Breeding programme development of Bali cattle at P3Bali

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ABSTRACT: Growth performance of Bali cattle has been a major concern in Indonesia. To improve genetic quality of it, breeding program is needed to develop intensively. To further strengthen these activities, it has been modified based on data of weaning weight. Data were analyzed using VCE and PEST. We set up breeding program based on the accuracy of selection methods. The results showed that the ratio of male: female 1:5 would increase the selection response per generation about 53.08 percent. The highest selection response was obtained when males maintained for 3 years and females maintained over 6 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 bones percentage less than 15% and low-fat meat (Pane, 1991).

Those potentials are encouraging the Government of Indonesia to conserve and develop genetic resources of Bali cattle by forming breeding centre (P3Bali) which was founded in 1976. This project involves farmers in the maintenance of cattle by providing credit, and the cattle would be selected to be placed at the breeding center (Open Nucleus Breeding). This pattern was pyramid-shaped with the top layer is filled by the core group as the main breeding group, the second layer was breeding stock which was originally selected from the layer beneath. The bottom layer is a group of farmers with the highest number of breeders and livestock, which are classified into commercial farms (BIAA, 1989). In this pattern there are gene flow of superior-quality (such as the best female cattle about one percent) from the bottom layer to 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 by 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 were from breeders who are members of the community. Male candidates must meet the basic criteria of one year of age regardless of body weight. These candidates were kept in Pulukan (breeding centers) and received the same treatment. 3-5 males are selected for at the end of performance test with criteria phenotip not deviate as Bali cattle with the best vital statistics.

The selection process as described above is compliance 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 note that P3Bali is expected to act as centers of excellence 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 programs in accordance with environmental conditions with all limitations. The breeding program is simple and applicable need to be made based on the field data. Data that have been available for 28 years is considered adequate to perform these modifications.

MATERIALS AND METHODS

The data used includes 428 data weaning weight (WW), yearling weight (YW) and body weight gain (BWG); 107 data 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). Fix effect for weaning weight, yearling weight and body weight gain were rainfall, age of measurement and year of birth, whereas the fix effect for 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 models for animal model 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 which is the vector of breeding values evaluated; 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 determines the amount of selection response achieved by each generation, the fewer cattle were selected to produce next-generation the higher selection intensity was found. Selection intensity obtained under the table presented as in Falconer and Mackay (1997).

Accuracy of selection was calculated based on the relative selection response, which was the ratio of each selection (family, within families or sib) on individual selection. If we assume the accuracy of individual selection was 100% or 1 then the relative selection response obtained can describe the accuracy of selection. When the value was above 1 it means the selection was better than individual selection.

Breeding program was set up based on the accuracy of selection. When we found that individual selection were more accurate than other methods, the determination of the population at every level based solely on individual performance. However, if family selection was more accurate then the performance based on the average of families it will be the benchmark when choosing the individuals selected.

RESULTS AND DISCUSSION

Response of and Accuracy of Selection

Response of selection and accuracy of selection of some traits are presented in Table 1.

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
CG	0.85	2.56	1.91	1.09	1.78	0.75	0.43	0.69
LB	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

The best selection response per generation for all characters was individual selection, and this is very likely due to individual selection based solely on the ability of individual itself, while other selection is based on the ability of their collateral in addition to the ability of the individual. The results showed that based on information of their collateral the within family selection has a better

accuracy than other selection (family selection and sib selection), although the accuracy was still below the level of accuracy of individual selection.

Preparation of Breeding Program

The results of selection accuracy indicate that the individual selection was the most accurate selection. Because selection response depends on the generation interval, selection intensity, and variance, the increasing of response can be done by improving of all three issues. From those three issues, the improvement on generation interval and selection intensity was most likely done. Based on breeding values estimation above average, it can 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 were 99:82 and 71:67, respectively. Improvements to the selection intensity in this population based on the theory that the optimum ratio of male and female to produce the next generation was 1:5. The ratio brought the total number of selected candidates will be holding much more, making it possible to obtain the number of progeny that more and more also, on the other hand with such ratio, it can 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, whereas 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 are presented in Table 2.

Table 2. The selection response estimation of weaning weight based on different selection intensity[1]

				Female selected (%)				
				10	15	20	25	27
		Selection	n	1.755	1.554	1.400	1.271	1.225
		intensity		37	56	74	93	100
Male selected	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

Heritability = 0.09 and standard deviation of weaning weight = 11.79 kg

Table 2 showed that by the optimum ratio of male: female it will increase the selection response per generation amounted 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 means that in the preparation of breeding programs breeders should consider the optimum selection intensity in order to increase selection response.

With the dam was about 429 heads the ideal number of male for getting the optimum response to selection was 22 heads, so it can be made some alternative distribution of males and females of various ages in a population of Bali cattle in P3Bali, as shown in Table 3, with the assumption that male used for five years and females used for seven years, percentage of calf crop was 83.27 percent, standard deviation of weaning weight was 11.79 kg and heritability was 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

Breeding scheme for the five alternatives as presented in Figure 1. Figure 1 was 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 was 72 heads; (2) There were no directly flow of cows from the unit to an elite herd because the cows have not been proven genetic quality. 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 were much more. Costrad et al. (2009) have given the same illustration on their breeding scheme in order to optimize selection response of multiple traits.

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

Alternative	Cattle 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	

Breeding scheme as in Figure 1 was the application of open nucleus breeding program patterns. Elite herd was a core herd as the main breeding herd, the second layer was breeding herds (performance test), which the breed initially selected from the layer underneath and / or receive also from the upper layer. Bottom layer was a group of breeders with the highest number of breeders and livestock, which were classified into commercial farming

From Fig 1 it can be noted that the number of performance test participants were expected to 50 males and 100 females. The participants may 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 he/she can be used as a 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 together kept in Pulukan (as test station) to be tested and evaluated on the same environment. The method can reduce the effect of non-genetic (environmental) and it allowed cattle to show the genetics ability. The cattle were adapted for two months by giving the same treatment, especially good nutrition to optimize growth. Performance test was conducted during the 12 months ending 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 gone to progeny test, the percentages were minimum (8 heads) for male candidates who will be performed the progeny test. Left males were returned to the IPD as sires for dams. The number of males used as sires adjusted by the number of females in IPD by maintaining the ratio of male: female at 1:20. The males unwanted especially in terms of reproduction were expected to be removed but not more than 25 percent. The female candidates who pass the performance test that would enter an elite herd based on her performance and took into account the capabilities of her parent by estimating of MPPA. The cows were then mated with superior males of performance test. Sasaki et al. (2006) 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 6. With 6 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 range between 3-28 heads. The number of progeny per sire used in this study was in accordance to 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 allows to minimize the selection pressure, when tested bull selected was only one or two it can enlarge the selection intensity. Addition to eight males was still possible in participants of progeny testing due to output of performance test was 16 percent or about 8 males.

Trait used for progeny testing was weaning weight because the traits were coming earlier than other traits. In addition, from analysis of data showed that the genetic correlation between weaning weight and yearling weight, weaning weight and body weight gain showed a positive value. This indicates that by making selections on weaning weight may also increase the yearling weight and body weight gain. Despite a negative genetic correlation between weaning weight and vital statistics at 24 months old, however due to its magnitude close to zero the selection for weaning weight will not interfere to vital statistics.

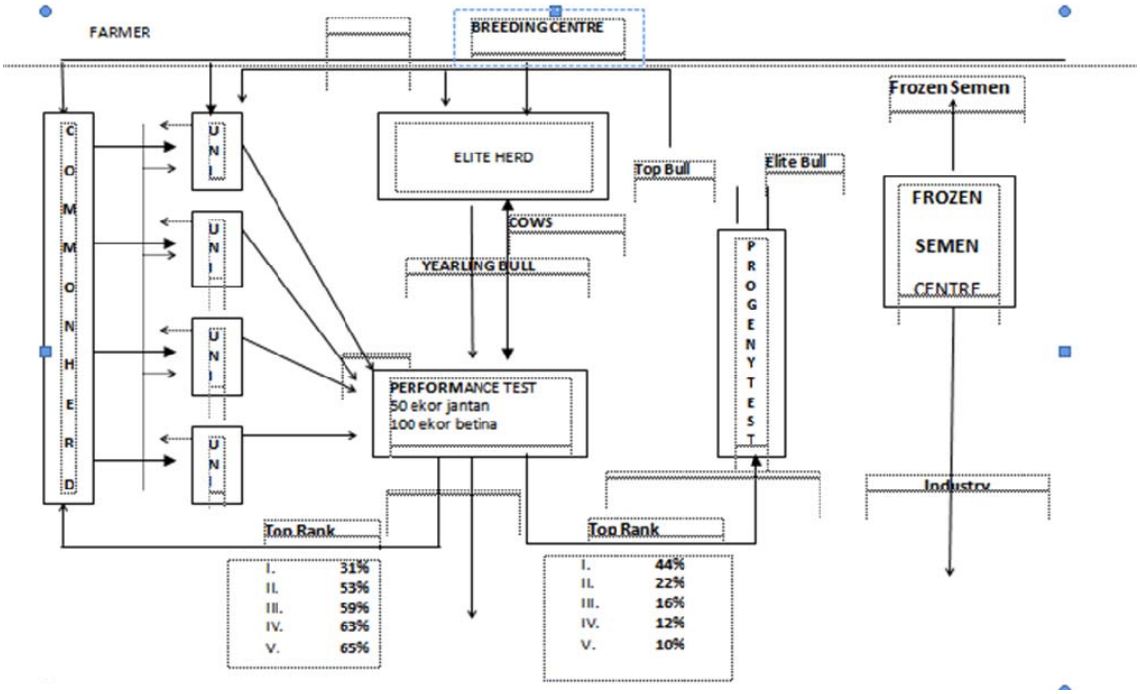

Figure 1. Breeding Scheme Alternative of Bali Cattle

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