Tropical Animal Production 1984 9:203-215

EGG PRODUCTION OF INDONESIAN NATIVE AND CROSSBRED DUCKS UNDER INTENSIVE AND EXTENSIVE CONDITIONS

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Khaki Campbell and Indonesian native and crossbred ducks were allocated to farmers using intensive and extensive husbandry for the purpose of developing a system for field evaluation and to obtain preliminary information on the importance of genotype x environment interactions. Egg production was higher to 72 weeks of age under intensive husbandry, since production declined whenever extensively managed flocks became short of feed and were moved to new rice fields. Native Indonesian crossbred ducks moulted and egg production ceased during December/January, but Khaki Campbell ducks were unaffected. Tegal ducks laid more eggs and were more profitable than crossbred Alabio x Tegal ducks under extensive husbandry. Under intensive management, differences between the groups were inconsistent but Khaki Campbell ducks were more productive and profitable than any other group. It was concluded that genotype x environment interactions are likely to be important for extensive and intensive duck production.

Key words: Ducks, crossbreeding, management systems, eggs.

There are more than 17 million ducks in Indonesia, with the predominant egg laying breeds being Tegal, Alabio and Bali (Anon, 1978). In earlier trials, Khaki Campbell ducks produced almost 70% more eggs and had a higher efficiency of production than Tegal ducks (Hetzel, 1983a), and crosses between the Alabio and Tegal breeds laid nearly 24% more eggs than did Tegal ducks (Hetzel, 1983b). Both trials were carried out at a research station under high levels of feeding and intensive management. However, before recommendations about the use of new breeds or crosses can be made, their relative performance under feeding and management systems likely to be encountered under commercial conditions needs to be evaluated. Accordingly, a small field trial was undertaken with two major objectives. The primary objective was to develop a system for evaluating breeds or crossbreds in the field which could be used for larger scale studies in the future. The second was to collect some preliminary information on breed or crossbred performance in several different environments, thereby giving an indication of the possible magnitude of genotype-environment interactions.

There is a wide range of duck production environments in Indonesia. The two environments chosen for this trial were a fully intensive production environment which is being recommended in current government development programmes, and fully extensive management conditions under which most of the ducks in Indonesia are farmed. In this context,

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"intensive" means that the farmer supplies the bulk of the feed consumed by the ducks, whereas extensive refers to conditions where ducks forage under supervision for most of their feed. In addition to measuring performance traits of the breeds and crosses, records of costs and prices were kept, thereby allowing a simple economic analysis over the 18 month period of the trial. A progress report of the study has been published (Gunawan and Hetzel, 1983).

Materials and Methods

Treatment and design: The area near Karawang, a town 70 km due east of Jakarta, was chosen for the trial. It is a rice growing area supporting large numbers of ducks. Following a prelimiminary survey, and a test recording period with 12 farmers, 4 farmers were selected for the trial. Two farmers had been using intensive husbandry and 2 farmers had used extensive systems. Soon after the start of the trial, one intensive farmer changed to extensive management, and several months later an extensive farmer changed to a more intensive system. All farmers except the one with the largest number of ducks were asked to dispose of their previous flocks before the present trial began.

The extensive farmers (E_1, E_2) regularly herded their ducks to the rice fields and on occasions stayed away from their village for up to 4 weeks. Soon after the trial began, it was discovered that the 2 farmers were father and son, and both flocks were frequently shepherded by the son. During the day the ducks were free to scavenge for food. At night, if the farmer considered that the ducks were not getting sufficient to eat, supplementary feed was provided.

One of the farmers using intensive husbandry (I_2) had been experimenting with intensive systems for several years and had farmed up to 600 ducks. His ducks were fully confined in pens at all times. During the day they had access to an outside shaded run with a water trough, but were locked in covered pens at night. All feed was provided by the farmer. The other farmer in this category (I_1), initially herded his ducks to the nearby rice fields but always brought them home at night. He provided generous feed supplements daily. Soon after the ducks started to lay, he changed his management system. During the day his ducks were free to roam in the confines of the village and his own backyard. Three times a day, the farmer or his wife gave extra feed to the ducks. It appeared that the ducks were acquiring little feed from around the village, so that the classification of intensive as defined earlier seemed appropriate.

Ducks, feeds and management: Ducks for the trial were hatched at Balai Penelitian Ternack (BPT) during late January/early February 1980. They comprised Khaki Campbell, Bali, Tegal, Tebio (Tegal ♂ x Alabio ♀) and Alagal (Alabio ♂ x Tegal ♀). Ducklings were reared on a compounded starter diet containing 200 g/kg protein and 12.5 MJ/kg metabolizable energy. Due to lower hatchability than expected, the number of Tegal ducks was supplemented by purchasing extra ducks, aged 4 weeks, in

Karawang. Ducks were allocated to the farmers at between 4 and 6 weeks of age (Table 1). All farmers were asked to use their normal feeding and management systems. Extensive farmers and farmer I_1 ran the different groups together during the day, but separated them at night for the purposes of recording feed supplement and egg production.

Measurements: Each farmer was supplied with a simple balance and recording sheets to record egg production, the type and weight of feed supplement given and changes in duck numbers. Feed costs and egg prices were noted wherever purchases or sales were made. Farmers were visited monthly by staff from BPT and the local Department of Livestock Services office. At this time, eggs were collected for weighing and specific gravity determination, ducks were weighed and feed samples were taken for analysis. Feed analyses were conducted as in Hetzel (1983a). Aflatoxin levels are presented in terms of aflatoxin B_1 equivalents based on the relative toxicity of aflatoxin B_1, B_2, G_1 and G_2 to ducks (Carnaghan *et al.*, 1963).

At the conclusion of the experiment, 10 ducks from each flock were autopsied for evidence of liver damage.

A qualitative measurement system was used. Liver abnormalities were scored according to the size of the lesions as follows: 0, no lesion; 1, lesions up to 0.5 cm in diameter; 2, lesions 0.5 to 1 cm in diameter. Samples from the right and left lobes of the liver were fixed in 10% neutral buffered formalin, embedded in paraffin, cut at 5 to 7 microns

Table 1:
The allocation of ducks to the intensive (I) and extensive (E) farmers in the trial.

Farmer	Breed (origin)	Number of ducks	
		Male	Female
E_1	Alagal	4	37
	Tegal (local)	4	40
E_2	Tebio	4	32
	Tegal	4	32
I_1	Tebio	3	41
	Tegal	5	33
I_2	Tebio	4	40
	Alagal	4	40
	Tegal	4	40
	Tegal (local)	4	40
	Khaki Campbell	4	37
	Bali	4	33

and stained with haematoxylin and eosin. The extent of bile duct hyperplasia as visualised under the light microscope was scored as follows: 0, normal; 1, some evidence of bile duct hyperplasia; 2, bile duct hyperplasia affecting up to 50% of live lobules and some necrosis of

parenchymal cells; 3, bile duct hyperplasia affecting more than 50% of live lobules and necrosis of parenchymal cells; 4, bile duct hyperplasia affecting all liver lobules and widespread necrosis of parenchymal cells.

Results

Feeds: The amount and type of feed supplements given by the farmers are shown in Table 2 and the mean and range in composition in Table 3. Farmers E_1 and E_2 supplemented with a mixture of rice and whole paddy

Table 2:

The feed types and quantities fed by the intensive (I) and extensive (E) farmers.

Farmer	Feed types	Ratio	Breed	Average amount of feed supplied (g/duck/d) for weeks 6-24	24-76
E_1	Whole paddy (1)	-	Alagal	77 (2)	74 (3)
			Tegal (local)	38 (2)	69 (3)
E_2	Whole paddy (1)	-	Tebio	82 (2)	70 (3)
			Tegal	81 (2)	64 (3)
I_1	Rice bran:prawn heads (to 23 weeks)	6:1	Tebio	153	169
	Whole paddy:prawn heads (after 23 weeks) (1)	3:1	Tegal	153	178
I_2	Maize: whole paddy:rice bran:soybean meal:fish meal:coconut meal:shell grit	2:2:4 1:1: 0.5:0.5	Tebio	81	130
			Alagal	82	130
			Tegal	83	141
			Tegal (local)	81	160
			Khaki Campbell	92	129
			Bali	88	132

(1) During December/January (planting time), broken rice was fed in place of whole paddy.
(2) In addition, approximately 75 g rice bran/duck/d was given during the first 4 weeks of the trial.
(3) No supplementary feeding given after 56 weeks of age.

at the start of the trial, but after 4 weeks fed only whole paddy. Farmer E_1 supplemented little during April/May (ducks aged 10 to 16 weeks), while farmer E_2 did not give extra feed to his ducks during most of May and June 1980 (ducks aged 14 to 20 weeks). Both farmers did not provide a feed supplement from mid-February 1981 until the end of the trial (July). During lay, each farmer supplied up to 200 g/duck/d of whole paddy. Farmer E_1 regularly disobeyed instructions to feed both groups equally, because he claimed that the crossbred Alagal ducks were less efficient at gleaning fallen rice grains from the rice fields. During November/December, the main rice planting time in the Karawang area, farmers E_1, E_2 and I_1 fed broken rice rather than whole paddy because the latter was unavailable. Paddy rice purchased by farmers E_1 and E_2 was high in moisture content, with some samples during the wet season containing up to 20% water. Aflatoxin content was low, probably because the rice was used soon after harvest, allowing little time for the production of aflatoxin by mould fungi.

Table 3:

The composition (as fed) of some feedstuffs used by the intensive (I) and extensive (E) farmers.

Feed Type	Farmer	Moisture (%)		Protein (%)		Fibre (%)		Aflatoxin (μgB_1 equiv/kg)	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range
Mixed feed (1)	I_2	11.2	9.7-12.8	15.3	13.2-19.6	6.4	2.3-8.8	21	0-63
Soybean meal	I_2	10.2	4.5-12.0	41.9	37.1-45.5	7.1	5.0-10.2	3	0-20
Fish meal	I_2	9.3	5.2-11.7	47.2	38.9-57.3	1.8	0.5-4.1	0	-
Coconut meal	I_2	8.8	5.6-11.8	19.1	16.9-22.2	14.3	9.8-18.8	16	0-28
Rice bran	I_2	10.9	8.4-14.2	12.3	9.6-13.3	8.2	4.6-11.6	2	0-10
Maize	I_2	11.5	6.0-13.2	9.0	7.5-10.8	.3.0	1.4-6.7	49	8-230
Paddy rice	I_2	12.9	11.0-15.1	7.1	5.4-8.4	11.6	5.7-13.3	4	0-15
Paddy rice	I_1, E_1, E_2	16.3	12.5-20.7	7.1	5.7-8.5	10.2	3.8-14.9	2	0-24
Broken rice	I_1, E_1, E_2	12.1	9.5-14.3	8.5	7.5-9.7	3.5	2.4-4.4	0	-

(1) Other analyses: mean (range); calcium (%) 2.3 (1.5-2.8); phosphorus (%) 0.9 (0.8-1.2); gross energy (MJ/kg) 17.9 (15.4-21.0).

Farmer I_1's feeding system was based on rice bran (up to start of lay), whole paddy and prawn heads being mixed with water and fed 3 times per day. The quantity of feed supplement was considerably higher than for E_1 and E_2, on occasions reaching 275 g/duck/d and the moisture content of the whole paddy was also higher. Only two analyses of prawn heads were obtained, and the crude protein content averaged 45.2%.

Farmer I_2 mixed his feed on the farm according to his own formula. The same mixture was used throughout the trial although the amount offered to the ducks was increased during lay. The quantity of feed supplied differed slightly between groups only because the farmer did not adjust the feed quantity per pen following mortality. The protein content of the feed averaged 15.3% and the large variability between batches was apparently due to variation in the protein content of the soybean meal and fish meal. The fibre content of the mixed feed was high, due to the fibrous nature of the coconut meal. Aflatoxins were generally present in the mixed feed but at low levels. The major sources of aflatoxins were corn and coconut meal. Calcium level in the ration averaged 2.3% but on one occasion was as low as 1.5%.

Egg production: Egg production traits for the flocks are presented in Table 4. In general, extensively farmed ducks reached maturity at the same age as ducks under intensive husbandry. Differences between crossbred and Tegal ducks were small. Peak production was also similar for all groups except for the group of Tegal (local) ducks at I_2. Peak production was reached at a later age under extensive husbandry dependent on the availability of feed rather than on the age of the ducks.

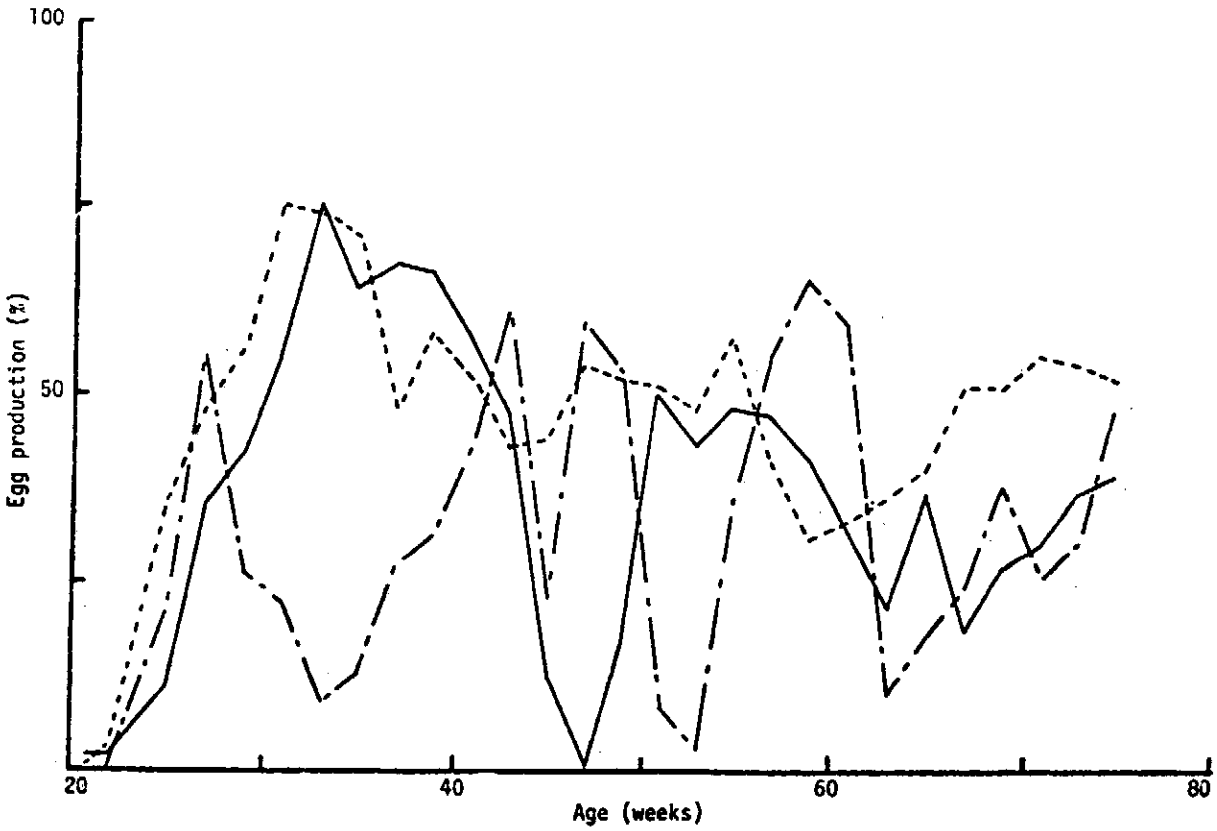
Table 4:
Egg production and mortality of ducks under intensive (I) and extensive (E) husbandry.

Farmer	Breed	Age at 5% production (weeks)	Peak production (%)	Peak production (week)	Eggs to 76 weeks Nº	Eggs to 76 weeks Mean wt (g)	Eggs to 76 weeks Specific gravity (g/ml)	Mortality (%) 6-24 weeks	Mortality (%) 24-76 weeks
E_1	Alagal	24.3	73	61	114	67.6	1.075	0	32
	Tegal (local)	22.6	73	55	127	69.2	1.078	13	32
E_2	Tebio	24.9	71	49	98	67.9	1.074	13	20
	Tegal	24.3	73	43	121	68.0	1.077	3	14
I_1	Tebio	24.4	80	32	114	66.3	1.072	4	14
	Tegal	24.7	79	72	101	64.9	1.071	0	16
I_2	Tebio	24.4	71	33	114	63.3	1.074	0	7
	Algal	27.0	76	39	121	61.6	1.075	0	7
	Tegal	23.9	76	33	144	62.1	1.077	5	10
	Tegal (local)	24.9	64	58	105	63.2	1.081	46	45
	Khaki Campbell	23.6	77	33	184	-	-	6	15
	Bali	26.4	74	36	110	-	-	10	4

Egg production at I_2 was generally higher to 72 weeks of age than for E_1 and E_2, although the differences were smaller to 76 weeks of age. Representative egg production curves for Tegal (BTP) ducks belonging to one extensive farmer (E_2) and one intensive farmer (I_2) are illustrated in Figure 1. There were more fluctuations in the production curve for the extensive group with most of the major drops occurring when feed was exhausted in one area and ducks were transported to another area or back to their home village until new rice fields were available. On these occasions, the stress caused some ducks to go through a partial moult.

Figure 1:

Egg production of Khaki Campbell ducks at I_2 (----), Tegal (BPT) ducks at I_2 (——) and Tegal (BPT) ducks at E_2 (— - —— -)



On one occasion during the recording period, most of the ducks at all four farms passed through a complete moult, when pin feathers were shed as well as smaller feathers. This moult resulted in the flocks being out of production for about 4 weeks in early January for E_1 and E_2 and late December for E_1 and E_2 and for I_1. All groups of ducks at

I_2 except Khaki Campbell started to moult heavily at the end of November. The farmer then changed the feed for these groups to 100% rice bran for 3 weeks to accelerate moulting and to save on feed costs. Consequently, production declined for all groups except Khali Campbell.

Owing to the nature of the trial, statistical comparisons of breeds and crossbreds were not possible. Under extensive husbandry, Tegal ducks appeared to lay more eggs and have a higher intensity of production than crossbred ducks. Under intensive husbandry, differences between Tegal and crossbreds were not consistent. At I_2, Khaki Campbell ducks laid more eggs than Tegal, Bali or crossbred ducks.

Ducks kept extensively consistently laid heavier eggs than at I_1 or I_2. Specific gravity, a measure of shell thickness, was lowest at I_1 but similar at the other three farms.

The body weights of ducks (Table 5) revealed small differences between breeds and crosses, and between intensively and extensively run flocks. All groups gained weight during the laying period. Surprisingly, extensive ducks were on average heavier in mid-production (37 and 55 weeks) than the ducks at I_2.

Mortality: With the exception of Tegal (local) ducks at I_2, mortality was higher under extensive husbandry (Table 4). Additional

Table 5:
Bodyweights (kg) of ducks under intensive (I) and extensive (E) husbandry.

Farmer	Breed	Age (weeks) (1)			
		26 (2)	37	55	67
E_1	Alagal	1.38	1.43	1.49	1.50
	Tegal (local)	1.40	1.41	1.60	1.48
E_2	Tebio	1.27	1.50	1.51	1.37
	Tegal	1.40	1.54	1.49	1.45
I_1	Tebio	1.40	1.54	1.54	1.64
	Tegal	1.36	1.37	1.47	1.56
I_2	Tebio	1.36	1.36	1.39	1.62
	Alagal	1.28	1.46	1.47	1.58
	Tegal	1.33	1.34	1.38	1.41
	Tegal (local)	1.45	1.37	1.35	1.45

(1) Tegal (local) ducks were two weeks younger than the specified ages.
(2) 21 weeks for E_1 and I_2 ducks.

causes of death under extensive management were cited as car accidents, consumption of insecticides or poisonous plants, eating fish hooks and drowning. At I_2, nearly 50% of Tegal (local) ducks died in the first two months of the trial. The cause was thought to be fowl pox which broke out soon after the purchase of the ducks. Subsequent mortality was also high, although the ducks appeared healthy.

Profitability: Feed costs per kg were lowest for I_1 although during lay the total feed costs per duck were lowest for the extensive farmers since the quantity of feed supplement was considerably less (Table 6). Feed costs were highest for I_2 where a conventional compounded diet was fed. The egg price varied markedly during the period

Table 6:

Feed costs, egg returns, egg prices and profitability of ducks under intensive (I) and extensive (E) husbandry.

Farmer	Breed	Feed costs (Rp/duck)* 6-24 (weeks)	Feed costs (Rp/duck)* 24-76 (weeks)	Range in feed cost (Rp/kg)	Egg returns to 76 weeks (Rp/duck)	Range in egg price (Rp/egg)	Gross margin to 76 weeks (Rp/duck)
E_1	Alagal	1225	2950	75-160	6740	40-78	2565
	Tegal	635	2420		7945		4890
E_2	Tebio	1185	2875	75-160	5815	40-78	1755
	Tegal	1165	2435		7200		3600
I_1	Tebio	840	3880	40-80	7800	50-80	3080
	Tegal	840	4130		6835		1865
I_2	Tebio	1365	6620	126-164	8070	55-82	85
	Alagal	1335	6620		8590		605
	Tegal	1395	7135		10215		1685
	Tegal(local)	1580	8370		7385		-2565
	Khaki Campbell	1405	6890		12185		3890
	Bali	1360	6765		7130	48-78	-995

* US $ - Rp 625 at time of the study.

of the study. The lowest prices coincided with a period of civil unrest. The price received for white shelled eggs, laid by Khaki Campbell and Bali ducks, was 20 to 30 % lower than for the green shelled eggs laid by Tegal ducks and crossbreds.

Except for the Tegal (local) ducks at I_2, for which mortality was high, returns exceeded costs during lay. When the feeding costs during the rearing period were included, many of the groups at I_2 showed little profit. For extensively raised ducks, and the ducks at I_2 where the feeding was based on low cost ingredients, profitability was reasonable. Tegal ducks gave a greater return under extensive husbandry than crossbred ducks. The profitability of Khaki Campbell ducks was reduced by the lower egg price received, but they still gave the highest return.

Autopsy: Examination of the livers of ducks from each flock showed little evidence of damage (Table 7). Gross lesions and bile duct

Table 7:
Liver abnormality and bile duct hyperplasia scores[1] of ducks under intensive (I) and extensive (E) husbandry.

Farmer	Breed	Liver abnormality			Bile duct hyperplasia[2]		
		0	1	2	0	1	2
E_1	Alagal	10	0	0	16	2	2
	Tegal (local)	10	0	0	16	4	0
E_2	Tebio	10	0	0	12	8	0
	Tegal	8	1	1	8	10	2
I_1	Tebio	10	0	0	13	7	0
	Tegal	9	1	0	4	15	1
I_2	Tebio	6	4	0	3	12	5
	Alagal	9	1	0	8	9	3
	Tegal	10	0	0	4	14	2
	Khaki Campbell	8	2	0	8	11	0
	Bali	8	2	0	16	4	0

1 For details of scoring systems, see materials and methods.
2 Both left and right lobes of liver were scored.

hyperplasia were more pronounced in ducks from I_2 where the levels of aflatoxins had been consistently higher, although rarely above 40µg aflatoxin B_1 equivalent/kg (Table 3).

Up to 30% of ducks in some of the extensive flocks had severe liver damage thought to be due to schistosomiasis infection, since schistosoma eggs were seen in some sections.

Discussion

The primary objective of this trial was to develop a system for conducting future field trials for the evaluation of breeds and crossbreds. Our experience suggests that the following factors would be important to the success of such trials.

a) The level of education of the co-operating farmers is likely to be low. Therefore there is a need to explain carefully the background to the trial and to outline the management and recording systems to be followed.

b) The involvement of local field staff is essential both in terms of making the initial contact with potential co-operators and also to gain their confidence.

c) Close supervision is necessary, particularly at the start of the trial and when the ducks start to lay. From this point of view, the location of the trial should be close to the centre which is conducting it.

d) Some financial incentives should be offered to the co-operators, since their economic status may be low. In this study, the feed costs until the ducks started to lay were reimbursed and the ducks were given to the farmers at the end of the trial.

e) The recording sheets need to be simple and the amount of data to be recorded must be kept to a minimum.

The farmers in this study did not follow all their instructions. However, since one is relying on their goodwill and co-operation, some mistakes must be expected. With larger scale experiments involving more farmers, such problems will be less serious.

Our study is unique in that we have recorded actual production under field conditions over a full year, at the same time measuring the feed inputs by the farmer. In the only other study on egg production of Tegal ducks under extensive husbandry, Kingston (1980) reported that average production around Indramayu and Tegal was 151 and 84 eggs per year respectively. Both areas are close to the site of the present trial. The author suggested that feed supplementation was lower at Tegal and that the corn supplement commonly used in Tegal may have contained high levels of aflatoxins. The egg production of Tegal ducks under extensive husbandry in the present study averaged 120 eggs over one year. Claims are frequently heard for production of 250 to 300 eggs per year but these are not substantiated by the above studies.

The egg production and average egg weight for Tegal and crossbred ducks at I_2 were considerably less than in a recent experimental study under intensive management at BPT (Hetzel, 1983b). The same Tegal and Alabio breeding flocks were used to produce ducks for both trials. Although there are no published recommended nutrient levels for these breeds, or indeed for egg-type laying ducks, the observed levels of protein and calcium were lower than those used by other farmers. It is therefore likely that the low production may have been due to an inadequate ration. Further, the feed was not fed *ad libitum* so that there was no opportunity for the ducks to compensate for lower levels of some nutrients.

At the intensive farm I_2, Khaki Campbell ducks were more productive than the other groups. This was primarily due to a greater persistency of production, since the ducks did not moult. In a previous trial, Hetzel (1983a) also reported that, under intensive management, Khaki Campbell ducks did not moult during the year, unlike Alabio, Bali and Tegal ducks. He suggested that the change of seasons may have played a part in inducing the Indonesian breed to moult. In the present study, all groups of ducks except the Khaki Campbell passed through a complete moult in December or January. All farmers said that moulting generally occurred at the end of the year, being related to the heavy rain and "cool winds" associated with the change in seasons. Therefore, this is

further evidence that the native breeds and crossbreds exhibit seasonal moulting behaviour, which is largely absent in Khaki Campbell ducks.

Although statistical comparisons between Tegal and crossbred ducks were not possible because of the lack of replication, and the small scale of the trial, some generalisations can be made. Under intensive conditions, on one farm crossbred ducks were superior, and on the other, if one averages the two Tegal groups, there was little difference in production. It was surprising that the crossbreds did not outperform Tegal ducks at I_2, since the housing and management of the ducks were similar to what was used in the trial cited earlier (Hetzel, 1983b), in which crossbreds laid 24% more eggs. An explanation may be that the feeding level of I_2 was not sufficiently high to meet the requirements of the crossbred ducks in the BPT trial was reversed when the ducks were farmed under extensive husbandry. It appears that Tegal ducks may be more adapted to production systems based on herding and foraging in rice fields than Tegal x Alabio ducks. Alabio ducks are native to South Kalimantan where they are traditionally farmed on swampy areas. The result is an indication that genotype x environment interactions are likely to be significant over the wide range of environments found in Indonesia. Therefore testing in specific production environments will be required before recommendations about the introduction of new duck breeds, strains or crossbreds are made. Recommendations may only be valid to that production environment.

Finally, although field evaluation trials are difficult to conduct and less precision can be achieved than under research station conditions, they have two important attributes. Firstly, information can be collected in production systems which cannot be simulated elsewhere. Secondly, they can provide comparisons under commercial production conditions. Therefore such trials can generate the sort of information which is needed to persuade farmers to use a new or improved breed or crossbred if it proves to give greater economic returns.

Acknowledgements

We would like to thank Kosasih and Pak Atang Suwarno for record collection and field supervision; the four farmers Pak Suparto, Sekar, Karmin and Amin for their excellent co-operation; and Ambarsiah for data processing.

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Received April 18, 1984