day. Asking farmers in your villages will help produce figures relevant for your area:

- At what times of the year do they cut-and-carry feed;
- How long do such period(s) extend, in terms of weeks or months;
- How many hours per day — in each period — is needed to collect the required amount of feed?

Supervised grazing

The second most common method of feeding cattle and buffalo is through supervised grazing. Animals are taken from the farm area, or pens, during the day and allowed to graze waste lands, roadsides, crop stubbles or fallow land. It is characteristic for people always to be close to the animals to ensure that they do not stray and damage other farmers' crops or property, or that the animals are not stolen.

This is work of low labour intensity. The herder can sit and watch the animals or do something else at the same time. It is often done by children or older people who cannot perform heavy manual tasks on the farm. Animals may be supervised individually or be put into herds during the day to graze together under the supervision of one or two herders. This latter method obviously reduces the cost per animal in terms of labour time.

Whichever methods are used, herded grazing obviously absorbs a lot of time. The herder is prevented from doing major tasks while watching over the animals and the cattle or buffalo must be out long enough to satisfy their needs for feed and water. Studies in Subang indicated that supervised grazing required some 6–9 hours per day and was used for 50–75 per cent of the year. Again, if we simplify by estimating that grazing took seven hours per day on average and 240 days (66 per cent of the year), this gives a time requirement of 210 eight-hour labour days per year.

It is quite obvious that feeding cattle or buffalo absorbs large amounts of labour. If we add the 50 days cut-and-carry to the 210 days of supervised grazing, we get a total requirement of some 260 days per year for Subang farmers to feed their cattle or buffalo. They reduced this total somewhat by running the cattle from a number of farms together under the supervision of a few adolescent herdboys, giving some saving in labour. But this may not apply elsewhere in Indonesia. The information that you need from farmers in your area on supervised grazing is similar to that for cut-and-carry:

- Which period(s) of the year;
- How many weeks or months for each period;
- How many hours per day?

Tethered grazing and unrestricted grazing

These two types of feed management have been included as they are important in some parts of Indonesia and also require relatively low labour inputs from the family or hired workers.

Tethered grazing is reasonably common. Cattle or buffalo are restrained by a halter, rope and peg and then left to graze the material available to them. The main labour requirements are accompanying the animal to the site chosen for the day and returning occasionally to move the peg and allow the animals access to fresh material.

Unrestricted grazing is much less common in Indonesia. Animals are left to roam virtually at will, selecting whatever feed they choose on spare land, fallow land or within secondary forests. Occasionally they are collected together for inspection or the selection of animals suitable for sale. Such systems do not need much labour but they do require access to large land areas.

These two systems have not been included in the budget examples as most cattle and buffalo in Indonesia are maintained within intensive farming systems. However, if such practices are common in your area then you would need to get some estimates of their demand on labour: when are they used; for how long; what is their labour requirement?

Summary

Labour for the management of feeding systems is, by far, the largest variable cost involved in rearing cattle and buffalo. It is also possibly the single greatest factor which deters many farmers from starting large ruminant enterprises. They can see that a commitment to cattle or buffalo is a constant commitment to ensuring that they are fed.

Estimating the labour required for feed management is something that you simply cannot avoid if you want to evaluate cattle or buffalo as a farm enterprise. Your estimates do not have to be absolutely accurate (after all, management practices will be highly variable even at one location) but they must reflect the annual pattern of feeding in your area. Ultimately they must provide an estimate of the total number of labour days required to provide feed to the animals all year.

LABOUR FOR FEED MANAGEMENT ON TYPICAL FARMS

a. Cut-and-carry

Period(s) used each year   Period 1   _______ months
Period 2 etc.   _______ months

Average labour requirement   Period 1   _______ hrs/day
Period 2 etc.   _______ hrs/day

Total labour (_____ months) x (_____ hrs/day) = _____ hrs/year ÷ 8 hrs = _____ days/year

Total cut-and-carry labour for year = _____ labour days

b. Supervised grazing

Period(s) used each year   Period 1   __________ months
Period 2 etc.   __________ months

Average labour requirement   Period 1   __________ hrs/day
Period 2 etc.   __________ hrs/day

Total labour (_____ months) x (_____ hrs/day) = _____ hrs/year ÷ 8 hrs = _____ days/year

Total supervised grazing labour for year = _____ labour days

c. Total labour required for feed management

	(a)	Cut-and-carry	_______ days/year
+	(b)	Supervised grazing	_______ days/year
=	(c)	Total feed labour	_______ days/year

Labour for draught work

When draught animals work in the field they must be controlled by someone. The ploughman (or operator) is usually the farmer who looks after those animals. It is relatively rare that a farmer will entrust his animals to another person's control. The time that the farmer must spend with the animals to plough, harrow or level a field is an input (or cost) to the total labour required in animal management.

The estimation of labour used for draught work is very simple. If you have already estimated that the farmer uses his animals for draught work for some 40 days per year, the labour required is thus 40 days per year at least. The only difference will come if **more** than one person usually accompanies the animals to the field for work. Some areas typically have two, or even three, people — the farmer who controls the ploughing plus another member of the family who walks next to the cattle to guide them round the field. In such circumstances the calculation would be 40 days x 2 people = 80 labour days.

The most important requirement is that you do **not** exclude the time that the farmer spends ploughing his own fields. His labour input for ploughing his own fields is no different from family labour used for hoeing, planting, weeding or harvest. Use of the animals for work means that the farmer must be with them – this is one of the costs of managing draught animals.

LABOUR FOR DRAUGHT WORK

Total time spent for draught work
- On own farm and __________ days
- On other peoples farms __________ days

Total annual labour for draught work __________ days

Labour for other animal management activities

There are a number of minor husbandry tasks that are required at various intervals such as cleaning out pens or washing the animals. In terms of using labour these activities are insignificant by comparison with feed management. The figures that you use for total feed management will be sufficient to cover all other important but minor tasks. Unless local conditions are very different, such items can be left out of most budgets.

Who supplies the labour?

Estimation of total labour inputs is the first requirement. The next step is to determine who supplies that labour or, more specifically, how much will come from the family (at no cash cost) and how much of that labour will be supplied by purchased labour (which usually involves some sort of payment).

The proportions will be highly variable. In some areas the family will supply all the labour; in other parts, hired or purchased labour contributes most of the total labour inputs.

One example is sufficient to illustrate the point. The Subang survey of labour requirements for feeding asked farmers to estimate the average labour inputs for feed management and also asked who supplied the labour for feed management. Their responses are summarised in Table 3.4.

Table 3.4 Source of labour for feeding management, Tanjungwangi village, West Java

	Percentages of labour used in	
Type of labour	Herding	Hand feeding
Family only	81	88
Hired labour	17	7
Combination family + hired	2	5
Total	100	100

What is the effect of these proportions? If feed management involved 150 days labour in the year, of which the family supplied 80 per cent and hired labour the 20 per cent remaining, labour inputs (for feed) would be distributed:

Family	150 days x 80%	=	120 days/year
Hired	150 days x 20%	=	30 days/year

Further, if the cost of hiring labour is Rp 1000 per day we can value annual labour charges at 30 days x Rp 1000 = Rp 30 000 per year. However, this is for hired labour only. We are still left with the problem of evaluating the family's labour input, which is done in the next section.

People are not paid one rate for all types of work, so the next question must be, *'What are the local daily wage rates for different types of tasks?'* For convenience, we have split these into two main groups.

Labour for cut-and-carry

Cutting, collecting and transporting forage material is a demanding physical task. Loads of up to 30 kg are typically carried on foot; loads of up to 100 kg may be transported by bicycle. If a farmer is paying someone to do this work it is probable that they must pay the worker the full daily wage. This can vary by a large amount. Workers in Pandansari, West Java, said they were paid Rp 3000 per day for *mencangkul* or hoeing in the fields; workers in the Sasak area of Lombok island received Rp 750 per day, plus a meal, for the same task.

You need to choose a rate appropriate for your area and it is best to use a rate (Rp/day) similar to that for heavy labouring.

Labour for herding

Supervision of grazing is not a physically demanding occupation thus people employed for this work tend to get paid less than those who are doing cut-and-carry. Farmers may also pay their herders through some other system. One example given to us included a distribution of calves. The herders (adolescent boys) looked after a group of cattle on behalf of a number of farmers. They received a very low cash wage from each farmer (possibly Rp 100–500 per week) and clothing at *Lebaran*. In addition they were given an occasional calf which ran with the herd and became their property. A six-month calf is possibly worth Rp 100 000 or more and the boys might work for two years or longer before they receive it but, in total, the value of payments they received was quite substantial, probably equivalent to Rp 1000–1500 per working day.

This is a difficult area in which to gather information as no standard rules apply. But it is something that needs to be done and the results will reward the efforts that you make.

Lastly, remember to include seasonal variations in wage rates if these occur in your area and display relatively large differences. Daily labour rates are usually higher at times of peak activity (such as the periods of land preparation) and lower at off-peak times (e.g. dry season).

COST OF HIRED LABOUR

1) Cut-and-carry
- Period 1 ____ days x Rp ____/day = Rp ________
- Period 2 ____ days x Rp ____/day = Rp ________
- etc.

Total annual cut-and-carry costs Rp ________

2) Supervised grazing
- Period 1 ____ days x Rp ____/day = Rp ________
- Period 2 ____ days x Rp ____/day = Rp ________
- etc.

Total annual supervised grazing costs Rp ________

3) Total annual hired labour costs
- Cut-and-carry + supervised grazing Rp ______/year

Use and valuation of family labour

Most of the labour for the care and utilisation of cattle and buffalo will come from the resources of the farm family – adults and children. If this labour input is very small — just a few days per year — we could choose to ignore it in our economic assessment without much effect on the final outcome. But all the evidence points the other way. Farmers and families must contribute a lot of time to the tasks involved in the management of their cattle and buffalo. If we do not include this input there will be a serious misrepresentation of the use of the farm's resources. As we said at the start of the chapter, economics is concerned with the allocation of all resources and not just money. The problem is **how** can we incorporate family labour? A budget cannot add Rupiah to days as they are not the same thing. What can we do?

There are a number of solutions. The first is to keep the family labour **out** of the budget as a separate total. Then we can divide the net cash income for an enterprise (cash income minus cash costs) by the number of family labour days used in that enterprise. A simple example is given below.

Cash income	500 kg of crop @ Rp 500/kg	**Rp 250 000**
Cash costs	fertilizer, 40 kg @ Rp 250/kg	**Rp 10 000**
Net cash income		**Rp 240 000**
Family labour	used in production of this crop	**100 days**
Cash return per family labour day		**Rp 2400**

This is an extremely useful measure of returns gained for effort involved. There is a lot of evidence to suggest that Indonesian farmers judge the value of any business opportunity by the net cash income they receive for the amount of labour they use. It is a common phenomenon in some villages for men and adolescent boys to leave their villages in the dry season and find work (labouring, *becak* driver) in a nearby city. The return per labour day as a *becak* driver may be low but the prospect of finding a day's paid work in the village is probably even lower.

A second method commonly used is to put some financial value on the family labour, a system referred to as a *'shadow wage'*. The main reason for using this technique is to incorporate money values throughout a budget. If every input and output is given a value in Rupiah terms we can prepare a budget that expresses the utilisation of **all** resources used in a particular business and **all** outputs that are obtained.

The use of a shadow wage for family labour is largely for our analytical convenience but it is also a very powerful tool. We can apply the selected shadow wage levels to all enterprises — cattle, buffalo, rice, cassava, fish, fruit trees — and produce a management budget for the whole farm allowing comparison between each of its component enterprises, which is the most useful exercise of all.

The shadow wage approach also allows us to distinguish between the types of activity the farm family does. In the example given above the family received a daily cash return equivalent to Rp 2400 for each day of family labour used. However, the farmer and family are doing more than just providing muscle. They are also providing management skills. A more skilful manager will tend to earn more income because, over time, he or she makes better decisions about what to do and when to do it. Labourers are employed to provide the muscle and get paid regardless of the outcome: the farmer reaps the benefits above the cost of labour if he has made good decisions.

Let's illustrate that by going back to the previous example. This time, assume that all the labour used in the production of the crop was hired labourers, all paid the current daily wage rate which (for our example) is set at Rp 1,500 per day.

Cash income	500 kg of crop @ Rp 500/kg	**Rp 250 000**
Cash costs	Fertilizer, 40 kg @ Rp 250/kg	**Rp 10 000**
	Hired labour, 100 days @ Rp 1,500/day	**Rp 150 000**
Net cash income		**Rp 90 000**

This second budget has taken account of **all** the direct production costs for our hypothetical crop and indicates that the farmer receives a net return of Rp 90 000 for his managerial skills. You could argue that he is earning less than in the first example (Rp 240 000 *vs* Rp 90 000) but, don't forget, in the first example the family provided 100 labour days and in the second they provided none. The decision whether to hire-in labour or to use family labour (or some combination of both) is just one of the managerial decisions that smallholder farmers must make every day.

Family labour inputs will be given a monetary value in most of the budget examples that we provide later. It is important for you — as an analyst — to be confident in your interpretation of the budgets that you prepare, particularly if you are discussing these matters with your farmer clients. Remember, always distinguish between a **cash** budget and a fuller **economic** or financial evaluation.

- **Cash budgets.** In this instance family labour is **not** given a Rupiah value as you are trying to estimate the actual **cash** that will be received for a particular farm business. How many Rupiah will the farmer get? What inputs are **not** included in that estimation?
- **Economic budget.** All inputs and outputs are given a cash value **as if** they had been purchased (or hired) and sold. This is the better method of analysis as it is more complete and objective but may confuse the farmer.

Finally this still leaves us with a big problem – if you want to use a shadow wage for the family's labour days, what is the correct rate? We already know that wage rates for the same task vary widely from place to place and from season to season. If the local demand for labour is strong (e.g. harvest period) then rates for hiring labour tend to be high; if there is little demand for labour (e.g. dry season and no cropping) labour rates tend to be low. Within all these possible variations we can provide some useful guidelines:

- Do not make the common mistake of assuming that family labour can be set at a shadow wage of zero Rupiah. How often we hear the familiar story, *'People here have nothing to do, therefore family labour costs nothing'*. This is simply not true and it is very bad economics. Even leisure time has a value. A farmer might prefer to stay at home for a day to talk to his family rather than work in someone else's field for Rp 1000 in cash. This indicates that — for him, on that day — his time with his family was more valuable than Rp 1000.
- The shadow wage should not be set above the current daily rate for hiring labour to do particular tasks. Most farm work is done with family labour, indicating that the family consider their labour to be worth something **less** than the current daily wage rate: for most tasks it is 'cheaper' to use their own labour than hiring someone else.

- This means that the shadow wage rate which you use should be **greater than zero** and **less than the cost of hiring labour**. In our examples we have chosen to use a shadow wage that is **50 per cent** of the cost of hiring someone else to do a certain task at a particular time of the year. Is that a right or wrong choice? There is no answer to that question but there is a mountain of economic literature that argues the cases for all sorts of alternatives. It does not matter too much what rate you choose – select one and be consistent. The most important point is that people do not work for nothing and that your budget recognises this.

Having selected a shadow wage factor appropriate to your area, how should you apply it? Here we come back to the problem of different payments for different tasks.

Labour for cut-and-carry feeding

This is a demanding physical task that may attract relatively high wage rates in your area. If it costs Rp 3000 per day to hire someone to cut and transport forage and you have set a 50 per cent factor for family labour, the shadow wage for this input would be Rp 1500 per day when the family does the work.

Labour for supervised grazing

This is not a demanding task and often done by children and older people. If you have assumed that hiring a person to do this task would cost the farmer Rp 500 per day then a 50% factor would value the family labour at Rp 250 per day for the same activity.

Labour for draught work

The farmer has chosen to raise cattle and buffalo. The fact that he must accompany them to the fields to operate the draught animals and their equipment means that his labour is an input to the animal business. So, if it costs Rp 3000 per day to hire a DAP unit and ploughman we would apply our chosen 50% factor and say that the shadow wage of ploughing work is Rp 1500 per day.

This is used both when the farmer ploughs his own land or other people's land. Assume that a farmer works on someone else's land for two days at Rp 3000 per day. He will receive a cash income of Rp 6000 (2 days x Rp 3000/day) and we deduct his shadow wage of Rp 3000 (2 days x Rp 1500/day). This indicates that he has 'earned' Rp 3000 for his physical labour in controlling the cattle, plus Rp 3000 for his managerial skills in raising the animals and having them available for work.

3.3.3 Feed

Most of the costs associated with feeding are the costs of labour which we have already covered. There are some places where farmers do buy feed for their buffalo or cattle, often during the dry season. The systems vary – fresh green forage is sold at the roadside; farmers purchase truckloads of dry rice straw from the paddock. On Madura island some farmers rent areas of hillside from which they cut forage in the dry months. The cost of that rental is the cost of purchasing the feed (but don't forget to add the farmer's labour for cutting and transport).

If you live in an area where purchase of feed is a common practice then, obviously, it is an input that must be included in your valuation.

PURCHASED FEED

- Cash cost for purchasing feed Rp ________/year

3.3.4 Equipment and housing

The last two items that we will consider are normally classified as 'capital assets'. They are inputs required for animal management but they are different in character to the others, e.g. they can be used again and again. The same plough can be used in many fields; a buffalo will return to the same pen every night. By contrast, feed can obviously be used only once!

Equipment

The variations in design of draught implements and the materials used for their construction are many in number within Indonesia. The plough body may be carved from wood or built from steel; shafts can be wood or bamboo; traces come in steel wire, cable, rope or bamboo. Implements are designed for one animal or two; harnesses are cut and adjusted to suit the shape of a particular animal. And there is almost as much variety in the people who make this equipment (farmers, blacksmiths, artisans, factories) as in their design and components.

Most implements are made relatively cheaply and do not have a long working life. Wooden ploughs are very solid and might last 3–6 years before a replacement is needed, whereas harnesses and shafts might be replaced every year.

You need to establish the costs in the local area for such implements and also estimate their typical working life. It is easiest to assume that all items are purchased and that they are replaced, in total, every 2–3 years. This avoids the fuss of trying to estimate very minor depreciation or repair costs during the year. Nothing beats asking farmers or those who make and supply draught animal equipment within the village.

Housing

Housing systems can range from a tree, to which the farmer tethers his animals at night, to a sophisticated animal house with tiled roof, planked walls, internal pens plus feed and water troughs (see Sections 1.3.8 and 1.4.8). The cheapest system will cost nothing while the most expensive pens may well have cost the farmer over Rp 500 000 or more, depending upon the number of animals that are kept.

Housing may be a large cost or a small one but it is an input that you have to include in an evaluation. Farmers in any region tend to follow the examples of others. If most farmers in a village tie their cattle to the trees, a farmer starting a new cattle enterprise will do just the same. Similarly if another village pens buffalo in elaborate stalls, a new buffalo farmer will fully expect to build such a house and will include its cost in his mental budget. You know what is the accepted standard within your area, all you need to find out is the total cost involved (materials and labour).

EQUIPMENT AND HOUSING

a. Draught equipment
- Purchase cost (full set) Rp ________
- Frequency of replacement ________ years

b. Housing
- Purchase cost (materials and labour) Rp ________
- Repairs Rp ________/year

3.3.5 Other inputs

The last input we want to cover is **time**, particularly the appropriate length of time that should be used in the evaluation of cattle and buffalo as a business.

Large ruminants grow fairly slowly. They reach sexual maturity at two to three years of age and maximum weight at six to eight years of age, sometimes longer. Within those six years a farmer with an area of irrigated *sawah* may have grown eight crops or ten crops of rice. These two systems can be compared but not, for example, on the basis of the profitability of one cycle of rice production against one cycle of cattle production. The two enterprises belong to different frameworks of time.

When you are preparing a management budget for large ruminants it is reasonable to recommend that you run such a budget over four to eight years. One year's results do not tell you much; ten years represents a very distant horizon for most farm families. We are not putting a cost on time (unless there are interest payments on loans) but simply suggesting that cattle and buffalo must be assessed relative to their natural rate of development.

3.4 SUMMARY OF OUTPUTS AND INPUTS

This section summarises outputs and inputs considered essential in the evaluation of cattle and buffalo enterprises. These same classifications are used in the examples given in the Section 3.5.

Note that all inputs and outputs marked with an asterix (*) may be required at more than one period each year. For example, if the draught animals are used for ploughing for a first rice crop followed later by a second rice crop (within the same year) then two distinct work periods need to be taken into account. Similarly, labour for cut-and-carry feeding might be required at two distinct periods of the year and different wage rates might apply during these two periods.

3.4.1 Outputs (or benefits or income)

Outputs which earn cash

Draught work on other peoples' land (*)
The total number of days per year on which the farmer's DAP unit is rented out to work on other farmers' fields. This total should be multiplied by the daily rental rate for hiring DAP animals and their operator.

No. of days DAP
unit hired-out x daily rental Rp _________/year

Sale of calves or older animals
The sale value of cattle and buffalo that go from the farm, taking into account their sex, age, weight and condition, etc. Note that calves are included with mature animals: the farmer only receives income from any animal when it is sold from the farm. Those animals retained on the farm increase total farm wealth but not farm income.

Farm-gate sale value Rp _________

Outputs which reduce farm costs (non cash)

Draught work on the farmer's own land (*)
The number of days per year on which the farmer uses his DAP unit to prepare his own land for cropping.

No. of days of work on own land_________ days/year

3.4.2 Inputs (or costs)

Purchase

The value of the animal when it enters the farm **except** for those calves born on the farm, the same principle applies at the start of a budget exercise: all animals are valued at their market value taking due notice of age, weight, sex and condition, etc.

Value of animal
already on farm or purchased Rp _________

Hired labour for feed management (*)

Cut-and-carry
The proportion of the year during which cut-and-carry feed is supplied by hired labour, estimated as number of days per year multiplied by average hired labour use per day. The total hours per year are then divided by eight to estimate the equivalent number of labour days per year and multiplied by the local daily wage rate paid for cut-and-carry labour.

Total hired labour
for cut-and-carry feeding Rp _________/year

Supervised grazing
As above, the proportion of the year during which hired labour is paid to look after the farmer's cattle or buffalo while they are grazing. Expressed as days per year and multiplied by the daily wage rate paid for that kind of work.

Total hired labour
for supervised grazing Rp ________/year

Purchased feed

Cash costs for purchase of feed during year, excluding the use of hired labour for feed collection or grazing.

Purchased feed Rp ________/year

Equipment and housing

Equipment
Assumed that all required equipment is purchased for cash (ploughs, leveller, harnesses, ropes, etc.) The expected replacement rate must also be specified (e.g. every second or fourth year, etc.)

Cost of equipment Rp ________
Replacement period______ years

Housing
Assumed that any materials or labour required for housing or pens are either bought or hired. An annual repair allowance should also be made to cover the costs of damaged or worn-out parts of any housing or pens. This is usually estimated as some percentage of the original cost.

Cost of housing Rp ________
Annual allowance for repairs
(__% of original cost) Rp ________/year

3.5 BUDGET EXAMPLES

The final section provides some budget examples which may be a useful basis for your own evaluation. All the examples are based on one set of physical and financial assumptions and we then vary some of these assumptions to show the effects on profitability.

- An evaluation of draught work.
- The basic budget – long-term evaluation of cattle or buffalo management, including shadow wages for family labour.
- Long-term evaluation of cattle or buffalo management; no shadow wage for family labour.
- Reducing labour requirements for feeding (i.e. the effect of reducing costs).
- Reducing the periods between calves (i.e. the effect of increasing income).

3.5.1 Assumptions

The physical and financial assumptions listed below have been used in all the examples which follow except where some variations are noted. Physical and financial assumptions are the most critical parts of the budget process – if you select unrealistic assumptions the resulting budget is meaningless.

Physical assumptions cover those items in the basic physical plan that you are making, such as the number of draught days worked each year; the labour days required for feeding; growth and weight of the cattle or buffalo involved. **Financial assumptions** are the Rupiah values which you place on these physical items – the daily wage for hiring labour; the sale value of cattle or buffalo. A good budget is one which bases these assumptions on local conditions. The examples that we have provided show how to put together an enterprise budget for cattle and buffalo. Your task is to adapt it to your conditions.

The examples assume, broadly, that the farm family operate an area of land for the production of irrigated rice and other crops. They rear two Ongole cattle, used for draught work both on their own fields and those belonging to other people.

Purchase and sale values

The purchase and sale values for these cattle are taken from Table 3.11 at the end of this section. (Table 3.12 lists similar information for Bali cattle). Listed in the table are relationships between age, weight and value for female cattle from 1–120 months of age. Girth measurements are also listed as it is relatively easy to measure an animal's girth and, thus, estimate its weight.

These measurements were all made near Grati, East Java, in 1990/91. The physical relationships (girth—weight—age) will not change much over time but the Rupiah value of animals will become outdated. However, they serve as a useful guide and were accurate for that time and place.

Number of cattle

The examples assume that the farm starts with two female cattle. At the start of each budget one cow is assumed to be eight years of age and pregnant, the other is four years of age and not yet pregnant. Referring to Table 3.11 we find that the assumed purchase (or opening value) for these two animals is:

Cows	Weight	Value
8-year-old	310 kg	Rp 600 000
4-year-old	290 kg	Rp 580 000

Calving interval

We have assumed a **three-year calving interval** for both females. This means that the eight-year-old cow will calve in Years 1 and 4 of the budget (she is sold when she reaches 12 years of age); the 4-year-old becomes pregnant during the first year of the budget, and then calves in Years 2, 5 and 8.

Purchase and sale

The mature animals are sold (and replaced) at twelve years of age. This means that the older female is sold at the end of Year 4 in the budget and replaced at the start of Year 5 by a purchased four-year-old cow. The younger animal is sold at the end of Year 8 (the last year of these eight-year budget examples.) In fact, all animals on the farm are sold at the end of the budget to allow an evaluation of the total 'worth' of the cattle enterprise during the selected budget period.

Calves are all assumed to be born at the start of the year and sold in their ninth month. According to Table 3.11 the sale value would be of some Rp 280 000 each, regardless of whether they are male or female.

Draught work

Assume that two cows work as the DAP unit for the farmer. Two rice crops are grown each year and the animals work only for land preparation during these times.

Work on farmer's land	Period 1	20 days
	Period 2	15 days
Work on other people's land	Period 1	10 days
	Period 2	10 days

In total this means that they work for 35 days per year on the farmer's land and for 20 days per year they are rented-out to other farmers. The farmer earns Rp 3000 per day for renting-out the DAP unit to other people. He also 'saves' himself Rp 3000 per day through using his animals on his own land and not paying other people to do this work.

Total labour requirements

Labour for draught work

The farmer uses his own labour to operate the DAP unit. This means 35 days per year on his land and 20 days per year renting-out to other people, a total of 55 days per year.

Labour for feeding

The farmer uses a combination of cut-and-carry feeding and supervised grazing. The labour requirements for feeding the two mature females are listed below.

	Days/ year	hours/ day	hours/ year	Labour days*/ year
Cut-and-carry	120	2.0	240	30
Supervised grazing	240	6.0	1,440	180

* A labour day is assumed to equal 8 hours of work

The family provides 60 per cent of the cut-and-carry labour and 80 per cent of the labour for supervised grazing. This means that annual feeding labour supply for the two mature females will be:

	Family	Hired	Total
		Labour days	
Cut–and–carry	18	12	30
Supervised grazing	144	36	180

A calf is assumed to require, on average, an **additional** one hour of cut-and-carry labour per day for four of the nine months that it spends on the farm (it would not require additional labour for supervised grazing as it will graze at the same time as its mother).

Calf labour 120 days x 1 hour/day = 120 hours
120 hours ÷ 8 hours = 15 labour days

Having a calf on the farm will, thus, require an additional **15 labour days** for feeding during the time that the calf is there. All this additional labour will be supplied by the family.

Wage rates for labour

Hired labour

The cost of hiring labour for heavy tasks, such as cut-and-carry, is Rp 2000 per labour day; for light tasks (supervised grazing) Rp 500 per day.

Shadow wages

When Rupiah values are being placed as the use of family labour, these are set at 50 per cent of the rate paid to hire someone else to do that work:

- Operating DAP unit Rp 1500/day
- Cut-and-carry feeding Rp 1000/day
- Supervising grazing Rp 250/day

Purchased feed

Assume that the farmer spends Rp 18 000 each year purchasing rice straw and other crop residues for feeding. This cost includes the feed and also the cost of transporting it to the farm.

Housing and equipment

Housing

Assume that the animal house and pens cost, in total, Rp 100 000 for materials and labour, and that 10 per cent of this cost per annum should be allowed to cover repairs and maintenance, i.e. Rp 10 000 per annum.

Equipment

The cost of DAP equipment is set at Rp 30 000 in total. These items are completely replaced after three years of use.

3.5.2 Example one – Draught work only

The first example addresses the question, *'Do draught animals pay their way on draught work alone?'* We will estimate the income and costs for the activities required to use and maintain the two draught cattle for one year. No calf output will be assumed as this example concentrates only on draught.

The example indicates that the family has 'lost' Rp 21 000 over the year by keeping cattle only for their draught work. A couple of points immediately spring to mind.

Table 3.5 Keeping cows for draught work only; all items valued

			Rupiah/year
INCOME			
	Cash income	• Draught rental 20 days x Rp 3000/day	60 000
	Cash saved	• DAP on own land 35 days x Rp 3000/day	105 000
	Total cash and savings		165 000
COSTS			
	Hired labour	• Cut-and-carry 12 days x Rp 2000/day	24 000
		• Supervised grazing 36 days x Rp 500/day	18 000
	Purchased feed	• Purchased feed	18 000
	Family labour	• Draught work 55 days x Rp 1500/day	82 500
		• Cut-and-carry 18 days x Rp 1000/day	18 000
		• Supervised grazing 144 days x Rp 250/day	36 000
	Total cash costs and shadow wages		186 000
NET INCOME (income – costs)			–Rp 21 000

Shadow wages

We used shadow wages for family labour, set at 50 per cent of the rate of hiring labour for that task. You might protest that this is unfair – the family are not paid cash and these 'costs' should not be included in money terms. What if the shadow wages were left out and we restricted our analysis only to cash income and cash costs? In this case, the budget for draught work would be as follows:

Table 3.6 Keeping cows for draught work; cash items only

			Rupiah/year
INCOME			
	Cash income	• Renting out DAP unit 20 days x Rp 3000/day	60 000
	Total cash income		60 000
COSTS			
	Hired labour	• Cut-and-carry	24 000
		• Supervised grazing	18 000
	Purchased feed		18 000
	Total cash costs		60 000
NET INCOME (cash income – cash costs)			0

This looks slightly 'better' in that annual cash income from the DAP unit has just covered the cash costs: no loss or no gain. But better from whose point of view? The analysis has completely ignored the fact that, in terms of benefits, the animals also ploughed the farmer's fields for 35 days and saved the cost of hiring power from someone else . In terms of costs the budget does not include the fact that the family devoted 227 days of labour time to looking after these two animals and operating them in the field. As we've said before, family labour cannot be ignored. The analysis implies that the family would be willing, in total,

Table 3.7 The basic budget: all inputs and outputs valued

Rupiah x 1000

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Benefits	**a. Cash earned**								
	• Draught rental	60	60	60	60	60	60	60	60
	• Cow sales				600				1,190
	• Calf sales	280	280		280	280			280
	b. Cash saved								
	• DAP used on own land	105	105	105	105	105	105	105	105
(1) Total cash earned or saved [a+b]		445	445	165	1,045	445	165	165	1,635
Costs	**c. Capital items**								
	• Housing	100							
	• Equipment	30			30			30	
	d. Cash costs								
	• Purchase cows	1,180				580			
	• Hired labour								
	• cut-and-carry feeding	24	24	24	24	24	24	24	24
	• supervised grazing	18	18	18	18	18	18	18	18
	• Purchase feed	18	18	18	18	18	18	18	18
	• Repair housing	10	10	10	10	10	10	10	10
	e. Family labour costs (shadow wages)								
	• DAP work	83	83	83	83	83	83	83	83
	• cut-and-carry (for cows)	18	18	18	18	18	18	18	18
	• Supervised grazing	36	36	36	36	36	36	36	36
	• Additional cut-and-carry (for calves)	15	15		15	15			15
(2) Total cash and family labour costs [c+d+e]		1532	222	207	252	802	207	237	222
(3) Net annual benefits or costs [1-2]		-1087	223	-42	793	-357	-42	-72	1413

to put in 227 days of labour for no benefit. This would **not** be the case in practice.

Losing money

The example in Table 3.5 indicates that the family 'lost' Rp 21 000 over the year or, more accurately, their costs exceeded income by Rp 21 000. In fact they did not lose cash: the results displayed in the second table show that, in cash terms, the family broke even. What the first table does indicates is that it is not worth keeping cattle **only** for their draught work, given the values **we** have put on the non-cash inputs and outputs. Rp 21 000 is certainly not a large deficit and the figure could be changed quite easily through using different levels for any of the financial or technical assumptions used. But it is worth considering the alternative. What if the farmer did not have the two cattle and had to hire a ploughman to till his fields? What would he gain and what would he lose?

Benefits lost

- The farmer would need to pay Rp 105 000 to hire someone to plough the fields (35days x Rp 3000/day).
- He would not gain the income from renting-out his cattle for work (20 days x Rp3000/day).

Costs not required

- He would not have to hire labour for feed collection or supervision (Rp 42 000).
- He would not need to purchase feed (Rp 18 000).
- The farmer and family would not have to utilise any labour for cattle management (227 days).

We can summarise these as,

a) Income or savings foregone	Rp 165 000
b) Cash costs not required	Rp 60 000
c) Extra family labour days available	227 days

If we deduct (b) from (a) we get a figure of Rp 105 000 – this is the 'loss' to the farmer of not raising cattle for draught work. Against this must be balanced the 'gain' in labour time: the family have an additional 227 days per year available to do something else. Divide Rp105 000 by 227 days and we get a result of around Rp 500 per day. So – if the family can get work worth, on average, some Rp 500 per day for 227 days of the year it is just as profitable for the family either to keep cattle for draught work or use the family's labour for something else. If they can earn more than Rp 500 per day then it is definitely better **not** to keep cattle.

These examples can be run forever, with minor adjustments bringing minor changes and requiring new interpretations. **What they emphasise, however, is that it is only worth rearing cattle and buffalo exclusively for DAP work if they can be rented-out for a very substantial number of days each year – probably 100 days or more.** For most farmers the draught-related benefits are important but relatively minor. It is the non-draught benefits that, potentially, provide the incentives.

3.5.3 Example two – Basic budget; all items valued

The basic budget uses all the assumptions listed and is run over an eight-year period. It is also assumed that the farmer had no cattle when he started – the budget analyses the situation starting from scratch.

The results shown in Table 3.7 indicate that the enterprise is profitable over the eight-year span, although some years are positive and others are negative. If we add the annual net benefits (last row of the table) we end up with a cumulative figure of Rp 829 000, thus benefits are greater than costs. Economists would also estimate an Internal Rate of Return (IRR) figure for these net income flows. Example Two has an IRR of 12 per cent which indicates that all resources used in the enterprise earned a return equivalent to 12% per annum. This is a reasonable level of return. It is not very high but cattle and buffalo are enterprises that develop slowly and, consequently, earn income at a slow rate.

It is worth noting that the majority of income comes from the sale of animals. All the animals remaining at the end of the project were 'sold' in order that we can make a complete evaluation over the eight years. If we add up the different sources of income for Years 1–8 we get the following results.

Source of income	**Rupiah**
Draught work (own land and rental)	1 320 000
Sale of cows	1 790 000
Sale of calves	1 400 000
Total income over eight years	**4 510 000**

The benefits from draught work accounted for less than 30 % of total benefits: if the farmer kept the animals only for draught work they would definitely not be a worthwhile proposition.

3.5.4 Example three – Cash items only; family labour days counted separately

This example uses the same basic data in a slightly different way. In Table 3.8 the specific cash income and cash cost items have been left unchanged. All non-cash items relating to the use of family labour have been removed and summarised in the last part of the table. This allows us to estimate the cash returned per family labour day.

Totalling the net annual cash income figures and annual family labour days over all eight years of the budget gives the following results:

Net income, Years 1–8	Rp	1 285 000
Family labour, Years 1–8		1891
Cash return	**Rp 680/family labour day**	

This suggests that the family would gain a cash benefit for each day they spent gathering feed, supervising grazing or ploughing with the cattle. It is a useful alternative method of expressing the profitability of this enterprise as it can be compared with using this labour in other activities.

Is Rp 680 per day a high or low return? There is no easy answer to this question. Rearing cattle is profitable in that the family get a positive cash return to their labour. But this must be compared with local alternatives. For example, we assumed that labouring for another farmer earned Rp 2000 per day – the returns from rearing cattle did not reach that level. The cattle certainly made money but not a great amount.

3.5.5 Example four – Labour requirements for feeding reduced by 25 percent

The fourth example looks at the effect of cutting costs. Management of feed is one of the largest inputs to cattle or buffalo enterprises. What would happen if the labour required for cut-and-carry feed and grazing supervision could be reduced by 25%?

There are many ways that this can be attempted in practice. There has been a lot of research on high-yielding or better quality forage species, forage conservation and the treatment of crop residues to make them more palatable and digestible. In our hypothetical example we have assumed that one or more of these new techniques has been adopted by the farmer, with a net 25% reduction in the labour required for feeding.

The 25% reduction has been applied both to the use of hired labour and family labour. All other items in the

Table 3.8 Cash-only budget: family labour inputs in days

Rupiah x 1,000

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Benefits	**a. Cash earned**								
	• Draught rental	60	60	60	60	60	60	60	60
	• Cow sales				600				1190
	• Calf sales	280	280		280	280			280
(1) Total cash earned or saved [a]		340	340	60	940	340	60	60	1530
Costs	**b. Capital items**								
	• Housing	100							
	• Equipment	30			30			30	
	c. Cash costs								
	• Purchase cows	1180				580			
	• Hired labour								
	• cut-and-carry feeding	24	24	24	24	24	24	24	24
	• supervised grazing	18	18	18	18	18	18	18	18
	• Purchase feed	18	18	18	18	18	18	18	18
	• Repair housing	10	10	10	10	10	10	10	10
(2) Total cash costs [b+c]		1380	70	70	100	650	70	100	70
(3) Net annual benefits or costs [1-2]		-935	270	-10	840	-290	-10	-40	1460

labour days

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Family labour days	• All DAP work (own farm and rental)	65	65	65	65	65	65	65	65
	• cut-and-carry (for cows)	18	18	18	18	18	18	18	18
	• Supervised grazing	144	144	144	144	144	144	144	144
	• Additional cut-and-carry (for calves)	15	15		15	15			15
(4) Total family labour days		242	242	227	242	242	227	227	242

Table 3.9 Cost reduction: reduce labour for feeding by 25 percent

Rupiah x 1000

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Benefits	**a. Cash earned**								
	• Draught rental	60	60	60	60	60	60	60	60
	• Cow sales				600				1190
	• Calf sales	280	280		280	280			280
Costs	**b. Cashed saved**								
	• DAP used on own land	105	105	105	105	105	105	105	105
(1) Total cash earned or saved [a+b]		**445**	**445**	**165**	**1045**	**445**	**165**	**165**	**1635**
Costs	**c. Capital Items**								
	• Housing	100							
	• Equipment	30			30			30	
	d. Cash costs								
	• Purchase cows	1180				580			
	• Hired labour								
	• cut-and-carry feeding	18	18	18	18	18	18	18	18
	• supervised grazing	13	13	13	13	13	13	13	13
	• Purchase feed	18	18	18	18	18	18	18	18
	• Repair housing	10	10	10	10	10	10	10	10
	e. Family labour costs (shadow wages)								
	• DAP work	83	83	83	83	83	83	83	83
	• Cut-and-carry (for cows)	13	13	13	13	13	13	13	13
	• Supervised grazing	27	27	27	27	27	27	27	27
	• Additional cut-and-carry (for calves)	11	11		11	11			11
(2) Total cash and family labour costs [c+d+e]		**1493**	**193**	**182**	**193**	**773**	**182**	**182**	**193**
(3) Net annual benefits or costs [1-2]		**-1048**	**252**	**-17**	**852**	**-328**	**-17**	**-17**	**1442**

budget remain at the same level used for the basic budget in Table 3.7. The economic effects of reducing labour costs are summarised in Table 3.9. We can summarise the results as we did in Example Two:

Total benefits, Years 1–8	Rp 4 510 000
Total costs, Years 1–8	Rp 3 391 000
Cumulative net benefits	Rp 1 119 000

Reducing labour requirements thus cut total costs by some Rp 290 000 over eight years, boosting the total net income by the same amount. The IRR of this budget is about 16% compared to the 12% calculated in Example Two. In total, cutting labour requirements by 25% boosted profitability by some four per cent – not a large amount but quite significant. One obvious query is the likelihood of achieving a 25% cut in labour usage – it is a large change and experience indicates that many farmers seem reluctant to alter the patterns of their feeding practices.

3.5.6 Example five – Calving interval reduced from three years to two years

For the last example we use the same basic budget as in Table 3.9 but, this time, we have reduced the average calving interval from three years to two years. This shows the effect of changes that increase output (and income) rather than reduce costs. All other inputs and outputs remain as in Example Two except the requirement for more cut-and-carry feeding for the additional calves that are produced.

The results are shown in Table 3.10. Costs have risen slightly because of the extra feeding but total income has risen a lot more because of the increase in calf sales.

Total benefits, Years 1–8	Rp 5 245 000
Total costs, Years 1–8	Rp 3 741 000
Cumulative net income	Rp 1 504 000

The margin of benefits over costs has widened considerably. In Example Two this figure stood at Rp 829 000 and now has almost doubled to Rp 1 504 000. The IRR has also moved from 12% to 20%.

The reason for the increase in profitability is the increase in calf numbers. Calves require relatively little extra work for most of their first nine months (which is the point at which we sell them in our budget) but sell for a good price. The example, as with all others, assumes that the calf has a total value of Rp 280 000 at nine months of age and required an additional 15 labour days for cut-and-carry feeding during that time. This was provided by the family at the shadow wage of Rp 1000 per labour day: Rp 15 000 in total costs for each calf. If we deduct these costs from Rp 280 000 we see that young calves are estimated to bring in a margin of Rp 265 000 over direct costs. **The example really does demonstrate that the big profits lie in calf production: the more the better, provided that they are not kept on the farm for too long.**

3.5.7 Evaluation

The five examples were based on an initial set of assumptions, later varied for particular reasons. What did we learn? The opening section of this chapter said that economic or financial analyses often seek to answer common questions, *'What is it worth? Is it profitable? Does it make money?'* Can we answer these questions?

The basic is answer is, *'Yes'* – after all, the examples usually achieved a positive result. But economists are cautious people. They would immediately qualify that response, *'Yes, but....'* That cautionary 'but' is an important addition. Any analysis is only as good as the assumptions upon which it is based. The assumptions we used are reasonable for the general farming system we outlined but ..... changes to the prices used, labour requires or any one of the many factors involved would

Table 3.10 Increasing income: calving every two years

Rupiah x 1000

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Benefits	**a. Cash earned**								
	• Draught rental	60	60	60	60	60	60	60	60
	• Cow sales				600				1190
	• Calf sales	280	280	280	280		560		560
Costs	**b. Cashed saved**								
	• DAP used on own land	105	105	105	105	105	105	105	105
(1) Total cash earned or saved [a+b]		445	445	445	1045	165	620	165	1915
Costs	**c. Capital Items**								
	• Housing	100							
	• Equipment	30			30			30	
	d. Cash costs								
	• Purchase cows	1180				580			
	• Hired labour								
	• cut-and-carry feeding	24	24	24	24	24	24	24	24
	• supervised grazing	18	18	18	18	18	18	18	18
	• Purchase feed	18	18	18	18	18	18	18	18
	• Repair housing	10	10	10	10	10	10	10	10
	e. Family labour costs (shadow wages)								
	• DAP work	83	83	83	83	83	83	83	83
	• Cut-and-carry (for cows)	18	18	18	18	18	18	18	18
	• Supervised grazing	36	36	36	36	36	36	36	36
	• Additional cut-and-carry (for calves)	15	15	15	15		30		30
(2) Total cash and family labour costs [c+d+e]		1532	222	222	252	787	237	237	252
(3) Net annual benefits or costs [1-2]		-1087	223	223	793	-622	383	-72	1663

have produced different results, some of which would be negative. Generally, however, we can conclude that rearing cattle or buffalo for draught work and sale looks reasonably profitable.

What the examples do not show — and what is far more important — is the **relative profitability** of rearing cattle and buffalo on Indonesian farms. It is this relative profitability that largely determines whether farmers will choose to keep these animals. For example, how do these profits compare with growing rice or cassava, keeping sheep or goats, having a fish pond or planting fruit trees? Some Indonesian farms keep cattle or buffalo but more choose not to so do. It is likely that these decisions have an economic basis. Rearing cattle and buffalo may well be profitable and our budgets will show this. But they are likely to be chosen only if they are as profitable, or more profitable, than other alternatives in a particular place. Discussions with farmers in your area would be a great help. Get them to rank this enterprise against others or discuss the strong and weak points of managing large ruminants. All answers will help increase total understanding.

Our budgets are appropriate for one type of system. To help you develop budgets for conditions in your area a blank copy of the basic budget is provided (Table 3.13). Sensible assumptions and this outline budget will get you a long way in helping you make your own economic assessment.

Table 3.11 Selected physical and economic characteristics of female Ongole cattle

Age (months)	Girth (cm)	Weight (kg)	1990 levels: Liveweight price (Rp/kg)	1990 levels: Total value (Rp x 10^3)
1	58–64	16–18	4800	74–83
3	82–90	47–52	3675	173–191
6	100–110	86–95	2850	245–271
9	111–123	118–130	2300	271–299
12	118–131	145–161	2150	312–346
18	129–143	189–209	2025	383–423
24	136–150	220–244	2000	440–488
36	144–159	258–286	1950	503–558
48	147–163	278–308	1950	542–601
72	149–165	292–323	1925	562–622
96	150–166	297–329	1925	571–633
120	150–166	298–330	1900	566–627

Table 3.12 Selected physical and economic characteristics of female Bali cattle

Age (months)	Girth (cm)	Weight (kg)	1990 levels: Liveweight price (Rp/kg)	1990 levels: Total value (Rp x 10^3)
1	53–59	12–13	6500	78–87
3	75–83	34–38	4150	143–158
6	92–108	64–71	3150	201–223
9	103–114	89–99	2650	236–261
12	110–123	111–122	2400	266–294
18	121–133	145–160	2250	326–360
24	127–141	170–188	2200	374–413
36	135–149	201–223	2150	433–479
48	138–153	218–241	2150	469–519
72	141–159	232–256	2150	499–551
96	142–157	236–261	2150	507–562
120	142–157	237–262	2140	507–561

3

Table 3.13 The basic budget: all inputs and outputs valued

Rupiah x 1000

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Benefits	**a. Cash earned**								
	• Draught rental								
	• Cow sales								
	• Calf sales								
Costs	**b. Cashed saved**								
	• DAP used on own land								
(1) Total cash earned or saved [a+b]									
Costs	**c. Capital Items**								
	• Housing								
	• Equipment								
	d. Cash costs								
	• Purchase cows								
	• Hired labour								
	• cut-and-carry feeding								
	• supervised grazing								
	• Purchase feed								
	• Repair housing								
	e. Family labour costs (shadow wages)								
	• DAP work								
	• Cut-and-carry (for cows)								
	• Supervised grazing								
	• Additional cut-and-carry (for calves)								
(2) Total cash and family labour costs [c+d+e]									
(3) Net annual benefits or costs [1-2]									

Suggested readings

Basuno E (1991) A whole-farm study of draught animal power in West Java, Indonesia, Unpublished manuscript, University of Melbourne.

Perkins J and Semali A (1992) Why do Farmers Sell Young Cattle? Proc. International Seminar on Livestock Services for Smallholders, (in press), INI–ANSREDEF, Bogor, Indonesia.

Petheram R J, Teleni E, Perkins J, Winugroho M and Hogan J P (1989) The ACIAR Draught Animal Power Project. In: D Hoffmann, J Nari and R J Petheram (eds.) Draught Animals in Rural Development, *ACIAR Proceedings No 27*, Canberra, 27–33.

4.1 INTRODUCTION

Sumanto, Komarudin-Ma'sum and C Liem

The main tillage operations on smallholder farms in Indonesia are ploughing and levelling carried out mainly by cattle and buffalo. Although tractors are used, and their number has slowly increased, their use is restricted to more organised large irrigated rice fields. The high capital and running costs, small farm units, difficult land topography and problems involved in obtaining spare parts and service are factors which discourage most farmers from investing in tractors.

The design of a plough is very important for the efficiency of a land tillage operation. From results of surveys undertaken by our Project it is clear that each region of Indonesia tends to develop its own model. Individual design takes into account local conditions and the experience of farmers gained from years of tilling their land. The structure of ploughs has undergone modifications through the years until they now meet most, if not all, of the farmers' requirements.

4.2 PLOUGHS

4.2.1 Objectives

Ploughing is a method of land preparation which has two primary objectives:

- To turn over soils and therefore bury unwanted vegetative materials which might interfere with the growth of cultivated crops.
- To loosen soils to facilitate the sowing and covering of seeds to which are sometimes added fertilizers and soil improvers such as farmyard manure and other organic matter.

4.2.2 Structure

The main structure of a plough consists of:

- a beam,
- a handle, and
- a base which includes the mouldboard (see Figure 4.1)

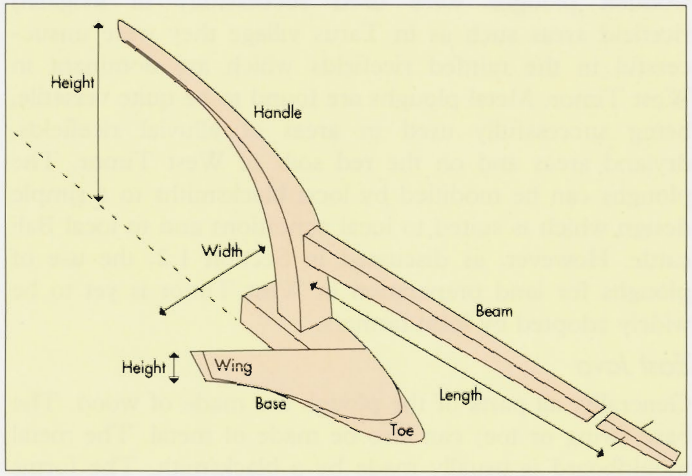


Figure 4.1
The parts of a plough.

All parts of the implement are normally made of wood, but the base (particularly the wing or the toe) can also be made of metal.

4.2.3 Designs

The designs of ploughs can vary, not only between provinces, but also between districts. Those within districts, which are used for wetland ploughing may also be different from those used on dryland.

Descriptions of ploughs used in some of the provinces of Indonesia are tabulated in Table 4.1.

Nusa Tenggara Timur

Wooden ploughs of West Java design were introduced into some areas of West Timor in 1988. However, most farmers have replaced these with metal ploughs of the type commonly used on the island of Bali. While the introduced wooden ploughs were used successfully in irrigated ricefield areas such as in Tarus village they were unsuccessful in the rainfed ricefields which are dominant in West Timor. Metal ploughs are found to be quite versatile, being successfully used in areas of alluvial ricefields, dryland areas and on the red soils of West Timor. The ploughs can be modified by local blacksmiths to a simple design which is suited to local conditions and to local Bali cattle. However, as discussed in Section 1.2, the use of ploughs for land preparation in West Timor is yet to be widely adopted by local farmers.

East Java

Generally, all parts of the plough are made of wood. The base (wing or toe) can also be made of metal. The metal mouldboard is usually made by a blacksmith. The forms of the wings are different between the dryland and wetland in terms of the height and width. A wing for the wetland is higher and wider than that for dryland.

West Java

Wooden ploughs are commonly used because unlike metal ploughs, they can be made by the farmers themselves. Stony soils may affect the shape of a plough, particularly its toe. For example, the *bajak* used by farmers in the village of Tanjungwangi, in the district of Subang, West Java, has a more rounded toe than its counterpart which is used under normal soil conditions (see Photograph 4.5). Sharper toes are more likely to break in stony soils.

South Sumatera (Transmigration areas)

Betung II-B and *Karang Agung Ulu*

Generally, farmers use the *bajak* Jombang which is a plough designed in Jombang, East Java (see Photograph 4.6). The *bajak* Betung which is a plough designed in South Sumatera, is also used, but is not popular. The ploughs are similar in design but are different in the strength of material used in their wing construction. The *bajak* Jombang has a thicker and therefore a stronger wing than the *bajak* Betung. The prices for the ploughs, however, are the same. The Jombang design is preferred in both the transmigration areas of *Betung II-B* and *Karang Agung Ulu*.

Table 4.1 Description of and comments on some of the ploughs more commonly used in some of the provinces of Indonesia

Province	Ploughs		
	Local names	Types of land in which implements are used	Comments
Nusa Tenggara Timur			
• Timor	*Luku/Bagale*	Dry Wet	This plough is used for wetland and dryland agricultural areas. It can be modified locally by a blacksmith. It is favoured over the introduced West Java designed wooden ploughs which have been unsuccessfully used in rainfed ricefields.

Photograph 4.1
A metal plough for dryland and wetland.

Dimensions

Beam	
. Length to yoke	180–280 cm
Handle	
. Height	50–60 cm
Base	
. Length	20–48 cm
. Height	16–22 cm
Average weight	12–21 kg

Table 4.1 cont'd

Province	Ploughs		
	Local names	Types of land in which implements are used	Comments
East Java			
• Pasuruan district, Sudimulyo village	*Brujul*	Dry	This is the best and most commonly used plough in the cultivation of secondary crops such as corns, groundnuts, etc.

Photograph 4.2
A brujul *is a dryland plough.*

The *brujul* has a wooden beam, handle and a base which is fitted with a metal toe for protection. It is normally pulled by a pair of draught animals but it can be modified for a single animal.

Dimensions

Beam
. Length to yoke 180–225 cm

Handle
. Height 70–75 cm

Base
. Length 65–77 cm
. Width 16–22 cm
. Height 13–20 cm

Average weight 11–23 kg

4

Table 4.1 cont'd

	Ploughs		
Province	Local names	Types of land in which implements are used	Comments
East Java			
• Pasuruan district, Sudimulyo village	*Singkal*	Wet	The *singkal* is the best and most commonly used plough for the cultivation of ricefields.

The *singkal* is made totally of wood except for the metal toe. Its base is wider and higher but shorter than that of a brujul.

Dimensions

Beam	
. Length to yoke	180–225 cm
Handle	
. Height	74–82 cm
Base	
. Length	48–52 cm
. Width	19–25 cm
. Height	18–23 cm
Average weight	15–22 kg

Photograph 4.3
A singkal *is a wetland plough.*

Table 4.1 cont'd

Province	Ploughs		
	Local names	Types of land in which implements are used	Comments
West Java			
• Subang district, Padamulya village	*Bajak/luku*	Wet (light soil)	This plough is more commonly used in ricefield cultivation. The plough may be pulled by a single animal when the soil is light. This would be more efficient than using pairs of animals.

Photograph 4.4
A bajak/luku *is a wetland plough.*

A *bajak* is totally made of wood except for its toe which is metal. Its dimensions are closer to the singkal than to the brujul although overall, it is a little lighter than these two types of plough.

Dimensions

Beam	
. Length to yoke1	90–233 cm
Handle	
. Height	75–79 cm
Base	
. Length	50–60 cm
. Width	20–28 cm
. Height	15–16 cm
Average weight	11–18 kg

4

Table 4.1 cont'd

Province	Ploughs		
	Local names	Types of land in which implements are used	Comments
West Java			
• Subang district, Tanjungwangi village	*Bajak/luku*	Wet (stony soil)	As for Photograph 4.4. Its toe is more rounded, however, to avoid ease of breakage in stony soil.

Photograph 4.5
A more rounded toe of a bajak/luku.

The plough is similar to that in Photograph 4.4 except that the toe is more rounded than that of the Padamulya plough. Used for first operation.

Dimensions

Beam	
. Length to yoke	190–230 cm
Handle	
. Height	70–80 cm
Base	
. Length	50–60 cm
. Width	25–28 cm
. Height	15–16 cm
Average weight	12–17 kg

Table 4.1 cont'd

Province	Ploughs: Local names	Types of land in which implements are used	Comments
South Sumatera (Transmigration areas)			
• *Betung II-B*	*Bajak* Jombang or *Bajak* Betung	Dry	The *bajak* Jombang is the preferred plough by farmers mainly because of its metal wing which is stronger than that of *bajak* Betung. The plough is used in the cultivation of land for soybean and/or rice crops.
• *Karang Agung Ulu*	*Bajak* Jombang or *Bajak* Betung	Dry	

The *bajak Jombang* or *Betung* is made of wood except for the base which is metal. It is pulled by a pair of draught animals.

Dimensions

Beam	
. Length to yoke	180–220 cm
Handle	
. Height	70–80 cm
Base	
. Length	50–55 cm
. Width	18 cm
. Height	26–27 cm
Average weight	15–20 kg

Photograph 4.6
A bajak *Jombang or* bajak *Betung is a dryland plough.*

4.3 LEVELLERS AND RAKES

4.3.1 Objectives

The objectives in the use of levellers (*garu*) or rakes (*bugis*) are:

- to break up the clumps of soil turned over by the plough,
- to level the surface of the field, and
- to clear the soil surface of materials which may hinder successful germination and growth of seeds.

These implements are traditionally used by Indonesian smallholder farmers instead of harrows.

4.3.2 Structures

A leveller and a rake, as in a plough, are made up basically of

- a beam,
- a handle, and
- a base which has either wooden or steel spikes (see Figure 4.2).

The beam and base of a *garu* or *bugis* are generally similar in design. The greatest variation in design is observed in the construction of the handle and base. Examples of these are illustrated in Photographs 4.7 to 4.10 which show *garu* and *bugis* used in West Java.

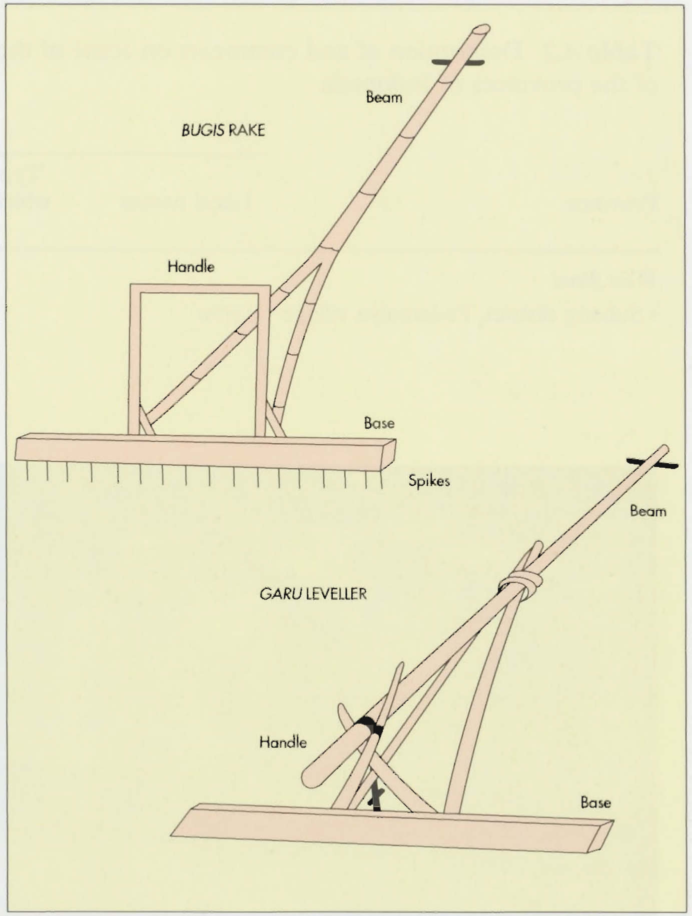


Figure 4.2
Diagrams of a rake (top) and a leveller (bottom) and their component parts.

Table 4.2 Description of and comments on some of the levellers and rakes more commonly used in some of the provinces of Indonesia

Province	Levellers/Rakes		
	Local names	Types of land in which implements are used	Comments
West Java			
• Subang district, Padamulya village	*garu*	Wet	The *garu* in normally used for heavier levelling work, e.g. transferring large volumes of soil.

The *garu* has a wider base than that of the *bugis*; spanning nearly 2 m. It is also heavier.

Dimensions

Beam	
. Length	190–224 cm
. Material	Wood
Handle	
. Length	70–83 cm
. Height	57–69 cm
Base	
. Width	166–172 cm
. Spike length	5–8 cm
. Number of spikes	14–16
Average weight	14–16 kg

Photograph 4.7
A garu is used for levelling in wetland.

Table 4.2 cont'd

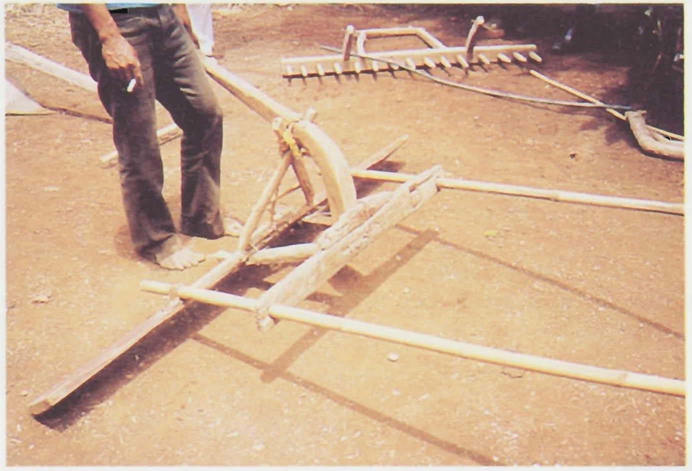
Province	Levellers/Rakes		
	Local names	Types of land in which implements are used	Comments
West Java			
• Subang district, Padamulya village	*bugis*	Wet (light soil)	This is totally made of wood or bamboo. It is usually used in ricefield cultivation.

Photograph 4.8
A bugis (left) used in the village of Padamulya, Subang, West Java.

A *bugis* has a smaller base width than the *garu*. It is lighter and is used for lighter work.

Dimensions

Beam	
. Length	190–250 cm
. Material	Bamboo, rope
Handle	
. Length	54–71 cm
. Height	32–49 cm
Base	
. Width	121–134 cm
. Spike length	12–18 cm
. Number of spikes	10–14
Average weight	8–13 kg



Photograph 4.9
A garu showing variation in design of handle. Compare with Photograph 4.7.

Photograph 4.10
A bugis showing variation in design of handle. Compare with Photograph 4.8.

5.1 INTRODUCTION

R Dharsana and R S F Campbell

Traditional management systems for non-dairy cattle and buffalo in Indonesia occur in two broad categories:

i) they are used to provide power for crop production, and also for calf production and rental
ii) the animals are kept for fattening and manure production.

In both systems little management is involved but today with increasing human population density and intensive irrigation especially on Java and Bali, little free land is available for common grazing. The cattle are allowed to graze on irrigation banks, roadsides or roam freely over the paddy stubbles during day time and are kept at night close to the houses when cut fodder may be supplied. In some regions, there are communal houses for cattle or buffalo. During rest seasons some draught animals are confined and fed mainly on cut fodder, the manure being used on vegetable crops.

Diseases caused by infectious agents (bacteria, viruses and parasites), nutritional deficiencies, chemicals and physical factors (managerial and environmental) are constraints to the success of the draught animal system. Many successful studies have been made in attempts to prevent and treat infectious diseases but less is known of the other factors which may be of equal economic importance.

Some diseases can be prevented simply by changing the management system. Others require interventions like vaccination or treatment. However maintenance of health in working animals differs from other domestic species in that they are subjected to heavy physical stress and occupational injuries. Death of the animal is very serious as it is a total loss of production to the individual farmer. But national economic losses from reduced work capacity, infertility, poor growth, chronic or subclinical infections are not fully appreciated and much more data is required before the total loss can be estimated.

5.2 GENERAL PRINCIPLES OF VETERINARY CARE

Treatment of the individual draught animal may be difficult and, for the farmer and extension services, uneconomic. Attempts should therefore be made to understand the local epidemiology of endemic diseases that affect a village area or district. There may be general problems of economic importance, e.g. infertility, calf losses, haemorrhage septicaemia and many others. Understanding may be achieved by regular meetings with farmer groups, questionnaires and spot investigations. Over a period of time it may be possible to classify the major causes of illness and death and to develop communal programs of disease prevention. The farmer is the key to success.

5.2.1 Working cows (cattle and buffalo)

A basic principle in the management of working animals is to limit stress to a level which animals can accommodate. Stressors can be genetic, nutritional, managerial, environmental or the result of disease. Good management will keep the working animals healthy, productive and fertile. Among the principles for good draught animal management are:

- Adequate feeding, with good quality feed and water, higher energy feeds during periods of work and pregnancy, cleaning of troughs and watering buckets before every feeding time.
- Adequate housing with protection from excessive sun, rain and insects; overcrowding must be avoided and the house kept clean.
- Avoidance of extremes of temperature. Buffalo are more susceptible to heat than cattle because of their skin structure and should have access to water for cooling.

- Regulating hours of work; the animal and the farmer need 5 minutes rest after each half hour of work.
- Adequate time for animals to feed and to ruminate.
- Avoid unnecessary change in the working environment including change of locality, human contacts, handling and changes in a working team of animals. Movement from high to low altitudes is particularly dangerous through exposure to new diseases, e.g. trypanosomiasis.
- Removing stress of chronic parasitism in adults by controlling ecto- and endoparasites.
- Control of acute parasitism in calves.
- Prompt identification and treatment of wounds or sores and their protection from flies. Repair of equipment which may have caused the lesions.
- Vaccination or prophylactic treatment of animals following the advice of veterinary staff at the time of year when the work load is least.
- Avoiding the use of cows from 1 month before to 1 month after calving.

Any disorders which affect large ruminants can affect draught animals. However, physical stress involved in draught work may make cattle more susceptible to generally occurring (endemic) diseases, e.g. trypanosomiasis. In addition they suffer physical problems resulting directly from their use as draught animals (harness sores, sprains, foot rot, etc).

Non-infectious diseases of draught animals

(i) Fatigue

Fatigue caused by too much work may cause loss of weight and weakness which may lead to death from exhaustion in extreme cases. Animals may become more susceptible to infectious disease. The experienced farmer is unlikely to expose his animals to this situation.

Symptoms:
More rapid breathing or even panting, increased saliva flow, acceleration of the heart beat, slowing down of pace, difficulty in pulling an implement or collapse.
Preventive measures:
The animal should not work for more than 6 hours a day. Allow the animal to rest for 5 minutes after working for half an hour. Use the animal to work in the morning before 10.00 am and after 3.00 pm in the afternoon to avoid excessive exposure to sunlight and heat. The experienced farmer usually follows this procedure.

(ii) Heat stress

This problem occurs mainly in buffalo. The time of day and duration of work are important. Cooling by wet hessian sacks on the back or, more traditionally, wallowing are an important part of buffalo management.

(iii) Physical injuries

These may be the result of bad handling, fighting or accidents, but are more commonly associated with harness pressure. Sprains are mainly seen in animals working on rocky or hilly ground.

Burns from fires lit in the stable to control biting insects are also reported in some places. Work in newly opened land, hilly or stony areas cause foot or leg problems. Muscle, joint and tendon strains result from excessive work on bad ground. They give rise to pain, swelling and lameness. Lame animals should receive immediate treatment and not be worked.
Prevention and treatment:
In the case of badly fitting harness, it is important to change or to adjust the harness so that the pressure or friction is removed from the injured area, otherwise the wound will have no chance to heal. The animal should be rested until the skin has returned to normal. Harnesses

must be kept clean by periodic cleaning or washing. The sweating points of the animal should be washed particularly in places where the harness rests on the body. This should be done regularly after completion of work.

WOUNDS:

If the wound is fresh and clean dust lightly with sulphonamide or antiseptic powder. If the wound is dirty, wash and clean with 0.1–0.5% potassium permanganate before treatment. In old infected wounds sulphonamide is not very effective and an antibiotic powder, spray or cream should be used. Wounds should be examined and treated daily. In the absence of drugs, soap or salt (1%) solutions may be helpful.

FOOT LESIONS:

Clean the cloven hoof regularly after work with a special tool or a piece of wood. Do not use pointed hooks or sharp knives. Treat any lesion as a wound. If the animal works on stony or hard ground, the provision of shoes for cattle is very useful. Severe infected lesions in the foot require treatment with antibiotic or sulphonamide. The animal must be rested or recovery cannot take place.

Strains:

The animal must be given complete rest until the condition is cured, then put back to work gradually. While the part is hot and painful it is douched with cold water as often as possible. If the swelling and lameness continue, rub the part with a rubefacient (ginger + palm oil) or a mild irritating medicine (vinegar).

(iv) Poisoning

The widespread use of fertilizers and pesticides in agriculture has been the cause of poisoning in draught animals. Other sources of poison are plants, feeds infected with fungi (mycotoxicosis) and industrial pollution. Industrial substances, e.g. petroleum products, paint are occasionally causes of illness or death.

Nitrite poisoning:

Nitrite as a cause of intoxication is found mainly in plants but may also be found in water supplies due to contamination by nitrogenous fertilisers. The highest concentrations of NO_3 are found in the stems and stalks of the plants, e.g. corn, rather than the leaves. Nitrate in the diet is broken down in the rumen to nitrite and then to ammonia. If the level of NO_3 is too high or the conditions for its metabolism to ammonia are not optimal, NO_2 will accumulate and be absorbed into the blood. NO_2 rapidly oxidises oxyhaemoglobin to methaemoglobin, which cannot transport oxygen.

Symptoms:

Dyspnoea, cyanotic (bluish) mucous membranes, a weak and rapid pulse, tremors, weakness, ataxia, prostration and convulsions.

Diagnosis:

At necropsy there will be typical dark brown blood and possible subepicardial and subendocardial haemorrhages. However after death there is a gradual return of the colour of the blood from brown to red due to the reduction to methaemoglobin back to oxyhaemoglobin.

Treatment:

Methylene blue given intravenously in doses of 9 mg/kg as a 1% solution or 8.8 mg/kg as 0.5 to 1% (w/v solution in isotonic saline). Treatment may need to be repeated in six to eight hours.

PESTICIDE POISONING:

Pesticides are still used extensively in agriculture and contamination of associated grazing land and draught animals occurs. Compounds include organophosphorus compounds, chlorinated hydrocarbons and carbamates. Investigations must include the study of recent agricultural practices or attempts to control animal parasites in the area. Access of animals to ponds or running water draining agricultural areas or livestock enterprises should be investigated.

Symptoms:

These are varied but almost always acute and severe. Dyspnoea, salivation, diarrhoea, abdominal pain, constriction of the pupils, weakness, tremor, depression of respiratory function, muscle stiffness with staggering, protrusion of the tongue, bloat, collapse and death. Effects are usually more acute than in infectious diseases but care must be taken to differentiate poisoning from anthrax, haemorrhage septicaemia, botulism and other acute infections.

Treatment:

Atropinisation. The dose of atropine sulphate is 0.25 mg/kg; intravenously about one-third of this dose should be given slowly in a dilute (2%) solution and the remainder subcutaneously or intramuscularly. Repeat treatment at 4–5 hourly intervals if signs return and continue after 24–48 hours.

CYANIDE POISONING:

Some plants consumed by ruminants contain cyanogenic glycoside which may cause cyanide intoxication, e.g. sorghum and cassava. They also occur in fertilisers and rat poisons. If the animal consumes a large amount of cyanogenic glycosides, hydrogen cyanide (HCN) is released from the plant in the rumen and rapidly absorbed in the blood. This can inhibit cytochrome oxidase and prevent cellular aerobic respiration leading to rapid death of the animal.

Symptoms:

Include accelerated and deepened breathing, irregular and weak pulse, salivation, muscular twitching, spasm, staggering gait followed by coma and death.

Treatment:

Simultaneous intravenous injection of 15 g sodium thiosulphate and 3 g sodium nitrite in 200 ml water. Sodium thiosulphate can be given alone at higher dose 660 mg/kg. In all cases 30 g sodium thiosulphate should be given orally or intraruminally to fix the free HCN in the rumen at hourly intervals. Alternatively large doses of thiosulphate (660 mg/kg body weight) alone may be both effective and safer. Sodium thiosulphate (hypo) may be obtained most quickly from photographic shops.

(v) Nutritional deficiency

Deficiency or lack of balance of the various minerals is a cause of poor health, failure to thrive or the cause of serious disease and mortality. Copper, cobalt and phosphorus deficiencies have been reported in Sumatera, Kalimantan, Sulawesi and Jawa. Sodium is generally deficient in forages in Indonesia. Appropriate supplements, e.g. salt licks may have a significant effect on body weight and general efficiency.

COPPER DEFICIENCY:

Copper deficiencies develop because of a simple lack of the element or because of excess of molybdenum and sulphate in the pasture that interfere with copper utilisation. Cattle raised on acid sulphate soils which are common on marine floodplains in Sumatera and Kalimantan may suffer copper deficiency.

Symptoms:

Include poor weight gain and loss in pigmentation of the hair. Around the eyes the pigmentation change has been referred to as ‘copper spectacles’. Anaemia, diarrhoea, poor conception rate and some nervous disorders may also result from severe deficiency.

Diagnosis:

Laboratory estimation of liver copper, whole blood and serum copper levels.

Treatment:

Copper sulphate can be given in a trace mineralised salt supplement mixed with feed. Injections with copper glycinate or copper calcium edentate (200 mg) repeated every 3 months; or oral dosing with 4 g of copper sulphate for calves from 2–6 months of age; 9–10 g for mature cattle given weekly for 3–5 weeks.

Cobalt deficiency:

Cobalt deficiency is a problem in South Sumatera and Malaysia and may be present in other areas. This may be due to the pasture species or the fact that the element in the soil is rendered unavailable to the plant.

Symptoms:

Loss of appetite, wasting and anaemia due to a lack of vitamin B12 which is formed by microorganisms in the rumen. Parenteral injection of cobalt is therefore not effective.

Diagnosis:

Pasture analysis for cobalt has been recommended as a useful guide. A rapid response to treatment is good evidence for the diagnosis.

Treatment:

Vitamin B12 injection every 6 weeks or oral dosing with 15–30 g cobalt sulphate per 45 kg of salt.

PHOSPHORUS DEFICIENCY:

Phosphorus is often limiting in tropical acidic soil and is the major nutrient deficiency in tropical forage systems. It causes economic loss in cattle by reducing fertility as well as their ability to withstand drought. In young animals stunting of development is the result. In addition to reduced production, deaths from secondary diseases, e.g. botulism may occur. Other deficiencies, e.g. protein are commonly present.

Symptoms:

Bone chewing, depraved appetite, unthriftiness, fragile skeletal fractures, joint deformities, lameness, low fertility and reduced milk yield. Sudden death from secondary botulism is a seasonal complication.

Diagnosis:

Serum and plasma samples may not be a reliable guide to the phosphorus status of the animal.

Treatment:

Supplementation with phosphorus in the feed or in the drinking water. Bone meal is simple and effective. Dicalcium phosphate may also be used. Where botulism is suspected vaccination with the appropriate serotype is recommended annually.

SODIUM DEFICIENCY:

Forages in Indonesia and other parts of Southeast Asia are commonly deficient in sodium.

Symptoms:

These include lower food intake, reduced body weight and milk production and in chronic cases an abnormal appetite with a craving for salt which may be expressed by chewing of soil, rock, and other abnormal materials. In terminal cases there is weakness and incoordination.

Treatment:

Loose salt or sodium chloride in a mineral lick should be offered with an ample water intake.

(vi) Infertility

A cow should produce one calf each year. If this does not happen the cause may be poor management or disease. Management factors include: lack of bulls, owner interference, poor heat (oestrus) detection, ineffective artificial insemination, poor nutrition, draught programs of excessive work. Disease factors could be infectious or genetic. Some genetic causes lead to anatomical abnormalities in cows or bulls which can be diagnosed in the live animal.

Management factors:

In the traditional management system today, free grazing community bulls may be scarce, partly because grazing land is scarce in many areas and small farmers are less prepared to keep bulls even though they are required for servicing their cows. Often the farmer sells the bull for cash. Short term benefit may lead to serious long term losses.

Conception requires detection of heat at an early stage, finding a healthy mature bull and servicing quickly. Finding a suitable bull at the right time may be difficult. Sometimes the basic problem is difficulty in communication between farmers or between the farmer and the AI Centre, especially in more remote areas.

The lack of bulls can be solved by artificial insemination (AI). Effective AI, however, depends on:

- good semen quality,
- a good insemination technique,
- optimal time for insemination (accurate heat detection),
- rapid communication with the bull owner or AI Centre, and
- good nutrition.

Draught programs may interfere with conception if owners prevent their cows from mating during times of heaviest employment, or the work stress may in itself affect fertility. Excess draught work may cause severe loss of fertility in cows. Fertility rates as low as 33% have been reported in buffalo. Calf mortality (Section 2) may further reduce productivity.

Many reproductive problems can be avoided by good management practices, and farmers should be advised of these. Therapeutic interventions are no substitute for sound management. Accurate oestrus detection and the use of a sound bull are fundamental to success.

Infectious diseases

Overwork in an animal can suppress the immune system due to an increased secretion of corticosteroid hormones. The depressed immune response results in greater susceptibility of animals even to normally avirulent bacteria, the activation of latent viruses or other organisms and poor response to vaccines. A large number of bacterial, viral and parasitic diseases which can affect draught animals. Some of the more common or important conditions are described here.

(i) Bacterial diseases

HAEMORRHAGIC SEPTICAEMIA (HS):

The primary cause is *Pasteurella multocida.* The disease is widespread in Asia in buffalo and cattle, the former being the most susceptible. The causal organism may be an inhabitant of the respiratory tract of healthy animals. The disease occurs most often while animals are under stress by transport, work or severe weather conditions, e.g. monsoonal rain in areas like South Sumatera and Sri Lanka.

Symptoms:

High fever, reluctance to move, hypersalivation, eye and nasal discharges, respiratory distress and swelling around the laryngeal region spreading down along the brisket and sometimes around the head. The swelling is hot and doughy (oedema).

Diagnosis:

The rapid course of the disease and the high incidence of throat swelling are only suggestive of HS. For precise diagnosis, a blood film, swabs, blood or oedema fluid and internal organs must be submitted immediately for isolation of the organism in the laboratory. Only in this way can the disease by accurately differentiated from other acute infections (anthrax, anaplasmosis). The organism will survive for only 48 hours in a sample. Speed is essential for laboratory diagnosis.

Treatment and control:

Treatment to be effective must start before bacteraemia becomes well established. Although the organism can be killed by sulphadimidine, sulphapyridine or broad-spectrum antibiotics, when symptoms are obvious the animal will usually die whatever treatment is used. Vaccination with oil-adjuvant vaccine may give protection to the cattle for 8–12 months. Development of immunity takes about 2 weeks and prophylactic vaccination is practiced where possible just before the onset of the season when the disease is most commonly encountered.

ANTHRAX:

The cause is *Bacillus anthracis*. In Indonesia the disease is known in areas of Sumatera, Java, Kalimantan, Sulawesi, East and West Nusa Tenggara. Anthrax is a peracute or acute disease often characterised by the sudden death of the animal. Cows become infected through feeding and drinking contaminated feed or water. The disease is a zoonosis and can be transmitted to man through contact with broken skin, inhalation of dust from wool or hair or even by eating infected meat.

Symptoms:

Weakness; lack of appetite; fever; some doughy oedematous swellings on the chest, belly and legs; bloody discharge from mouth, nose and anus and blood stained diarrhoea and urine on occasion. Pregnant animals may abort.

Diagnosis:

Blood samples should be taken from a peripheral (ear) vessel properly wrapped in a sterile gauze or cotton and sent to the nearest laboratory for examination. **Under no circumstances should a post mortem examination be carried out on an animal** which died from anthrax. The disease can be transmitted to people through the skin or mouth.

Prevention and control:

In all cases of **sudden death** without any forewarning symptoms of illness, anthrax should be suspected. All dead animals should be burned or buried deeply, covered in sump oil, lime or formalin. Chloride of lime should be spread around where the animal lay. All in-contact animals should be vaccinated. Control is by annual vaccination and it is possible to eradicate the disease from an area by vaccination alone.

BRUCELLOSIS:

Brucellosis is known to occur in North Sulawesi, Java, North and South Sulawesi and Kalimantan. Predominantly it affects dairy cattle and is at low prevalence in other cattle and buffalo. Man is susceptible to *Brucella abortus*; becoming infected by contact with infected placenta or carcases or by the ingestion of milk or water contaminated by infected animal excreta.

Symptoms:

Termination of pregnancy (usually abortion between 6 to 8 months of gestation); cervicitis; endometritis; repeat breeding and anoestrus; retained membranes; stillbirth; an occasional symptom is hygroma which is a large painless swelling of the joint (knee). Non pregnant infected females may show no clinical signs of infection.

Brucellosis is normally acquired by cattle by ingesting the bacteria. Infection may occur through the mucosa of the eyes, nose and teat or through the endometrium if the cow is artificially inseminated with infected semen. Infection of the bull is followed by chronic granulomatous (fibrous) and catarrhal disease of the testes and accessory genital organs. Infertility is the result.

Diagnosis:

Brucellosis should be suspected whenever a cow aborts. Diagnosis requires laboratory tests that include:

- Microscopical examination of smears from placenta, foetal stomach, exudates or semen. Material should be stained by the modified Ziehl-Neelsen method.
- Isolation of the organism from foetal membranes, foetal stomach contents, tissues and fluids, semen and milk. Material should be handled with great care. The infection can be transmitted to people.
- Serological test based on the demonstration of specific antibody in serum, vaginal mucus, semen or milk. The ELISA test would be most useful in draught cattle.

Prevention and control:

Control at the farm level is based on control of infection, good management and vaccination. A single vaccination of calves with strain 19 between 3 to 8 months old is recommended. There is no known cure.

LEPTOSPIROSIS:

Leptospirosis is produced by infection with pathogenic serovars of the genus *Leptospira.* Most infections appear to be subclinical therefore are not reported and recorded. Some known serovars in Indonesia are: *L. pomona, L. bataviae, L. icterohaemorrhagiae, L. grippotyphosa*, and *L. hebdomadis.* Scott-Orr and Darodjat found that 31% of 291 cattle sera collected in Java were positive to leptospirosis. The disease may be more important in buffalo due to the wallowing habits of the animals. The disease can be transmitted to man by contact with urine or injected water.

Symptoms:

The majority of infected animals show no symptoms even though they had a period of leptospiraemia and subsequently excrete leptospires in the urine. Clinical symptoms are generally most severe in young animals, but frequently the only symptom noted is foetal death and abortion. Occasionally the disease is characterised by haemolytic anaemia leading to jaundice, haemoglobinuria and death; in milder forms there is fever and agalactica often described as atypical mastitis. Most abortions occur during the last trimester of pregnancy.

Diagnosis:

Laboratory examinations require plasma and urine; or liver, kidney and foetal tissue from fatal cases for bacteriological and microscopical examinations. Following abortions the serum will show a rising titre to the serovar concerned.

Treatment:

Treatment of the suspected clinical case should be started early to prevent irreparable damage to liver and kidney and to prevent the development of the carrier stage. Streptomycin is given for three days at the rate of 25 mg/kg. A single injection of streptomycin will eliminate leptospires from the kidney in chronic cases. Treatment with chlortetracycline or oxytetracycline may also be effective.

VIBRIOSIS:

Vibriosis is a venereal disease in cows and bulls causing failure to breed and abortion. It is caused by *Campylobacter fetus*. It has been diagnosed in Sumatera. Young breeding cattle seem to be most susceptible. The infection may not be widespread in Southeast Asia.

Symptoms:

Vaginitis, varying from a discharge with small flecks of pus in clear, cervical mucus, to profuse yellow discharge. The most characteristic feature is irregular return to service and abortion. The time of abortion is variable, some are quite early when the very young foetus is expelled. In other cases, the foetus dies and becomes liquefied causing endometritis. Some abortions occur between 3 to 6 months gestation.

Diagnosis:

Abomasal contents of the foetus, oestral mucus from the cow, or, from the bull, preputial washings should be sent in Campylobacter transport media (CTM) requested from the diagnostic laboratory and packed in ice to reach the laboratory for culture on the same day.

Treatment:

Infected cows should be isolated and treated with antibiotics. In the bull, high doses of streptomycin injection and a streptomycin local douche of the preputial sac, or vaccination are the preferred methods of control.

BOVINE KERATOCONJUNCTIVITIS ('PINK EYE'):

'Pink eye' is a highly contagious disease affecting one or sometimes both eyes of cattle, particularly the Bali breed and buffalo. The disease, caused by the bacterium *Moraxella bovis*, is transmitted by flies and usually occurs where there are prolonged dry periods causing dusty conditions.

Symptoms:

Initially there is excessive lachrymation. This is followed by a severe keratitis with infiltration of blood vessels which gives the eye a pinkish appearance. In advanced cases, ulceration and panopthalmitis may occur (Photograph 5.2.1). Affected animals rapidly lose condition. The sight in the affected eye may be lost and some animals become permanently blind.

Diagnosis:

Confirmation of the clinical diagnosis is made by culturing the causal organism from lachrymal swabs.

Photograph 5.2.1 Bovine keratoconjunctivitis ('pink eye'). Cornea is pink as a result of keratitis and underlying panopthalmitis. Oedema of eyelids.

Treatment and control:

Separate infected animals from the rest of the herd. Spray animals, particularly the head with fly repellent to reduce transmission. **Topical treatment is not effective**. The best treatment is 2 ml of tetracycline mixed with 2 ml of steroid (hydrocortisone or other) injected subconjunctivally through a 23 g needle.

(ii) Viral diseases

FOOT AND MOUTH DISEASE (FMD):

Foot and mouth disease is a major transmissible disease of cattle and buffalo inhibiting their use for draught by directly affecting the feet and causing debilitation. The disease is endemic in parts of Asia but the last outbreak in Java was in 1983. The rapid mass vaccination and surveillance campaign at that time may have eradicated the disease because no further cases have been detected in Indonesia.

Photograph 5.2.2 Foot and mouth disease. The early vesicle soon ruptures to leave a shallow ulcer. Bovine tongue.

Symptoms:

These range from severe vesicles and ulcers in the mouth (Photograph 5.2.2) and feet with hypersalivation, inappetence, loss of condition, marked drop in lactation, abortion, severe lameness with loss of the horny covering of the hoof. In mild cases the lesions may escape notice by being almost entirely limited to superficial erosions of the epithelium. Death in calves is associated with lesions in the heart.

Diagnosis:

Rapid spread of disease among animals and the ulcerative lesions are suggestive of foot and mouth disease. In endemic areas where the signs are less obvious, blood and tissue swabs are required quickly by the laboratory to culture the virus.

Control:

By quarantine and vaccination. Movement of animals should be restricted and contact with sheep, goats and pigs prevented.

MALIGNANT CATARRHAL FEVER (MCF):

MCF is found throughout the country and in other parts of Asia and is usually fatal although the morbidity rate is low. It usually results from contact with carrier sheep which show no symptoms of the disease. Bali cattle and buffalo are more susceptible than other breeds but cases are encountered in Friesian-Holsteins and Bos indicus types. The causal virus in Southeast Asia has not been fully characterised.

Symptoms:

High fever, anorexia, sero-mucoid to mucopurulent discharges from the eyes and nose. The surface of the muzzle becomes dry, cracked and encrusted with exudate, the nostril is often blocked with debris causing distress in breathing. There is photophobia and bilateral ophthalmia

Photograph 5.2.3
Malignant catarrh. Acute conjunctivitis with congestion of the sclera. Slight opacity of the cornea. Bali cow.

progressing to corneal opacity and blindness (Photograph 5.2.3). Enlargement of the superficial lymph nodes is seen. Nervous signs include incoordination, paralysis and convulsions. Occasionally there is haematuria and severe diarrhoea.

Diagnosis:

Provisional diagnosis is based on the history, clinical signs and post mortem lesions. Confirmation is by histopathology for which affected tissues particularly small blocks of the liver, kidneys, brain and lymph glands are forwarded in 10% formal saline to the laboratory.

Treatment and control:

Acutely ill cattle are not infective. Treatment of affected animals is useless. Control depends on separating cattle and buffalo from sheep particularly during the lambing season.

BOVINE VIRAL DIARRHOEA (BVD; MUCOSAL DISEASE):

BVD is characterised clinically by fever, necrotic stomatitis, gastroenteritis and diarrhoea. Foetal calves are very susceptible when some develop cerebellar hypoplasia and others are aborted. Most infections are subclinical when animals do not appear ill. On the other hand animals that develop signs of disease usually die. The actual means of transmission of the causal pestivirus is probably ingestion or inhalation of contaminated materials.

Symptoms:

Fever, erosive necrotic stomatitis, diarrhoea, dehydration and death. Pregnant cows may abort 3 to 6 weeks after infection but others proceed to term giving birth to congenitally affected calves. Some sick animals develop transient corneal opacities, others exhibit encephalitis and some become lame from laminitis or from pododermatitis. Cows may become repeat breeders; fertilisation is not affected but embryonic death with foetal resorption occurs 8 to 18 days after breeding.

Diagnosis:

The mouth and foot lesions are irregular but not vesicular (*cf* FMD). The hard palate may be severely affected.

It is not easy to diagnose BVD, clinically or pathologically. The disease must be differentiated from MCF and FMD. Laboratory techniques are essential for confirmatory diagnosis. Samples like serum, blood, spleen, lymph nodes and other affected tissues should be sent to a veterinary laboratory both as fresh cold specimens for culture and serology and formalin fixed tissues for differential histopathology.

In some countries BVD must also be differentiated from rinderpest. Then laboratory examinations (tissue culture, histopathology) are essential.

Control:

By quarantine. Vaccination is possible but appropriate vaccines may not be easily available.

INFECTIOUS BOVINE RHINOTRACHEITIS (IBR) AND INFECTIOUS PUSTULAR VULVOVAGINITIS (IPV):

IBR is found throughout Indonesia including North Sumatera, but has not yet been accurately mapped out. The disease is caused by the bovine herpesvirus 1.

IBR or IPV are highly contagious conditions which affect either the upper respiratory tract or, less commonly, the genital tract. Rarely the virus invades the central nervous system causing encephalitis, and sometimes it affects the foetus causing abortion. The disease is seen in male and female cattle and buffalo. The IBR syndrome spreads by the airborne route when there is a close contact between sick and healthy animals. The IPV syndrome is usually spread venereally and may be overlooked unless the cow is examined closely. The male equivalent [infectious balanoposthitis (IBP)] causes lesions on the penis and prepuce of the bull.

Symptoms:

The onset of IBR is shown by a sudden high fever, loss of appetite, conjunctivitis, a serous discharge from nose and eyes and increased salivation. Later the discharge become purulent. In lactating cows the milk yield often falls dramatically. In pregnant cows abortion may occur at about 6 to 8 months of gestation. Occasionally there is coughing or nervous signs.

The IPV syndrome is less serious and includes fever, tail switching, painful urination, swollen vulva, petechiation and pustule and erosion formation in an inflamed vagina. There may be a thick yellowish discharge or pseudomembraneous form. Genital IBP lesions in bulls are similar but restricted to the prepuce and penis; the testes are not infected.

Death is rare except in newborn calves or in cases complicated by secondary infection. The virus can persist for life in cattle after clinical recovery and may be re-isolated from the nose, vagina or prepuce.

Diagnosis:

Based on the clinical findings. Confirmation can be sought by isolation of the virus from nasal or genital secretions during the acute stage of the disease or antibody in the serum. In fatal cases, formalised samples of trachea and lung may be useful for histopathology. IBR must be differentiated from other infections notably MCF and rinderpest.

Treatment and control:

Affected animals should be isolated as soon as clinical signs appear. Broad-spectrum antibiotics are useful in countering secondary infection. Vaccination may be useful in affected areas but there is a risk of abortion if the vaccine is administered to pregnant cows.

BOVINE EPHEMERAL FEVER (BEF):

Also known as three day sickness, stiff sickness, bovine epizootic fever, this acute infection is caused by a rhabdovirus and is insect transmitted.

BEF is characterised by an acute fever of short duration often accompanied by stiffness or lameness. Commonly the morbidity rate is high but mortality is low, usually less than 1%. BEF has been reported and serological surveys have indicated that some Indonesian cattle have serum neutralising antibody to BEF virus. The disease also occurs in Malaysia and probably other Southeast Asian countries.

Symptoms:

Fever which may last 1 to 4 days, lachrymation, dyspnoea; sick animals refuse food and water because swallowing is painful. There is nasal discharge and drooling of saliva.

Rumination ceases for about 2 days with diarrhoea in some cases, constipation in others. In lactating cows there is a sudden and severe drop in milk production. The yield returns to normal in about 2 weeks, but cows affected late in lactation may dry off. Mastitis sometimes develops and cows in advanced pregnancy may abort.

In most cases affected animals recover completely. Mortality is usually less than 0.5%, but it may be higher if the animals are under stress.

Diagnosis:

In the field a provisional diagnosis is made usually on clinical observations. Laboratory tests require paired serum samples collected 10 to 14 days apart which should be submitted to a central laboratory with adequate diagnostic facilities.

Treatment and control:

No treatment is satisfactory. Vaccination, except in valuable breeding animals, may not be warranted because this is a relatively mild disease.

AKABANE DISEASE:

Akabane disease is a term used to define congenital defects in calves due to infection with Akabane virus and other pathogenic viruses in the Simbu group of bunyaviruses. It is believed that transmission occurs solely by blood sucking insects.

Symptoms:

Infected young and adult animals show no clinical signs but when infection occurs during pregnancy the virus passes to the foetus causing severe disease of its central nervous system. The first observed manifestations of an outbreak are late abortion and stillbirths. The more generally recognised forms of the disease are seen in live calves with a variety of developmental defects depending on the time of infection during pregnancy:

- polioencephalomyelitis. Most affected calves are unable to stand, and show incoordination, ataxia, paralysis of one or more limbs, muscle atrophy, exophthalmos and lachrymation.
- arthrogryposis. The joints of one or more limbs are fixed usually in flexion. There is muscle atrophy; severely affected calves are usually dead at term and associated with dystocia.
- hydranencephaly. Mostly blind calves, unable to suck; poor response to stimuli, the behaviour varies from depression to hyperexcitability; deformed skulls.
- microencephaly (abnormally small brain). They are 'dummy' calves, uncoordinated and unable to stand.

Diagnosis:

May be made from clinical signs, and the pathology of congenital defective calves. The diagnosis is confirmed by demonstration of specific antibody in the serum of the newborn animal collected before it has taken colostrum. Virus can be isolated from the affected calves.

Treatment and control:

The usual practice is to destroy affected animals. Care should be taken not to import pregnant animals from non-endemic areas to endemic areas.

JEMBRANA DISEASE (JD):

Jembrana disease is considered to be a problem especially in Bali cattle. It is concentrated on the island of Bali, but a syndrome with similar characteristics (Rama Dewa) is also recognised in Lampung in the province in South Sumatera and in East Java. To date, JD has only been diagnosed in Indonesia. The causal agent has not yet been clearly identified but a filterable agent, probably viral, is involved. Jembrana disease is an acute, infectious condition usually with a low mortality rate. Buffalo, Bos indicus and other breeds may be less susceptible. The case mortality rate is usually less than 10%.

Symptoms:

These include fever, anorexia, mild lachrymation and hypersalivation and enlarged lymph glands (Photograph 5.2.4). Blood sweating, bloody diarrhoea and moderate, temporary anaemia are inconstant. Pregnant animals may abort.

Diagnosis:

Is based on the history, clinical signs, and the pathology of affected organs. A serological (ELISA) test is now available for diagnostic or epidemiological studies. From fatal cases, tissues for diagnosis should include small blocks of anterior lobe from lung, mediastinal lymph node, liver, kidney and brain including choroid plexus, all fixed in 10% formalin.

Photograph 5.2.4
Jembrana disease. Enlargement of prescapular and subiliac lymph glands. The animal also showed fever and diarrhoea. Bali heifer.

Treatment and control:

Tetracyclines give variable results. Spraying the animals with insecticide has also been reported as a precaution to control the disease but is of doubtful value. The possibility of vaccination is being investigated.

(iii) Parasitic diseases:

Internal parasites

TRYPANOSOMIASIS (SURRA):

The common pathogenic trypanosome in many parts of Asia is *Trypanosoma evansi*. The parasite infects horses, cows and buffalo and the disease can be epidemic causing heavy mortality. Flies of the genus Tabanus (*T. rubidus* and *T. meganops*) are among the main transmitters. The parasite has been detected in all main Indonesian islands except Sumba, Flores, Maluku and Irian Jaya. It is also present in India, Malaysia, Thailand and Vietnam. The disease can vary from inapparent infection to acute forms, with death in a few days. In endemic areas cattle and buffalo normally form subclinical reservoirs of infection. Overwork has been reported to disturb the equilibrium between host and trypanosome in carrier animals and clinical episodes with significant mortality have occurred. Acute outbreaks are seen in non-immune animals introduced into endemic areas, e.g. in imported cattle and buffalo. The disease can be severe in horses in eastern Indonesia where preventive measures are routinely used.

Symptoms:

Anaemia is the most consistent clinical feature of trypanosomiasis. Also noted are prolonged bleeding times in a wounded animal. Temperature elevation occurs during acute parasitaemia. A reduction in fertility may be found.

Diagnosis:

Trypanosomes are readily seen in blood films in acute disease, but low parasitaemias occur in chronic infections. Blood in anticoagulant should be forwarded to a veterinary laboratory for confirmative diagnosis. Both direct staining and serological tests (e.g. ELISA) are now used.

Treatment and control:

Suramin (naganol) is the most common drug used in Indonesia. Preventive measures include detection and treatment of infected animals, protection of animals from biting flies, the control of sale of meat from infected animals, the control of stock movement and avoidance of stress. Livestock introduced for the first time into endemically infected areas should be given prophylactic treatment. It should be noted that they may be equally susceptible to other local infections, e.g. anaplasmosis. A thorough knowledge of the regional epidemiology may save the lives of many cattle and buffalo.

BABESIOSIS:

Babesiosis caused by the protozoan parasites *Babesia bovis* and *Babesia bigemina* are transmitted by the ticks *Boophilus microplus*, *Amblyomma testinudinarum* or *Rhipicephalus pilans*. The disease has been reported in Sumatera, Java, Sulawesi and Kalimantan as well as in other Southeast Asian countries.

Symptoms:

The clinical infection is characterised by high fever, loss of appetite, anaemia and haemoglobinuria (red water). Calfhood infection produces a mild disease but susceptible adult cattle show acute symptoms.

Diagnosis:

Clinical findings and demonstration of *Babesia* spp in red cells in blood smears fixed in methanol and stained with Giemsa is considered diagnostic.

Treatment and control:

Drug therapy early in an uncomplicated syndrome will produce dramatic recovery but advanced cases with considerable destruction of red blood cells will only respond to blood transfusion. Among the drugs used are: Trypan blue, acriflavine, phenamidine, ganaseg, acaprin and imizole. Preventive methods available are: control of tick vectors, vaccination of susceptible animals, treatment of infected animals, control of stock movements, good nutrition and avoidance of stress. Imported livestock should not be introduced to an endemic area without previous vaccination.

ANAPLASMOSIS:

Anaplasmosis is an acute, subacute or chronic disease of cattle caused by *Anaplasma marginale* and is transmitted by the same ticks which transmit babesiosis. The disease has been reported in Sumatera, Java, Bali, Kalimantan, Sulawesi and elsewhere in South and Southeast Asia. Calves up to a year old suffer a mild form which may be symptomless and recovery results in a lasting immunity and a carrier state. At the age of 2 to 3 years the disease is acute but rarely fatal. In cattle over 3 years old it may be peracute and fatal.

Symptoms:

In clinical cases fever, loss of appetite, weight loss, dehydration, constipation, dyspnoea, anaemia and pale yellowish mucous membranes, urination is frequent but normal in colour. The animal is weak and walks with a stiff gait. Abortion may occur and recovery is slow.

Diagnosis:

Is based on the presence of *Anaplasma* spp. in the stained red blood cells and on the clinical symptoms.

Treatment and control:

Treatment with oxytetracycline is effective. Carrier infections can be eliminated with long acting oxytetracycline (20 mg/kg intramuscularly twice, 7 days apart). Vaccination should be carried out when susceptible cattle are moved to an area where anaplasmosis is endemic.

FASCIOLIASIS (LIVER FLUKE):

Fascioliasis has been reported in most parts of Indonesia and Asia generally. Prevalence rates up to 90% have been recorded. The most common fluke is *Fasciola gigantica.* Acute cases are rare in draught animals and the parasite is usually undetected until meat inspection in abattoirs. The flukes require aquatic snails for their development and multiplication. Animals become infected by eating rice stubble and grass growing in or around permanent water, or drinking water containing the infective stages (metacercariae).

Symptoms:

In severe chronic cases there is anaemia, emaciation and weakness, reduced milk yield and reproductive performance, anorexia, oedema of the jaw, ascites and jaundice.

Diagnosis:

The presence of liver fluke eggs in the faeces detected with a microscope is proof of the disease but does not necessarily indicate the degree of severity.

Treatment and control:

Treatment and control methods are available such as control of snails, sanitation and chemotherapy; however they are rarely used because of cost and inadequate knowledge of the epidemiology. In areas of known severe infection a degree of prevention may be obtained with a wide range of compounds but the choice may depend on the local epidemiology. Essentially animals should not be given access to herbage from aquatic habitats which contain the snail intermediate host.

GASTRO-INTESTINAL HELMINTHIASIS:

In cattle, gastrointestinal roundworms cause clinical and subclinical disease, producing economic loss between 1 and 4 months of age (*Toxacara vitulorum*) and for the first 5 to 10 months after weaning (mixed strongyles). Buffalo calves, 1 to 4 months old, are also fatally affected by *T. vitulorum* but less severely by strongyles. Calves acquire infection with *T. vitulorum* from larvae in the milk for the first 6 to 8 days after birth. Larvae of most species of strongyles are eaten with grass but some species are also able to penetrate the skin and become important when calves are reared in crowded, wet unhygienic pens. Calves on a low plane of nutrition are more severely affected by roundworms than well fed calves.

Symptoms:

Anorexia, weight loss or poor weight gain, diarrhoea, anaemia and ascites.

Diagnosis:

Gastrointestinal helminthiasis should be suspected in animals 1 to 4 months of age and in calves for the first 10 months after weaning; especially those reared intensively in groups in wet unhygienic pens and on a low plane of nutrition. Faecal egg counts are a useful aid to diagnosis but can be misleading. The clinical picture is therefore important.

Treatment and control:

Control of *T. vitulorum* is achieved by treating calves orally with 300 mg of pyrantel once between 10 and 16 days of age. A single treatment with levamisole at 10 mg/kg is also effective but calves must be weighed to ensure the correct dose is administered. With these treatments the parasites will be eliminated from the intestine while still larvae and thus recontamination of the environment with eggs will be prevented.

Control of strongyles is probably not necessary in buffalo calves, or in calves from cattle that are reared after weaning with adult animals under extensive conditions, or in calves reared in hygienic pens and fed cut-and-carry fodder, or a high quality ration (especially high protein). However, where calves from cattle are reared after weaning on a low plane of nutrition, in crowded unhygienic pens or intensively on pasture as a group with other weaners, strongyle parasites may be expected to suppress growth rate and animals may die. Under such conditions control can be achieved by changing management or by treating animals with anthelmintic each 2 months for 2 or 3 treatments, commencing 2 months after weaning. All modern broad-spectrum anthelmintics are effective and choice should be made on the basis of availability and price.

CASCADO (STEPHANOFILARIASIS)

The disease is caused by *Stephanofilaria dedoesi* and the prevalence is high in some areas, e.g. Sulawesi. The worm produces a dermatitis. The disease is spread by biting flies.

Symptoms:

Lesions occur on the sides of the neck, the withers, dewlap, shoulders and around the eyes. A small number of small papules develop and coalesce to form a larger lesion covered by crust, the hair falls out and the skin thickens with blood and lymph which can be squeezed out readily. The lesion extends outwards while the centre becomes hard and covered with a thick, dry crust and may reach a size of 25 cm in diameter. Itching leads to rubbing and aggravates the lesion.

Diagnosis:

Demonstration of adult worms or microfilariae in skin scrapings.

Treatment and control:

Ointments containing 40% trichlorphon, 4% Supona-20 twice daily for 15 days or once daily for 30 days, or 4% fenitrothion once daily for 30 days. Control measures include control of fly vector with insecticidal ear tags, good nutrition and treatment of infected animals with topically applied organophosphates (e.g. trichlorfon) may be tried.

EXTERNAL PARASITES

A number of arthropods, which include flies, mosquitoes, lice, fleas, mites and ticks, may impair productivity. They cause loss of condition and damage to hides through intense irritation of the skin and mechanical activity. Some are also important vectors of viral, bacterial, fungal, protozoan and other diseases. In general a warm humid climate and low nutritional status of animals favours multiplication of these parasites.

Lice which breed on the animals are the easiest to control, and are susceptible to almost all insecticides. Two treatments are required, first to kill lice which are present on the animal at the time and the second 10–14 days later to kill lice which have hatched from the eggs attached on the animal hair.

Ticks are the biggest problem in many parts of the world but are less important in draught animals which are usually more resistant breeds and because they are regularly cleaned by their owners. *Bos taurus* breeds are significantly more susceptible to infection than *Bos indicus* or *Bos taurus* crosses.

Chemicals for control of arthropods may be sprayed by using hand or motor operated pumps. The simplest way for smallholders is washing with a cloth, brush or sponge dipped in a bucket. Insecticide or acaricide mixture applied in selected areas of the body will suffice. Backline pour-on application of parasiticide is more practical but less satisfactory than dipping. It must be emphasised that most of the chemicals used are very poisonous, especially in their concentrated form. Therefore they should be handled carefully and diluted before use exactly as directed by the manufacturers.

In villages at night, farmers repel flies, midges and mosquitoes from the host by burning grass or wood.

5.2.2 Calves

(i) Management and care of calves

All healthy working cows should be able to produce a calf each year. Under traditional systems with simple management, various authorities report serious losses in calves in the first few weeks of life. Such losses can be of great economic importance to the individual farmer and the national economy irrespective of the size of the production unit and should be considered unacceptable. Calves can be saved by better care. The following steps are necessary for successful management:

- Make an effort to identify oestrus in the cow and arrange mating or artificial insemination quickly.
- Record the time when the cow is mated to know when the calf is expected to be born and watch closely for signs of impending parturition.
- The cow should be provided with a clean, dry, well-bedded, well-drained and easily observed stall for calving.
- When the cow is showing signs of calving, she should be observed carefully, but not disturbed unless help is needed.
- As soon as the calf is born, the foetal membrane and mucus should be removed from the nose and mouth of the calf and the tongue pulled forward. If the cow calves normally, she will immediately begin to lick the newborn and thus stimulate respiration and circulation and dry the calf. If the calf does not breathe immediately, it should be stimulated by alternately compressing and relaxing the chest wall (artificial respiration) or by lifting up by its hind legs with a sudden jerk and letting it hang in this posture for a few minutes till the start of respiration.
- Make sure the calf is dry and warm. It should be closely inspected at least twice daily for signs of injury, illness or distress.
- The navel cord should be squeezed and tied about 2.5 cm away from the body and cut below the ligature. Painting the cord with tincture of iodine or dipping in 20% lysol will avoid any infection.
- **It is vital that a calf receives colostrum from the mother as soon as possible after it is born and certainly within the first 6 hours of life; it should continue to do so for the first 3 days.** If the calf is weak and unable to rise it should be assisted in getting a feed of colostrum.
- De-worm the calf against ascariasis with 300 mg pyrantel at the age of 10 to 16 days.
- In known infected areas vaccination againt brucellosis, haemorrhage septicaemia or other diseases should be arranged at the appropriate age.

(ii) Calf diseases

Mortality in young calves may be a serious problem under village conditions as well as in organised farming. Any negligence in feeding and management may result in losses especially during the first three months of age. Problems with calves may occur at various times:

- abortion of cows,
- birth of weak or dead calves,
- disease a few days after birth
- disease in the first three months of life.

5.2.3 Abortion

The causes here already have been discussed in Section 5.2.1. Factors that are important in determining the cause of abortion include the stage of gestation, season of the year, geographical location, whether the animals have been introduced into the herd recently or not, sources of feed and water, gross lesions, and many others. It is important to note the time of abortion by the cow to determine the causes. Some specific abortive diseases and their time of abortion are given in Table 5.1.

5.2.4 Birth of weak or dead calves

These may be caused by the same infections that cause abortion between 7 and 9 months of pregnancy. The foetus has been affected while it is still inside the mother. The sick foetus may be born but is weak and eventually will die, or it might die shortly before calving when the cortex of the kidneys just under the capsule will be liquefied; or die at calving (no blood clot in the umbilical vessels); or die after calving (a firm blood clot in the umbilical arteries will show that it was born and survived a rupture of the navel cord).

Table 5.1 Causes of abortion and affected pregnancy period

Disease	Time of abortion during pregnancy
Brucellosis	4–6 months; 7–9 months; weak or dead calf *
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Vibriosis	3–6 months
Ephemeral fever (BEF)	Late pregnancy
Akabane disease	Late pregnancy
Bovine viral diarrhoea (BVD)	3–6 weeks after infection
Infectious bovine rhinotracheitis (IBR)	6–8 months

* Calves, placenta and excretions are infective to farmers, veterinarians and other in-contact personnel

Weak and dead calves should be examined for any gross pathological changes. If the mother is suspected of any disease, submit blood samples, placenta and tissues from the dead calf to the laboratory for confirmatory diagnosis. For control measures the cow should be isolated and the calving stall cleaned and disinfected. If brucellosis is suspected al tissues should be handled with great care, preferably using rubber gloves, and the hands washed in disinfectant solution.

In addition to infectious disease there are other causes of weak and dead newborns such as dystocia (difficult calving), faulty maternal nutrition, stresses and inbreeding.

5.2.5 Disease in the first few days of life

(I) Calf diarrhoea or scours

This is a very contagious group of diseases of young calves and occurs mainly from 2 to 10 days of age. The incidence of mortality is highest in the first fortnight of life. It is a complex disease caused by a variety of pathogenic agents and is complicated by poor management and unhygienic environmental conditions. Various strains of *Escherichia coli* were considered to be the main cause of enteritis but the frequent involvement of other bacterial, protozoal and viral agents is now recognised. Calves obtain organisms from contaminated bedding and feed utensils, dirty pens, diarrhoeic calves, overcrowded calving ground, milk from cows affected with mastitis and from the skin of the perineum and udder of the cows.

Symptoms:

There are yellowish white and rancid smelling faeces, the hind quarters are dirty, the calf rapidly becomes dehydrated and loses weight, is dull and weak, the eyes become sunken, breathing is rapid and body temperature drops below normal. Unless treatment is given, death follows rapidly. Should a calf be infected there is a real risk that the disease will quickly spread to neighbouring calves.

Diagnosis:

Clinical findings and faecal samples to be cultured in the laboratory for toxigenic K99 *Escherichia coli.*

Treatment and control:

Prevention of colibacillosis is best achieved by ensuring that the calf receives colostrum in the first 48 hours and is kept under clean conditions.

The treatment of acute diarrhoea should include:

- isolation of affected animals from the group
- cessation of milk feeding for 24–36 hours
- replacing milk with warm water containing 0.95 g (2 teaspoonfuls) salt and 50 g (1/2 teacup) sugar per litre, the amounts must be measured carefully
- no other dry or liquid feed should be given.

For the next 24 hours diluted milk with water should be given until the faeces become firmer. Then undiluted milk may be offered again. Sulfa drugs and broad spectrum antibiotics given orally are useful for disease control.

NAVEL ILL - (JOINT ILL):

The disease occurs in calves raised under poor hygienic conditions. The infective agent enters via the navel in the first few days of life when it is moist and open. The mortality rate is high and in acute cases death is rapid.

Symptoms:

In less acute cases there is usually some swelling of the navel with abscess formation or the infection may spread to the liver and bladder with more serious effects. The calf loses its appetite, has a slightly elevated temperature and becomes prostrated. The hock and kneww joints may become swollen and painful.

Preventive measures:

Housing calves in a clean, hygienic environment and by dipping navels in tincture of iodine soon after birth.

5.2.6 Disease in the first three months of life

Many problems can occur during this period but the most important include:

SALMONELLOSIS:

This is an infectious disease of man and animals caused by organisms of the genus *Salmonella.* The septicaemic syndrome of salmonellosis usually occurs in young calves 2 to 3 weeks after birth, but it may occur as early as 48 hours. Adults are also susceptible. The source of infection is usually infected animals which contaminate pasture, feed or water with faeces. Salmonellae can survive many months in moist conditions, but are susceptible to drying and sunlight. In calves an important predisposing factor for occurrence of clinical sickness is stress, e.g. transportation, overcrowding and drought.

Salmonellosis can be transmitted to people. Animals and their excrete should be tended with care and proper disinfection procedures carried out.

Symptoms:

The clinical signs are subject to wide variation; some may be so mild as to pass unnoticed and others show acute septicaemia and die without signs of diarrhoea. Typical cases are characterised by dullness, high fever, incoordination of gait and recumbency. The faeces are putty-coloured and contain blood streaks. Death may occur between 1 and 2 days after the onset of symptoms, or it may be delayed to 5–7 days. When cases are prolonged the carpal and tarsal joints become enlarged and occasionally pneumonia and enteric symptoms may occur.

Diagnosis:

Peracute salmonellosis in calves is undistinguishable clinically from infection with *E. coli* and laboratory cultural examination of the faeces or rectal swabs are the only means of definite diagnosis.

Treatment and control:

Many drugs including sulphadimidine, nitrofurazone and antibiotics have been used with varying degrees of success in the treatment. It should be borne in mind that clinically recovered animals continue to excrete the organism in their faeces and thus act as carriers.

Control measures include good husbandry and hygiene, isolation of newly introduced calves and management of calves so that they can not be in touch with their own faeces to prevent reinfection. Where stress factors are involved, they should be eliminated. All manure and effluent from infected animal should be safely disposed in such a way to minimise the danger of contaminating the environment or infecting other animals or people.

TOXACARA (NEOASCARIS) VITULORUM

This parasitic disease is one of the most serious problems in buffalo and cattle calves in draught animal areas. It affects only young calves, and is transmitted via the colostrum during the few days of life. *T. vitulorum* larvae are only present in the milk of buffalo for about 8 days. Usually it causes clinical signs in calves 1 to 4 months of age. Mortality rate is high.

Symptoms, diagnosis and control methods have already been described.

5.2.7 Bulls

In some parts of Southeast Asia poor calf production is due to lack of bulls or AI services at village level.

Bulls are generally reared mainly for the following three purposes:

- breeding bulls to be used either for natural service or for collection of semen and use in artificial insemination,
- for draught purposes, mainly in paddy fields,
- for meat production,
- for sale

There is a need to make more bulls available at village level to ensure calf production. AI is often not available or readily provided when cows are in oestrus.

Bull fertility and management

For the improvement of animal production the breeding male plays a distinct role. To achieve his objectives:

- bulls should be of a good genetic type,
- they should have sound sexual health for the regular production of a large number of fertile sperm. Greater attention should be paid to the examination of bulls both for physical characteristics, e.g. testicular size and semen production.

A breeding bull should be sound in all aspects. Any factor that lowers the physical efficiency of a bull can affect reproductive performance. Recent work has indicated that infertility may be common in buffalo bulls. There is an urgent need for more research in both male buffalo and cattle.

There are three main types of infertility in bulls. These are:

Type I: bulls neither show libido nor give semen.
Type II: they ejaculate poor quality semen.
Type III: bulls yield poor quality semen after being normal.

Among these type of infertility, Type III is attributed to management or disease problems while the other two could be due to hereditary or infectious causes.

It is good practice to examine a stud or village bull for fertility. Examination of bulls for fertility includes: proportionate growth rate of bull according to age; normal development of genitalia assessed by measurement of scrotal circumference; sexual behaviour; excellent or very good libido and mating behaviour; semen production ability and quality; excellent or very good progressive sperm motility and concentration, sperm morphology; normal and abnormal sperm percentages.

An infertile bull should be sold for meat, never for breeding purposes.

(i) Management of the breeding bull

The management of bulls can be subdivided into two parts: (i) feeding, and (ii) general care and handling.

Feeding

A bull in service should not be too fat. Excessively fat bulls may lack a desire to breed and become impotent. He should not be underfed and thin. During heavy breeding periods, the bull should have an increase in the daily concentrate ration. Green fodder and sunlight are beneficial to the breeding bull and it is desirable to provide some pasture if possible. Pasture furnishes the best feed for bulls and also assures ample exercise. When the pastures are not available, some green fodder should be cut and carried to the bulls. The practice of giving only the low grade roughages to bulls is not recommended. Drinking water should be plentiful, fresh, clean and available at all times.

Care and handling of the bull

Cleanliness of bulls, bull pens and their surroundings, and efficient attendants are important for breeding efficiency.

For easy control and handling of a bull, a metallic ring or rope string is usually inserted into the nose through the cartilage of the nasal septum. Bulls should be handled gently. Rough behaviour, shouting and beating may affect the libido, quality of semen and approach to mating as well as the animal's temperament. Daily grooming keeps the animal clean and helps in detecting illness and injury. Ectoparasites such as ticks should be removed.

Keeping the bull standing at one place for a long period weakens his leg muscles and causes the toes to overgrow which puts an abnormal strain on legs and feet. Exercise helps to keeps animals fit and active, maintaining health and metabolic processes. With proper managerial practices and exercise the productive life of a bull can be increased. Abnormal growth of toes will change the walk and interfere with normal copulation. The horn should be kept at a normal length.

Buffalo bulls must be allowed to wallow in fresh water in the morning and evening. The water should be as clean as possible.

Disease control

To achieve greater production through a high fertility rate, the bull must be sexually perfect and free from any congenital, metabolic, nutritional, parasitic, infectious and non-infectious diseases. Disease control is necessary to prevent spread of infection and unwanted characters to the offspring.

Major diseases in bulls

See Section 5.2.1 - Diseases of working cattle and buffalo. Bulls are susceptible to the same range of diseases as females but the resultant pathology and clinical effects may be expressed differently.

(i) Infertility diseases

Infertility in bulls is often characterised by normal sexual desire and the ability to copulate and ejaculate but a complete or abnormally high percentage of failure of fertilisation or conception, or delayed return to oestrus indicating early embryonic death may occur in cows. Infertility is probably as common in the male as the female but it has received less attention.

Following are the main infectious diseases which cause infertility in bulls:

ACUTE INFECTIOUS DISEASE:

Among their systemic effects viral, parasitic and bacterial infections may affect the genitalia causing temporary or permanent infertility. These may include trypanosomiasis and ephemeral fever. Although *T. evansi* has a worldwide distribution there are few detailed studies on the pathology of the disease it causes. Bovine ephemeral fever in bulls has been reported to cause Wallerian degeneration of the spinal cord and the bull seldom recovers completely. More research is needed to measure their effects accurately.

BRUCELLOSIS IN BULLS:

Genital organs are usually infected. Lesions are present in seminal vesicles, often in the testicle and sometimes in the epididymis.

During the acute early stage, semen is highly infective. The acute stage may last several weeks but as the disease becomes chronic, the number of organisms decrease and excretion may stop altogether. In some cases, however, the organisms may be excreted intermittently and continue for years. Affected genital organs become firmer because of fibrosis.

VIBRIOSIS:

A venereal disease spread by infected bulls to susceptible females at the time of coitus or the time of artificial insemination with improperly handled and antibiotic treated semen. It is characterised by infertility with an increased number of services necessary per conception. At the time of breeding, the bull acquires the infection on a transient or permanent basis from the use of infected bulls. The older bull remains a chronic carrier. Young bulls under five years of age are difficult to infect. They may transport the organism from bull to cow to bull during the breeding season but rapidly become free of infection when isolated from infected cows. In bulls over five years of age vibriosis may become a chronic infection in the prepuce and persist for years.

The *Campylobacter fetus* carrier state in bulls can be determined by bacteriological culture and identification of the organism in semen, preputial smegma or washings from an artificial vagina. The infection can be effectively eliminated in bulls by dihydrostreptomycin injection subcutaneously at a dosage of 20 mg/kg of body weight, and 5 mg of 50% solution of the same antibiotic is applied locally to the penis and prepuce daily for 5 treatments.

TRICHOMONIASIS:

A venereal disease caused by *Trichomonas foetus* and spread at the time of coitus or artificial insemination. *T. fetus* is found in the genital tract and contents of the uterus of cows and on the penis, prepuce and urethra. In rare occasions it can be found in seminal vesicles and epididymis.

Clinical signs:

Characterised by early abortion, pyometra and infertility in female. In males, purulent balanitis may occur, associated with seminal vesiculitis. The prepuce may be swollen with mucopurulent discharge. Within a few weeks, the bull recovers from the initial clinical signs of preputial swelling completely but may become a non-clinical carrier all his life.

Diagnosis:

The presence of motile trichomonads by direct microscopy examination under low power objective from aborted material, foetal stomach contents or amniotic fluid. The examination might be followed by sending a number of mucus samples, preputial scrapings and preputial washings on ice to the laboratory for immediate culture.

Treatment and control:

The majority of infected cows have self-cured completely after one normal heat after a normal parturition. In bulls acriflavine douches applied via massage into the penis or prepuce is effective. Systemic treatment with dimetridazole 50 mg/kg body weight daily for 5 days has proved useful. Infected cows after recovery should be given sexual rest for at least three months and be examined before breeding. A method of selective culling old bulls combined with the use of young bulls is also effective under field conditions.

Acknowledgments

The advice of Associate Professor D B Copeman and Associate Professor R G Hirst in the preparation of this chapter was greatly appreciated.

Suggested reading

Many textbooks and original papers are available but for concentrated information on diseases of cattle the following are recommended.

Beveridge, W.I.B. (1983) Bacterial diseases of cattle, sheep and goats. Australian Government Publishing Service, Canberra, Australia.

— (1986) Viral diseases of farm livestock. Australian Government Publishing Service, Canberra, Australia.

Callow, L.L. (1984) Protozoal and rickettsial diseases. Australian Government Publishing Service, Canberra, Australia.

Campbell, E.A. (1983) Nutritional deficiencies and diseases of livestock. Australian Government Publishing Service, Canberra, Australia.

Cole, V.G. (1986) Helminth parasited of sheep and cattle. Australian Government Publishing Service, Canberra, Australia.

Siegmund, O.H. (1979) The Merck veterinary manual [5th Ed.] Merck and Company Inc. Rahway, N.J., USA. 1680 p.

5.3 Summary Tables

Table 5.2 Diseases of working cattle

Disease	Cause/Transmission	Symptoms	Prevention	Treatment
NON-INFECTIOUS DISEASE				
Fatigue	Too much work	Panting, increases saliva, fast cardiac rythym, loss of weight, weakness and death	Avoid sun heat and working more than 6 hours a day, 5 minutes rest after half an hour work	Rest the animal Good feeding and drinking water
Physical injuries	Bad handling, fighting, accidents, harness pressure, work on stony areas, excessive work	Swollen, hot painful lesions, ulceration, lameness	Hygiene, management care	Clean wound, antiseptic dressings, treatment with sulphonamides or antibiotics
Nitrite poisoning	Accidental excess in feed or water	Acute: dyspnoea, abdominal pain, diarrhoea, tremor, ataxia, convulsions. Chronic: weight loss, reduced milk yields, stillbirths	Management care	Methylene blue injection (intravenously)
Pesticide poisoning	Accidental excess in feed	Dyspnoea, salivation, lachrymation, diarrhoea, vomiting, abdominal pain, bradycardia, involuntary urination, tremor, ataxia, convulsions, coma	Management care	Emesis induction with apomorphine and atropinisation
Cyanide poisoning	Feeding on plants which contain cyanogenic glucosides, e.g. sorghum, cassava	Dyspnoea, irregular weak pulse, salivation, muscular twitching, spasm, staggering gait, coma	Feeding and management	Intravenous injection of sodium thiosulphate and sodium nitrite
Copper deficiency	Acid sulphate soils, molybdenum excess	Poor weight gain, loss in pigmentation, 'spectacles', anaemia, diarrhoea, poor conception rate, nervous disorders	Management	Injections with copper glycinate or copper calcium edentate every 3 months

introduced into the herd recently or not, sources of feed and water, gross lesions, and many others. It is important to note the time of abortion by the cow to determine the causes. Some specific abortive diseases and their time of abortion are given in Table 5.1.

5.2.4 Birth of weak or dead calves

These may be caused by the same infections that cause abortion between 7 and 9 months of pregnancy. The foetus has been affected while it is still inside the mother. The sick foetus may be born but is weak and eventually will die, or it might die shortly before calving when the cortex of the kidneys just under the capsule will be liquefied; or die at calving (no blood clot in the umbilical vessels); or die after calving (a firm blood clot in the umbilical arteries will show that it was born and survived a rupture of the navel cord).

Table 5.1 Causes of abortion and affected pregnancy period

Disease	Time of abortion during pregnancy
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* Calves, placenta and excretions are infective to farmers, veterinarians and other in-contact personnel

Weak and dead calves should be examined for any gross pathological changes. If the mother is suspected of any disease, submit blood samples, placenta and tissues from the dead calf to the laboratory for confirmatory diagnosis. For control measures the cow should be isolated and the calving stall cleaned and disinfected. If brucellosis is suspected al tissues should be handled with great care, preferably using rubber gloves, and the hands washed in disinfectant solution.

In addition to infectious disease there are other causes of weak and dead newborns such as dystocia (difficult calving), faulty maternal nutrition, stresses and inbreeding.

5.2.5 Disease in the first few days of life

(I) CALF DIARRHOEA OR SCOURS

This is a very contagious group of diseases of young calves and occurs mainly from 2 to 10 days of age. The incidence of mortality is highest in the first fortnight of life. It is a complex disease caused by a variety of pathogenic agents and is complicated by poor management and unhygienic environmental conditions. Various strains of *Escherichia coli* were considered to be the main cause of enteritis but the frequent involvement of other bacterial, protozoal and viral agents is now recognised. Calves obtain organisms from contaminated bedding and feed utensils, dirty pens, diarrhoeic calves, overcrowded calving ground, milk from cows affected with mastitis and from the skin of the perineum and udder of the cows.

Symptoms:

There are yellowish white and rancid smelling faeces, the hind quarters are dirty, the calf rapidly becomes dehydrated and loses weight, is dull and weak, the eyes become sunken, breathing is rapid and body temperature drops below normal. Unless treatment is given, death follows rapidly. Should a calf be infected there is a real risk that the disease will quickly spread to neighbouring calves.

Diagnosis:

Clinical findings and faecal samples to be cultured in the laboratory for toxigenic K99 *Escherichia coli.*

Treatment and control:

Prevention of colibacillosis is best achieved by ensuring that the calf receives colostrum in the first 48 hours and is kept under clean conditions.

The treatment of acute diarrhoea should include:

- isolation of affected animals from the group
- cessation of milk feeding for 24–36 hours
- replacing milk with warm water containing 0.95 g (2 teaspoonfuls) salt and 50 g (1/2 teacup) sugar per litre, the amounts must be measured carefully
- no other dry or liquid feed should be given.

For the next 24 hours diluted milk with water should be given until the faeces become firmer. Then undiluted milk may be offered again. Sulfa drugs and broad spectrum antibiotics given orally are useful for disease control.

NAVEL ILL - (JOINT ILL):

The disease occurs in calves raised under poor hygienic conditions. The infective agent enters via the navel in the first few days of life when it is moist and open. The mortality rate is high and in acute cases death is rapid.

Symptoms:

In less acute cases there is usually some swelling of the navel with abscess formation or the infection may spread to the liver and bladder with more serious effects. The calf loses its appetite, has a slightly elevated temperature and becomes prostrated. The hock and kneww joints may become swollen and painful.

Preventive measures:

Housing calves in a clean, hygienic environment and by dipping navels in tincture of iodine soon after birth.

5.2.6 Disease in the first three months of life

Many problems can occur during this period but the most important include:

SALMONELLOSIS:

This is an infectious disease of man and animals caused by organisms of the genus *Salmonella.* The septicaemic syndrome of salmonellosis usually occurs in young calves 2 to 3 weeks after birth, but it may occur as early as 48 hours. Adults are also susceptible. The source of infection is usually infected animals which contaminate pasture, feed or water with faeces. Salmonellae can survive many months in moist conditions, but are susceptible to drying and sunlight. In calves an important predisposing factor for occurrence of clinical sickness is stress, e.g. transportation, overcrowding and drought.

Salmonellosis can be transmitted to people. Animals and their excrete should be tended with care and proper disinfection procedures carried out.

Symptoms:

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Peracute salmonellosis in calves is undistinguishable clinically from infection with *E. coli* and laboratory cultural examination of the faeces or rectal swabs are the only means of definite diagnosis.

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Many drugs including sulphadimidine, nitrofurazone and antibiotics have been used with varying degrees of success in the treatment. It should be borne in mind that clinically recovered animals continue to excrete the organism in their faeces and thus act as carriers.

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Symptoms, diagnosis and control methods have already been described.

5.2.7 Bulls

In some parts of Southeast Asia poor calf production is due to lack of bulls or AI services at village level.

Bulls are generally reared mainly for the following three purposes:

- breeding bulls to be used either for natural service or for collection of semen and use in artificial insemination,
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For the improvement of animal production the breeding male plays a distinct role. To achieve his objectives:

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A breeding bull should be sound in all aspects. Any factor that lowers the physical efficiency of a bull can affect reproductive performance. Recent work has indicated that infertility may be common in buffalo bulls. There is an urgent need for more research in both male buffalo and cattle.

There are three main types of infertility in bulls. These are:

Type I: bulls neither show libido nor give semen.
Type II: they ejaculate poor quality semen.
Type III: bulls yield poor quality semen after being normal.

Among these type of infertility, Type III is attributed to management or disease problems while the other two could be due to hereditary or infectious causes.

It is good practice to examine a stud or village bull for fertility. Examination of bulls for fertility includes: proportionate growth rate of bull according to age; normal development of genitalia assessed by measurement of scrotal circumference; sexual behaviour; excellent or very good libido and mating behaviour; semen production ability and quality; excellent or very good progressive sperm motility and concentration, sperm morphology; normal and abnormal sperm percentages.

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(i) Management of the breeding bull

The management of bulls can be subdivided into two parts: (i) feeding, and (ii) general care and handling.

Feeding

A bull in service should not be too fat. Excessively fat bulls may lack a desire to breed and become impotent. He should not be underfed and thin. During heavy breeding periods, the bull should have an increase in the daily concentrate ration. Green fodder and sunlight are beneficial to the breeding bull and it is desirable to provide some pasture if possible. Pasture furnishes the best feed for bulls and also assures ample exercise. When the pastures are not available, some green fodder should be cut and carried to the bulls. The practice of giving only the low grade roughages to bulls is not recommended. Drinking water should be plentiful, fresh, clean and available at all times.

Care and handling of the bull

Cleanliness of bulls, bull pens and their surroundings, and efficient attendants are important for breeding efficiency.

For easy control and handling of a bull, a metallic ring or rope string is usually inserted into the nose through the cartilage of the nasal septum. Bulls should be handled gently. Rough behaviour, shouting and beating may affect the libido, quality of semen and approach to mating as well as the animal's temperament. Daily grooming keeps the animal clean and helps in detecting illness and injury. Ectoparasites such as ticks should be removed.

Keeping the bull standing at one place for a long period weakens his leg muscles and causes the toes to overgrow which puts an abnormal strain on legs and feet. Exercise helps to keeps animals fit and active, maintaining health and metabolic processes. With proper managerial practices and exercise the productive life of a bull can be increased. Abnormal growth of toes will change the walk and interfere with normal copulation. The horn should be kept at a normal length.

Buffalo bulls must be allowed to wallow in fresh water in the morning and evening. The water should be as clean as possible.

Disease control

To achieve greater production through a high fertility rate, the bull must be sexually perfect and free from any congenital, metabolic, nutritional, parasitic, infectious and non-infectious diseases. Disease control is necessary to prevent spread of infection and unwanted characters to the offspring.

Major diseases in bulls

See Section 5.2.1 - Diseases of working cattle and buffalo. Bulls are susceptible to the same range of diseases as females but the resultant pathology and clinical effects may be expressed differently.

(i) Infertility diseases

Infertility in bulls is often characterised by normal sexual desire and the ability to copulate and ejaculate but a complete or abnormally high percentage of failure of fertilisation or conception, or delayed return to oestrus indicating early embryonic death may occur in cows. Infertility is probably as common in the male as the female but it has received less attention.

Following are the main infectious diseases which cause infertility in bulls:

ACUTE INFECTIOUS DISEASE:

Among their systemic effects viral, parasitic and bacterial infections may affect the genitalia causing temporary or permanent infertility. These may include trypanosomiasis and ephemeral fever. Although *T. evansi* has a worldwide distribution there are few detailed studies on the pathology of the disease it causes. Bovine ephemeral fever in bulls has been reported to cause Wallerian degeneration of the spinal cord and the bull seldom recovers completely. More research is needed to measure their effects accurately.

BRUCELLOSIS IN BULLS:

Genital organs are usually infected. Lesions are present in seminal vesicles, often in the testicle and sometimes in the epididymis.

During the acute early stage, semen is highly infective. The acute stage may last several weeks but as the disease becomes chronic, the number of organisms decrease and excretion may stop altogether. In some cases, however, the organisms may be excreted intermittently and continue for years. Affected genital organs become firmer because of fibrosis.

VIBRIOSIS:

A venereal disease spread by infected bulls to susceptible females at the time of coitus or the time of artificial insemination with improperly handled and antibiotic treated semen. It is characterised by infertility with an increased number of services necessary per conception. At the time of breeding, the bull acquires the infection on a transient or permanent basis from the use of infected bulls. The older bull remains a chronic carrier. Young bulls under five years of age are difficult to infect. They may transport the organism from bull to cow to bull during the breeding season but rapidly become free of infection when isolated from infected cows. In bulls over five years of age vibriosis may become a chronic infection in the prepuce and persist for years.

The *Campylobacter fetus* carrier state in bulls can be determined by bacteriological culture and identification of the organism in semen, preputial smegma or washings from an artificial vagina. The infection can be effectively eliminated in bulls by dihydrostreptomycin injection subcutaneously at a dosage of 20 mg/kg of body weight, and 5 mg of 50% solution of the same antibiotic is applied locally to the penis and prepuce daily for 5 treatments.

TRICHOMONIASIS:

A venereal disease caused by *Trichomonas foetus* and spread at the time of coitus or artificial insemination. *T. fetus* is found in the genital tract and contents of the uterus of cows and on the penis, prepuce and urethra. In rare occasions it can be found in seminal vesicles and epididymis.

Clinical signs:

Characterised by early abortion, pyometra and infertility in female. In males, purulent balanitis may occur, associated with seminal vesiculitis. The prepuce may be swollen with mucopurulent discharge. Within a few weeks, the bull recovers from the initial clinical signs of preputial swelling completely but may become a non-clinical carrier all his life.

Diagnosis:

The presence of motile trichomonads by direct microscopy examination under low power objective from aborted material, foetal stomach contents or amniotic fluid. The examination might be followed by sending a number of mucus samples, preputial scrapings and preputial washings on ice to the laboratory for immediate culture.

Treatment and control:

The majority of infected cows have self-cured completely after one normal heat after a normal parturition. In bulls acriflavine douches applied via massage into the penis or prepuce is effective. Systemic treatment with dimetridazole 50 mg/kg body weight daily for 5 days has proved useful. Infected cows after recovery should be given sexual rest for at least three months and be examined before breeding. A method of selective culling old bulls combined with the use of young bulls is also effective under field conditions.

Acknowledgments

The advice of Associate Professor D B Copeman and Associate Professor R G Hirst in the preparation of this chapter was greatly appreciated.

Suggested reading

Many textbooks and original papers are available but for concentrated information on diseases of cattle the following are recommended.

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5.3 Summary Tables

Table 5.2 Diseases of working cattle

Disease	Cause/Transmission	Symptoms	Prevention	Treatment
NON-INFECTIOUS DISEASE				
Fatigue	Too much work	Panting, increases saliva, fast cardiac rythym, loss of weight, weakness and death	Avoid sun heat and working more than 6 hours a day, 5 minutes rest after half an hour work	Rest the animal Good feeding and drinking water
Physical injuries	Bad handling, fighting, accidents, harness pressure, work on stony areas, excessive work	Swollen, hot painful lesions, ulceration, lameness	Hygiene, management care	Clean wound, antiseptic dressings, treatment with sulphonamides or antibiotics
Nitrite poisoning	Accidental excess in feed or water	Acute: dyspnoea, abdominal pain, diarrhoea, tremor, ataxia, convulsions. Chronic: weight loss, reduced milk yields, stillbirths	Management care	Methylene blue injection (intravenously)
Pesticide poisoning	Accidental excess in feed	Dyspnoea, salivation, lachrymation, diarrhoea, vomiting, abdominal pain, bradycardia, involuntary urination, tremor, ataxia, convulsions, coma	Management care	Emesis induction with apomorphine and atropinisation
Cyanide poisoning	Feeding on plants which contain cyanogenic glucosides, e.g. sorghum, cassava	Dyspnoea, irregular weak pulse, salivation, muscular twitching, spasm, staggering gait, coma	Feeding and management	Intravenous injection of sodium thiosulphate and sodium nitrite
Copper deficiency	Acid sulphate soils, molybdenum excess	Poor weight gain, loss in pigmentation, 'spectacles', anaemia, diarrhoea, poor conception rate, nervous disorders	Management	Injections with copper glycinate or copper calcium edentate every 3 months

Sodium deficiency	Soil deficiency	Weight loss, reduced milk production, weakness, incoordination	Management	Introduce salt with adequate water
Phosphorus deficiency	Acidic, deficient soil	Bone chewing, loss of appetite, unthriftiness, fragile skeleton, lameness, breeding troubles, reduced milk yield, sudden death from secondary botulism	Management	Phosphorus supplementation, protein if required
INFECTIOUS DISEASES				
BACTERIAL DISEASES				
Haemorrhage septicaemia (HS)	*Pasteurella malticida* in contaminated water and feed, saliva and nasal secretions from infected animals	High fever, salivation, eye and nasal discharge, doughy swellings around larynx and brisket	Annual vaccination	Antibiotics
Anthrax	Contaminated food, water or wound infected with *Bacillus anthracis*	Sudden death, swellings, bloody discharge from mouth, nose and anus, diarrhoea, abortions	Annual vaccination	Antibiotics
Brucellosis	Ingestion of *B. abortus* or infection by *B. abortus* through the mucosa of eyes, noses, endometrium, semen	Abortions, cervicitis, endometritis, repeat breeding, retained placenta, stillbirths, hygroma of the knee joint, male infertility	Vaccination at 3 to 8 months old	None
Leptospirosis	Contaminated food, water with leptospira in urine	Abortion, jaundice, haemoglobinuria, fever, mastitis	Segregation, isolation of infected animal, sanitary procedures	Antibiotics, e.g. Streptomycin
Vibriosis	*Campylobacter foetus* in genital tract	Vaginitis, irregular return to service, abortion	Segretion, isolation of infected animal, sanitary	Antibiotics

5

VIRAL DISEASES

Foot and mouth disease (FMD)	Direct contact with infected animal or contact with contaminated material	Vesicles and ulcers on tongue and feet, loss of condition, lameness	Quarantine and vaccination	None
Malignant catarrhal fever (MCF)	Virus in carrier sheep	High fever, anorexia, discharge from eyes and nose, respiratory distress, corneal opacity, incoordination, paralysis convulsion, haematuria and severe diarrhoea occasionally	Avoid close contact with lambing sheep	None
Bovine viral diarrhoea (BVD) or mucosal disease	Ingestion or inhalation of virus contaminated materials	Fever, necrotic stomatitis, diarrhoea, abortion, sometimes corneal opacity, encephalitis, laminitis, pododermatitis	Quarantine and vaccination	None
Infectious bovine rhinotracheitis (IBR) or Infectious pustular vulvo-vaginitis (IPV). Infectious balano–posthitis in bull (IBP)	Direct contact between sick and healthy animals, airborne route	IBR: High fever, loss of appetite, salivation, discharge from nose and eyes, abortion IPV: fever, painful urination, swollen vulva, purulent discharge from inflamed vagina	Vaccination of the incidence is high. Avoid pregnant animals	Isolation and antibiotic treatment for secondary infections
Bovine ephemeral fever (BEF)	Virus transmitted by blood sucking insects	Fever which lasts 1–4 days lachrymation, dyspnoea, nasal discharge, salivation, sometimes diarrhoea or constipation, stiffness, lameness, abortion		Antibiotic injection in severe infection, intravenous fluid therapy if necessary
Akabane disease	Virus transmitted by blood sucking insects	Late abortion and stillbirths, no clinical signs in young and adult animals. Defects in live calves	Quarantine, destroy affected animals	None
Jembrana disease	Filterable agent	Fever, anorexia, lachrymnation, hypersalivation, lymphadenopathy, haemorrhage in mucous membrane, blood sweating, bloody diarrhoea, anaemia, abortion		Tetracycline with variable results

PARASITIC DISEASES

INTERNAL PARASITES

Trypanosomiasis	Blood sucking flies transmit *T. evansi*	Fever, anaemia, loss of body weight, poor reproductive performance	Fly eradication and avoidance of stress	Naganol injection (Suramin)
Babesiosis (piroplasmosis)	*B.bovis* or *bigemina* is transmitted by ticks	Fever, loss of appetite, anaemia, jaundice, reddish urine	Tick control and elimination, vaccination	Chemotherapy with trypan blue, acriflavine, avaprin, imizole, etc
Anaplasmosis	*A. marginale* is transmitted by ticks	Fever, loss of appetite, weight loss, dehydration, dyspnoea, anaemia, weakness, stiff gait, abortion	Tick elimination, vaccination	Long acting tetracyclines
Fascioliasis	Ingestion of infective stages	Anaemia, emaciation, weakness, oedema, jaundice, ascites, poor reproductive performance	Snail control, sanitation, controlled grazing	Chemotherapy
Gastrointestinal helminthiasis (see Ascariasis below)	Ingestion of infective larvae	Anorexia, weight loss, poor weight gain, diarrhoea, ascites, anaemia	Good management. Regular check and treatment	Chemotherapy especially to weaned calves every 2 months for 3-4 treatments
Calf diarrhoea (scours)	Contamination of bedding feed, utensils, teats with *E. coli*, other bacteria and virus	Rancid smelling faeces, dehydration, weight loss, rapid breathing, temperature below normal, often death	Sanitation, colostrum wherever possible	Isolation of affected calf, treatment with sulpho-namides and antibiotics. Fluid treatment
Navel ill (joint ill)	Infective agent enters moist and open naval	Swelling, abscess formation of the navel, loss of appetite, fever, swollen hocks and knee joints	Hygiene and dipping navel with tincture of iodine soon after birth	Antibiotics
Salmonellosis	Contaminated feed and water with *Salmonella* species	High fever, dullness, incoordination of gait and recumbency, putty coloured and blood streaked faeces, enlarged carpal and tarsal joints, sometimes pneumonia, death 1–2 days after the onset of symptoms	Isolation of recovered animal/carrier, good husbandry, good hygiene, eliminate stress factors, good sanitation	Sulphonamides and antiobiotics with variable results. Fluid replacement
Ascariasis	*Toxocara vitulorum* is transmitted via the colostrum	Diarrhoea, emaciation, dyspnoea, coughing, ill thrift, pot belly	Prophylactic treatment with pyrantel at 10–16 days old	Anthelmintics

G

GLOSSARY

Acid soil: Soil of pH less than 5.0.

ACIAR: Australian Centre for International Agricultural Research

Ad libitum: As referred to feeding, the animals have free access to as much feed as they can eat.

AI: Artificial insemination

Bajak or *luku*: A term normally used in West Java for a plough used in wetland.

Balik jerami: Zero tillage in which rice straws are turned over and are worked into the ground through trampling by people or are submerged in water by flooding of fields.

BC: Body condition

BEF: Bovine ephemeral fever

Brujul: A term normally used in East Java for a plough used in dryland.

Bugis: An implement used in West Java for levelling in wetland cultivation (lighter work).

BVD: Bovine viral diarrhoea (mucosal disease)

Carrying capacity index (CCI): The amount of digestible dry matter (DDM) of the available feed in a given area divided by the total feed requirement of the resident livestock units.

Carrying capacity: The maximum number of animals which can be carried in an area given its feed resources.

cm: Centimetre

CTM: Campylobacter transport media

Cukup baik: Good enough or fair.

Dibbling: Use of pointed instrument for making holes in ground for sowing of seeds or planting.

Digestibility: Digestibility of fodder eaten is that proportion which is not excreted in the faeces and therefore is commonly assumed to be absorbed by the animal.

DM: Dry matter

Draught force (DF): Force which is required to pull a plough or a leveller. It is measured in kg or newton.

Dry agroclimatic zone: A zone with 5 to 8 consecutive dry months.

Dry month: A month with less than 100 mm of rain and will not support the growth of most of the economically important crops.

EE: Ether extractives

ELISA: Enzyme-linked immunosorbent assay

FMD: Foot and mouth disease

Fodder: All plants and plant residues eaten by ruminants.

Garu: A Javanese implement used for levelling in wetland cultivation (heavier work).

Gotong royong: Helping each other without payment.

ha: Hectare

Harvest index: Proportion of crop yield over total biomass of all parts of a plant (dry matter basis).

HCN: Hydrogen cyanide.

High altitude: Land which is greater than 500 m and less than 1000 m above sea level.

Horse power (HP): A unit for measuring rate of work. One horse power is equal to 726 watts.

HS: Haemorrhagic septicaemia

IBP: Infectious balanoposthitis

IBR: Infectious bovine rhinotracheitis

Idhul Haj: Moslem celebration day approximately two months after *bulan puasa* (see *Lebaran*).

Intermediate agroclimatic zone: A zone with 2 to 4 consecutive dry months.

Intermediate soil pH: soil of pH greater than 5.0 and less than 6.0.

IPV: Infectious pustular vulvovaginitis

Irigasi teknis: Irrigation system.

Jamu: Traditional medicine.

JD: Jembrana disease

Joule (J): Unit of work or energy equal to that required to exert a force of one newton over a distance of one metre.

Kabupaten: District.

Kelels: An implement usually made of bamboo which an animal is made to pull along the ground during training.

kg: Kilogram

Kutu loncat: A leaf hopper (psyllid) which destroys leucaena plants.

Lebaran: Moslem celebration day after the fasting month (30 days) called *Bulan phusa*

Lime soil: Soil of pH greater than 6 and less than 6.8.

Linggis: A metal tipped digging stick commonly used in Timor for land cultivation.

Livestock unit (LU): One LU is equivalent to an animal weighing 250 kg. The factors used for converting the number of large and small ruminants to LU are:

LU = 0.7 x number of cattle, or
= 0.8 x number of buffalo,
= 0.06 x number of sheep or goats.

Low altitude: Land which is less than 100 m above sea level.

LW: Liveweight

m: Metre

Mantri hewan: District veterinary assistant.

MCF: Malignant catarrhal fever

Medium altitude: Land which is 100 to 500 m above sea level.

Mencacah: Zero tillage in which rice straws are chopped into short lengths and are either subjected to trampling or flooding as described for *balik jerami.*

Merancah: Preparation of land for rice cropping by flooding of field with rain or irrigation water and trampling the soil using a herd of cattle.

Metabolisable energy (ME): The total energy of a feed eaten less the energy which is lost via the faeces and combustible gases particularly from the rumen through eructation.

mg: Milligram

MJ: Megajoule

Mm: Maintenance energy requirement

Monoculture: One crop cultivation.

NDF: Neutral detergent fibre

Newton (N): A unit of force required to move 1 kg mass at 1 m/sec. 1 kg = 9.81 newtons.

NTT: Nusa Tenggara Timur

Palawija: Secondary crops.

Peranakan ongole (PO): Ongole cross cattle.

Paron: A system of fattening male cattle in Timor.

Pasang: Use of draught animals in pairs.

Pegon: Use of draught animals as singles.

Rp: Rupiah

RUP: Rumen undegradable protein

Sapi perah: Dairy cattle.

Sapi potong: Beef cattle.

Singkal: A term normally used in East Java for a plough used in wetland.

Soil shear strength: Measured by a hand vane tester which comprises a torque head with a direct reading scale. The vane which is 19 mm in diameter and mounted on an extension rod is pushed into the soil to a depth of 10 to 15 cm for reading of shear strength

Swidden agriculture: This is slash and burn agriculture; shifting agriculture

t: tonne

Wet agroclimatic zone: A zone with less than 2 consecutive dry months.

Wet month: A month with enough rainfall to grow a crop of lowland rice. It has at least 200 mm of rain.