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Flock structure and phenotypic characteristics of local chickens in the Solomon Islands.

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Abstract:

This study was designed to characterize and describe Solomon Islands's local chicken and assess their production. Flock size, flock composition, egg production, mortalities were studied , in addition, some phenotypic features of chickens, including general feather colour, feather type, shank colour are examined. Ten villages were surveyed in West Kwara'ae and located within 15 km of the western coastline of the Island of Malaita. Villages were selected based on accessibility and availability of indigenous chickens. A series of pre interviews were then conducted from a previously exercised 360 households. Two record sheets, one for phenotypic traits and the other for flock measurements and productivity were used in the present study. Flock size and composition results showed that there was no significant ($P < 0.05$) difference in flock size amongst the surveyed villages and the overall average flock size was 8.4±0.27 chickens per household. Adults comprised 45.3 % of the flock, while chicks and growers formed 31.0% and 23.7 % of the flock respectively, and the overall ratio of cocks to hens was almost 1:1.85. Male farmers owned flock with more ($P < 0.05$) chickens per household than females. Different household sizes have no any effect ($P > 0.05$) on flock size and flock compositions parameters. Highly educated farmers had more ($P < 0.05$) chick and grower numbers per household. Providing house or shelter increase ($P<0.05$) the flock size. Egg production surveys analysis illustrated that although eggs/hen/year was almost equal ($P > 0.0.5$) among the different locations, but it was high ($P<0.05$) in Dala North and low ($P<0.05$) in Gwanaru'u compared to other surveyed villages. Rearing practices under village systems, including housing, supplementary feeding and provision of water to chickens, did not have any significant ($P > 0.05$) effect on clutch/hen/year, egg/hen/year, egg/clutch, hatchability and survivability of chicks. Mortality data revealed that more chickens predators have been killed by predators in comparison to diseases while thieves were the major causes of chicken losses. Phenotypic traits results showed that black-feathered chickens were the most common overall, forming 24.9% of household chickens, followed by red and barred feathers. Up to 57.5% of village chickens regardless of sex were normal feathered, 35.0% were naked-necked and 7.5% were frizzle-feathered birds. The majority of chickens (43.8 %) in the surveyed area had yellow shanks. The differences in the body measurements were varied significantly ($P < 0.05$) between male and females. The average of the specified body measurements was higher for adult male birds than for adult females. Phenotypes and body measurements correlations were showed significant effect in different ways in adult male and female chicken.

Adoptable findings
The data generated from this study can be used for national planning towards re-development of the local breeds. The information can also be used by extension staff, in allocating resources when they provide services to the local farmers.

Keywords: Solomon Islands, local chickens, phenotypic traits, egg production, body measurements

Introduction

Local chickens comprise over 90 % of birds in the poultry sector in the Solomon Islands. This scenario is due to a number of factors including, low investment costs of local chickens and high cost of farming commercial hybrid chickens. Flock performance and egg production are often influenced by geographical, social, management, health, nutritional, and genetic factors. These same factors can also have an effect on overall flock mortality levels. To improve the genetic potential and production efficiencies of village chickens imported commercial hybrids were introduced in the 1980s. These greatly influenced both the genetic characteristics and phenotypic features of current flocks. In terms of phenotypes, Solomon Island local chickens generally appear to be heterogeneous in plume colour and other phenotypic features although there is evidence of homogeneity in plume colour patterns in some flocks and populations. The apparent heterogeneity in these populations is largely the result of continuous cross breeding with commercial hybrids as well as local strains over many years. Understanding the effects of how these factors impact on flock performance and mortality is fundamental to improving village chicken production systems.

The objective of the present study was to describe flock sizes, flock composition, egg production, mortalities and factors which could have an effect on these variables. Some phenotypic features of village chickens, including general feather colour, feather type, shank colour and the extent to which they occur are examined. It is envisaged that this study will promote further investigations into the existing genotypes in the village chicken industry and how production performance could be improved.

Materials and methods

Study area

A survey of village chickens was conducted to investigate and describe production practices and limitations with the local chicken production system in the West Kwara'ae constituency of Malaita province. Ten villages including Tiuni, Kakara, Dala North, Dala South, Gounoa, Bubuitolo, Gwanaru'u, Koa, Buma and Rufoki were surveyed. The constituency of West Kwara'ae is located to the north of the provincial capital of Auki. Numerous villages in the constituency are connected to the provincial centre by a network of feeder roads merging into the main East road and North road. All the villages surveyed are located within 15 km of the western coastline of the Island of Malaita. Administratively West Kwara'ae is a constituency of Malaita province. The district has a human population of 30,000 people in less than 80 square kilometres. Almost 100% of the constituency's population practises subsistente agriculture in garden crops and small livestock, comprising of pigs and poultry, as the basis of their livelihood, even though they may engage in some other form of employment or small scale commercial activity. Small scale cash agriculture in the area comprises of wet and dried cocoa beans, copra, and taro (Colocasia esculenta) sold to local middlemen who further sell to Honiara for domestic and export demands. This zone, like the rest of the country is tropical, with maximum temperatures of 32ºC, night temperatures of around 25ºC,and relative humidity of 70 %. The average annual rainfall in the region is 600 mm, spread over the months of November to February.

Survey procedures

The villages were selected in collaboration with animal health and production field staff of the Department of Agriculture and Livestock, based on accessibility and were located within one kilometre from both sides of the main North road highway connecting the township of Auki to the villages of the West Kwara'ae constituency and northern region of the Malaita province. Another important criterion was the availability of indigenous or local chickens in these villages and rearing of village poultry was a significant practice. A list of households was developed in January 2008 by field staff initially to

determine families which raised local chickens, and those to be later interviewed during the survey. From this exercise 360 households were listed as keepers of village chickens. A series of pre interviews were then conducted, on three to five key household leaders per village as a means of acquiring background information and raising awareness to the village populace regarding the formal survey. Two record sheets, one for physical traits (feather colour, shank colour, comb type, shank length, body length and body height) and the other for egg production, prepared by researchers and field staff of the national department and institutions, were used in the present study. The scope of the present study was to observe selected morphological traits and body measurements of local chickens in the district.

Flock size, structure and morphological traits

Flock population and flock structures of village chickens were observed in 10 villages with 36 households per village. Chicks, grower and adult birds were counted when owners called the birds in for feeding, when they were housed or perched on tree tops or by interview. Adult and grower (pullets and cockerels) village chickens of both sexes were assessed by qualitative observation and quantitative measurements of morphological characters and body characteristics. Where flock size was below 10, all birds were assessed, and with flock sizes above 10, 10-20 birds were assessed. A total of 1106 adult and grower birds of both sexes were assessed for phenotypic traits in randomly selected households of the surveyed villages .Morphological traits observed included feather colour, shank colour, comb type, shank length, body length and body height. Where a house was constructed for chickens, farmers were asked to house their chickens to record morphological traits and body measurements. When assessing the morphological features of the birds which were not housed, two methods of observations were adopted. These included;

Observations during feeding time

During providing supplementary feed to birds, an observation on their morphology was conducted. This method was generally applied where flock size was not greater than five. This method was a quicker way of observing and recording some morphological features of the local chickens. In some instances it was necessary to place an elastic rubber band around chickens' legs after observation to indicate that an observation or measurement had already been taken.

Observations at night

Observations were made at night between 19.00 and 22.00 h using torches when chickens were housed or perched on the tree branches usually outside the farmer's house. Field officers returned during the night with the consent of farmers to observe and record birds. Plumage colours were generalised as waxy black, black, barred, white, reddish and brown following the commonly dominant plumage colour of local strains, although many birds had spots, specks or patches of varying colours. Legs or shanks were categorised as yellow, black, pale, and grey, which are typical shank colours of village chickens.

Egg production

Egg production of 375 laying birds from 8 randomly selected households in Gounoa and 9 randomly selected households each from the rest of the other surveyed locations in the study area were assessed for 12 months. Number of clutches per hen, total egg production per hen, egg consumption by household, eggs sold, hatchability and rates of survival to adult age were studied. An egg production sheet was given to the selected famers per village to record egg production with the supervision of an agricultural extension officer. Data were obtained for numbers of clutches per hen per year, clutch sizes, eggs consumed, eggs hatched, and survival rates were obtained from farmers as a written record or by interview. There were a total of 30 laying birds in Bubuitolo, 45 in Buma, 27 in Dala North, 30 in Dala South, 39 in Gounoa, 41 in Gwanaru'u, 40 in Kakara, 46 in Koa, 31 in Rufoki and 46 laying birds in Tiuni.

Data collection

Data were collected using qualitative observation, quantitative measurements, and interviews. Morphological traits were assessed by qualitative observation and interview and were recorded in the questionnaire and data sheets. To measure body length and height, a measuring tape was used. Body

length was measured from the tip of the beak (*Rostrum maxillare*) to the tail (*Cauda*) (without feathers), and body height was measured from the leg on the ground to the level of the back of the bird. To obtain data on egg production, a record sheet was distributed to the randomly selected farmers to assess egg production under village management conditions. In this case farmers, with the assistance of field extension workers, monitored egg production on a monthly basis and farmers were interviewed as to how many eggs were consumed or hatched and survived to adult age of more than 24 weeks.

Statistical analysis

Data on proportion and frequency of morphological features across villages were analysed using Chi square analysis of Minitab version 15 for Windows (Minitab, 2000). Flock size, flock composition, mortality and egg production means were analysed using the Minitab General Linear Model (GLM) for the effects of location, systems of raising birds, supplementary feeding, and providing water. Data on flock sizes, composition and mortalities were Log_{10} transformed using Windows Excel 2007 before analysis by GLM. The one-way ANOVA was used to separate means between factors which were significantly different. Other factors, including farmer gender, farmer leadership, household size and education levels of farmer were analysed for their effect on mean flock size, mortality or egg production, using the same analysis procedures.

Results

Flock performance

The overall average flock size for the ten villages surveyed was 8.4±0.27 chickens per household. The ratio of chicks, growers and adults was 1: 0.8:1.9. Adults comprised 45.3 % of the flock, while chicks and growers formed 31.0% and 23.7 % of the flock respectively. The overall ratio of cocks to hens was almost 1:1.85. Hens in the area produced an average of 22.7±0.36 eggs/hen/year, in 2.8±0.02 clutches/hen with average of 8.1±0.11 eggs/clutch per household. Eggs set and survivability of chicks to adult stage were 50.0 % and 41.3 %, respectively. Survivability (%) was derived from the number of chicks surviving to adult stage in relation to number of eggs hatched. (Table 1).

Factors affecting flock size and composition

Village, gender, household size and education levels

There was a significant ($P < 0.05$) difference in flock size amongst the villages surveyed (Table 2). The highest flock sizes per household across villages surveyed were found in Gounoa (10.6 ± 0.87) followed by Koa (10.6±0.94) and Dala South (10.4±0.63) respectively. Location had a significant ($P<0.05$) effect on chicks, with not effect ($P>0.05$) on other flock composition elements. Koa had the highest ($P<0.05$) number of growers (3.3± 0.57) per household compared to the rest of the locations. Also the number of hen is bigger ($P < 0.05$) in Koa in comparison to other villages.

Male farmers owned flock with more ($P < 0.05$) chickens (8.9±0.51) per household than females (6.8±0.51) (Table 2), furthermore higher ($P < 0.05$) number of adult birds (4.1±0.16) per household has been noticed in male's flocks than female (2.9±0.26). These differences were also observed in cock and hen compositions per household. Different household sizes have no any effect ($P > 0.05$) on flock size and flock compositions parameters. The education level of farmers had a significant ($P < 0.05$) effect on chick and grower numbers per household. Low educated farmers had more chicks (3.1±0.24) than highly educated farmers (2.1±0.24), while high level of education increase the number of grower than low level of education. Farmers that provided housing or shelter (FH), regardless of type of housing had a higher ($P<0.05$) flock size, more adult birds, growers and chicks per household than those that did not provide housing (FW) for their birds (Table2). Giving supplementary feeding have no any effect ($P > 0.05$) on flock size and other measurements. Offering water increase the sizes of flock and flock compositions categories, but it was statistically not significant.

Table 1: Mean and SEM of household production variables

Variables	Number of households	Mean± SEM
Flock size	360	8.4±0.27
Chicks	360	2.6±0.17
Growers	360	2.0±0.14
Adults	360	3.8±0.14
Cocks	360	1.3±0.06
Hens	360	2.5±0.10
Cock to Hen ratio	89	1: 2 (1.00: 1.85)
No. of clutches/hen	89	2.8±0.02
No. of eggs/hen	89	22.7± 0.36
No of eggs/clutch	89	8.1±0.11
Hatchability	89	9.0± 0.12 (50.0%)
Survivability	89	3.7± 0.08 (41.3%)
Total mortality	360	3.8±0.14

Egg production

Clutches/hen/year were not significantly different across the surveyed villages. Eggs/hen/year was highest (P<0.05) in Dala North (25.8±1.21eggs), while the lowest egg/hen/year mean was showed in Gwanaru'u (20.1±0.85). Eggs/clutch/hen was highest (P < 0.05) in Bubuitolo (8.8±0.38 eggs), whereas the lowest means for egg/clutch/hen were found in Koa (7.2±0.22 eggs). Hatchability as percentages was seen to be ranged from 45.4 in Dala North to 59.9 % in Gwanaru'u. Chick survival rate to adult stage ranged from the 36.5% in Buma to 51.6% in Kakara (Table 3).

Effect of gender, household size and education on egg production

Social factors such as gender, household size and education levels did not have any significant (P > 0.05) effect on egg production per household. Hatchability (%) and survivability (%) between genders, household sizes and education levels showed slight non-significant (P > 0.05) difference (Table 4). Results showed in Table 5 revealed that rearing practices under village systems, including housing, supplementary feeding and provision of water to chickens, did not have any significant (P > 0.05) effect on clutch/hen/year, egg/hen/year, egg/clutch, hatchability and survivability of chicks. Flock sizes did not affect the listed egg production variables.

Mortality

In the surveyed villages, predators have killed more chickens (1.6±0.08) compared to diseases (0.5±0.04 chickens) while thieves were the major causes of chicken losses (1.6±0.08) followed by accidents. The main predators included hawks, dogs and cats. There was a big difference in the total number of mortalities per household across villages. Gounoa had the highest mean (4.9±0.45 chickens) total mortality of chickens per household, while the lowest number of mortalities was recorded in Rufoki (2.5±0.49 chickens). Mortalities caused by predators were highest in Koa (2.7±0.27 chickens) compared to the rest of the villages.

Table 2: Flock size and flock composition by villages and production practices

Village	N	Flock size	Chicks	Growers	Adults	Cocks	Hens
Bubuitolo	36	7.6±0.75^{ae}	1.9±0.43^{ab}	2.5± 0.44^{d}	3 .2±0.5 1	1.1±0.20	2.1±0.35^{ad}
Buma	36	8.3±0.93^{a}	2.8±0.57^{abd}	1.7±0.41^{acd}	3 .6±0.41	1.4±0 .17	2.2±0.29^{ad}
Dala North	36	8.5±0.94^{abed}	3 .3±0.59^{bd}	1.9±0.41^{acd}	3 .3±0.38	1.4±0 .23	2.0±0.26^{ad}
Dala South	36	10.4±0 .63^{bcd}	5 .0±0.53^{cd}	1.0±0.26^{a}	4.4±0 .25	1.5±0.13	2.8±0.18^{acb}
Gounoa	36	10.6±0.87^{cd}	4.0±0.63^{d}	2.4± 0.48^{cd}	4.3±0.35	1.2±0.13	3 .1±0.28^{c}
Gwanaru'u	36	6.4±0 .65^{ae}	1.7±0.43^{a}	1.4±0 .32^{acd}	3 .4±0 .36	1.0±0.15	2.4±0 .26^{acbd}
Kakara	36	8.7±0.87^{abcd}	2.5±0.53^{ab}	2.1± 047^{acd}	4. 1±0.53	1.5±0.25	2.6±0.38^{abcd}
Koa	36	10.6± 0.94^{d}	2.8±0.53^{abd}	3 .3±0.57^{bcd}	4.5±0.46	1.3±0.16	3 .2±0.34^{bc}
Rufoki	36	5 .7±0.74^{e}	0.2 ± 0.13^{e}	2.0±0.45^{acd}	3 .4±0 .52	1.4± 0.21	1.9±0.36^{d}
Tiuni	36	6.9±0.80 ^{ae}	1.7±0.45^{a}	1.4±0 .36^{acd}	3 .8±0.56	1.6±0.26	2.2±0.37^{acd}
System							
FH	183	10.4±0 .39^{a}	3 .4±0 .26^{a}	2.4±0 .22^{a}	4.5±0.20^{a}	1.6±0.09^{a}	3 .0±0.15^{a}
FW	177	6.3±0.30^{b}	1.7±0.19^{b}	1.5±0.15^{b}	3 .0±0.18^{b}	1.1±0.08^{b}	1.9±0.13^{b}
Supplementary feeding							
No	196	7.9±0.32	2.6±0.23	1.6±0.17	3 .7±0.18	1.3±0.08	2.4±0 .13
Yes	164	8.9±0.45	2.6±0.25	2.4±0 .22	3 .9±0.22	1.3±0.09	2.5±0.16
Giving water							
No	275	8.0±0.29	2.5±0.19	1.8±0.15	3 .7±0.16	1.3±0.07	2.4±0 .11
Yes	85	9.6±0.64	3 .0±0.37	2.6±0.3 1	4. 1±0.3 1	1.3±0.13	2.7±0.23
Household							
Large	107	8.5±0.47	2.8±0.30	1.9±0.24	3 .8±0.26	1.3±0.11	2.5±0.18
Medium	176	8.5±0.40	2.5±0.25	2.1±0.20	3 .9±0.21	1.4±0 .09	2.6±0.15
Small	77	7.8±0.59	2.6±0.36	1.8±0.32	3 .5±0.27	1.2±0.11	2.3±0.19
Education							
High (H)	163	8.5±0.43	2.1±0.24^{a}	2.5±0.23^{a}	3 .9±0.23	1.5±0.01	2.5±0.16
Primary (P)	197	8.3±0.34	3 .1±0.24^{b}	1.6±0.16^{b}	3 .7±0.18	1.2±0.07	2.5±0.13
Gender							
Female	94	6.8±0.5 1^{a}	2.2±0.3 1	1.8±0.23	2.9±0.26^{a}	1.0±0.11^{a}	1.9±0.19^{a}
Male	266	8.9±0.3 1^{b}	2.8±0.20	2.0±0.17	4. 1±0.16^{b}	1.5±0.07^{b}	2.7±0.11^{b}

Values within the same column with different superscripts are significantly different (P < 0.05), FH= Free range with housing or night shelter, FW=Free range w without housing.

Morphological features

Feather colour

Of 1016 village chickens assessed black-feathered chickens were the most common overall, forming 24.9% of household chickens, followed by red (19.9 %) and waxy black (18.1 %) feathered chickens (Table 6). Chickens with brown (14.2%), white (13.3%) and barred (9.6%) feathers comprised a smaller proportion of flocks in the surveyed area. About 96.4% of black feathered chickens were female and only 3.8% were male birds (Table7). Males were, however, predominantly reddish (82.2%) or waxy black (73.9%) in plume colour. Brown-feathered chickens were almost exclusively female chickens (99.3%). White feathered-birds comprised 34.1% male and 65.9% female while barred chickens comprise 81.6% females and 18.4% males.

Table 3: Egg production, hatchability and survivability across villages

Village	Clutch/he	Eggs/hen/ye	Eggs/clutc	Egg consume	Hatchabilit y %	Survivabilit y %
Bubuitol	2.8±0.12	24.6±1.56^{afg}	8.8± 0.38^{a}	4.8±0.81	50.0	41.1
Buma	2.8±0.08	23.2±1.22^{a-g}	8.4±	4.6±0.62	51.2	36.5
Dala	2.9±0.05	25.8±1.21^{a}	8.8± 0.41^{a}	6.7±0.94	45.4	44.4
Dala	2.8±0.11	21.0±0.79^{b-g}	7.7±	6.4±0.65	54.4	44.5
Gounoa	2.7±0.07	21.4±0.94^{c-g}	8.1±	4.0±0.15	55.6	37.0
Gwanaru'	2.8±0.08	20.1±0.85^{d-g}	7.5± 0.36^{c}	4.8±0.43	59.9	37.9
Kakara	3.0±0.03	24.5±0.76^{afg}	8.3±	6.8±0.94	47.8	51.6
Koa	3.0±0.02	21.3±0.63^{efg}	7.2±	4.2±0.78	56.0	37.5
Rufoki	2.8±0.08	21.1±0.90^{fg}	8.0± 0.27	4.6±0.71	51.0	38.8
Tiuni	2.8±0.05	22.3±0.95^{g}	7.9±	6.2±0.45	53.1	45.9
Average	2.8±0.02	22.7±0.63	8.1± 0.11	5.3±0.45	52.1	41.2

a,b -Mean ± SEM within the same column with different superscripts are significantly different ($P < 0.05$)

Table 4: Egg production by gender, household size and education levels of farmers

Factor	N	Clutch/hen/year	Eggs/hen/year	Eggs/clutch	Hatchability %	Survivability %
Gender						
F	22	2.8±0.06	22.9±0.86	8.1±0.27	51.6	41.8
M	67	2.8±0.03	22.6±0.39	8.0±0.12	52.3	41.1
Household size						
L	31	2.8±0.04	22.7±0.67	8.0±0.20	52.3	40.3
M	39	2.8±0.04	22.4±0.54	8.1±0.18	53.3	41.1
S	19	2.9±0.04	23.2±0.63	8.0±0.20	49.6	43.1
Education level						
H	42	2.81±0.03	22.7±042	8.12±0.13	53.2	41.2
P	47	2.84±0.04	22.6±0.57	8.00±0.18	51.2	41.2
Education level						
H	42	2.81±0.03	22.7±042	8.12±0.13	53.2	41.2
P	47	2.84±0.04	22.6±0.57	8.00±0.18	51.2	41.2

Mean± SEMs within the same column (for each factor) with the same superscripts are not significantly different ($P \geq 0.05$). Gender: F = Female, M = Male; Household size; L= Large (≥ 8 person), M=Medium (5-7 persons), S=Small (2-4 persons).

Feather types

Up to 57.5% of village chickens in the surveyed households, regardless of sex were normal feathered, 35.0% were naked-necked and 7.5% were frizzle-feathered birds (Table 6). This trend was consistent across all ten locations with a distinct majority of birds being normal feathered. In all villages, roosters and cockerels were predominantly normal feathered, comprising 75.8 % of all male birds. A similar observation was also recorded overall in adult females although hens and pullets in Dala South (51.7 %), Bubuitolo (50.0 %), Buma (44.6 %) and Rufoki (48.1 %) were by majority naked-necked (Table 8).

Table 5: Egg production and hatchability, and survivability under village rearing practices

Factor	N	Clutch/hen/year	Eggs/hen/year	Eggs/clutch	Hatchability %	Survivability %
System						
FH	56	2 .8±0.03	22 .5±0.47	8.1±0.14	52 .2	4 1.6
FW	33	2 .9±0.04	22 .9±0.54	7.9±0.19	52 .0	40.6
Supplementary feeding						
NF	44	2 .9±0.03	22 .4±0.45	7.9±0.15	51.7	42 .7
SF	45	2 .8±0.04	22 .7±0.56	8.3±0.16	52 .5	40.0
Watering						
NW	65	2 .9±0.03	22 .7±0.39	7.8±0.12	51.9	4 1.8
YW	24	2 .8±0.04	22 .6±0.83	8.2±0.26	52 .7	39.9
Flock size						
L	33	2 .8±0.04	21.9±0.46	7.9±0.15	53.8	42 .5
M	36	2 .8±0.03	23.1±0.62	8.2±0.19	51.3	40.3
S	20	2 .9±0.06	23.1±084	8.1±0.26	51.0	4 1.1

Mean ± SEM for rearing practices within the same column with same superscripts are not significantly ($P > 0.05$) different. FH=Free range with housing, FW=Free range without housing, NF= No supplementary feeding, SF=Supplementary feed given, NW=No water given, YW=Water provided, L=Large flock size (≥11), M=Medium (6-10), S=Small (1-5).

Shank colour

A majority of chickens (43.8 %) in the surveyed area had yellow shanks, compared to grey (35.8 %), pale (19.4 %) and black (1.0 %) shanks (Table 6). The majority of chickens with yellow shanks were males (62.0 %) compared to females (38.0 %) with the same shank colour (Table 9). Hens and pullets constituted the majority of birds with grey shanks (92.6 %) and pale shanks (62.9 %). Within the surveyed male population (N = 376) 73.4 % had yellow shanks, 19.4% had pale shanks and 7.2% had grey shanks. Within the female sample population (N = 640), 26.4% had yellow shanks, 1.6 % black shanks, 19.4 % pale shanks and a majority of 52.7 % had grey shanks. In all villages, males predominantly had yellow shanks compared to other shank colours. A majority of females throughout the surveyed locations had grey shanks except for Bubuitolo where the majority (53.6 %) of females had yellow shanks (Table 9).

Body measurements

The overall (N = 376) mean shank length, body length, and body height of males were 9.8±0.05, 40.9±0.06, and 21.1±0.06 cm, respectively. While in female (N = 604) were 6.6±0.02, 35.7±0.03 and 17.6±0.03 cm respectively. The differences in the measured body variables between male and females were significant ($P < 0.05$). The average of the specified body measurements was higher for adult male birds than for adult females (Table 10). Male birds from households in Rufoki had longer ($P < 0.05$) shanks than males from other studied villages. Whereas, female birds from Gounoa had longer ($P < 0.05$) shanks than those from the rest of the locations. Rufoki's male chickens had longer ($P < 0.05$) body frame than males from the remaining nine villages, while females from Tiuni had longer ($P < 0.05$) body than females other location's females. There were significant ($P<0.05$) differences in body height for both males and females across locations. Cocks and cockerels in Koa were higher ($P < 0.05$) than those from remaining villages. Hens and pullets in Gounoa were slightly higher ($P < 0.05$) than those from all other surveyed locations (Table 10).

Table 6: Proportion of the various phenotypic characteristics of village chickens

Feather color	**Waxy black**	**Black**	**Berried**	**White**	**Red**	**Brown**	**Total**
Total	184	253	98	135	202	144	1016
Percent	18.1	24.9	9.6	13.3	19.9	14.2	100
Feather type	Normal	Naked Neck	Frizzle	Total			
Total	584	356	76	1016			
Percent	57.5	35.0	7.5	100			
Shank Colour	Yellow	Black	Pale	Grey	Total		
Total	445	10	197	364	1016		
Percent	43.8	1.0	19.4	35.8	100		

Total number of household assessed (118). Roosters and cockerels in Tiuni (48.1%), Kakara (60.7%), Dala south (40.0%), Gounoa (47.7%), Koa (47.6%) and Buma (60.0%) were predominantly reddish in plume colour. The majority of male birds in Dala North (46.7%), Bubuitolo (38.9%) and Rufoki on the other hand were waxy black in plume colour. The majority of hens and pullets in Buma (34.1%) and Rufoki (30.4%) were brown in feather colour, while black plumed females formed the majority in the rest of other surveyed villages.

Phenotypes and body measurements

Adult males

There was a significant ($P < 0.05$) difference in shank length and body length amongst 376 adult male birds on account of plume colours (Table 11). Adult males with white feather colour had longer shanks (10.2±0.13 cm) than the rest, while males with brown plumage colour had the shortest shank (7.8±1.06 cm). Adult males with white (41.4±0.14 cm) or waxy black (41.1±0.07 cm) plume colour had longer body lengths than similar male birds of other listed feather colours. Male birds with brown feather colour had the shortest body (37.6±1.65 cm). There was no significant ($P > 0.05$) difference in body height amongst male birds of the listed feather colours. Naked neck cocks had longer ($P < 0.05$) shank length than, normal and frizzle feathered. Naked-neck adult males had a significantly ($P < 0.05$) longer body than frizzle- feathered male birds with significant different to normal necked males. There were no differences ($P > 0.05$) in body height of adult male birds of the different feather types.

Table 7: Feather colour frequency as percentage of (N) number of birds (by sex) across villages

	Tiuni	Kakara	Dala North	Dala South	Gounoa	Bubuitolo	Gwanaru	Koa	Buma	Rufoki	Within sex tota (%)	Feather colour total (%)
Households	12	12	11	12	13	12	12	12	11	12		
Males												
N	52	28	30	35	44	36	40	42	30	39	376	
Feather colour (%)												
Waxy black	28.8	21.4	46.7	34.3	36.4	38.9	37.5	40.5	30.0	46.2	36.2	73.9
Black	7.7	0.0	0.0	0.0	0.0	8.3	5.0	0.0	0.0	0.0	2.4	3.6
Barred	7.7	3.6	6.7	5.7	6.8	5.6	0.0	4.8	3.3	2.6	4.8	18.4
White	7.7	14.3	10.0	20.0	9.1	19.4	20.0	7.1	3.3	12.8	12.2	34.1
Reddish	48.1	60.7	36.7	40.0	47.7	27.8	37.5	47.6	60.0	38.5	44.1	82.2
Brownish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.3	0.7
Females												
N	66	76	63	60	74	56	53	82	56	54	640	
Feather colour (%)												
Waxy black	0.0	0.0	1.6	5.0	25.7	12.5	0.0	12.2	14.3	0.0	7.5	26.1
Black	42.4	43.4	38.1	35.0	47.3	41.1	43.4	19.5	26.8	48.1	38.1	96.4
Barred	13.6	17.1	4.8	15.0	14.9	14.3	3.8	18.3	14.3	3.7	12.5	81.6
White	16.7	21.1	17.5	21.7	5.4	5.4	20.8	11.0	10.7	9.3	13.9	65.9
Reddish	9.1	13.2	3.2	3.3	2.7	8.9	0.0	4.9	3.6	5.6	5.6	17.8
Brownish	18.2	5.3	34.9	20.0	4.1	17.9	32.1	34.1	30.4	33.3	22.3	99.3

Table 8: Distribution of feather types of birds by sex and village

	Tiuni	**Kakara**	**Dala North**	**Dala South**	**Gounoa**	**Bubuitolo**	**Gwanaru,u**	**Koa**	**Buma**	**Rufoki**	**% of sex total**	**% of feather type total**
Households	12	12	11	12	13	12	12	12	11	12		
Males												
N	52	28	30	35	44	36	40	42	30	39	376	
Feather type %												
Normal	73.1	82.1	83.3	82.9	75.0	66.7	75.0	73.8	70.0	79.5	75.8	48.8
Naked	25.0	17.9	10.0	11.4	22.7	27.8	22.5	26.2	30.0	12.8	21.0	22.2
Frizzle	1.9	0.0	6.7	5.7	2.3	5.6	2.5	0.0	0.0	7.7	3.2	15.8
Females												
N	66	76	63	60	74	56	53	82	56	54	640	
Feather type %												
Normal	51.5	47.4	50.8	35.0	55.4	42.9	47.2	46.3	42.9	44.4	46.7	51.2
Naked	36.4	44.7	33.3	51.7	40.5	50.0	43.4	42.7	44.6	48.1	43.3	77.8
Frizzle	12.1	7.9	15.9	13.3	4.1	7.1	9.4	11.0	12.5	7.4	10.0	84.2

Table 9: Frequency of chickens with specified shank colour as percentage of (N) number of

	Tiuni	**Kakara**	**Dala North**	**Dala South**	**Gounoa**	**Bubuitolo**	**Gwanaru'u**	**Koa**	**Buma**	**Rufoki**	**% of sex total**	**% of total**
Households	12	12	11	12	13	12	12	12	11	12		
Male												
N	52	28	30	35	44	36	40	42	30	39	376	
Shank colour %												
Yellow	61.5	78.6	70.0	71.4	88.6	66.7	82.5	66.7	66.7	82.1	73.4	62.0
Black	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pale	26.9	2 1.4	0.0	28.6	11.4	22.2	0.0	33.3	33.3	15.4	19.4	37.1
Grey	11.5	0.0	30.0	0.0	0.0	11.1	17.5	0.0	0.0	2.6	7.2	7.4
Female												
N	66	76	63	60	74	56	53	82	56	54	640	
Shank colour %												
Yellow	22.7	25.0	9.5	25.0	37.8	53.6	24.5	26.8	26.8	11.1	26.4	38.0
Black	4.5	0.0	0.0	0.0	0.0	0.0	13.2	0.0	0.0	0.0	1.6	100.0
Pale	22.7	22.4	22.2	2 1.7	20.3	1.8	0.0	31.7	25.0	16.7	19.4	62.9
Grey	50.0	52.6	68.3	53.3	41.9	44.6	62.3	41.5	48.2	72.2	52.7	92.6

Table 10: Mean of specific body measurements of adult and female chickens

	Shank length (cm)		Body length (cm)		Body height (cm)	
Location (n)	Male	Female	Male	Female	Male	Female
Bubuitolo (12)	9.6±0.20^{ag}	6.70±0.07^{a}	40.6±0.28^{a}	35.7±0.13^{acd}	20.9±0.23^{af}	17.7±0.11^{afg}
Buma (11)	9.9±0.20^{abcde}	6.6±0.12^{ac}	40.7±0.27^{a}	35.6±0.07^{abd}	21.2±0.22^{abc}	17.4±0.08^{acd}
Dala North (11)	9.7±0.12^{a}	6.5±0.08^{c}	40.8±0.13^{a}	35.6±0.06^{abe}	20.4±0.16^{abf}	17.6±0.08^{afgd}
Dala South (12)	9.9±0.13^{abcd}	6.7±0.07^{ac}	41.0±0.13^{ac}	35.7±0.07^{ade}	21.1±0.23$^{a\ b}$	17.8±0.07^{fbg}
Gounoa (13)	10.1±0.15$^{b\text{-}e}$	6.4±0.06^{bc}	41.0±0.18^{bc}	35.7±0.06^{adc}	21.2±0.22^{abc}	18.0±0.09^{b}
Gwanaru (12)	10.3±0.13^{cde}	6.7±0.06^{a}	40.9±0.14^{f}	35.9±0.11^{c}	21.5±0.16^{bcd}	17.3±0.07$^{cd\ e}$
Kakara (12)	9.3±0.13^{gf}	6.6±0.068^{c}	40.5±0.19^{a}	35.7±0.09^{adc}	20.5±0. l7^{fe}	17.7±0.09^{g}
Koa (12)	9.2±0.1l^{f}	6.53±0.61^{ac}	41.4±0.11^{e}	35.8±0.14^{dc}	20.5±0. l7^{e}	17.2±0. ll^{e}
Rufoki (12)	10.3±0.1^{1e}	6.5±0.06^{abc}	41.0±0.27^{ac}	35.6±0.08^{e}	21.6±0.13^{d}	17.7±0.12^{afg}
Tiuni (12)	10.3±0.12^{de}	6.6±0. l^{ac}	41.2±0.14^{c}	35.4±0.06^{be}	21.7±0.16^{cd}	17.5±0.09^{e}
Average	9.8±0.05	6.6±0.06	40.9±0.06	35.7±0.03	21.1±0.23	17.6±0.03

Means ±SEM within the same column with different superscripts are significantly different (P < 0.05)

Table 11: Mean of specific body measurements of adult male chickens by feather colour and feather types

Feather colour	**Waxy**	**Black**	**Barred**	**White**	**Red**	**Brown**
N	135	7	18	46	167	3
Body measurements						
Shank length (cm)	9.9±0.07^{a}	9.0±0.44^{bd}	9.7±0.20^{ab}	10.2±0.13^{c}	9.9±0.07	7.8±1.06^{d}
Body length (cm)	41.0±0.07^{ac}	40.2±0.47^{a}	40.8±0.18^{ac}	41.4±0.14^{c}	40.9±0.11	37.6±1.65^{b}
Body Height (cm)	21.2±0.10^{a}	20.1±0.51^{a}	20.7±0.24^{a}	21.5±0.18^{a}	22.8±1.89	19.0±1.04^{a}
Feather type	Normal	Naked neck	Frizzle			
N	283	79	14			
Body measurements						
Shank length (cm)	9.8±0.05^{a}	10. 1±0.12^{b}	9.2±0.141^{c}			
Body height (cm)	22.1±1.06^{a}	21.4±0.15^{a}	20.3±0.21^{a}			

Mean ± SEM within the same row with different superscripts are significantly different (P < 0.05)

Table 12: Means of specific body measurements of adult female chickens by feather colour and feather types

Feather	Waxy	Black	Barred	White	Red	Brown
N	48	244	80	89	36	143
Body						
Shank length	6.8±0.1	6.5±0.03	6.8±0.0	6.7±0.0	6.9±0.	6.5±0.0
Body length	35.8±0.	35.6±0.0	35.8±0.	35.7±0.	36.l±0	35.6±0.
Body Height	17.9±0.	17.5±0.0	17.8±0.	17.6±0.	17.9±	17.4±0.
Feather type	Normal	Naked	Frizzle			
N	301	276	63			
Body						
Shank length	6.5±0.03[a]	6.8±0.03[b]	6.2±0.05[c]			
Body length	35.6±0.	35.8±0.0	35.3±0.			
Body height	17.5±o.	17.8±0.0	17.l±0.			

Mean ± SEM within the same row with different superscripts are significantly different (P < 0.05)

Adult females

Table 12 summarize female body measurements of the listed feather colours. Adult females with reddish plumage had longer (P < 0.05) shanks than the rest. Females with black or brown plumage had the shortest (P < 0.05) shank. Adult females with reddish plumes had a longer body (P < 0.05) than those with black or brown feather colour, but were not significantly (P > 0.05) different to females with waxy black or barred plumage. Reddish, waxy black and barred adult females were higher (P < 0.05) than black, white (17.6±0.08 cm) and brown hens. Naked neck hens had longer (P < 0.05) shanks, body length and height than normal or frizzled-feathered chickens.

Discussion

Flock performance

Village chicken production is largely small scale and this is evident in the average flock size of 8.4±0.27 chickens per household. This size is similar to observations by Farooq *et al*. (2003) in Pakistan but smaller than observations in Botswana (Badubi *et al*., 2006). The low proportion of chicks and growers in the flock ratio indicated high mortalities in the young as they are the most vulnerable to predators and other causes of mortality in village systems. This is reflected in the lack of stock and small flock sizes common in village poultry systems in the district. Consequently, once birds become aged or are sold or consumed then farmers face the problem of stock replacement. Average egg production in households throughout the district was lower than reported by Bhuiyan *et al.* (2001) in Bangladesh and Tadelle and Ogle (2001) in Ethiopia.

Factors affecting flock size and composition

The results show that farmers from Dala South, Gounoa, and Koahad had larger flocks than other villages. Apparently a majority of farmers in these villages built houses for their chickens and this may have had an effect on maintaining flock size and composition of the flock. This observation is confirmed by results showing that farmers who constructed housing for their chickens have a higher mean of flock size as they tended to build houses for the protection of their flocks.Supplementary feeding and watering in the manner currently practiced by village farmers did not have any effect on flock size and compositions, as feed and water provided were usually insufficient both in quality and quantity. Male farmers owned bigger flocks than female farmers. This observation is similar to reports by Abubakar *et al.* (2007) in Nigeria but contradicts observations by Badubi *et al.* (2006) in Botswana. In many cases a majority of men claim ownership of village chickens but contribute little to the caring of chickens.

Mortalities

The major causes of mortalities and losses were predators and theft. Diseases and accidents were regarded by farmers as minor causes of losses to village flocks. Total flock mortality per household appeared to be highest in Gounoa although not significantly different to total mortalities per household in most villages except for Rufoki. This observation generally indicates high total flock mortality across villages. Mortalities due to predation were highest in Koa and Gounoa compared to the other locations. Losses due to theft were not significantly different across villages indicating that vandalism was common in all surveyed locations. Housing did not have any significant effect on total mortalities or mortalities due to the listed causes, as during the day chickens were left outside to scavenge and are most vulnerable to bird of prey and dogs, and furthermore, rudimentary night shelters did not deter vandals. The high level of mortality due to diseases may be the result of lack of hygiene, in the cleaning of watering equipment, not changing dirty water from one watering session to another rather than a problem of water source.

Egg production

Hens are rarely given any care during the laying stage, with regards to feed supply or management practice. Laying nests provided by some farmers were in the form of old paper boxes laid with old cloth or old banana leaves, old suitcases or bedding made out of folded banana leaves. Similar practices were reported by Tadelle and Ogle (2001) in Ethiopia. Where no care was given, hens often lay their eggs on dirt under the main house and under shrubs outside the homestead. Results show that existing village management practices of night shelter, supplementary feeding, or providing water did not have any significant effect on egg production. Farooq *et al*. (2003) in Pakistan reported a slightly higher average rate of hatchability (60.8±1.56 %) and that a higher hatchability was associated with an egg holding period of < 7 days compared to > 14 days. Differences in egg production under village management systems are usually due to variations in nutrition, genetics and management (Safaloah, 1997; Abdelqader *et al*, 2007).Lower hatchability and survivability are the result of less intensive selection and very few options for breeding or replacement stock.

General phenotypic characteristics and body measurements

Existing in the villages are birds of varying plume colours and patterns. The main feather colours include waxy black, black (dull), barred, white, red and brown. Chickens with these feather colours are common throughout the district. Results show the dominance of chickens with black plumes in the district, comprising 24.9% of the sample population. The black plume is typical of local hens and its occurrence is strengthened by the high female to male ratio. On the other hand reddish or waxy black plume is typical of roosters and cockerels.

By feather type, chickens in the surveyed area are predominantly normal feathered (57.5%) regardless of sex. There has been an increased influx of the Naked Neck type from Papua New Guinea (PNG) into the border Islands and the Naked Neck populations have increased rapidly over the years and currently comprise 35.0% of the chickens in the surveyed areas. There has been an increased preference for the Naked Neck following perceptions of its ability to cope with heat stress and generally large body frame. A specialist breeding centre is established on Ontong Java as initiatives to breed Naked Necks chickens are underway on the Island.

Preference in the local phenotypes was not investigated in this study. However, colour and feather type may become important phenotypic characteristics in selection as farmers' relate feather colour to hybrids. For example waxy black plume is related to Australorp or reddish plume to Rhode Island Red, and these breeds have been used in programmes to improve growth and egg production in village chickens. The Depertment of Agriculture and Livestock and Solomon Islands College of Higher Education have established a poultry breeding facility to produce fertile eggs for incubation and hatching With the aim of supplying village chickens for research trials and for farmers who lost their birds during the tsunami (Glatz *etal.*, 2009).

Body measurements

Village chickens in the Solomon Islands are generally small in frame, however, indiscriminate cross breeding and selection over the years may have had a bearing on its existing body size, height, length and shank length.It is obvious by physical observations that chickens which are derived from crosses between native and imported strains may appear to have a superior body frame to native strains. Body measurements are an important indicator of body size and weight of chickens. For instance, a significant degree of correlation exists between shank length and body weight, therefore body measurements could be used to predict body weight in mature village chickens *(*Badubi *et al.*, 2006). The differences in body measurements in relation to morphological characteristics across locations illustrate the extent to which imported hybrids including, Australorp, Rhode Island Red and White Leghorn etc. are crossed with native types. The superiority in body measurements of chickens in certain locations or of birds with certain phenotypic features – plume and feather type not only provides a population for selection for growth and egg production but also necessitates further investigation into breed and genotypiceffects. The introduction of Naked Neck chickens has to an extent broadened the basis for selection. Roosters and hens of this strain are observed to have superior body measurements and therefore it could be worthwhile to explore the potential of Naked Neck chickens for both growth and egg production.

Conclusion

Many populations of local chickens are most likely crossbred populations, as imported hybrids have been used in the past in programmes in attempt to improve the genetic potential of village chickens. These are evident in the physical features of existing phenotypes and indicate a degree of improvement in the genetic potential of village chickens. A strategic step towards improving village poultry systems is to give both technical and funding support to the existing village poultry training programmes undertaken by KGA (Kastom Gaden Association), the initiatives of 'Kai Kokorako' on breeding Naked Neck chickens on Lord Howe atoll, and the village chicken research and breeding unit which are currently operated by DAL and SICHE.

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