Chinese Poultry Genetic Resources and Utilization of Native Breeds in Poultry Production

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Summary
Basic situation of poultry genetic resources and poultry production in China was briefly introduced. The strategy on conservation and utilization were to breed new breeds or lines, to use heterosis and to develop new poultry products. Methods of selection, breeding procedure of quality meat yellow chickens, functional eggs with green shell, breeding systems of pure and cross breeds were also introduced.

Key words: genetic resources, poultry production, China.

Introduction
Animal genetic resources are a resource for future food and environmental and socio-economic stability. (H.Blackburn et al.1998). It is important to keep the diversity of animal genetic resources for sustainable development of agriculture. Currently there are two situations in the conservation and utilization of animal and poultry resources in the world. In developed countries only a few breeds with high economic values and their hybrids are raised in great numbers. In developing countries, they are rich in breed resources, but improper conservation and undiscriminating importation of foreign breeds have also caused the deterioration in quality and reduction in number of the native breeds. In both cases, a worldwide crisis of genetic resources, or, an exhaust of animal and poultry gene pool, is impending. As for chickens, white egg-layers are basically Leghorn while brown egg-layers are synthetic strains of Red Island and White Island. Almost all of broilers are hybrids from a few breeds such as White Plymouth Rock and Cornish.

It was estimated that 40% of all breeds of domestic livestock and fowl have been lost since 1970(L.Alderson,1989). The FAO World Watch List (1995) estimated that three breeds are lost every two weeks worldwide. The two estimates are not quite the same but the situation is grave.

1. Basic situation
China is a developing country and rich in animal genetics resources. She started to investigate her native breeds in 1976, and published five volumes of “Breeds of Domestic Animal and Poultry in China” with 280 colour photos from 1986 to 1989. One of the volumes was “Poultry Breeds in China” in which 27 chicken breeds, 12 duck breeds and 13 goose breeds were included.(P. Cheng, 1986) Some small number species like pigeon, quail, and peacock were not included in that book.

Management Committee of China Domestic Animal and Poultry Genetic Resources (CDAPGR)
was founded in 1996. The organizing structure of the Committee is as follows:

![Organizing structure diagram]

Technical training and financial support are important for conservation of animal genetic resources especially for native breeds which usually have low productivity.

Animal genetic resources should be conserved and properly managed. But the purpose of conservation is to keep the gene pool, which may be useful at present or in the future. If certain numbers of males and females of native breeds are kept as conserved populations, the rest animals can be improved either by purebred selection or to cross with imported foreign breeds. The minimum effective population size for conserving a poultry breed is 200, that is 100 males and 100 females or 60 males and 300 females. But 1/3 number of males and females can be reduced if the variance of family size is zero (Wu, Ch., 1990)

2. Produce function eggs with green shell
   It was an example of breeding a new breed through selection on native chickens.

2.1 Collection of genetic material
   In some villages, especially in southern China, people found a few chickens laying green shell eggs, from light green to dark green, but not all offspring from green shell hens laid green eggs. Investigators from Jiangxi Agricultural Research Institute bought hens laying green eggs from villagers to organize a small population as foundation stock, and also bought cocks from same villagers but unknown neither phenotypes nor genotypes.
2.2 Enlarge the population and test for genotype of green shell

It was necessary to enlarge the number of chickens before family selection. Male and female chickens mated randomly at generation zero to produce generation one. Hens were selected by phenotype that was only those hens laying green shell eggs could be kept as seeds stock. Test mating was done in both male and female chickens. A commercial brown egg line was selected for test cross. Since green egg shell gene is autosomal dominance, so it is easy to detect homozygote chickens according to the phenotype of their female offspring.

2.3 Selection for performance and utilization as colour marker of function eggs

Native green shell chickens only could lay 120 eggs up to the age of 72 weeks. After selection of 5 generations, egg number increased to 160 and still kept egg weight about 50-55g.

In 1997, The Research Institute combined with a chicken company to produce function eggs with green shell. There are not any differences on nutrition inside eggs no matter what shell colours are. But consumers like something special. When function eggs with high zinc, high iodine or high selenium, consumers buy green eggs rather than brown or white eggs. So it becomes a marker of function eggs which have been sold in good price.

In some supermarkets, they sell half dozen packed eggs with different colours that is white, light green, green, dark green, brown and dark brown. People like to buy those colourful eggs though it costs a little much money.

1. Produce quality meat chickens

Most of Chinese native chickens grow slowly but have very good meat quality. Consumers have different requirement to quality chickens, some people like black bone, some people like yellow feather. In southern China including Hong Kong and Aomen (Macao), the price of “Three yellow” chickens usually is two or three times of fast growing broilers.

3.1 “Guangdong Model” to produce yellow chickens.

Three way cross is used for producing commercial yellow chickens. Line A and Line B both are quality meat type with “three yellow” characteristics (feather, lag and skin) selected from native breeds. Line C is a recessive white line originally from Hong Kong. The recessive white lines have also been imported from Israel and France. The cross system for producing commercial yellow chickens is as follows:

\[ \text{Line A} \sigma^a \times \text{Line C} \ \varphi \ (\text{White feather}) \]
\[ \downarrow \]
\[ \text{Line B} \sigma^a \times F_1 \ \varphi \ (\text{yellow feather}) \]
Commercial "three yellows"

3.2 "Shandong model" produce black feather chickens

A famous native chicken breed in Shandong province named Shouguang with black feather and white skin. The meat quality of Shouguang is good, tender and juicy with intramuscular fat. In order to increasing the growth rate and egg number, purebred selection have done more than 10 years. The cross system for producing commercial black chickens is also three way cross. Here, Line A and Line B are different lines of Shouguang emphasized growth rate and egg number respectively, Line C is recessive white feather with dwarf gene.

\[
\text{Line C}^0 (\text{dwarf}) \times \text{Line B} \quad \varnothing (\text{black}) \quad \Rightarrow \text{Line A}^0 (\text{black}) \times \text{F}_1 \quad \varnothing (\text{dwarf black}) \quad \Rightarrow \text{Commercial black chickens}
\]

Since dwarf gene is a sex linkage gene on chromosome Z, the F₁ females are dwarf chickens with black feather.

It is a good idea to use F₁ females as parent stock to produce commercial chickens because dwarf chickens eat less feed than normal size chickens.

2. To breed small egg type chickens with sex-linked dwarf gene

Usually sex-linked dwarf gene was kept in female parent stock to produce normal type broiler. For economical reason, breeders from China Agricultural University brought the dwarf gene into egg type chickens by crossbreeding. These small birds with the dwarf gene lay a little less egg mass but at high feed efficiency. The ratio of feed to eggs is about 2:1 during egg lay period. (Yang, N., et at, 1996)

Table 1. The comparison between dwarf and ordinary brown egg layers

<table>
<thead>
<tr>
<th>Economic traits</th>
<th>Ordinary brown</th>
<th>Dwarf brown</th>
<th>Dwarf light brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of eggs (72 weeks)</td>
<td>270</td>
<td>250</td>
<td>260</td>
</tr>
<tr>
<td>Average egg weight (g)</td>
<td>60</td>
<td>60</td>
<td>58</td>
</tr>
</tbody>
</table>
5. Methods of selection

5.1 Selection for favorable recessive genes
Methods of selection that we used very often in poultry breeding were individual selection and family selection. The individual selection is based on individual's performance and the family selection is based on performance of its relatives. Generally speaking, individual selection is used for high heritability traits like body weight, and family selection is used for low heritability traits like egg number. If a quantitative trait is affected by polygenes in which recessive brings beneficial effect, ordinary selection methods such as individual selection, family selection will not be efficient. Sometimes it may lead to wrong selection.

In the situation of natural selection the population remains dominant genes which are mainly favorable to poultry themselves but unfavorable to human being because of low output of products. On the contrary, recessive genes in quantitative traits are mainly favorable to human being because they contribute more meat and eggs, but it is no good at all to poultry themselves. The theory of favorable recessive genes in quantitative traits has been proved by Drosophila experiment (Wu, Ch., 1986). It can be applied to improve growth rate, egg number, feed efficiency for Chinese native breeds, and also can be applied to improve meat quality, abdominal fat, disease resistance for imported foreign breeds.

5.2 Selection between and within mixed families
A mixed family is a sire family in which both full-sibs and half-sibs are existent. Obviously, genetic relationship in a mixed family should be from 0.25 to 0.5. Selection between mixed families is family selection, and within mixed family is individual selection. If we consider both individual performance and family mean then we have combine selection. Almost all kinds of poultry species have mixed families. So it is easy to calculate heritability and to estimate breeding values. In China, poultry breeding farms have done mixed family selection since 1980's and got good results in both meat and egg production.

5.3 Early selection for fast growing meat type chicken and duck
Usually people select meat type chicken and duck at market time that is at the age of 6 or 7 weeks. There is no feed restriction to birds before selection in order to show the genetic differences between individuals of seed stock. But to those fast growing poultry breeds especially to meat type male lines, the booty weight is too heavy before sexual mature. An early selection method was suggested for broiler breeders (Zhang, X., 1992). There is a highly significant rank correlation between body weight at age of 5 weeks and of 6 weeks. To select seed stock one week earlier is profitable for reducing leg problems and mortality rate, and is easier to reach the proper body weight for egg laying and for natural mating.
5.4 Late selection for egg type chicken and duck
Here, "Late selection" does not mean to select chickens and ducks in old ages. It means to use more performance record of later time than ordinary selection program. Taking egg type chickens, for instance, people use the egg performance record at the age of 40 weeks to select chickens in accordance with egg numbers or egg mass, because selection at an early period can shorten generation interval and can have more genetic gain in each year. But the early period selection may reduce the selection efficiency. To solve this problem we have done so called "early and late records combined selection" That is hatching eggs at 40 weeks of hens age and select young birds at 19 or 20 weeks of age before they get into the laying house. At that time old hens reach the age of 62 or 63 weeks. So we can use the family mean by pedigree records and use their mother performance by individual record at 60 weeks of age. It has been calculated that the correlation of egg number between 60 weeks and 72 weeks of age is much higher than the correlation between 40 weeks and 72 weeks of age. The improved selection method brings good results for China's egg production both in chickens and in ducks.

6. Methods of conservation

6.1 Specifying the conservation program
A list of national or local important and urgent conservation breeds should be presented. The list must be based on thorough investigations on breed resources, and on meticulous discussion and examination. It should also be subject to modification and adjustments at a fixed time period, to add some new breeds while crossing out some others.
Here a distinction is made between important conservation breeds and urgent conservation breeds. Important conservation breeds are those with special merits, famous or special breeds, while urgent conservation breeds are those with a very small population size or even near to extinction. Conservation of the former can be easily combined with their utilization, and extra expenses on conservation may be saved. On the other hand, urgent conservation breeds generally have low economical value, and can easily become extinct without proper conservation. Of course there are some breeds that are both important and urgent for conservation. In sum, breeds for conservation should be considered in a step by step manner according to local needs and the availability of funding, labor and other conditions.

6.2 Setting up breed resources farms
It is often said that conservation should be carried out at the original location of the breeds. It is believed that ecological, social, and economical conditions at the original location must have played an important role in the formation of the breed. And conservation at another location may lose some characteristics the breed originally possesses. However the natural, social, and economical conditions at the original location may as well have changed due to the development of market economy and the widespread transport lines. As such conservation need not necessarily be carried out at the original location. Any site is acceptable for conservation if
conservation can be performed economically and efficiently there.
In recent years, more and more breeding animals are imported from foreign countries. Due to the market rule, it is possible to forbid such importation and outcrossing in a conservation area. For this reason, resource farms should be set up for breeds. For some species, such as poultry, large scale breed resource pool can also be considered in order to conserve several breeds simultaneously (mass conservation). For the moment a chicken resource pool can be set up, as chicken can be raised in cages, and thus need little space occupation, small conservation expenses and easy management. According to the requirement on the size of conservation populations, 60 cocks and 300 hens are needed for each breed (group or strain). In a small farm of 10,000 chicken, about 30 breeds can be conserved.

6.3 Conservation and utilization
Though the aim of conservation is utilization, there exists considerable contradiction between the two. Breeds currently in active use usually have large populations and do not need critical conservation, while breeds really in urgent need of conservation usually lack economic profits. For such breeds the more animals are raised, the greater the loss will be. It is very difficult to expand the population. Conservation during utilization is thus only feasible for those breeds with current profits, but most of such breeds are not the target of major conservation work. The breeds in urgent need of conservation are mainly those scarce in number, special in character, without profit for the moment but with great potential for the future. They should be conserved in conservation farms or collecting them into resources gene pools. Animals of those breeds outside the conservation population can be selected for improvement or used in crossbreeding to meet the economical needs. It is thus quite possible that selection may cause changes in the production performance or even loss of the original characteristics, and some of the genes which has no merit at the present but may be valuable in the future may be lost. It does not matter only if the conservation population set up according to the conservation objective, which is like a storehouse, still exists. We can look for the needed genes there if future necessitates them.

7. Breeding system
Purebred breeding system is mainly for keeping native breeds and for breeding lines or strains to produce commercial stock by cross. Crossbred breeding system is common for commercial purpose to use a 2-way or 3-way cross in order to get high heterosis, and a 4-way cross is only used in double auto-sex lines especially in egg type chickens which need auto-sex in both parents and commercial stock. State breeding farms and a few poultry breeding companies are keeping pure lines and great grand parents (GGP), taking individual and family records, doing data analysis, calculating genetic parameters, estimating breeding value, and passing grand parents (GP) to multiple farms. Most of multiple farms keep both GP and parents stock (PS), and sell PS and commercial stock (CS). A large number of commercial farms mainly are individual farms in which birds are kept either under confinement circumstances or in field conditions.
Reference