Breeding Programme Development of Bali Cattle at Bali Breeding Centre

A Supriyantono[1)*], L Hakim[2)], Suyadi[2)] and Ismudiono[3)]

[1)]**Faculty of Animal Science Fishery and Marine Science, The State of Papua University, Indonesia**
[2)]**Animal Husbandry Department Faculty of Animal Science, Brawijaya University, Indonesia**
[3)]**Faculty of Veterinary, Airlangga University, Surabaya, Indonesia**
***Corresponding author e-mail: andoyo@yahoo.com**

Abstract. Growth performance of Bali cattle has been a major concern especially in the character of body weight at a certain age, birth weight and weaning weight. Efforts to increase the quality of the performance of Bali cattle have been carried out by the government by forming P3Bali. In the activities of quality improvement, the government is guided by the breeding program which has been prepared. To strengthen these activities further, the breeding program has been modified based on weaning weight data for 10 years (1994-2004). Data were analyzed using the VCE and PEST to estimate the components of genetic variance and covariance. The breeding program was set up based on the results of the accuracy of some methods of selection. The results showed that the ratio of male to female optimum (1:5) would increase the selection response per generation about 53.08 percent. Selection responses were obtained when males were maintained for three years and females over six years in the population.

Key Words: Bali cattle, breeding program, selection response

Introduction

Growth performance of Bali cattle has been a major concern especially in the character of body weight at a certain age, birth weight and weaning weight. With a good diet, body weight gain was about 0.7 kg/day (adult male) and 0.6 kg/day (adult female), carcass percentage ranged from 51.5 to 59.8%, with bone percentage less than 15% and low-fat meat (Pane, 1991). Those potentials encourage the government of Indonesia to conserve and develop genetic resources of Bali cattle by founding breeding centre (P3Bali) in 1976. This project involves farmers in cattle maintenance by providing credit and the cattle that would be selected to be placed at the breeding center (Open Nucleus Breeding). The pattern is pyramid-shaped with top layer occupied by the core group as the main breeding one, the second layer was breeding stock which was originally selected from the layer beneath. The bottom layer is the group of farmers with the highest number of breeders and livestock, classified into commercial farms (BIAA, 1989). In this pattern there is a flow of superior-quality gene (such as the best female cattle about one percent) from the bottom layer to the second layer. From the second layer also flows female replacement (two percent) to the core layer, thereby it can reduce inbreeding depression that may occur quickly when the group is closed. Another good impact of this pattern is that the introduction of genes from a group of commercial livestock raised in a simple environment will prevent environmental inequalities.

Selection in P3Bali has been done to evaluate sire through the progeny test. The sire must first pass a performance test conducted in Pulukan for one year. Bull candidates are from breeders who are the members of the community. They have to meet the basic criteria of one year of age regardless of body weight. These candidates are kept in Pulukan (breeding centers) and they receive the same treatment. Three to five males are selected for the end of performance test in which the phenotype is not deviate as Bali cattle with the

best vital statistics. The selection process as described above is compliant with the breeding scheme in P3Bali. However, not all processes in the scheme are performed because of technical constraints. Non-fulfillment of these requirements led to the slow genetic improvement of Bali cattle although P3Bali is expected to act as the excellence center of Bali cattle in Indonesia. The research of Sukmasari et al. (2002) showed no increase in genetic trend during the period of 1983-1986 and 1988-2000. Modification of breeding programs needs to be made as an alternative breeding program in accordance with environmental conditions with all limitations. The simple and applicable breeding program is needed based on the field data. Data available within 28 years is considered adequate to perform these modifications.

Materials and Methods

The data used included 428 data of weaning weight (WW), yearling weight (YW) and body weight gain (BWG); 107 data of withers height (WH), body length (BL), chest girth (CG) and body weight (BW) at 24 months of age of Bali cattle in P3Bali. Estimation of components of variance and covariance genetics and environment, and heritability was obtained using VCE 4.2 (Groeneveld, 1998). The fix effect for weaning weight, yearling weight and body weight gain: rainfall, age of measurement and year of birth; withers height: rainfall, age of measurement, parity and age of dam; chest girth: rainfall, age of measurement and year of birth; body length and body weight: rainfall, age of measurement, parity, age of dam, season and year of birth. As random effects for all the characters were animals. In general, statistical model for animal is as follows: Y = XB + Zu + e, with Y = observation vector n x 1 size; b = vector of fixed effects pxl size; u = vector of random effects sized qxl that has variance and covariance G matrix as the evaluated vector of breeding values; X = matrix to express the fixed effect (b); Z = matrix to express random effects (u); e = random vector that cannot be observed sized nxl with variance and covariance R matrix.

Response selection was estimated based on heritability obtained, the standard deviation of the population and selection intensity (i). The intensity of selection determined the amount of selection response achieved by each generation, the fewer cattle selected to produce next-generation the higher selection intensity found. Selection intensity was obtained under the table presented as in Falconer and Mackay (1997). Accuracy of selection was calculated based on the relative selection response, the ratio of each selection (family, within families or sib) on individual selection. If the accuracy of individual selection was assumed 100% or 1 then the relative selection response obtained could describe the accuracy of selection. When the value was above one, it implied the selection was better than individual selection. Breeding program was set up based on the accuracy of selection. When we found that individual selection was more accurate than other methods, the determination of the population at every level was based solely on individual performance. However, if family selection is more accurate than the performance based on the average of family it will be the benchmark when choosing the individuals selected.

Results and Discussion

Response and accuracy of selection

Response and accuracy of selection of some traits are presented in Table 1. The best selection response per generation for all characters was individual selection, and this was very likely due to individual selection based solely on the ability of individual itself, while other selection was based on the ability of their collateral in addition to the ability of the

Tabel 1. Response of selection and accuracy of selection

Traits	i	Response of selection				Accuracy of selection		
		Individual	Family	Sib	Within familiy	Family	Sib	Within familiy
WW	1.30	1.38	1.28	0.96	0.99	0.93	0.70	0.72
YW	1.35	6.31	5.08	3.77	4.61	0.80	0.60	0.73
BWG	0.88	2.06	1.51	0.99	1.49	0.73	0.48	0.73
C G	0.85	2.56	1.91	1.09	1.78	0.75	0.43	0.69
BL	0.76	1.30	1.02	0.57	0.88	0.78	0.44	0.68
WH	1.18	2.17	1.58	0.90	1.53	0.73	0.41	0.70

i: selection intensity; WW: weaning weight; YW: yearling weight; BWG: body weight gain; CG: chest girth; WH: withers height; BL: body length

individual. The results showed that based on information of their collateral. the internal family selection had a better accuracy than the other (family and sib selections). although the accuracy was still below the level of accuracy of individual selection.

Breeding program

The results of selection accuracy indicated that the individual selection was the most accurate selection. Since the selection response depends on the generation interval. selection intensity. and variance. the increasing of response can be done by improving of all those three issues. From those three issues. the improvement on generation interval and selection intensity was the most likely to implement. Based on the above average breeding value estimation. it could be taken to find the selection intensity based on the percentage of male and female selected. The ratio number of males and females for the traits of weaning weight and yearling weight was 99:82 and 71:67 respectively. Improvements to the selection intensity in this population were based on the theory that the optimum ratio of male and female to produce the next generation is 1:5. The ratio of the total selected candidates would be increased. making it possible to obtain the increasing number of progeny; on the other hand. such ratio could reduce maintenance costs of male because the number of selected males will be less. The selection intensity of weaning weight for male and female used in this study was 1.25 from 26.47% (99 males) and 1.35 from 21.93% (82 females) with an average of 1.3. while for the yearling weight was 1.32 from 22.47% (71 males) and 1.37 from 21.20% (67 females) with an average of 1.35. The optimum of selection intensity for weaning weight was 1.89 from 1.34% male selection (5 males) and 26.74% female selection (100 females). whereas for yearling weight the optimum of selection intensity was 1.81 derived from 58% male selection (5 males) and 31.65% female selection (100 females). thus allowing the ratio of male: female about 1:20. The selection response estimation per generation of weaning weight on the basis of different selection intensities is presented in Table 2.

Table 2 shows that by the optimum ratio of male: female it will increase the selection response per generation to 53.08 percent. The percentage was obtained by comparing the responses of individual selection (R_{ind}) in Table 1 with optimum results in Table 2. It implied that in the preparation of breeding programs breeders should consider the optimum selection intensity in order to increase selection response. With the dam about 429 heads. the ideal number of male for getting the optimum response to selection was 22 heads. Therefore. some alternative distribution of males and females of various ages could be made in a

Table 2. The selection response estimation of weaning weight based on different selection intensity

Male selected			Female selected (%)				
			10	15	20	25	27
	Selection intensity	n	1.755	1.554	1.400	1.271	1.225
			37	56	74	93	100
1.0	2.665	3	2.35	2.24	2.16	2.09	2.06
1.5	2.526	5	2.27	2.16	2.08	2.01	1.99
2.0	2.421	7	2.22	2.11	2.03	1.96	1.93
2.5	2.338	9	2.17	2.06	1.98	1.91	1.89
3.0	2.268	11	2.13	2.03	1.95	1.88	1.85

The calculation in Table 2 using heritability : 0.09 and standard deviation of weaning weight : 11.79 kg

Table 3. Some alternative distribution of males and females as basic of breeding program for the best response to selection of weaning weight

Alternative	Catlle Herd	Age (YR)						I	L	R/Y
		3	4	5	6	7	8			
1	Sires	22						1.627	3.00	0.33
	Dams	82	78	73	69	65	62	0.984	5.33	
2	Sires	11	11					1.918	3.50	0.35
	Dams	82	78	73	69	65	62	0.984	5.33	
3	Sires	8	7	7				2.135	3.95	0.36
	DAMS	82	78	73	69	65	62	0.984	5.33	
4	Sires	6	6	5	5			2.243	4.41	0.35
	Dams	82	78	73	69	65	62	0.984	5.33	
5	Sires	5	5	4	4	4		2.232	4.86	0.34
	Dams	82	78	73	69	65	62	0.984	5.33	

I: Intensities selection; L: Generation Interval; R/Y: Selection Response per Year

population of Bali cattle in P3Bali. as shown in Table 3. with the assumption that male used for five years and females for seven years. percentage of calf crop is 83.27 percent. standard deviation of weaning weight is 11.79 kg and heritability is 0.09.

Table 3 showed that the best selection response was found at the third alternative by keeping males for three years and females for six years in the herd. Generation interval of sires and dams was 3.95 and 5.33 year respectively. Enns and Nicoll (2008) showed the difference of generation interval at each birth was 2.34–3.86 year for sires and 4.00-7.67 year for dams. The selection response was the same as the selection response of the ideal ratio of male and female in Table 2. and breeding scheme for the five alternatives as presented in Figure 1.

Figure 1 is a breeding scheme modification from the scheme that has been made by P3Bali. The modifications were (1) 100 females included to the test performance. The number is based on the minimum proportion of females selected which was 72 heads; (2) There is no direct flow of cows from the unit to an elite herd because the cows have not been proven to genetically qualified. Before entering into an elite herd. the cows must pass the performance test; (3) selection pressures on males and females performed more loosely so that the number of selected sires and dams increases. Costard et al. (2009) has given the same illustration on their breeding scheme in order to optimize selection response of multiple traits. Breeding scheme as in Figure 1 is the application of open nucleus breeding program patterns. Elite herd is the core herd as the main breeding herd. the second layer is breeding herds (performance test). The breed initially selected from the layer underneath and/or received from the upper layer. Bottom layer is a

group of breeders with the highest number of breeders and livestock classified into commercial farming.

From Figure 1 it can be noted that the number of performance test participants is expected to 50 males and 100 females. The participants might come from elite herd (Pulukan) and IPD (Tabanan) without any percentage distribution formula. When the cattle met the criteria of objective and subjective in the performance test they could be used as the participant. The objective criteria was a uniform body weight at 12 months old. While subjective criteria was skeleton disorders, especially in the feet, jaw, shoulder, reproductive organs and skin color distorted. The participants who came from different environments were together kept in Pulukan (as test station) to be tested and evaluated on the same environment. The method could reduce the effect of non genetic (environmental) and it allowed cattle to show the genetics ability. The cattle were adapted for two months by being given the same treatment. Especially good nutrition to optimize growth.

Performance test was conducted during the 12 months ended with the measurement of vital statistics (body weight. chest girth. body length and height withers) and a subjective evaluation. For the male 16 percent of performance test was progeny test. The percentage was minimum (8 heads) for male candidates who would performed the progeny test. and the rest were returned to the IPD as sires for dams. The number of males used as sires was adjusted to the number of females in IPD by maintaining the ratio of male: female at 1:20. The unwanted males especially in terms of reproduction were to be removed but not more than 25%. The female candidates passing the performance test would enter an elite herd

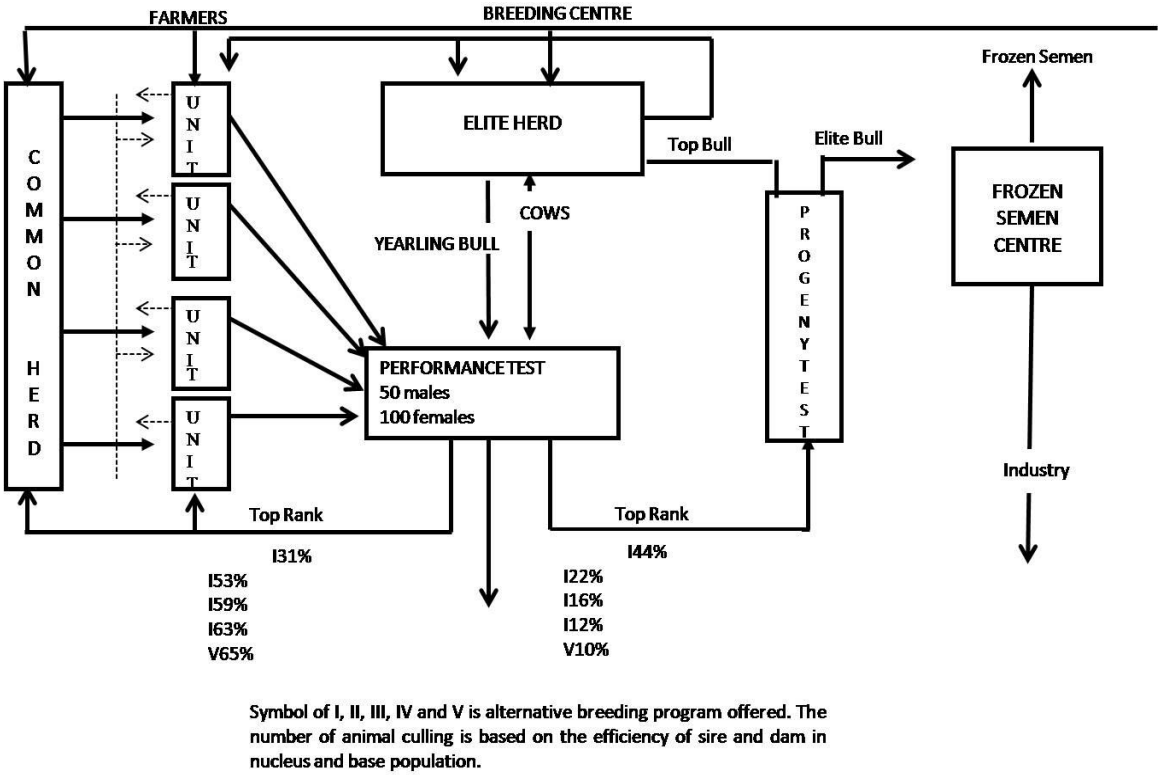

Figure 1. Breeding scheme modification from the scheme that has been made by P3Bali

based on her performance and be taken into account the capabilities of her parent by estimating MPPA. The cows were then mated with superior males of performance test. Sasaki et al. (2005) stated that aiming at improvements of carcass traits in Wagyu. The progeny testing in test station improved only a few traits including carcass weight and beef marbling standard. Based on the value of relative efficiency of progeny test. the number of progeny tested per male should be six. With six progeny. it was possible to increase the number of male to 6-8 heads. The calculation was based on the distribution of progeny per male tested between 3-28 heads. The number of progeny per sire used in this study was in accordance with Kahi and Hirooka (2005) who conducted study on Wagyu cattle breeding scheme.

On their study, the number of progeny per sire fluctuated between 5 and 300 with the aim of determining the optimal number of progeny upon which sires could be accurately selected using an on-farm progeny test. The more males involved in progeny testing allowed to minimize the selection pressure. when tested bull selected was only one or two it could enlarge the selection intensity. Addition to eight males was still possible in participants of progeny test because the output of performance test was 16 percent or about 8 males. Trait used for progeny testing was weaning weight because it came earlier than other traits. In addition, the data analysis showed that the genetic correlation between weaning weight and yearling weight. Weaning weight and body weight gain showed a positive value. This indicated that by making selections on weaning weight might also increase the yearling weight and body weight gain. Despite a negative genetic correlation between weaning weight and vital statistics at 24 months old. The selection for weaning weight would not interfere the vital statistics due to its close to zero magnitude.

Conclusions

1. The best selection was individual selection on the Bali cattle selection. When the information based on sib family, selection of within family had to be done.
2. Breeding program that produced the best response to selection per year was produced when the sire were maintained within the population for three years and the dam for six years with the sex ratio of male: female was 1: 20.
3. The scheme of breeding program proposed required a performance test on both males and females with a minimum number of 50 and 100 respectively. Sixteen percent of top-rank male was taken for progeny test in order to get the more number of males for the next generation.

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