STRATEGIES TO IMPROVE BALI CATTLE IN EASTERN INDONESIA

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ACIAR PROCEEDINGS No. 110

ACIAR
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Survey of Population and Production Dynamics of Bali Cattle and Existing Breeding Programs in Indonesia

C. Talib[1], K. Entwistle[2], A. Siregar[1], S. Budiarti-Turner[3] and D. Lindsay[4]

Abstract

The paper provides information on the current status of Bali cattle in Indonesia gleaned from national and regional statistical records, and amalgamates them with research and subjective information from government and university officers and farming groups in the regions in which Bali cattle are run.

There are about 2.95 million Bali cattle in Indonesia or about 26% of the total cattle population, around 80% of them to be found in the Eastern Islands and South Sumatra. Numbers have declined in three of the last four years; this is believed to be a long-term trend, but the information and numbers vary widely from region to region. The annual calving rate is 52–67%, which is moderate, but calf mortality varies from 8 to 48%, which is very high. It is concluded that there are opportunities for reversing the decline in numbers of Bali cattle through encouraging husbandry practices that improve survival, reducing the slaughter of pregnant animals and improving the genetic base towards animals that grow and survive better than at present.

Introduction

BALI cattle (*Bos sondaicus*; *Bos javanicus*; *bos/Bibos banteng*) are one of the important beef cattle breeds contributing to the development of livestock industries in Indonesia, and are the most predominant genotype within the Eastern Islands and some provinces in western Indonesia. This well-adapted genotype forms the basis for many smallholder enterprises in the region, but in recent times there have been considerable pressures placed on the Bali cattle population because of high demands for slaughter animals: large numbers of productive females have been slaughtered, no effective selection has been applied in the basic population and there has been a probable decline in the genetic resources of the genotype because the best bulls and heifers are exported from the population, while high calf mortalities occur in some areas.

[1] Central Research Institute for Animal Science, Bogor
[2] Australian Centre for International Agricultural Research, c/o University of New England, Armidale
[3] Director General for Livestock Services, Jakarta
[4] Australian Centre for International Agricultural Research, c/o University of Western Australia, Perth

In contrast to many other more extensive tropical cattle production systems which rely on the production and adaptational traits of *Bos indicus* and their crossbreds, the Bali cattle industry is characterised by a smallholder farming system with a heavy dependence on the availability of natural feed resources and on the survival traits of the genotype, which is extremely important in the frequently harsh and low-input/low-output management system typical of the region.

Productivity of Bali cattle in Indonesia, Malaysia and Australia has been reviewed by a number of authors (Devendra et al. 1973; Kirby 1979; McCool 1992; Wirdahayati 1994; Talib 2002), and these details will not be discussed here other than in the context of the projects to be described. However work by Wirdahayati (1994) indicates that the genotype can be more productive than a *Bos indicus* genotype, the Ongole, under conditions of poor nutrition and low levels of management; and Talib (2001) showed that under good nutrition and management calf mortalities can be reduced.

Bali cattle have been widely distributed throughout the Eastern Islands of Indonesia outside Bali, to form three major foci in South Sulawesi and East and West Nusa Tenggara, and numbers there

Strategies to Improve Bali Cattle in Eastern Indonesia
edited by K. Entwistle and D.R. Lindsay
ACIAR Proceedings No. 110
(printed version published in 2003)

now exceed those in Bali (Siregar et al. 1985). The distributed areas could be divided into two management type groups: those under pasture management and those under a cut and carry system. Outside of Indonesia, the breed is distributed in other areas of South East Asia and in northern Australia.

Demand for meat in Indonesia is growing at 6–8% per annum, with demand greatest in the densely populated and more urbanised areas of Java. Records over the past decade indicate that the size of the Bali cattle herd is declining in most areas of the Eastern Islands as export demand exceeds replacement rates. There is also a widespread view among many animal scientists that the genetic merit of the genotype may be declining as a consequence of regular and sustained disposal of larger bulls (genetic erosion). The average weight of these exported bulls is decreasing (Talib et al. 2001) and this, combined with an increasing number of exported females and fattened bulls (it is important to remember that exported bulls and females are usually the largest and best animals in the basic population), is putting increasing pressure on the development of Bali cattle. Thus both the size and quality of the genetic pool may be decreasing.

In some areas the shortage of mature bulls also appears to be an impediment to herd improvement (Wirdahayati and Bamualim 1990; Siregar et al. 2001), and while AI is promoted widely and used extensively in some areas (Talib et al. 2000) success levels appear variable, depending upon local husbandry practices and environmental conditions.

Bali Cattle

Bali cattle (variously named *Bos sondaicus*, *Bos javanicus*, *Bos/Bibos banteng*) belong to the family *Bovidae*, the most common being the domestic animals *Bos taurus*, *Bos indicus* and Bubaline groups. In some countries other breeds of bovids are also used by local farmers, including *Bos bison* in the United States and *Bos grunniens* in Tibet. The diploid chromosome number of bovids varies between 30 and 60 but the fundamental number varies only from 58 to 62. *Bos taurus* has the same diploid number (60) as *Bos indicus* and *Bos sondaicus*, and they can therefore hybridise with each other. Karyotype studies show that the Y male-sex chromosome of *Bos sondaicus* is apparently identical to that of *Bos taurus*, but not to that of *Bos indicus* (Kirby 1979). Kikkawa et al. (1995) state that *Bos taurus* and *Bos indicus* had a common ancestor more than three million years ago (*Bos primigenius* — Aurochs), and that both groups diverged more than one million years ago prior to domestication. These authors used restriction fragment length polymorphisms (RFLPs) of mitochondrial DNA (mtDNA), and the sequences of mitochondrial genes for cytochrome b confirmed that *Bos sondaicus* (Bali cattle) had a different ancestor from that of European and Zebu cattle.

Bali cattle are well adapted to the tropics and are indigenous to South East Asia. Their morphological characteristics differ markedly from those of *Bos taurus* and *Bos indicus* (Kikkawa et al. 1995). Their hair colour is very distinctive, usually reddish-brown, except for a clearly defined white area on the hindquarters that extends along the belly, and also white socks reaching from the hooves to just above the hocks. There is a well-defined narrow band of black hair running along the back from behind the shoulder to the tail. In bulls, but not in females, the red hair over the whole of the body begins to darken at 12–18 months of age and by maturity is almost black, the band of black hair on the back still being visible. In castrated bulls, black hair on the whole body changes to red again within a few months of castration. These are humpless cattle, the body being relatively large framed and well muscled, with good hindquarters.

Pulungan and Ma'sum (1978) have shown that male F1-generation crossbreds between *Bos sondaicus* and *Bos taurus* are infertile. Kirby (1979) reported that all F1 ¼ Bali and ¾ Bali bulls resulting from crossbreeding with Brahman/Shorthorn cattle were infertile, although some semen was present in ¼ Bali bulls. All the crossbred females were fertile.

Objectives

The objectives of the project from which this report arises are to develop appropriate options for the genetic improvement of the Bali cattle herd in the Eastern Islands of Indonesia. This project is one of the research activities of the Australian Centre for International Agricultural Research (ACIAR) in Indonesia in collaboration with scientists from the Central Research Institution for Animal Science, Bogor, and the Director General for Livestock Services, Jakarta.

Materials and Methods

Data collection was conducted from June 2001, when the Indonesian and Australian team visited East Nusa Tenggara (NTT), West Nusa Tenggara (NTB), Bali and South Sulawesi in the Eastern Islands and Lampung in South Sumatra to gather information on population dynamics and production data of Bali cattle under several different management regimes.

There are areas in the Eastern Islands that have some Bali cattle breeding herds in the Bali cattle breeding institutes. NTT and NTB have Bali cattle

breeding offices (Lily and Sarading), while Lampung, South Sulawesi and Bali have special projects for Bali cattle breeding called P3Bali. In fact only one institute, P3Bali in Bali, has any real selection activity; in this paper the evaluation of existing breeding programs will be focused on that institute.

National population data are from statistical information on Indonesian livestock published by the National Statistic Institute and the Directorate General of Livestock Services. Regional population data come from animal services offices in every region, as a result of calculating the total population of Bali cattle in the region between 1998 and 2001. Productivity data collection for the project began in May 2001 and has involved an exhaustive review of published information on the genotype, which was followed by a detailed survey at project and provincial level undertaken by the team from late June 2001. The team met with a wide range of research and extension groups at provincial and national levels, with staff at universities in NTT, NTB, Bali and South Sulawesi, and with farmers at a number of localities.

Results

Population dynamics of Bali cattle

The Indonesian beef cattle population was 11m and 11.2m head in 2000 and 2001 respectively. The percentage of Bali cattle in this total decreased slightly from 26.9% to 26.5% in 2001 (Ditjenak 2001). Dynamics of Bali cattle population are summarised in Table 1.

Reasons for the population decline in Bali cattle are many and varied, and have been discussed in a number of previous reports. However, data for 2000 on slaughter rates, numbers exported, mortality rates, and calculated calving numbers, summarised in Table 2, provides partial explanations for this shift in population size.

Between 1998 and 2000 Bali cattle numbers declined by 3.2%, but this decline slowed to –1.5% in 2001. There were wide variations in population declines between provinces: the greatest were in NTT and Lampung (between –22 and –25%), and these were significant declines (around 9%) in NTB and South Sulawesi.

Table 1. Population dynamics of Bali cattle, 1998–2001.

Location	1998	1999	2000	2001*	Change (%)
NTT	633 704	633 451	442 940	472 626	–25.4
NTB	429 847	374 970	376 526	392 090	–8.8
Bali	524 615	526 013	529 064	533 042	1.6
S. Sulawesi	823 245	749 392	718 139	751 277	–8.7
Lampung	331 502	278 360	254 823	256 312	–22.6
Sub-total	2 742 913	2 562 181	2 332 330	2 405 347	–12.3
% of total	91.03	78.64	79.96	81.11	10.1
Total Indonesia	3 013 174	3 257 993	2 916 944	2 965 610	–1.5

* Preliminary figure to May

Table 2. Bali cattle: information by province for 2000 on bulls, cows, slaughter, export and mortality, together with estimated calving of the herd. (Numbers in parentheses are percentages of total Indonesian cattle population.)

Province	Bulls	Cows	Slaughterings and export	Mortalities	Calving numbers (estimated)*
NTT	11 077	224 025	78 283	71 567	149 089
NTB	39 050	153 197	72 550	11 878	79 183
Bali	71 940	184 572	66 475	10 347	122 322
South Sulawesi	39 789	337 051	99 459	16 294	203 680
Lampung	19 554	165 084	178 836	5 163	73 740
Total	253 342 (10.9)	1 032 079 (44.3)	495 603 (21.3)	115 294 (4.9)	628 014 (26.9)

* Calving rate of population extrapolated from research data and from female Bali cattle population statistics. Data are estimates only and should be viewed with some caution.

It seems that local governments have applied some strategies to slow the continuing population decline that occurred from 1998 to 2000, resulting in some improvement in 2001. If the progress in that year continues it will be good for future Bali cattle development, but if not, in the next decade the low herd size will be of even greater concern. Such a situation would seriously affect Indonesian beef production capacity, the economic wellbeing of many Indonesian smallholders (679 990 households rely on Bali cattle as an income source), and constrain opportunities for improvement of this genotype. It is predicted that if the Indonesian economic crisis is overcome and beef consumption increases by 1 kg/cap./year, an additional one million head of cattle will be needed. Therefore local government should create appropriate and applicable strategies to increase the number and the quality of Bali cattle.

Some local governments have recognised the significance of the declining Bali cattle population and created strategies to stem the decline. For example, the NTT government decided to ban export of the best bulls and heifers and now permits disposal of only lower quality and culled animals. It will also buy productive females from slaughter houses and redistribute them to smallholders under a contract system. Management and nutrition of Bali cattle are also being improved through increasing the role of extension workers.

Combined slaughter and export rates ranged from 13% to 64% of the total population in 2000, the higher figure being from Lampung. So far the project team has not been able to analyse in any detail the reasons for this high figure. However, the close proximity of the province to high-density populations in western Javan, where demand for beef is increasing and where major meat processing plants are located, may be an explanation.

On the basis of the data in Table 2 it can be calculated that, at least for 2000, some 21% of the total Bali cattle population was either slaughtered or exported (for grow-out, for breeding or for slaughter). Mortalities accounted for further overall declines in numbers of almost 5%. Mortality rates were especially high in NTT (16%); in other provinces they ranged from 2% to 3%.

The combination of slaughterings, exports and mortalities accounted for a total population off-take of almost 26%. Some of this off-take probably represents the export of breeding animals. Nevertheless the overall rate is extremely high compared with standards in developed country cattle industries. Such rates are unlikely to be sustainable in the short to medium term without serious damage to the national economy, to the Indonesian cattle industry and to the wellbeing of individual smallholders.

Some caution is needed in interpreting the estimated calving numbers and the ratio between number of bulls and cows, as shown in Table 2. These are extrapolated data from research results on reproductive performance, calculated from small numbers of animals, and then calculated for each province from estimated cow numbers. Hence they probably have a large error variance, and their use for comparative purposes needs to be approached cautiously. Another point that has to be highlighted is that even though the cow:bull ratio is good, almost all the best bulls are housed as fattening cattle for export and never used for breeding. The bulls for breeding are therefore young bulls of small size, which in the long term will influence the productivity of the herds.

When slaughterings were dissected by gender the ratio of cow to bull slaughter rates ranged from 3:1 to 20:1, with an average of about 4:1. Depending on the proportion of productive (reproductively active/pregnant) cows being sent to slaughter, the effects of such a ratio on future population dynamics may vary.

In fact only limited data are available on the proportion of productive cows slaughtered. These slaughterings represent potential losses in terms of offspring for replacement or later slaughter. For NTT, NTB, Bali and South Sulawesi, the data indicate that such animals represent 30%, 15%, 69% and 35% respectively of all cow slaughterings. For all these provinces the mean figure is 34% — i.e. one-third of all cows slaughtered were reproductively active. If these data are extrapolated to the entire Bali cattle population in Indonesia, of which approximately 44% are cows, the potential for increasing herd reproductive performance and changing herd dynamic patterns by limiting the slaughter of pregnant females becomes apparent.

In summary, the population dynamics data presented here confirm a significant and serious decline in Bali cattle numbers. Should these trends be allowed to continue a number of adverse impacts, discussed above, will occur. These will have unfortunate national consequences. A range of options. both genetic and non-genetic, need to be developed to counter these adverse trends and to enable smallholders to continue to use and benefit from this well-adapted and valuable genotype.

Current productive performance

One of the key tasks of the current ACIAR–CRIAS project is the collation of available data on productive performance of Bali cattle in those provinces where they are the most important/dominant genotype. These data are essential as a prerequisite to the development of future strategies to improve the productivity of the Bali cattle herd.

Summarised data on weight traits in Bali cattle by province are presented in Table 3.

Some of the apparent variations between provinces in the data probably reflect the impact of variable environmental and management conditions, particularly nutrition, on performance levels. Mature cow weights are lower in NTT and South Sulawesi than in either Bali or NTB. When compared with other published estimates for weight traits (Table 4), the current data set is at about the mid-point of the range for mature cow weights of Bali cattle in Indonesia.

Data on reproductive performance traits and milk production in Bali cattle are summarised in Table 5. Again the estimates derived here are not dissimilar from those summarised by Wirdahayati (1994). The data highlight the fact that given the harsh conditions and generally poor nutritional regimes under which Bali cattle are run, reproductive performance is moderate (calving rates 50–67%). Previous studies in NTT and NTB (Wirdahayati 1994, Talib 2001) identified calving rates ranging from 63% to 78%.

In line with earlier reports, milk production was extremely low, and is no doubt a factor contributing to low calf growth rates and high calf mortalities. Calf mortality rates were a feature of the survey data and ranged from 8% to 48%, levels similar to those found in Timor (20–47%) by Wirdahayati and Bamualim (1990) and Talib (2001).

Current management and breeding strategies

While the vast majority of Bali cattle are naturally mated, AI has been used extensively in some areas, especially in 'cut and carry' systems, and offers the only short-term solution to the implementation of breeding strategies for genetic improvement. For

Table 3. Production performance of Bali cattle.

Province	Production traits (kg)				
	Birth weight	Weaning weight	Yearling weight	Puberty weight	Mature cow weight
NTT	11.9 ± 1.8	79.2 ± 18.2	100.3 ± 12.4	179.8 ± 14.8	221.5 ± 45.6
NTB	12.7 ± 0.7	83.9 ± 25.9	129.7 ± 15.1	182.6 ± 48.0	241.9 ± 28.5
Bali	16.8 ± 1.6	82.9 ± 8.2	127.5 ± 5.7	170.4 ± 17.4	303.3 ± 4.9
South Sulawesi	12.3 ± 0.9	64.4 ± 12.5	99.2 ± 10.4	225.2 ± 23.9	211.0 ± 18.4

Table 4. Published estimates for mature cow and bull weights for Bali cattle.

Location	Mature weights (kg)		Reference
	Cows	Bulls	
Malaysia	264	—	Devendra et al. 1973
Sulawesi, NTT, NTB	224–234	335–363	Astawa 1989
Bali	264	395	Pane 1990
NTT, Bali, Sulsel, Australia	180–306	—	Talib 2001
South Sulawesi	110–230	—	Siregar et al. 2001
NTT, NTB, Bali, Sulawesi	221–303	—	Current study
Australia	248	315	McCosker Eggington & Doyle 1984

Table 5. Reproductive performance and milk production data in Bali cattle.

Province	Age at puberty (years)	Calving age (months)	ICI* (months)	Calving rate (%)	Calf mortality (%)	Milk production (kg/6 months)
NTT	2.5	41	15.4 ± 2.0	66.6	48	164.7
NTB	2.0	36	16	51.7	15	(no data)
Bali	2.0	32	14	66.3	8.5	274.5
South Sulawesi	2.5	36	15.7 ± 1.8	60.4	8.0	164

* Inter-calving interval

Bali cattle, because the only selection work appears to have been at P3Bali, production and distribution of frozen semen from proven bulls is very restricted, both in numbers of doses and area of distribution, which has prevented the spread of specific Bali cattle diseases that exist in Bali and may be contaminants in semen. Therefore the location of any future breeding institute should take into consideration disease issues as well. It would be advantageous if some provinces that have high Bali cattle populations could create a breeding institution or local station. These could then undertake performance testing to identify the best bulls and heifers that could be used for breeding purposes in breeding herds which have similar treatments, especially nutritional status. Together with this, standardising the performance records of Bali cattle and dividing the standard into some classes is important so that every breeding institute can know how good the cattle are.

Although there have been some Bali cattle breeding activities in Indonesia in the form of breeding institutes and projects such as Lili (NTT), Sarading (NTB), P3Bali, Bone (South Sulawesi) and in Pulukan (Bali) and Lampung, only P3Bali in Bali has applied selection programs to produce proven bulls. Even though this institute has existed since the 1970s, the effectiveness of selection and the use of proven bulls should be re-evaluated. Evaluation of the data from breeding centres and from the basic population suggests that breeding has not effectively improved the genetic quality of the herd in the 20 years from 1980 to 2000 because individual breeding values have not changed in that period (Talib et al., these proceedings).

AI has been applied in beef and dairy cattle development in Indonesia since the 1970s. It was planned at first to improve both dairy and beef cattle but AI is working well in only dairy cattle. In beef cattle almost all of the AI is directed at the production of commercial stocks and only a small amount is being used for purebred animals, including Bali cattle. The semen for AI in Bali cattle is produced at the AI Centre at Singosari, East Java and distributed throughout the Eastern Islands, but the genetic source of bulls used for producing it is unknown. This is an area that needs to be examined.

Data for 2001 indicate that 1 356 521 doses of frozen semen from nine breeds of cattle were produced and distributed, at Singorasi, including some 50 239 doses of Bali semen. About 30% of the beef cattle population and 30% of inseminators (857) are located in the Eastern Islands. The capability of one inseminator is only one cow per day inseminated and almost exclusively for cows in cut and carry systems. Assuming that all Bali semen produced is inseminated, along with predicted calving rates from AI of around 30%, about 15 000 calves would be produced yearly. If these calculations are correct, a specific evaluation is needed to examine the impact of subsequent slaughter of inseminated cows on genetic improvement, the environment and the welfare of the farmers.

Conclusions

1. Bali cattle are the predominant beef cattle in the Eastern Islands of Indonesia.
2. The declining population should be improved by applying strategies to reduce calf mortalities, decrease the slaughter of productive cows, and prepare and retain appropriate bulls in the herds.
3. No significant improvement in production and reproduction traits is likely in a randomly mated population such as exists at the moment.
4. The activities of breeding institutes and projects need to be reviewed to re-evaluate their location and operations for producing better Bali cattle in the future.
5. AI should use semen from proven bulls not only to produce commercial stock but to contribute to genetic improvement programs.

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