

Indigenous Bali Cattle is Most Suitable for Sustainable Small Farming in Indonesia

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Livestock husbandry is essential for Indonesia. This study reviews cattle characteristics and husbandry methods in the country with special interest in describing the importance of indigenous breeds of cattle. As a conclusion, the Bali cattle ought to be considered the most suitable indigenous cattle breed for the low-input, high stress production system still practised by millions of families in Indonesia.

Introduction

Indonesia has a total population of approximately 206 million people with 4.5 million households keeping livestock. Approximately half of the cattle farmers are small farmers. The Indonesian archipelago is a land area of 1.8 million km² consisting of over 13 000 islands stretching from the Western tip of Sumatra to the eastern border of Papua. The largest island, Kalimantan (Borneo), covers 28% of the total land area. Java, with only 6–7% of the total land area, is inhabited by approximately 60% of the total population and is the most densely populated island. The agro-ecological zones vary from the humid coastal wetland swamps in Sumatra, Java, South Sulawesi and Bali, to the subhumid and semiarid dry land in the eastern part of Java, Sulawesi and most of the Nusa Tenggara islands. There is a wetter to a dryer climate from the west to the east. Approximately 60% of the archipelago has almost 7–9 consecutive months of rain in the wet season and <2 months with no rain in the dry season. The eastern islands have the lowest rainfall with the dry season varying from 3 to 8 months. The average temperature stays within a constant range differing in only a few degrees centigrade between the hot and cool months. The farming systems are regulated more by rainfall than temperature. The plantations and food crop areas are located primarily in the western wetter regions. Extensive marginal grasslands are in the drier eastern islands. Rain forest areas are found in Sumatera, Kalimantan and Papua, with limited areas on Java, Madura, Bali and Sulawesi. An alarming deforestation process is still occurring caused the illegal logging activities.

The soil fertility varies greatly, strongly affected by the climate and active volcanoes found in many of the large and small islands. The heavy rainfall causes soil erosion and high temperatures resulting in chemical weathering. The eastern islands generally have very poor soils that prevent intensive farming. The animal production systems involve both ruminants and non-ruminants. Crops and animals are integrated with the benefits associated with the complementary interactions between these products. The economic benefits of these

integrated systems contribute to their sustainability (Devendra 1993). Three major cattle production systems can be described in the country (Devendra et al. 1997): (i) Extensive grazing systems, primarily low-input-low-output systems with less opportunity for improvement through the application of new technologies, implying use of native grassland grazing or of upland forest and forest margin grazing; (ii) Arable crop land and pasture combination systems where the interactions between crops and animals are important, including roadside and communal grazing combined with stubble grazing, animals tethered or allowed free access or, grasses, crop residues and agro-industrial by-products stall-feeding and (iii) Systems integrated with perennial tree crops, such as grazing under coconut, rubber, oil palm and fruit trees. In the first system, the farmers are primarily small landholders with occasional tribal herds of a few hundred head owned by a tribal head. In the second system, nearly all participants are small landholders. In the third system, the oldest traditional system, traditional small coconut plantation grazing, is practised. The third system is a relatively new effort, still being tried, to integrate large commercial plantations (rubber, oil palm and fruit trees) with small landholder animal production (small and large ruminants).

In the eastern islands, Nusa Tenggara Barat (NTB) and Nusa Tenggara Timur (NTT), large areas of native grasslands occur and are grazed continuously throughout the year by buffalo, cattle and goats. These grazing areas are communal and no one is held responsible for the land maintenance. Most of these areas currently have fast growing weed infestation problems, namely *Chromolaena odorata*. Latest unofficial observations stated that approximately 80% of the edible native vegetation in the grazing lands in the NTT are covered by weeds, creating serious feed resource problems for the cattle and other ruminants. The overall availability of feed for the ruminants is probably adequate; however, the problem is unequal distribution. Sumatera is over-supplied, while deficiencies can be found in Java, Madura, the eastern Islands and Papua. Trials on forage integration with perennial tree crops such as the oil palm, rubber and fruit trees are in progress. Most cattle feed on the native forages on wastelands, roadsides, unplanted land and crop-stubble. Cattle are stall-fed year-round in systems that are more intensive. In extensive systems, cattle are herded or let out to graze in the natural common grazing areas during the day and corralled at night. The present review intends to provide an overall view of the importance of Bali cattle for Indonesia, for cultural reasons and also for the small farm-holding in the country. Some of the information

hereby verted has been presented elsewhere (Martoyo 2003).

The Bali cattle breed

The Bali breed is one of the four existing indigenous cattle breeds (Aceh, Pesisir, Madura and Bali) in Indonesia. The Sumban-Ongole and Javan-Ongole may also be considered local breeds. Although no official historical records exists, it is generally accepted that the Bali cattle is the domesticated direct descendant of the wild Banteng still surviving as an endangered species in three National Wild Reservation Parks (Ujung Kulon, Baluran and Blambangan) in Java.

Taxonomy of the Banteng / Bali cattle

Many taxonomical names have been given to the Banteng/Bali cattle. Some of these names are *Bos sondaicus*, *Bos sondaicus*, *Bos javanicus*, *Bos bantinger*, *Bos banten*, *Bos bantinger*, *Bibos banteng* and *Bibos sondaicus* (Merkens1926). The last two names using *Bibos* are based on the opinion that the Banteng belongs to a separate species (*Bibos*) from the other cattle groups (*Bos*). The Banteng are more closely related to the Gaur and Gayal. The earliest documented report on the Banteng was by Schlegel and Muller in 1836 (Merkens 1926). They stated that the Banteng was found wild in small herds with a single bull and several cows and calves in the forests of Java and Kalimantan (Borneo). The Banteng is a large animal according to this report. The bulls have a wither height of 1.76 m. The t'Hoer has a smaller wither height of 1.4–1.5 m and a chest girth of 2.0–2.1 m. There is no recent report on the measurements of Bantengs still surviving in the Wild Reservation areas. This is because of the difficulty in catching these animals in the wild. The few samples in the Zoos in Java have no authentic records of their origin and dates of capture, casting doubt on whether they were actually wild Bantengs or just domesticated Bali cattle. The distinguishing difference between the Banteng and Bali cattle is the size and some behavioural traits.

The more recent taxonomical names adopted by the IUCN/SSC Asian Wild Cattle Specialist Group (Byers et al. 1995), naming three subspecies of wild Banteng are the Burma banteng (*Bos javanicus birmanicus*), the Javan banteng (*Bos javanicus javanicus*) and the Kalimantan (Borneo) banteng (*Bos javanicus lowii*). How many subspecies should be recognized and included in captive breeding programmes remains an unresolved problem. There is a need to further assess the genetic and phenotypic variations within the global population of wild Banteng utilizing new DNA technologies to determine the validity of the above three traditionally recognized subspecies. Additionally, there are unresolved questions about the purity of the genetic status of the captive population. Many founder animals for the captive populations were Bali cattle, which is the domesticated form of the wild Banteng. Because Banteng can interbreed with common cattle, there exists the possibility that zoo populations may contain genetic

material from Bali cattle X *Bos Taurus* crosses. Domestic and feral Bali and other breeds of cattle are also a threat to the genetic integrity of wild Banteng populations in the National Wild Reserves in Java.

Conservation

Both the IUCN Red Data List and the U.S. Endangered Species Act classify the Banteng as endangered. This is based on an overall decline of at least 20% over the last three generations. The Banteng is not currently listed by CITES, although the IUCN/SSC Asian Wild Cattle Specialist Group (Byers et al. 1995) is seeking to have them listed as Appendix I. There is no immediate concern for the Bali cattle considering the current total population estimate of 2.3 million head. There is some concern about the purity because of intensive cross-breeding programmes using natural mating and AI using exotic breeds that may cause extinction because of indiscriminate crossing.

Current population estimates and distribution

Banteng

No subpopulations of more than 500 Banteng are known, and only six to eight subpopulations of more than 50 Banteng are known to remain (five or six on Java). The population trend on Borneo is unknown. The Banteng populations on Java are relatively stable, although there are threats attributable to illegal hunting, habitat destruction and diseases from domestic livestock.

Bali cattle

The current population estimates (of 2000) for the Bali cattle in the five major resource areas are as follows (Talib et al. 2002):

Estimates of population size (in 2000), head numbers

Number of heads	Area				
	Bali	NTB	NTT	South Sulawesi	Lampung
	529 000	377 000	443 000	718 000	255 000

There are other provinces with fast growing population numbers managed by small landholders. One of the most promising provinces is South-east Sulawesi with a recent population of 300 000 head. These herds were started using small numbers of imported Bali cattle in 1923 and larger numbers during the 5-year plans. Propagation was conducted through governmental owned cattle distribution to participating farmers and redistribution of the offspring to a growing number of participating farmers. This is another example of the superior quality of Bali cattle as a pioneer breed for the farming system in many new cattle production areas (transmigration projects).

There is however some concern for the negative population growth trend of 12.3% on average because of extraction during the monetary crisis years. Measures to halt this negative trend have been taken by local

governments. The total populations of the major local breeds are as follows:

Breed population size, head numbers

Number of heads	Breed			
	Ongole	Bali	Madura	Others*
	1 033 000	2 632 000	1 131 000	4 980 000

*includes exotic breeds and crossbreeds

The Bali cattle have the largest number, showing it as the local cattle breed most suitable for small landholder cattle farming.

Characteristics

The Banteng is considered one of the most beautiful of all wild cattle species. They are most likely the ancestors of the domestic cattle of South-east Asia. The Banteng are a sexually dimorphic species, with mature males being dark bluish black and cows and juveniles reddish brown. Both sexes have white rump patches and stockings. Both sexes carry horns, although they are much heavier and larger in the males. The Banteng are smaller and have a more even temperament than the gaur. There is a well-defined narrow dark stripe along the backbone, only seen in the calves and females. In bulls, the red hair on the body begins to darken at 12–18 months of age and by maturity, the animal becomes almost black. In castrated bulls, the black hair on the body changes to red again within a few months of castration. The body is relatively large-framed and well muscled. Adult males weigh between 600 and 800 kg, while adult females weigh between 500 and 650 kg. Their average lifespan in the wild is 11 years, although they can live to 20–25 years of age. It is very common for captive Banteng to live into their late teens or mid-twenties (Byers et al. 1995). These are humpless cattle.

Productivity traits of the Bali cattle

The Bali cattle are similar to the Banteng, differing only in size and temperament. Domestication has brought about smaller, easier to handle and docile animals. The average production traits of the Bali cattle females under the extensive farming system showed in Table 1 (Talib et al. 2002).

Average mature bull weights for NTB, NTT and South Sulawesi range 335–363 kg, and the corresponding weight for the Bali is 395 kg (Talib et al. 2002). Table 2 shows the reproductive performance and milk production of the Bali cattle (Talib et al. 2002).

Table 1. Production traits of Bali cattle females

Trait	Bali	NTT	NTB	South Sulawesi
Birth weight, kg	16.8	11.9	12.7	12.3
Weaning weight, kg	82.9	79.2	83.9	64.4
Yearling weight, kg	127.5	100.3	129.7	99.2
Weight at puberty, kg	170.4	179.8	182.6	225.2
Mature cows weight, kg	303.3	221.5	241.9	211.0

NTB, Nusa Tenggara Barat; NTT, Nusa Tenggara Timur.

Table 2. Reproductive performance and milk production of Bali cattle

Trait	Bali	NTT	NTB	South Sulawesi
Age at puberty, year	2.0	2.5	2.0	2.5
Calving age, month	32	41	36	36
Calving interval, month	14	15.4	16	15.7
Calving rate, %	66.3	66.6	51.7	60.4
Calf mortality, %	8.5	48	15	8
Milk production, kg/6 month	274.5	165	–	164

NTB, Nusa Tenggara Barat; NTT, Nusa Tenggara Timur.

Those average figures for the cows are considered low compared to figures from the *Bos taurus* cattle in the intensive production systems in temperate zones. However, these figures are the highest among the indigenous cattle breeds in Indonesia, especially the calving rates. The figures in Tables 1 and 2 were cited from the latest article presented in an ACIAR-CRIAS organized Bali Cattle Workshop held in 2002 (ACIAR-CRIAS, 2002). The data were based on field observations and measurements in four areas from a limited number of animals. The measurements are likely influenced by the differences in environmental and management systems, thus making comparisons difficult.

Unique traits

A harsher environment induces smaller/lower performance in several traits such as lower calf birth weight, low milk production, lower calf growth rate and earlier calf age at foraging as well as cattle health resilience. A herd will also show lower birth rate (calving percentage/crop) and higher calf mortality under stressful climatic conditions. The smaller average growth rate and weight at different ages are also a herd survival adaptation. If necessary, a herd could revert to its wild ancestor feral/wild animal traits to survive in the wild without any human intervention. The proof of this can be seen in the feral Bali cattle populations in several small-uninhabited islands in Indonesia. The most extreme example of feral Bali cattle is the thriving population on the Coburg peninsula in Northern Australia.

The Bali cattle is a species that has the ability to show different phenotypes under different circumstances, also known as phenotypic plasticity. This ability may not be beneficial for intensive management systems. However, it is favourable for the small landholder system.

Genetic improvement (Breeding programmes)

Pure breeding, cross-breeding and selection programmes were applied utilizing local and exotic breeds in Indonesia. The following is a concise report on the efforts started in the early 19th century (Merkens 1926; Fordyce et al. 2002; Martojo 2002).

Ongole and Hissar breeds

Local breeds (Aceh, Pesisir, Madura, Bali, Javan-Ongole and Sumban-Ongole) were improved using Ongole bull from India. This was recorded in the 19th century

using Ongole bulls and small-sized local Javan breeds (now considered extinct) in East Java. Ongole bull imports by several private plantation companies to produce larger draught cattle continued in small numbers. This was terminated at the end of the century because of rinderpest disease outbreaks in India. Massive Ongole cattle importation from India continued until 1920 on field observations and measurements in four areas from a limited number of animals. The measurements are likely influenced by the differences in environmental and management systems, thus making comparisons between these performances may not be valid. In 1923, the number of cattle in Sumba Island accounted to approximately 1500 head. Sumba has been a source of breeding stock for other regions since then. The Hisar breed was also imported and used in Sumatra and Northern Sulawesi.

Madura breed

Starting early in the 20th century, the Madura breed was maintained pure in Madura by closing the Madura from other breeds. Trials were started to propagate Madura cattle in Java and Flores Island. However, these cattle did not thrive and a gradual change was made to the Bali breed.

The Bali breed

In 1926, the Bali breed numbered 275 000 head in Bali and 125 000 in the Lombok islands. The Bali breed was then distributed to Timor, South Sulawesi and other regions in the eastern islands. After a century of effort, the highest population among the other breeds (local and exotic) totalled 9.8 million head of cattle consisting of 2.6 million head of the Bali breed. This has proven the superiority of the Bali breed for most agro-ecological zones in Indonesia. Most of these cattle are in the hands of small farmers. The Bali breed is the best for small landholders.

Exotic breeds

Beginning with the second 5-year plan in the 1970s, frozen semen from exotic cattle breeds was imported. Many cross-breeding programmes using exotic bulls (*Bos taurus*, *Bos Indicus* and *Bos indicus* derivatives) or frozen semen (artificial breeding) in these regions were failed to yield desirable results. Success occurred only where zebu or zebu derivative cross-breeding was utilized. It is likely that such programmes will never succeed in the harsh zones unless adequate fodder availability is assured and the farmers can afford the feed and concentrates required by the crossbred cattle. Most of the eastern island regions have plenty of grazing lands, but such lands are communal and not properly managed. Grazing on these lands is uncontrolled, leading to poor land productivity. Fodder cultivation is not in practice in these regions. The local Bali cattle survive primarily on fodder trees; grasses cut from forests or graze in nearby forests. Fodder cultivation is

not a priority for the small, marginal farmers that are the majority in the eastern regions.

Breeding programmes for the small landholder farming system

The unique conditions in the small landholder cattle farming system have drawn special attention because efforts to improve productivity by introducing new technologies developed in the developed world ended in failure. New breeding approaches (Martoyo 2002; Talib et al. 2002), nutrition (Bamualim and Wirdahayati 2002) and management programmes (Fordyce et al. 2002) were suggested in the ACIAR workshop. The most current recommendation was the 'Contribution to sustainable livelihood and development; Realising Sustainable Breeding Programs in Livestock Production' (INRA and CIRAD, 2002). This recommendation is based on the presence of three production levels: Level 1 – Subsistence-based production, Level 2 – Market-based production and Level 3 – High-input production. The small landholder system fits in Level 1 and requires a special method for the planning and application of various improvement efforts.

Disease resistance

It is also a known fact that exotic and crossbred cattle are less resistant to parasitic infestation and diseases in comparison with local cattle. Poor transportation, communication and marketing infrastructure make these regions inaccessible. Extension services are therefore poorly equipped to meet the requirements for the efficient technology transfer needed for most input-intensive improved breeds. Thus, after several 5-year trials and plans, the government of Indonesia should have been able to determine a best breeding policy for the best suited cattle breed for the small landholders system. The Aceh breed for Aceh province, Pesisir for West Sumatra, Javan-Ongole for provinces in Java, Madura for Madura province and most importantly the Bali cattle for the other provinces and the eastern Islands and Kalimantan were considered (Borneo).

Weaknesses of the Bali cattle

Despite its superior qualities as a pioneer breed, this breed has weakness. The Bali breed has a unique susceptibility to the Malignant Catarrhal Fever, which is contracted through sheep as a vector. In provinces with a high sheep population, such as West Java, the Bali cattle cannot survive. Another disease unique to the Bali cattle is the Jembrana disease. This disease also has a high morbidity rate. No economically effective vaccines have been developed for these diseases. Only Bali cattle originating from Bali island (which may have a higher rate of inbreeding as a result of decades of isolation because of conservation) and non-Bali cattle from the other areas (NTT, NTB and South Sulawesi) have this susceptibility. This major weakness has not influenced the government against using the Bali breed to improve existing populations or start new cattle populations utilizing the Bali breed.

Role of the Bali cattle in small landholder livelihood

Under harsh environmental conditions, indigenous animals performed much better than the improved stock. It would not be a sustainable practice to improve the genetic potential of this breed by breeding under artificially improved conditions for higher production. Scientists and decision-makers in the regional and central government have underestimated Bali cattle. Local Bali cattle have been acclimatized over the years in these regions and have been integrated into the rural small landholder economy in marginal areas for various reasons. The important contribution of these cattle has been studied and reported as follows:

1. As source of progeny (calves)
2. Weight gain
3. As a safe deposit (source of cash in emergencies)
4. Insurance for crop harvest failures
5. Draught animal in tillage work and hauling farm products
6. Manure for fertilizer

The first two roles are biological production traits most studied and given the highest attention. However, the second trait may not be important in a harsh environment where survival is most important and faster-growing animals may have a reduced chance for survival. In the grassland areas where crop planting is minimal, only the first and third traits are important.

Organic farming system

Environmental issues are becoming increasingly important internationally. The indigenous cattle are an important and integral component of the small land-

holder cattle production system. This cattle production system is essentially 'organic' in nature and the most sustainable system. The farmers also prefer indigenous cattle because they are less demanding and less prone to the problems usually associated with most of the 'improved' and/or crossbred cattle.

Ecological or organic farming is seen as an alternative to chemical intensive agriculture. One of the important points in this direction would be the development of indigenous technologies for ecological and economical farming methods. It has not been argued here that crossbreeding or external genetic interventions are non-sustainable. However, the rural small landholder regions in Indonesia cannot sustain these interventions because the agricultural production method in these regions is essentially low external input in nature. Thus, any external intervention calling for input intensiveness would cause ecological imbalances that damage the long-term sustainability. Policies reoriented towards maintaining the indigenous Bali breed and improving their efficiency, not through external genetic intervention, but through within breed genetic improvement are required. Effectively harnessing locally available resources is also an essential requirement.

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Conflict of interest

The author does not have any conflict of interest to declare.

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