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58

# A guide to setting up a selective indigenous chicken improvement program: The Horasi breed in Tanzania

TALIRI TANZANIA LIVESTOCK RESEARCH INSTITUTE UTAFITI KWA MAENDELEO

African Chicken Genetic Gains

TPGS Tropical Poultry Genetic Solutions

# A guide to setting up a selective indigenous chicken improvement program: The Horasi breed in Tanzania

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# Foreword

’See it big and keep it simple.’

Wilfred Peterson

This manual shows the critical steps that need to be followed to start up and run an indigenous chicken breed improvement program in sub-Saharan African (SSA) settings. Although the steps in most programs remain the same, indigenous chicken breeding programs have peculiar characteristics. The indigenous chicken breeding program in SSA ideally focuses on developing a dual-purpose chicken based on the interests and aspirations of village chicken producers. Indigenous chicken must meet in simple terms the farmers desires to have chicks with high survival rate, chicken that grow fast and big, lay more eggs, chicken strains with mixed colour and with high scavenging ability. Indigenous chickens may not compete with commercial chickens but are preferred by farmers. Our previous engagement was successful, and confident that such a program can be successful with less sophisticated facilities. This manual will be instrumental to achieving the overall goal of developing an improved indigenous chicken strain.

Tadelle Dessie

Principal scientist, ILRI Tropical Poultry Genetic Solutions (TPGS) program leader

# 1 Introduction

Chickens have several adaptive traits and genes such as necked necks, minimum and frizzle feathers, black bones, and chicken breeding in the developed world has achieved a higher level of practical application than larger animal breeding. Through a combination of well planned and executed selection and crossbreeding programs, the production of a laying fowl had reached up to 300 eggs a year with an average egg weight of 60 g, compared to less than 100 eggs/hen per year produced by unimproved poultry (Lillico et al. 2005). A similar improvement in growth rate has been achieved by broilers, whereby over 2 kg live body weight is achieved in six weeks or less. High reproductive rates and short generations have made developing highly productive inbred lines. Indigenous chickens show high genetic diversity, diverse uses, and benefits (Dessie 2003; Asgedom 2007; Hassen et al. 2007). Indigenous chickens are an essential source of food, meat, and eggs. Besides, such birds play crucial roles in lucrative sports in many southeast Asia regions. Chicken, in general, is a means of investment that is important to the welfare of women and children in traditional, low-input farming systems in the tropics. Most indigenous birds, except those bred for cockfights, are non-specialized and known for their ability to survive on irregular feed and water supplies with minimal health care. However, they form vital and integral parts of a balanced farming system.

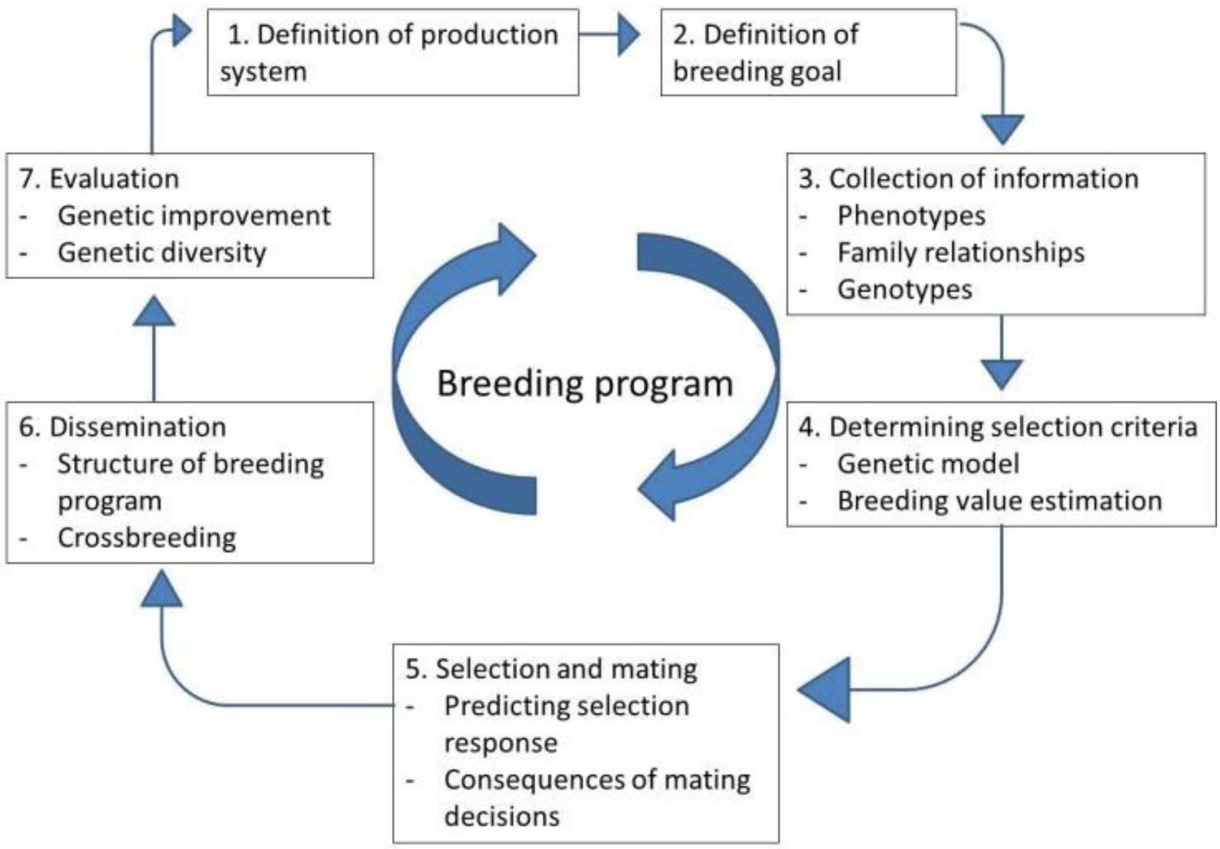
Earlier evaluating productivity of indigenous chicken identified some highly productive indigenous bird populations exhibiting a remarkably higher performance level than the other improved ecotypes, especially under low to medium production systems (Dessie et al. 2000). Although indigenous meat has unique utility in the hot and humid tropics, the real value of indigenous breeds remains underestimated (Belew 2018). This is mainly due to their lack of uniformity, appearance (darkness), less tenderness of their meats, etc., hence low levels of commercial interest in them. Although some of these negative attributes are non-genetic, the negative prejudices remain, leading to continued neglect and little attention being given to the research on them and their development. Although the local chicks are slow-growing and poor layers of small-sized eggs, they are ideal mothers, good sitters, excellent foragers, and hardy and believed to possess better natural immunity against common poultry diseases (Dessie et al. 2000). TALIRI (Tanzanian Livestock Research Institute) and International Livestock Research Institute (ILRI) set up selective breeding for Horasi chicken of Tanzania in 2018, which combines both mass selection and best linear unbiased prediction techniques (BLUP) and, testing and dissemination of improved genetic materials to people in the surrounding villages. Horasi is one of the promising indigenous chickens in Tanzania (Magonka et al. 2016)

# 2 Steps

*Genetic improvement is permanent, cumulative, and sustainable approach to bring about desired goal. Permanent: unlike management interventions, the change in the population remains for live or it is permanent. The improvement achieved in the current generations is added to those of previous generations and is cumulative. Finally, the improvement is sustainable if the improvements can continue to be made and if there is genetic variation. Even though the markets for animal products and the resources available for animal production are continually changing, breeding goals can be readily modified.*

The overall process and steps in a typical breeding program can be summarized in the scheme below (Figure 1). The steps need to be followed to arrive at the overall aim.

Figure 1. Steps in a typical breeding program.



## 2.1 Defining the selection and production environment

The location where the improvement of the chickens takes place and where the birds end up are the two most important aspects of the breeding program. The selection environment is where the selected candidates are kept, mated and the best individuals selected. They are provided with ideal/appropriate management to help them reveal their genetic potential. The breeder should bear in mind the expression of the possibility of the birds in their destination environment. When there is a big difference between the environment and the actual production environment, there will be a difference in expressing the traits of interest. When animals are destined to a substandard environment, exposing the selection candidates to less ideal conditions might help the selected birds' best fit to the actual environment.

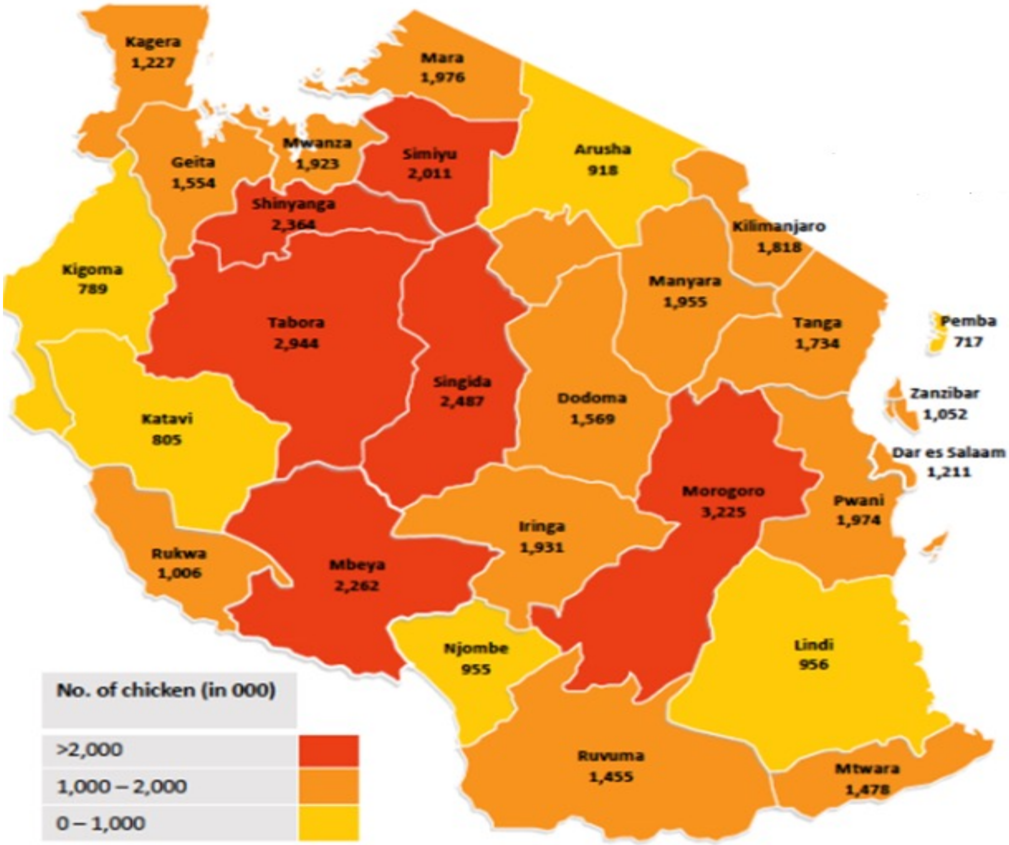
## 2.2 The selection environment

This breeding program is located at TALIRI Naliendele, in Mtwara region, southern part of Tanzania. TALIRI Naliendele is located 13 km south of Mtwara town and 6 km southwest of Mtwara airport at an altitude of 120 metres above sea level. The area receives a mean annual rainfall ranging from 800 to 1,250 mm, of which more than 80% falls in the months of December to April. The mean maximum temperature is 30.5$^{0}$C, which occurs in December (the hottest month), while the mean minimum temperature is 21.7$^{0}$C in July and the relative humidity varies from 85% in March to 72% in October.

## 2.3 The production environment

The production environment is where the improved birds are destined (Cooper et al. 1995) and is part of the disseminating plan once the goals of the breeding program are met. Birds that are designed for substandard management conditions and should therefore fit the smallholder poultry production system. In Tanzania, geographical locations where Horasi chicken eggs exist were identified for collecting egg, bearing in mind that this is their destined environment. Fertile eggs were collected from six districts, three from Tabora region (Uyui, Nzega and Igunga) and three from Shinyanga region (Shinyanga rural, Ushetu and Nsalala) (Figure 2).

Figure 2. Districts and villages/wards visited during purchasing and collecting Horasi eggs.




Source Poultry Subsector in Tanzania: A Quick Scan (2018).

# 3 Forming breeding flock

Enough birds to set up the breeding program should be established and can be done by collecting either birds or fertile eggs from the field. Both options have their challenges. Selecting a flock by collecting birds from the area might appear an easy adoption and the right birds are selected but present problems of higher mortality due to confining of free-ranging chicken. The mortality is due to the stress of confinement and diseases that these birds might have carried from their location of origin. The second option is collecting fertile eggs from the field. The eggs can be fertile or infertile, fresh or old, and as a result, can cause poor hatchability that is expected. Therefore, collecting more eggs that can cater for potential hatchability reduction is required. It is necessary to pay more for fertile eggs to motivate farmers to bring high-quality and fresh eggs.

## 3.1 Collection of hatching eggs

In Tanzania, 12,000 fertile eggs were collected from farmers in six districts of the Tabora and Shinyanga regions. The eggs were cleaned following a standard procedure before being stored. The next day the eggs were set to hatch in an incubator. Not all eggs collected were suitable for hatching; therefore, only eggs that met the criteria were used for hatching. Eggs were collected based on the criteria shown below. During transporting, eggs were packed in trays and well wrapped with boxes to avoid unnecessary bumps and should be free from overloading. It is essential to stick to proper hatchery procedures to produce first-quality chicks. There is a direct relationship between the size of the egg and the size of the chick. Clean and fertile eggs would have quality chicks. The eggs should be properly disinfected not to introduce disease into the hatchery. Necessary steps such as candling should be done to remove infertile eggs or dead embryos from the setter.

## 3.2 Preparing before chick arrival

Cleaning and disinfecting are critical components of routine biosecurity in poultry houses and to kill any disease organisms like virus, bacteria, and parasite, and mold that might be present on a farm at the end of a production cycle or after a disease outbreak. To protect disease agents physical removal of foreign material like dust and organic material such as droppings, blood, secretions are necessary. Further, disinfecting the poultry houses and the premise are required to kill the remaining disease agents left after cleaning. In the Horasi chicken improvement program, locally available disinfectants such as V-Rid and D4V were used. After cleaning and disinfecting, the poultry farm was left free for 30 days before placing a new flock.

# 3.3 Identifying and weighing of chicks

Necessary preparation such as availing vaccines and vaccinators, vitamins, tags, weighing balance must be prepared before the eggs are taken out of the hatchery. Brooding of chickens can be conducted either in the pens or in the dedicated brooding houses. Chicks were unloaded from boxes immediately, counted, weighed, and identified by attaching an aluminium wing tag. Individual body weight was taken by weighing the birds using a balance. The Horasi breeding program started with 2,360 chicks obtained from hatching 12,000 fertile eggs collected from Shinyanga and Tabora regions.

# 3.4 Brooding chicks

Brooding rings, lighting, bedding materials should be fitted into the brooding house. Chickens should be provided with vitamin-mineral premix or a sugar solution to help them adapt to the environment soon. The brooding ring should provide enough space for feeders and drinkers. An adjustable light source should be appropriately placed and monitored. Temperature control is the most critical factor during brooding. The ability of chicks to effectively regulate their temperature will directly affect their ability to grow well.

At a day old, the chicks should be placed at a temperature between 30–33$^0$C and relative humidity between 40–60%. Care should be taken to prevent the chicks from being exposed to drafts, resulting in wind chill. When the chicks are one week old, the temperature is reduced by 2$^0$C and continue reducing until the housing temperature of 21$^0$C is met. During the brooding period, observing the birds assist in providing the most desirable temperatures. Birds that are cold huddle together in a very tight group. Should this condition exist, the temperature needs to be increased. Chicks that are too hot will pant and appear drowsy. Chicks that are comfortable will be evenly dispersed within the brooder ring and be active except during rest periods. The source of heat in the brooder ring can be an infrared bulb hanging from the house's roof. These act as a source of heat and light. Lighting during the first two days should be maintained for 20–22 hours per day at an intensity of 30–40 lux to encourage water and feed intake. Bright light (30–50 lux) during 0–7 days helps chicks to quickly find feed and water and adapt to a new environment. After the first week, we begin a slow step-down lighting program to provide rest periods for chicks (establishes more natural behaviour of rest and activity) and feedings.

From the day old to two weeks of age, feeding chicks can best be done by placing a small amount of feed on newspaper or flat tray and shifting to round pan and finally to bell/round feeder. This will encourage comfortable feeding and avoid wastage of feeds. Feeding must be done early in the morning, around 0700 hours adlib feeding where feed is always available with the quantity and frequency of consumption being the free choice of the animal. Three diets (starter, grower, and layer mash) during the brooding/growing and laying period are adequate for Horasi chicken.

Figure 3. Feeding baby chickens using tray feeder.

Photo by Wondmeneh E.

## 3.5 Feeding and watering

The feed for the indigenous chicken can be formulated using the locally available raw material. The formula should consider the requirements of the birds. Finding the correct nutrient requirement might challenge the indigenous chicken to create a hybrid formula between layers and broilers. Lighter birds can adopt a layer diet until the proper nutritional needs are identified through optimizing nutrition studies. There are various freely available excel programs used as feed formulation software.

Figure 4. Feed formulating steps using an Excel app.

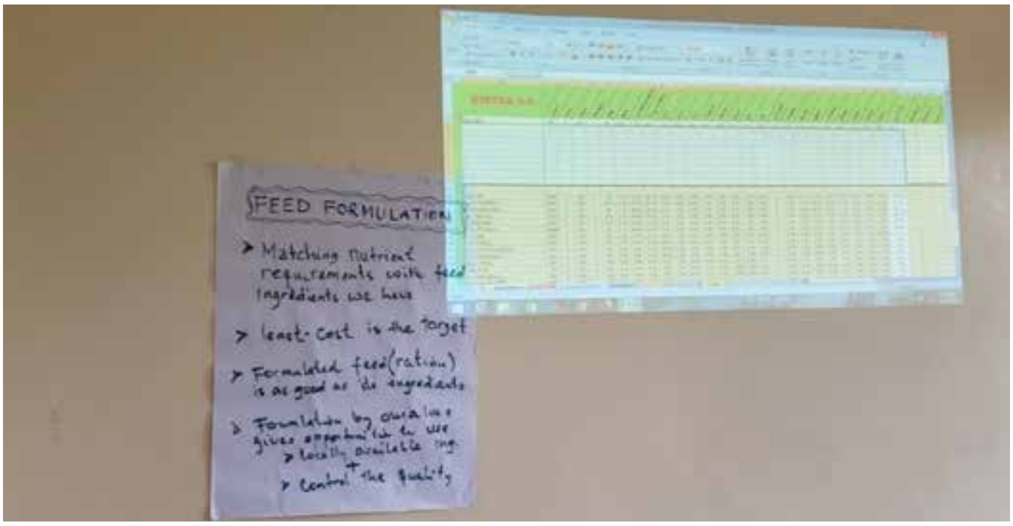



Photo by Wondmeneh E.

In the Horasi breeding program, diets were formulated using locally available feed ingredients in Tanzania. The feeding regime for Horasi chicken was obtained by investigating available standard feed formulae for dual-purpose chicken.

Watering of chicken is done daily, early in the morning and afternoon. Before watering, the drinkers are cleaned to prevent the developing of germs.

Table 1. Proposed feeding regime for Horasi chicken.

| Week | Feed type | Approximate feed consumed/chick per day (g) | Approximate feed consumed/chick per day + 40% allowance (g) |
|---|---|---|---|
| 1 | Chick starter | 15 | 21 |
| 2 | | 25 | 35 |
| 3 | | 30 | 42 |
| 4 | | 35 | 49 |
| 5 | | 40 | 56 |
| 6 | | 45 | 63 |
| 7 | | 50 | 70 |
| 8 | | 55 | 77 |
| 9 | Grower's mash | 60 | 84 |
| 10 | | 65 | 91 |
| 11 | | 70 | 98 |
| 12 | | 75 | 105 |
| 13 | | 80 | 112 |
| 14 | | 85 | 119 |
| 15 | | 90 | 126 |
| 16 | | 95 | 133 |

Figure 5. Manual drinkers used to rear pullets.


Photo by Wondmeneh E.

## 3.6 Vaccination

Vaccination is an important way of preventing diseases (Aini 1990). Different regional epidemic situations require suitably adapted vaccination program.

Vaccination methods which were used at poultry unit were:

i. Individual vaccinations such as sub-cutaneous injections, eye-drops and wing wave which are very effective and generally well tolerated were used in the hatchery for vaccinating chicks against Marek's disease.

ii. Drinking water vaccinations: This is another method used to vaccinate chicks against Newcastle, infectious bronchitis, infectious bursal disease, and avian encephalomyelitis.

iii. Wing web vaccination: These methods are suitable for vaccinating chicken against fowl pox

Table 2. Vaccination types administered to the breeding flock

| Age (weeks) | Disease | Application route |
|---|---|---|
| Day 0 at hatchery | Marek's | Subcutaneous injection |
| | Infectious bronchitis | Course spray |
| 7 days | Gumboro | Drinking water |
| 10 days | Newcastle disease | Drinking water |
| | Infectious bronchitis | |
| 16 days | Gumboro | Drinking water |
| 3 weeks | Newcastle | Drinking water |
| | Infectious bronchitis | |
| 6 weeks | Fowl pox | Wing web |
| 8 weeks | Newcastle | Drinking water |
| | Infectious bronchitis | |
| 10 weeks | Fowl pox | Wing web |
| | Avian encephalomyelitis | Drinking water |
| 12 weeks | Newcastle | Drinking water |
| | Infectious bronchitis | |
| 24 weeks | Newcastle | Drinking water |
| | Infectious bronchitis | |
| 36 weeks | Newcastle | Drinking water |
| | Infectious bronchitis | |
| 48 weeks | Newcastle | Drinking water |
| | Infectious bronchitis | |
| 60 weeks | Newcastle | Drinking water |
| | Infectious bronchitis | |
| 72 weeks | Newcastle | Drinking water |
| | Infectious bronchitis | |

## 3.7 Biosecurity and managing disease

Biosecurity which means the safety of living things, is a program designed to prevent the exposure of birds to disease causing organisms by reducing the introduction and spread of pathogens into and between the farms. The objective of biosecurity is to prevent the infectious disease from affecting otherwise healthy flocks. Among the strategies used to avoid infectious disease at poultry unit at TALIRI, Naliendele are:

i. Limit access of unnecessary visitors to farm. Visiting to farm should be limited to those essential for its operation.
ii. Clean boots, clothing and head cover are provided to workers and visitors.
iii. Clean footbaths containing disinfectant placed outside entries to all poultry houses and at the gate entrance.
iv. Human and equipment movement onto farm are strictly controlled.
v. Staff/poultry attendants are not allowed to have visits to multiple farms on the same day.
vi. Shower in and out of any poultry facility.
vii. Personnel entering the farm should dip their feet in footbath at entrance.

# 4 Breeding goal traits

The breeding program aims are to address the needs of the smallholder farmers in Tanzania. Therefore, there is a need to define the most critical traits of the breeding goals. The breeding goal dictates which characteristics to consider and the direction to be improved. The breeding goal indicates the attributes of interest mainly identified through directly communicating with the end-users (Dana et al. 2010). *African Chicken Genetic Gains* (ACGG) study in Tanzania revealed that farmers in Tanzania focus on meat related traits, growth rate, weight for age and feed efficiency. Eggs traits include age at first eggs, clutch length, egg size and number (Alemayehu et al. 2018).

## 4.1 Collecting information

Information is critical for successfully implementing the breeding program, such as phenotypes, family relationships and even genotypes. It is essential to establish a working flock by collecting indigenous birds from the field using a protocol. One must develop a protocol that includes location for collecting eggs, price, number, and quality of fertile eggs collected, handling, storing and transporting.

## 4.2 Recording data

To generate the information required for genetic selection and other critical decisions data recording is essential in a sustainable breeding program. Estimating breeding value needs phenotypic data on selection candidates; therefore, in the Horasi breeding program, the following data are being collected from individual chickens.

Body weight of both sexes: The hatch weight and subsequent records of body weight of each chicken are collected every week using a digital weighing scale. After collecting, the data are entered into the computer for analysis. The body weight record on individual chicken will be taken up to 16 weeks, where the best candidate selection will be made.

Age at first eggs: The age (days) at which the female chicken will first produce eggs will be recorded. Ability of chicken to make eggs sooner in life increases a farmer's profitability.

Group feed intake daily: These records are taken daily where chicken is fed with a certain number of feeds and then the next day in the morning before giving them another feed, then the amount of feed refused is collected, weighed, and recorded.

Egg number and weight until 45 weeks: Egg production will be measured until the age of 45 weeks. Best egg producers will be identified based on egg produced and ranked and selected to produce eggs to be hatched as next generation. Ideally, pens with individual laying cages will be used.

# 4.3 Correlation between traits

Trait correlations are the phenotypic covariation between two or more traits among a population. The genetic correlation is defined as the correlation of breeding values of traits. It can be used to describe traits on the same individual or the same characteristic on different individuals reared in different environments when it is less than one if there is genotype × environment interaction.

Figure 6. Dedicated experimental house for breeding program at TALIRI Naliendele.

Photo by Wondmeneh E.

# 5 Determining selection criteria

Selection is a standard or set of criteria by which candidates are identified as the parents of the future generation. These sets of criteria indicate the level that birds should meet or exceed to qualify. In the Horro breeding program, birds should weigh at least 1,500 grams or more at week 16 (Esatu et al. 2016).

## 5.1 Estimating breeding value

After all, data are recorded, cleaned, arranged and the breeding value of each bird can be estimated. Breeding value is part of the genotypic value transmitted to the offspring. The choice is to use the animal model, a tool in quantitative genetics used extensively to estimate parameters, such as additive genetic variance or heritability. Ideally, estimated breeding values should be unbiased and of high accuracy. The animal can be ranked and selected as a parent for the next generation based on the estimated breeding value. To obtain correct and unbiased estimates of breeding values, BLUP methods will be used in the breeding program. The advantage of using BLUP is that:

i. it considers the systematic environmental effect

ii. BLUP is more flexible and therefore more suitable as operational tool

iii. it takes account of selection

Selection based on the ranking of estimated breeding values can be possible if population parameters are available. However, when all this information is not ready, the choice of birds based on their performance, also known as the mass selection, will be used. The breeding value will be estimated using the heritability (h2) of the traits under consideration in mass selection. Heritability is the proportion of the difference in phenotype (phenotypic variation), which can be explained by differences in breeding values (A).

An animal model that uses information from relatives and adjusts data for fixed effect will be used in estimating breeding value. Genetic effects are maps relating phenotypes to parameters with genetic meaning and biological insight. Genetic models assume a genotype-phenotype linkage. An implicit assumption of animal models is that all founder individuals derive from a single population.

*Estimated breeding values (EBVs) provide a measure of the breeding potential of an animal for a specific trait. They consider performance data collected on known relatives, the relationships between performance traits (correlations) and the degree to which traits are inherited from one generation to the next (heritabilities). EBVs are expressed in the same units as the recorded trait and compared to the average breeding value of a population (zero). A hen with an EBV of +20 for cumulative egg number is estimated to have the genetic potential to lay 20 more eggs per year as compared to one with an EBV of 0.*

# 6 Selecting and mating

Selecting an individual to be the parent of the next generation is called selection. Individuals are identified based on their merits on traits of importance. In the Horasi breeding program, mass selection will be applied where chicken with superior characteristics (highly heritable breeds) will be selected from a flock and then allowed to mate among each other at random. This breeding program aims to develop chickens with higher productivity and a more optimal adaptive capacity to withstand harsh conditions than the unselected population. More specifically, the objectives are to build an improved breed of Horasi chicken that attains at least 1,500 grams at 16 weeks of age and lay more eggs (200 eggs/hen per year), higher survival and shorter age at days of first eggs under suboptimal management condition.

## 6.1 Selecting intensity

Selecting intensity defines the proportion of male and female selection candidates selected as the parent of the next generation. The proportion is set in indigenous breeding programs like Horasi, considering the surviving mortality and physical deformities of chicken. When more animals per generation survive till selection age, more intense selection can be applied and relaxed otherwise. In this approach, selecting birds of both sexes that qualify the criteria will be selected for body weight to consider body weight in both sexes. Afterwards, eggs will be collected for 21 weeks after commencing egg production and selected for egg number. Selecting will be done in the Horasi breeding program when the chicken is 16 weeks old. We practice truncation selection (i.e., chicken, which will reach 1,500 kg at 16 weeks) to select male and female candidates. Fifty cocks and 400 hens are selected based on the index to produce the next generation in each generation. Every generation, 7–10% of the best cockerels and 50–60% of the best hens will be selected as parents of the next generation.

Selection exercise based on truncation points (body weight at 16 weeks)

Target body weight for selection = 1,500 grams and more

Number of layers above 1,500 grams = 34

Number of males above 1,500 grams = 136

Number of breeding females needed = 400

Lowering the cut-off points required

Lowering cut-off point for females to 1,000 = 312 females available

To compensate the loss of weight in females, the cut-off point for males was raised

Table 3. Body weight and number of selection candidates available for selection decisions at week 16

| Batch | No. of selection candidates | Sex | Total | >1,500 grams | Mean no. of birds >1,500 grams |
|---|---|---|---|---|---|
| 1 | 404 | M | 173 | 68 | 1,771 |
| | | F | 225 | 14 | 1,890 |
| | | No tag | 6 | 2 | 1,794 |
| 2 | 381 | M | 167 | 60 | 1,862 |
| | | F | 165 | 18 | 1,900 |
| | | No tag | 49 | 13 | 1,670 |
| 3 | 201 | M | 67 | 8 | 1,704 |
| | | F | 95 | 2 | 1,562 |
| | | No tag | 39 | 0 | 0 |
| Total | M | | | 136 | |
| | F | | | 34 | |

Table 4. Female selection candidates qualifying differenet cutoff points at week 16

| Batch | | No. of birds >1,500 | No. of birds >1,300 | No. of birds >1,200 | No. of birds >1,100 | No. of birds >1,000 |
|---|---|---|---|---|---|---|
| B1 | Females | 14 | 51 | 86 | 128 | 164 |
| | Mean | 1,890 | 1,503.7 | 1,396.8 | 1,313.8 | 1,256 |
| B2 | Females | 18 | 39 | 54 | 79 | 105 |
| | Mean | 1,900 | 1,632.3 | 1,526.7 | 1,407.7 | 1,319 |
| B3 | Females | 2 | 14 | 23 | 29 | 43 |
| | Mean | 1562 | 1394.6 | 1336.0 | 1296.8 | 1218 |
| NO | | 34 | 104 | 163 | 236 | 312 |

Figure 7. Selected males and females on week 16 body weight.

Photo by Wondmeneh E.

Table 5. Male selection candidates qualifying differenet cutoff points at week 16

| Batch | | No. of birds >1,750 | No. of birds >1,800 |
|---|---|---|---|
| B1 | Males | 25 | 20 |
| | Mean | 2,069.4 | 2,146.7 |
| B2 | Males | 31 | 26 |
| | Mean | 2,108.7 | 2,172.1 |
| B3 | Males | 1 | 1 |
| | Mean | 2,291 | 2,291 |
| No. | | 57 | 47 |

Figure 8. Mean (SD) body weight of unselected and selected males at week 16 (G0).

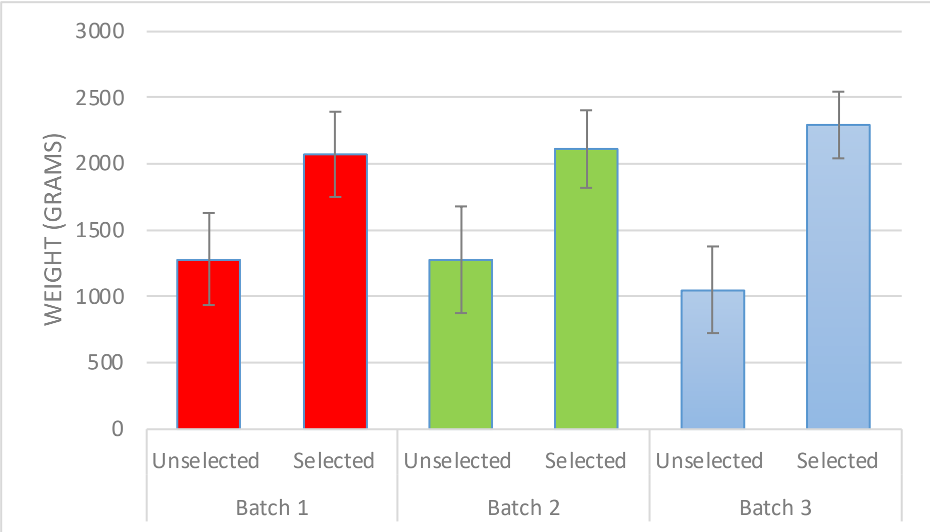
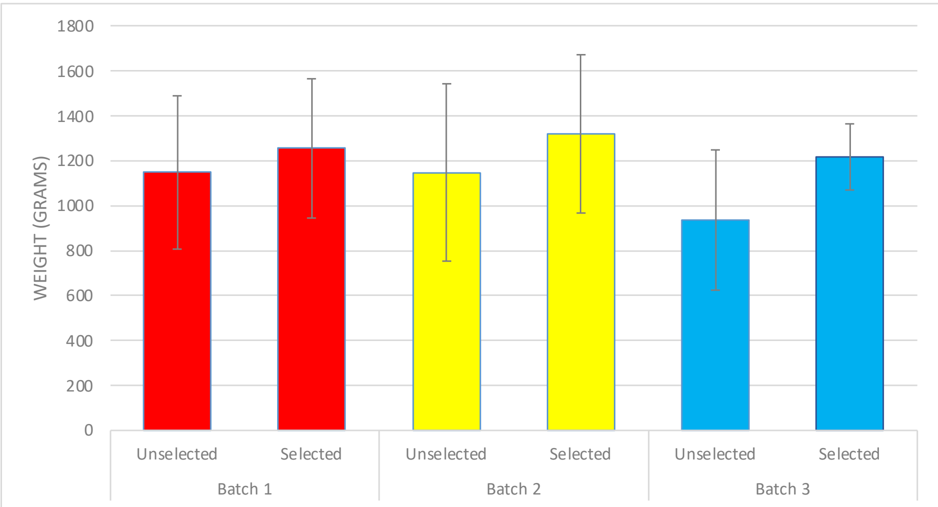



Figure 9. Mean (SD) body weight of unselected and selected females at week 16 (G0).



# 6.2 Predicting rate of genetic gain

Selection response per year is the function of intensity, accuracy, genetic standard deviation and generation interval

The above equation is based on a single trait only but, under the Horasi breeding program aims to improve multiple traits (body weight and eggs) simultaneously. Therefore 'selection index theory' will predict the rate of genetic improvement.

# 6.3 Selection scheme

The overall process and steps in a typical breeding program can be summarized in the scheme below. The steps need to be followed to arrive at the overall aim.

$$\Delta G = \frac{i * r_{IH} * \sigma_A}{L}$$

where ΔG = is the selection response per year expressed in trait unit

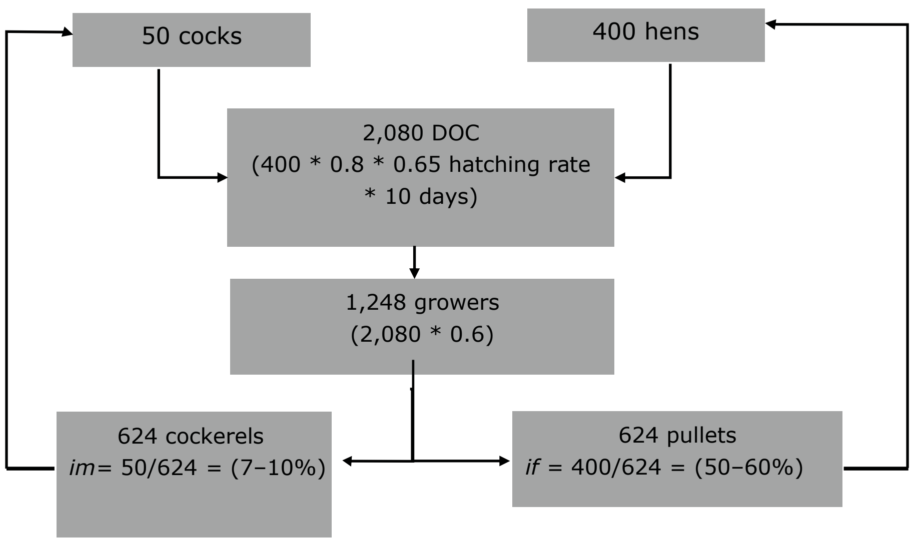
I = intensity of selection

rIH = is accuracy of selection

**σ**A = is the additive genetic standard deviation of the trait under selection

L = is the generation interval expressed in years

Figure 10. Selection scheme followed in the Horasi chicken improvement program.



## 6.4 Mating

Mating is the process that determines how maternally, and paternally derived alleles are combined within individuals. The total flock size in each generation will comprise 450 chickens (50 cocks and 400 hens), and the mating ratio will be 1 cock to 10 females; hence, 50 cocks will be mated with each generation of 400 hens. Indigenous cocks are active in breeding the hens assigned to them in pen. Regular monitoring of fertility should be necessary. If cocks have a unique attraction towards a particular hen and avoid the others, artificial insemination must be used. Alternatively, artificial insemination can be used if fixing the trap nests is difficult, as happened in Tanzania.

*Selecting future parents in chickens monitoring the laying capacity of the hens relating to their parents and relatives is essential. A method of trap nesting is therefore required. A trap nest is a box with a door that automatically closes when the hen enters it to lay an egg. A 'trap nesting' will help determine who's laying how many eggs each day and help choose breeding chicken.*

# 7 Inbreeding

Inbreeding is the practice of mating two genetically related animals. Inbreeding is inevitable in any long-term selection program involving a closed population. Sometimes, it might be necessary to mate inbred chicken to introduce certain characteristics in the flock that increases the frequency of favourable genes ~~or~~ more rarely to expose recessive genes. The practice of breeding inbred lines causes inbreeding depression by increasing the number of recessive or deleterious genes being expressed. The reduction in fitness and productivity is called inbreeding depression. Breeders need to find a balance to optimize rates of genetic gain, while controlling increases in levels of inbreeding. Breeding programs are prone to increases in inbreeding due to the frequent use of artificial insemination, fast generation turnover, selective use of specific family lines and the tendency for a relatively small number of different sire families to dominate within certain breeds. It is important to monitor and evaluate the level of inbreeding created in a population of every generation. This is called inbreeding coefficient. Inbreeding coefficient is defined as the probability of two alleles being identical by descent. Complete avoiding of inbreeding is impossible, and a balance should be created between the genetic superiority obtained from a specific chicken and the level of inbreeding that it creates in the future flock. The best solution to the inbreeding challenge is to measure the level of inbreeding between individuals and make recommendations based on this information.

*Typical inbreeding percentages, assuming no previous inbreeding between any parents:*

*Father/daughter, mother/son, or brother/sister ⇢ 25%*

*Grandfather/granddaughter or grandmother/grandson ⇢ 12.5%*

*Half-brother/half-sister ⇢ 12.5%*

*Uncle/niece or aunt/nephew ⇢ 12.5%*

*Great-grandfather/great-granddaughter or great-grandmother/great-grandson ⇢ 6.25%*

# 8 Data analysis

Several methods and computer software will be used to analyse the data collected under Horasi breeding program at TALIRI Naliendele. Such methods and software are as follows:

- BLUP is a standard method for estimating random effects of a mixed model. This method will be used for estimating breeding values.
- ASREML is a powerful statistical software specially designed for mixed models using Residual Maximum Likelihood (REML) to estimate the parameters.
- SelAction is a computer software which will be used to analyse the response to selection resulting from mass selection (use of own phenotype only).
- R-statistical package is a language and environment for statistical computing and graphics that provide a wide variety of statistical (linear and nonlinear modelling, classical statistical tests, time-series analysis, classification, clustering) and graphical techniques.
- RelaX2 is a program for studying relationships of animals in large pedigrees, it involved pedigree checking, pedigree pruning (e.g., for estimating variance components or inbreeding studies) and selecting individuals and their ancestors.
- Proximate method is method analyses the composition of feeds in terms of its fundamental components (proximate composition) moisture, crude protein, fibre, ash, fat, and the residue (nitrogen free extract).

# 9 Multiplying scheme to disseminate genetically superior chickens

The overall objective of the breeding program is to take a genetically superior chicken to the households. Improving the flock can continue in a nucleus flock where they are continuously improved and multiplied. Also, the birds should be multiplied and disseminated to the end-users. Ideally, multiplying the chickens is best done at a different farm than the nucleus breeding flock. Keeping multiple flocks in a few places is also important to protect against potential loss through disease outbreaks.

The government best handles breeding programs involving indigenous chickens to attract private sector companies. Public private partnerships might be an ideal arrangement. The public sector should transfer the improved nucleus flock and focus on other programs aiming to generate breeds.

# 10 Assessing genetic change and reviewing the breeding program

Evaluating impacts of the selective breeding program can be seen in two dimensions. The first one is the change that was realized in the breeding flock and the second is the change at the field.

## 10.1 Change realized in the breeding flock

This can be done by carrying out the genetic trend plot where estimated breeding values can be plotted against the improved generations. One can evaluate whether the trend is increasing or decreasing. The other is identifying the signature of selection by using whole-genome analysis. The signature of selection analysis would indicate the traits that were affected by the selective breeding program.

## 10.2 The change at the field

The improved chicken can be compared at the on-station/controlled environment or the field/on-farm condition against the wild or unimproved chicken. The magnitude of the difference in the performance under similar management conditions would reveal the actual improvement achieved in the program.

# 11 Conclusion

This manual provides the essential information and procedure required to set up and conduct indigenous chicken improvement programs. It is necessary to commit to carrying out a breeding program that needs to be run for generations. Besides, to ensure that the chickens retain their adaptive capacity for on-farm circumstances, the future generations should be performance tested in less expensive management conditions that resemble their aimed on-farm production environment. Second, the exact formulation of the breeding goal should be re-evaluated and may need to include additional traits that the farmers prefer. Such characteristics may consist of plumage colour. Farmers in villages are interested in brown plumage colour, suggesting it should be included in the breeding goal.

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