Chapter 7
Breed Improvement

Strategies to develop poultry breeds suitable for family poultry smallholders in tropical countries must differ from those used in intensive production, and should focus on improving indigenous breeds while also making use of pure exotic and cross-bred chickens where appropriate.

Conservation of local breeds possessing genetic variations specific to the particular environment is essential for sustainable development. Although they exist as numerically small populations, local breeds are not only highly adapted to the natural environment, but are also an integral part of the lifestyle of the rural people. People, livestock and environment form a delicately balanced but sustainable ecosystem, and thus the potential impact of any intervention to improve production in the traditional system should be predetermined. The situation is less sensitive in peri-urban, industrial and small-scale intensive poultry production, in which rapid improvements can be achieved through well-designed development programmes. The intensive poultry production sector, however, is generally much smaller than the family poultry sector in virtually all developing countries.

STRATEGIES FOR BREED IMPROVEMENT

The following two rules should be incorporated into breeding strategies:

- Germplasm in traditional conditions should not be modified until management and housing have been improved and, even then, selection should be restricted to local breeds.
- When technical conditions are optimum and a ready market exists for the products, then improved breeds, crosses and hybrid strains that have been selected for high performance can be introduced into the peri-urban system, even at small-scale levels.

The most common method of improving the local gene pool is crossing indigenous and exotic birds, and then leaving the hybrid offspring to natural selection. Pure-bred or hybrid cockerels (or pullets) selected for greater meat or egg production are introduced into local flocks, usually in order to increase egg production. It is important to note that improved growth (for meat production) and high egg production are genetically incompatible in the same bird. The genetic traits are negatively correlated, which means that selection for one trait will reduce the other.

Cockerel or pullet exchange

An example of this type of strategy is a flock of indigenous local hens laying 50 eggs a year and beginning to lay at 25 weeks of age, crossed with “improved breed” cockerels, which have a genetic breed potential of 250 eggs a year, with hens beginning to lay at 21 weeks. The results are cross-bred hybrid pullets beginning to lay at 24 weeks, with a genetic potential of laying 200 eggs per year. The first generation hybrid cross-breed has a higher theoretical genetic potential (genotype) than the average (150) of the two parent breeds, due to the effect of hybrid vigour. However, unless management (especially in the area of nutrition) is improved, this genetic potential will not be realized by the hybrid cross-breed in actual practice in the environment.

If subsequent generations of the hybrid cross-bred pullets are mated (back-crossed) again with the same “improved breed” cockerel, the genetic potential for increased production is raised, although at a slower rate (as hybrid vigour only works with first-time crossing). With each generation, higher levels of management (including the provision of properly balanced feeds) are required to achieve this potential.

If the hybrid cross-breeds mate among themselves, however, potential production falls in the very next generation to the average potential of the two original genotypes, even if management could support the higher hybrid level.

The use of cockerels in this way is the basis for the Cock or Cockerel Exchange Programme (CEP) or Opération Coq, which has been implemented in almost all tropical countries. Households exchange all their local cockerels for a few improved cockerels, which are then raised to maturity to allow them to adapt to local conditions.

In some cases, a Pullet Exchange or Hybrid Hatchable Eggs Programme is used. These approaches were used extensively from the early 1930s until the 1960s, by which time urban development had begun to give rise to peri-urban, intensive, small- to medium-scale poultry production, which makes use of imported commercial breeds and technology.

The gradual replacement of local genes through cross-breeding and artificial selection has been the basis of initial development in many countries (Omeje and Nwosu, 1986; Coligado *et al.*, 1986).

Although many strategies deemed appropriate for smallholder poultry production systems have been implemented, most have not succeeded, due to a lack of management input to support the improved potential.

Replacement of all indigenous breeds

The use of hybrid chickens under free-range rural conditions has often been studied, notably in Zimbabwe (Huchzermeyer, 1973), and in Sri Lanka, Zambia and Nicaragua (Roberts and Senaratne, 1992; de Vries, 1995).

It has consistently been found that entire flock replacement programmes lead to increased egg and meat production, but only where management supplies good nutrition and veterinary hygiene. There is, however, one great disadvantage, in that the use of commercial hybrids to increase egg production necessarily eliminates broodiness of hens, due to the negative genetic correlation between these two factors. For this reason, complete replacement of local birds should not be considered unless a reliable local supply of day-old chicks (of an appropriate breed) is available.

Selection within local breeds

Production traits of local breeds

The genetic development of local breeds and varieties in developing countries first requires proper documentation of their productive and reproductive performance. The main production characteristics of local breeds are:

- small body size (low nutritional maintenance requirement);
- lateness in maturing (up to 36 weeks of age);
- low performance in egg numbers (20 to 50) and egg size (25 to 45 g);
- small clutch sizes (two to ten eggs); and
- long pauses between laying of clutches and a predominant inclination to broodiness.

For rural smallholder extensive systems, meat production cannot be separated from egg or chick production, and thus a highly broody (with consequent low egg production), low body-weight (low-feed requirement) bird is best for survival under these conditions. Surplus cockerels, whatever they weigh, are usually sold for meat when they reach sexual maturity at three to four months of age. Under rural smallholder extensive systems, there is little reproductive control of the hens, as they brood their own chicks for continuous regeneration of the flock. The egg brooding (incubation) and chick rearing activity increases the reproductive cycle length by 58 days to about 74 days in total:

16 days for egg laying and clutch formation + 21 days for hatching + 37 days (5.3 weeks) for chick rearing = 74 days

Source: Horst, 1990b

Thus, most hens can produce chicks about four to five times per year, and only four times if the rearing period is extended to eight weeks. As malnutrition, infections, predators and accidents result in mortality rates of 60 to 70 percent during rearing, virtually all eggs are used for reproduction. With four to five reproductive cycles per year, only about nine replacement pullets may be obtained.

Fertility and hatchability are also high in local birds. They generally adapt well to unfavourable management conditions, and resistance to prevailing diseases is usually assumed to be high, although juvenile and sometimes adult mortality rates can be high in extensive production systems.

Considerable genetic differences exist between different regional and continental populations of indigenous chickens, and production rates of local populations should be evaluated before introducing development programmes.

Selection programmes for local breeds

Although better management procedures can significantly improve the performance of local birds, some feel there is also a need for genetic selection (Nwosu, 1979). Pure-breeding and selection programmes have been developed in Bangladesh (Ahmad and Hashnath, 1983), although not implemented in the field. Both of the above groups concluded that although improvement of local poultry breeds would be beneficial, it is essential to evaluate breeds and their crosses before undertaking a breeding strategy.

Research conducted in the United Republic of Tanzania (Katule, 1991) concluded that selection for dual-purpose characteristics within individual local populations is both time-consuming and costly. Cross-breeding with improved breeds is recommended, followed by selection in the composite population.

Although consumer preference in most developing countries is for dual-purpose breeds, it is important to restate that in the same bird, the traits of increased egg production and increased broodiness are genetically incompatible, as are the traits of high egg production and high meat production. Selection for any trait within these pairs will reduce the other trait of that pair.

Modifying local breeds using major gene types

The use of single or combined dominant genes for feather restriction (Na) and feathering structure (F), as well as the sex-linked recessive gene for reduced body size (dw), has been found to be particularly relevant for the tropics (Horst, 1989; Haaren-Kiso *et al.*, 1995). Research into the effects of these genes on economic factors has been undertaken in Malaysia (Khadijah, 1988; Mathur and Horst, 1989). For example, the feather restriction (Na) or Naked Neck gene results in 40 percent less feather coverage overall, with the lower neck appearing almost “naked”. This considerably reduces the need for dietary nutrition to supply protein input for feather production, and protein is a limiting factor in many scavenger feed resource bases. Barua *et al.,* (1998) has reviewed the available information on the performance of indigenous Naked Neck fowl in the hope that it will draw the attention of scientists worldwide to its interesting characteristics and facilitate future research.

The incorporation of such genes could be significant in the development of appropriate breeds and strains for smallholder poultry production in the tropics. There are now seven potentially useful major genes:

- Na - naked neck (autosomal -A);
- Dw - dwarf (sex-linked -S);
- K - slow feathering (S);
- Fa - Fayoumi (A);

- F - frizzle (A);
- H - silky (A); and
- Fm - fibro-melanosis (A).

The use of major genes to improve productivity in smallholder poultry breeding programmes has been researched in various tropical countries (including Indonesia, Malaysia, Thailand, Bangladesh, Bolivia, India, Cameroon and Nigeria).

Other morphological traits that allow better heat dissipation include large combs, large wattles and long legs. Gene coding for these traits, which are not major genes but the result of multiple genes and their interactions, could also be considered for incorporation into the development of high performance local birds for the tropics.

BETTER PRODUCTION: BY BREEDING OR MANAGEMENT?

Family poultry is well integrated into most village farming systems, with local breeds representing 40 to 70 percent of the national meat and egg supply in most tropical countries. Because of their scavenger adaptability, production ability and low cost, local breeds are kept by rural smallholders, landless farmers and industrial labourers. It is difficult to imagine birds better adapted for survival under scavenger free-range conditions than the breeds that have already evolved under those very same conditions, and are still surviving as proof of their ability to do so. However, there does remain a considerable and largely unexploited potential for increased production from local breeds through improved management.

The critical management objective for scavenger free-range systems is to reduce the high mortality in both growing and adult age groups, but especially the 60 to 70 percent mortality in the growers. This high mortality means that many eggs laid by the hen need to be used for reproduction to maintain flock size, instead of for sale or consumption. It also means that many birds that die could instead be sold or consumed as meat.

The problem with local breeds, as outlined above, is not inherently low egg production or low meat production, but high mortality. Breed improvement to increase meat or egg production would not solve the health and nutrition management problems. However, increased egg production (by breed improvement) would create a new problem – lack of broodiness in the flock – which would force the smallholder to buy stock rather than have the hen brood and rear her own.

Mortality can be significantly reduced through increasing farmer awareness of health needs, through the provision of vaccine (especially for Newcastle Disease) and through improving the nutrition of growing stock (for example, by providing creep feeding systems). These are the most important improvements to management activities that will enable to the farmer to best exploit the existing potential of local breeds under scavenging free-range conditions.

If management resources available to the smallholder or landless farmer increase to the extent of a local supply of balanced poultry feed, the options open to his income-generating ability are increased. However, the answer is not to confine local breeds in intensive management systems. The performance of local breeds will increase slightly under cage or deep litter management (Akinokun, 1975; Oluyemi, 1979; Nwosu, 1979) but, because the genetic potential for egg production (or meat production) of local breeds is lower than that of commercial hybrids, the same investment in intensive management will achieve a much higher production result by using commercial hybrids.

If balanced feed, good health-care supplies and day-old chicks of hybrid varieties are locally available, then intensive poultry management is an option. If these are not available, raising local breeds under scavenger free-range systems is still the best choice.

The vast potential for increasing income generation from scavenger free-range family poultry clearly lies in the management area of reducing mortality in growing chickens. This alone is sufficient challenge for the already overstretched resources of government and NGO field extension staff in developing countries.

The potential for breed improvement is a factor to be considered in the future, but only when the more immediate objective of reducing mortality is attained. Meanwhile efforts should be continued to preserve germplasm as a resource for the future.

Chapter 8
Production Economics

The agricultural subsector of animal production is part of a complex interdependent farming system. Analysis of livestock production cannot be based solely on input and output, but must also take into consideration other farming activities. The interaction between animal production and other subsectors can be complementary, as in the use of manure; or competitive, as in the allocation of land to crops or livestock grazing.

The farming system as a whole, and animal production in particular, is influenced by external factors (including government policy on rural development, livestock development programmes and marketing), which must be considered in any analysis or evaluation.

DEFINITION AND ANALYSIS OF PRODUCTION COSTS

The farming system is defined as the combination of all farm enterprises/subsystems, management and farmer objectives and the interaction between them. It is a decision-making and land-use unit, comprising the farming household and the crop and livestock systems, which transforms land, labour, management and capital into products that can be consumed or sold.

Enterprises/subsystems are defined as the different subdivisions of the farming system, each producing one kind of crop or livestock product. In the case of family poultry, the products are poultry meat and eggs, with manure as a by-product. The harvesting of family poultry for home consumption and sale can be considered as the management of a standing resource for economic yield. In this respect, the economic principles applying to the management of fauna, parklands, fisheries, wood and timber forests and rangelands are more appropriate than the economic concepts more commonly applied to the labour and capital-dependent livestock production and other commercial farming industries.

METHODS AND CRITERIA FOR COST CALCULATION

The cost of production can be seen from various angles. The inputs may be external (Non-Factor costs) or internal (Factor costs). Internal input is under the control of the farming household, and includes land, labour, management and capital. The cash involved in production represents either Cash (Paid) Costs or Non-Cash (Calculated) Costs. Another way to categorize the costs is to distinguish Variable Costs from Fixed Costs. Variable costs rise and fall with the size of the output and the level of the operation. Variable costs (for items such as feed, vaccine and casual labour) can be controlled to some extent and are not incurred when there is no production. Fixed costs (for items such as taxes, insurance, interest, and depreciation on buildings and equipment), are incurred whether or not there is any output.

The Opportunity Cost principle is applied in farm cost accounting. Opportunity costs can be defined as the "income that would have been generated if the production resource/input/factor were put to the next best alternative use". Many farm enterprises/subsystems yield more than one product. Poultry produce eggs, meat and manure. When calculating the cost-price per unit of production, the cash value of the by-products (sold externally or used as a substitute in another enterprise/subsystem of the farm), must be subtracted from the Total Gross Costs. This will result in the Total Net Costs. For the cost-price per unit of production, the Total Net Costs must be divided by the total number of units of production.

The cost-price calculation model splits production costs into two categories: Paid Costs and Calculated Costs. Paid costs involve actual payment in cash or kind for inputs or services used. Calculated costs are determined using mathematical formulae, and include the following:

- depreciation on the poultry house and equipment;
- interest on cash in hand and personal capital used to construct the poultry house and purchase equipment, birds and feed;

- maintenance of the poultry house and equipment; and
- labour supplied by the farm family.

Calculated Costs include Opportunity Costs as related to the national economy: for example, unemployment (including hidden unemployment) and high rates of devaluation of the national currency. These form a part of the socio-economic reality for the smallholder, and influence the Opportunity Cost of labour (reduced by high unemployment) and of capital (which tends to move towards zero when the rate of currency devaluation is higher than the interest rate). By making use of locally available and renewable materials for poultry housing and equipment, family poultry producers minimize the introduction of external capital into their enterprise.

Large-scale poultry production cannot really be compared with smallholder family poultry, because smallholders often face such constraints as the absence of organized marketing systems and the lack of price rewards for produce quality and uniformity. Therefore, the cost-price calculation for large-scale poultry production (and also that for free-range commercial poultry production) may not be applicable to smallholder family poultry systems without modifications.

Elson (1992) showed that for layers, production costs (per dozen eggs produced) increased with space allowance (stock density) per hen. The minimum stock density allowed in the EC (under EEC Council directive 1988/66) is 22 birds/m^2 (450 cm^2/bird). The production cost for birds housed in laying cages at this density is used as a baseline. The percent increases in cost over this baseline (each with their associated management system) are:

- 5 percent for aviaries;
- 7–12 percent for percheries (tiered wire floor aviaries) at 20 birds/m^2;
- 15 percent for cages at 20 birds/m^2 (750 cm^2/bird);
- 21 percent for deep litter systems at 7 birds/m^2;
- 30 percent for straw yards at 3 birds/m^2;
- 35 percent for semi-intensive systems at 0.1 birds/m^2 (1000 birds/ha);
- 50 percent for free-range systems at 0.04 birds/m^2 (400 birds/ha).

A comparison of the EC cage minimum as a base, with perchery and free-range alternatives, is shown in Table 8.1.

(Calculations were made using feed at £140/tonne; pullets at £2.35 each; old hens at 24.2p/kg)

A BROADER ECONOMIC FRAMEWORK FOR ANALYSIS

All economic activity consists of transforming resources (land, labour and capital) into goods and services which serve the needs and desires of people. Much of the quantitative assessment in cost-benefit analysis is simple accountancy: assigning monetary values to various measured or estimated physical quantities, categorizing them under a cost or benefit heading, adding them up, and finally comparing the totals. Proper economic analysis should provide a framework by which the benefits of production are shown in the economic system, and how these benefits are valued by society. This can only be done with a "before and after" or "with or without" analysis.

Benefits can be measured in two ways:

- by a **technical** component which represents the higher productivity of resources used (and hence reduced unit costs) in supplying poultry products; and
- an **economic** component which reflects the value placed by society on those supplies.

Table 8.1 Performance and production costs of three alternative systems in the United Kingdom

	System		
	Cage	**Perch**	**Free-range**
Performance			
Stock density	22	20	0.04
Eggs per hen housed	276	265	252
Feed intake, g/bird/day	115	116	135
Mortality, %	5	5	8
Old hen weight, kg	2.2	2.2	2.3
No of birds/worker	20 000	10 000	2 500
Production costs (pence per dozen eggs)			
Feed	25.5	27.8	32.8
Bird depreciation	7.9	8.4	8.6
Labour	1.5	3.2	13.3
Electricity	1.2	1.2	0.7
Medication	0.1	0.1	0.2
Other costs	1.1	1.2	1.3
Total	37.4	41.8	56.9

Source: Elson (1992), as quoted by Tucker (1989)

The technical effects are demonstrated in an economic analysis as a shift of the supply curve - the basic relationship showing the minimum price at which different levels of production can be made available to the market. This is shown in Figure 8.1 as the downward shift in the curve S_0 to S_1. The value placed on this change in potential availability is then entirely dependent on the demand for poultry products. With rising demand for these products, additional supplies become expensive, and therefore the extra production translates into a substantial gain in benefits to the community. It can be argued that this usually happens in developing countries where, compared to the staple diet, poultry products are a luxury commodity with a relatively higher value. Hence, the demand curve D shows that the quantity demanded is highly responsive to price and income changes, with additional consumption causing little decrease in value. The demand for poultry products is price/income elastic.

This simple model highlights the overall economic impact of higher poultry production as manifested on the market for poultry products. Production and consumption rise from Q_0 to Q_1 but the average price paid by consumers (and received by producers) falls from P_0 to P_1. Consumers gain significantly, reaping the benefits of both greater supplies and lower prices. Producers also gain. Although unit costs fall, the increase in production compensates for the price reduction and, as evident from the diagram, total revenue received by producers, (P_1Q_1) is greater than the previous P_0Q_0.

The overall net economic benefit from improved family poultry production technology is represented by the size of the shaded area. It is this net economic benefit that an economic analysis of family poultry development schemes and programmes should be seeking to estimate.

Fig. 8.2 A representation of the market for poultry products from smallholders

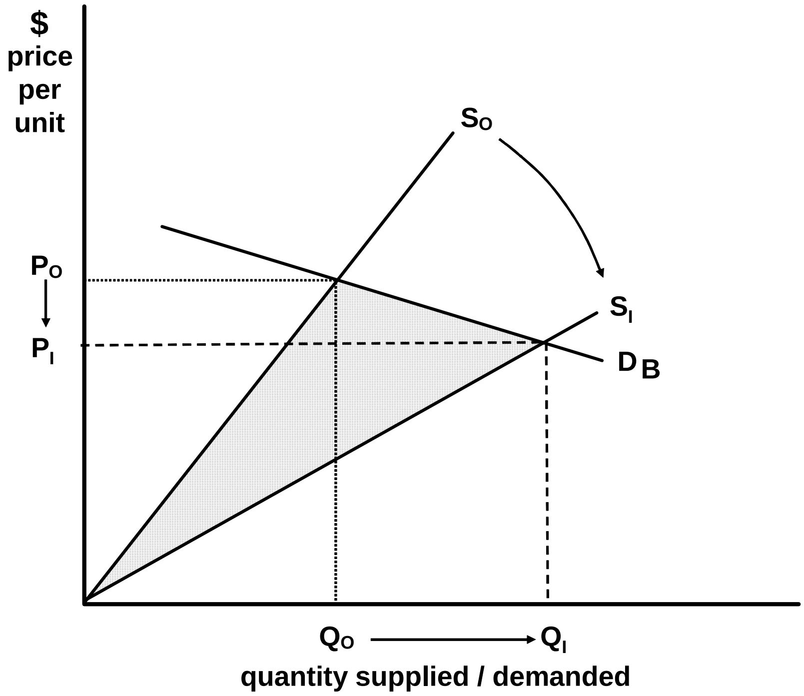

Image for demand-supply curve

Chapter 9
Marketing

As a country develops, more of its consuming population lose touch with the village and food producers. Thus more specialised marketing services are needed. Farm produce must be collected, packed and transported in good condition to the cities and distributed to retailers near consumers' homes. This also calls for grading and storage of the product. The more developed the country becomes; the greater is the variety of products that can be economically produced. All this must be provided at a cost that consumers can afford.

A study of existing marketing systems in a country will often reveal how they have evolved to their present state. Many developing countries do not have refrigeration as a factor in their storage, either during transport, retail or consumer household stages. For this reason, poultry meat is purchased live, and slaughtered immediately before consumption. Also, eggs are often retailed with a means for the buyer to check their quality before buying, either by "candling" (to see the internal quality with a lantern or battery-torch) or a bucket of water (to test the egg's age by the floatation method). Both methods essentially test for the size of the air-cell situated at the blunt end of the egg, which increases in size as moisture is lost from the egg. With a bigger air-cell, there is more floatation.

In developing countries, transport of eggs and poultry from the village to the city usually begins with a purchase by a middleman dealer, direct from the household, or from small locally held weekly markets. Baskets with layers of straw protect the eggs from breakage, and other types of baskets are used to carry live birds. Bullock carts are still used in many countries for transport of both live poultry and eggs to larger community centres. The roofs of buses or trains replace these slower vehicles as transport systems develop. Marketing quality considerations for live birds are usually concerned with weight loss in the bird from dehydration during transport. These are easily resolved by providing drinking water during the trip, and travelling during the cool part of the day when possible. Egg quality considerations are more complex and are dealt with in the second half of this chapter.

Improved marketing programmes must add no more cost to the product than the consumer can afford. Important marketing improvements can often be simply made by making small corrections to already existing handling, transport, packaging, grading and storage methods.

Marketing organisations generally come into being very gradually, and must be appropriate for the background, character and education of the people concerned. Plans for radical changes, which do not take sufficient account of social and economic environments, are likely to fail. Thus any improvement programme should be designed to achieve desirable modifications in existing commercial facilities (and their economic and legal framework) by a process of steady growth.

As a country develops, the task of marketing eggs and poultry will still involve the collection of live poultry and eggs from farmers, transporting them to a grading, packing or processing plant, grading and standardising the poultry meat and eggs, processing them and packaging them into more useful forms, storing them (preferably under refrigeration), moving them through wholesale and retail channels and delivering them to consumers at a convenient time and place.

This chapter provides a brief outline with some practical information and advice to those who are immediately concerned with egg and poultry marketing considerations. For a more detailed examination of marketing, the reader is referred to FAO Marketing Guide Nº 4 "Marketing eggs and poultry" (1961), from which some of the following material is taken.

FACTORS AFFECTING DEMAND FOR POULTRY MEAT AND EGGS

Ceremonial and traditional aspects

In traditional societies, poultry are often used for ceremonies, sacrifices and gifts. What follows are some traditional aspects of poultry keeping from the Mossi of Burkina Faso (West Africa), the Mamprusi of northern Ghana, and Bangladeshi and Malay farmers in South Asia.

Among the Mossi people when no poultry is available (such as after a Newcastle Disease outbreak), to meet customary family obligations, the household must purchase or borrow a bird. Chickens are given to convey value to a relationship, or to offer thanks for a favour or help (such as from government officials). For most socio-cultural and religious purposes, the required sex and colour of fowls are also prescribed. For example, a family will give a white cockerel when an agreement for marriage is reached.

The consumption of eggs in Mossi villages is uncommon. There is a strong belief that a child who regularly eats eggs will become a thief, reasoning that the good taste of eggs will make the child want to eat eggs often. The only eggs consumed are those that fail to hatch under broody hens. These are boiled and then eaten. Chicken eggs, unlike guinea fowl eggs, are not part of the trade in poultry products, since all eggs are required for hatching to maintain the flock (given the normally high losses during rearing). Dealers from urban areas reflect the demand for village eggs. The eggs are often bought by small food stall merchants who boil the eggs and resell them as snack food. A considerable number of guinea fowl eggs are collected by the Mossi for sale, most of which find their way to the cities via village markets, where dealers buy the eggs.

The Mamprusi society in northern Ghana has a variety of uses for poultry products. Chicken cocks are the most popular sacrificial animals. Guinea fowl cocks are not used. The colour of the bird is important. A red cock is sacrificed to ask for rain or a good harvest; a white cock is used to convey value in relationships, and a black cock is used to ask for protection against disease, war or quarrels. Because of these customs, red, white and black cocks have double the value of cocks of other colours.

The sale of young birds and eggs takes place in the Mamprusi village markets. Prices fluctuate during the year, and are low during the pre-harvest season, when the granaries are empty and the crops are still growing and thus cash is less available. At such times, traders from the south come to buy for resale in the cities. Sometimes, middlemen dealers are involved. They buy the birds in the villages and sell them at markets or to city-based traders. The sale of poultry products from Mamprusi households contributes about 15 percent to Mamprusi annual cash income.

Poultry consumption by the household is rare, as most birds are sold for income generation. In Mamprusi society, women, circumcised girls and first-born children do not consume eggs or meat. These products are only eaten by elderly men, male visitors and young children. The reasons are not fully understood. Some Mamprusi women believe that during pregnancy, their behaviour (including their food choices) can affect their unborn child.

In Bangladesh, eggs and meat are consumed mainly by men and boys, and very rarely by women and girls. Low-income groups generally do not consume eggs or meat. These products are sold, and from the proceeds, essential items are purchased, such as carbohydrate and low-cost vegetable protein foods.

Guinea fowl, more than chicken, are given as gifts to visitors. To give a gift is considered to be a wealth-increasing action as well as an act that conveys value on the receiver. Farmers often save for agricultural equipment or other materials and small livestock is used as a savings account. The offspring, like chicks, are considered to be the interest on the savings.

In many parts of Africa, birds are sold to meet unforeseen expenses, for example, to buy the beer and kola-nuts customarily given to gravediggers when a family member dies. The birds usually sold from the village flock are: surplus males (cockerels and cocks); pullets; old hens; non-productive hens; large-sized birds and sick birds. Young birds are often sold just before the onset of the high-risk period for Newcastle Disease.

Traditional taste values placed on poultry meat

It is important to understand traditional taste values and their effect on market demand. The market price for free-range birds for meat is usually stable because:

- the meat is considered tastier and stronger flavoured than commercial broiler meat;
- the meat (muscle tissue) is tougher, and retains its texture when prepared in dishes requiring longer cooking; and
- the birds are not fed with compounded feed which may contain antibiotics, anti-mould compounds, enzymes, sulpha drugs and other medicines or synthetic chemicals.

In eastern Asia, it is believed that chickens fed with chemicals and drugs have poorer therapeutic value, as they do not combine well with ginseng and other oriental herbs used in making soups, especially steamed types. For this type of soup, younger pullets are preferred and thus they fetch a higher price than do the cockerels. The female is said to be more beneficial and the meat tastier. Steamed chicken soup is believed to provide virility and vigour. It is commonly recommended in Malaysia for pregnant women and for those recovering from sickness.

In the case of large-scale commercial *ayam kampung* (local village chicken) production in Malaysia, local birds are confined and fed on commercial rations but they fetch lower prices than free-range local birds. Such large-scale production has an affect on the market value of all local birds, as purchasers have difficulty distinguishing between genuine free-range and commercially fed local birds. However, the price of *ayam kampung* continues to hold a margin above that of commercial meat chickens. The introduction of more appropriate methods of Newcastle Disease vaccination in Malaysia will reduce mortality at the village level which may also stimulate further interest in family poultry production. If this happens, there will be an increase in the supply of local free-range poultry products to the market, and the price of the *ayam kampung* product (from large-scale commercial production) may fall further.

Carcass parts and organ meats

The value of birds for sale in developing countries depends firstly on the available supply, secondly on the age and sex of the birds, and thirdly on their size or weight. Young birds, especially cockerels up to six months of age (weighing up to one kilogram live weight), are usually preferred by consumers. This is because larger birds are more expensive for most households, and smaller birds are more tender and have the same preferred portions (drumsticks for example). Table 9.1 shows carcass characteristics of the local village chicken in Bangladesh.

Table 9.1 Product characteristics of indigenous scavenging chickens in Bangladesh

Characteristic	Mean
Live weight, kg	1.14
Carcass weight, %	55
Eggs/hen/year	35 – 45
Egg weight, g	35 – 39
Hatchability of eggs, %	84 – 87

Source: Ahmed, 1994 (Bangladesh Livestock Research Institute)

Whatever the size of bird, all chickens have an equal number of high-demand portions (such as breasts and drumsticks), and a similar proportion of gizzards and other desirable organ parts (see Table 9.2).

Table 9.2 Organ weights and carcass composition of Ethiopian local chickens at different ages

	Slaughter age (months)			
Body part weight (grams)	**3**	**4**	**5**	**6**
Total body	502	674	892	1006
Gizzard	19.9	24.1	27.7	30.9
Heart	2.6	3.1	3.8	4.1
Intestine	60.9	67.0	77.4	81.8
Kidneys	4.6	5.4	5.6	6.4
Liver	15.8	20.0	22.9	25.9
Lung	4.0	5.1	6.2	6.6
Pancreas	1.8	2.0	2.3	2.9
Total organs	109.6	126.7	145.9	158.6
Body weight %	21.8	18.8	16.3	15.3
Carcass				
Bone	87	113	123	138
Meat	197	267	331	406
Skin	36	49	59	68
Total Carcass	320	429	513	612
Body weight %	63.7	63.6	57.5	60.8

Source: Forssido, 1986

Buying small birds supplies the same number of the desirable parts for a lower price. Together with the tenderness of the meat, this explains the heavier trade in young birds, which are also bought for replacement stock in depleted flocks.

SUPPLY MECHANISMS FOR POULTRY MEAT AND EGGS

Depending on the location of the farm dwelling, birds and eggs are sold from the household to traders (dealers or middlemen), direct to consumers, or carried by the farmer to the local market. The role of traders in the marketing of poultry products is an important one. Traders from urban areas buy eggs in villages to sell in cities. Where transport is an important consideration (as in many parts of Africa), guinea fowl eggs, with their stronger shells, are preferred to chicken eggs. Prices of eggs are related to supply and demand, to the higher risk of spoilage and lower use for hatching in hot and humid seasons, and to the availability of alternative protein foods such as fish. There is a tendency to hatch less in the hot season, due to low hatchability and diseases of young chickens, and there is also less hatching in the cold season, due to the risk of chilling stress to the young chicks.

Birds are either brought to the local market once or twice a week for sale to local consumers, to other local markets, or to local traders. Chickens are transported to the market in open-weave (well ventilated) baskets or wooden crates. They need not be fed on the day of sale, but should receive drinking water. If the trip to the market takes eight hours or more, stops should be made to supply water to the birds. In hot seasons, it is better to transport birds at night or in the cooler early morning. While the price of live birds depends on their size, the price of eggs depends more on number.

It is often assumed that for poultry and eggs, producers get 60 to 65 percent of the market price but this has been found to be false in Bangladesh, where they receive less than this. The role of traders or hawkers is very important, as it makes selling from the house possible, but these traders take up to 35 percent of the market value, with a consequent lower profit for the farmers who are responsible for production. This loss of income has stimulated farmers in many places to organize sales through their own marketing groups or formal cooperatives.

Supply channels

A study by Adeyanju *et al.* (undated, unpublished monograph) of the marketing of poultry products in Ondo State (in south-western Nigeria) revealed a large number of transactions and participants. The typical flow of the products from the producer to the consumer is shown in Figure 9.1. The local channel begins with the producer selling poultry products to retailers who serve the needs of local consumers. In most areas, local consumers also buy directly from producers. The other marketing channel involves wholesalers. They buy poultry products directly from producers and sell to retailers inside and outside the State, and are based in urban centres where urban-based consumers are located.

Fig. 9.1 Supply channel for poultry products in Ondo State, Nigeria

THE FARMER PRODUCER

⇙ ⇘

LOCAL MARKET RETAILERS URBAN WHOLESALERS

⇓ ⇓

LOCAL CONSUMERS URBAN MARKET RETAILERS

⇓ ⇓

WHOLESALERS URBAN CONSUMERS

⇓ ⇓

INTERSTATE BOUNDARY

⇓

URBAN MARKET RETAILERS IN STATES OUTSIDE ONDO STATE

⇓

URBAN CONSUMERS

Source: Adeyanju *et al.,* (Poultry Farming in Ondo State, undated, unpublished monograph)

Odi (1990) found that marketing channels for family poultry often cross international boundaries and can generate significant foreign exchange for the producing countries (see Figure 9.2).

Figure 9.2 Supply channels into Côte d'Ivoire for guinea fowls produced in Burkina Faso

BURKINA PRODUCER HOUSEHOLDS ($1.33/bird)

⇓

PRIMARY COLLECTOR (5-10 birds)

⇓

SECONDARY COLLECTORS (50-100 birds)

⇓

MERCHANTS (250-500 birds)

⇓

OUAGADOUGOU (5 000 per trip)

Railway Station
<25% mortality

ABIDJAN, Cote d´Ivoire (3 750 birds)
Railway Station
⇓
⇗ ⇗⇘⇘
IVORIAN CONSUMERS ($3.90/bird)

Source: Odi, 1990

Planning

Forming a marketing plan means identifying where and when birds and eggs will be sold to receive the best possible prices. Putting large numbers of birds up for sale in a small community may depress the price.

Even the sale of small numbers of intensively managed layers needs advance planning. A flock of 20 hens may produce 1 200 eggs in a year, even at the low production rate of 35 percent. The plans of other farmers must also be considered. If they all expand their flocks and have good years, prices will almost inevitably fall. Seasonal considerations enter into market plans as well. In India for instance, eggs are thought of as a heat-producing food and are eaten in the cool, rainy season. Many factors affect the quality of eggs (see Tables 9.3 to 9.6) and hence the price that consumers are willing to pay for them in the market.

Table 9.3 Egg quality parameters for four breeds of chickens

Trait	Nigerian Local	Isa Brown	Trait	Ethiopian Local	White Leghorn
	(Asuquo *et al*., 1992)			(Forssido, 1986)	
Egg wt., g	40.6	59.2	Egg wt., g	46.0	64.0
Yolk, %	36.9	26.3	Yolk, %	36.8	34.0
Albumen, %	52.6	62.8	Albumen, %	49.6	53.0
Shell thickness, mm	0.30	0.35	Shell thickness, mm	0.35	NA
Yolk index	0.36	0.46	Fertility, %	56.4	46.0
Albumen index	0.09	0.12	Hatchability %	42.1	24.1
Haugh unit	79.8	89.9	Haugh unit	NA	NA

Table 9.4 Length of lay and egg quality in Nigerian indigenous chicken

Traits	Months of Lay					
	2	3	4	5	6	7
Egg wt, g	35.8	37.2	36.9	37.1	39.0	38.6
Yolk wt, g	14.9	14.7	14.5	14.2	14.0	14.2
% Albumen	47.9	50.8	51.5	52.0	52.0	53.5
Shell thickness, mm	0.39	0.39	0.36	0.32	0.36	0.35

Source: Olori and Sonaiya, 1992b

Table 9.5 Quality of eggs of different shell colour of the Nigerian indigenous chicken

Trait	Brown	Light Brown	White
Egg wt., g	38.9	37.1	37.0
Yolk wt., g	14.5	14.0	14.8
Shell wt., g	3.78	3.58	3.51
Albumen wt., g	20.6	19.6	18.8
Shell, %	9.77	9.67	9.49
Yolk, %	37.4	37.8	39.9
Albumen, %	52.3	52.8	50.8
Shell thickness, mm	0.37	0.37	0.35
Surface area, cm^2	52.6	50.9	50.8

Source: Olori and Sonaiya, 1992a

EGG QUALITY CONSIDERATIONS

Quality determines the acceptability of a product to potential purchasers. The quality of eggs and the preservation of this quality during storage is a function of their physical structure and chemical composition. A basic outline of the most important factors of concern in egg quality is presented below.

Egg composition

The egg consists of shell, two shell membranes, the white (or albumin) and the yolk. The shell is quite porous to air and water vapour but is very resistant to invasion by micro-organisms as long as it is clean and dry. A thin outer covering on the shell called the "bloom" or "cuticle" (which is unfortunately easily removed by washing), assists this process. After the egg is laid, its contents shrink, both from cooling and water evaporation. Air is drawn in (along with anything else on the shell, such as bacteria or fungi) through the pores in the shell to replace this loss. A gap opens up between the two membranes because the outer one is attached to the shell and the inner one is attached to the egg white. This gap is known as the “air cell” and is usually found at the large blunt end of the egg. The egg white takes the form of a “thick” albumin sack enclosing the yolk, with a more fluid “thin” albumin between this sack and the yolk to the inside, and again between the sack and the shell to the outside. These layers provide a barrier to prevent the yolk touching the shell and to provide food for the embryo. Egg white has specific antibiotic effects, which further protect the yolk. Egg white also contains two fibrous cords (the chalaza), which are attached to the yolk and to either end of the egg, which help hold the yolk in the centre and assist in preventing the yolk from touching the shell.

The weight of an egg laid by a local village breed of hen is about 35 g. Commercial hybrids lay eggs of about 58 g weight. The shell comprises approximately 11 percent of the weight of an egg, the remainder being the edible portion. By weight of edible portion, the yolk is 36 percent and the white is 64 percent.

Shell quality

Eggs of unusual shape are more likely to be damaged during the marketing process, and consumers do not like them. Small thin cracks in the shell, which do not leak, are called “checks”. These are usually detected by candling. “Checked” eggs should be sold for immediate consumption, as their storage life is limited. The household usually consumes eggs with leaking cracks, where the eggshell membranes are broken as well as the shell. Brittle, thin-shelled eggs (shells less than 0.35 mm thick) are also unsuitable for transport to market. Dirty eggs must be cleaned by dry or wet methods, and thus have a higher marketing risk because of the removal of the cuticle.

Shell colour is not a guide to egg quality, but there is usually a consumer bias to either white or brown, which must be considered in marketing.

Egg yolk and egg white quality

Consumers prefer the odour and flavour of normal fresh eggs. The yolk should be round, firm and yellow in colour. Local yolk colour preferences may vary and can be easily adjusted by raising or lowering the amount of green leaf material included in the poultry ration or supplement. Egg white normally has a slightly yellow-green tinge and the thick white is slightly cloudy.

Consumers are usually critical of blood or meat spots, which can vary in colour from red to grey, and in size from small specks up to one square centimetre. Blood spots are caused by slight bleeding at the time of release of the ovule (yolk) from the ovary of the hen. They may be found in the white or adhering to the yolk.

Deterioration

The interior quality of eggs deteriorates after laying at a rate depending on time and conditions of storage, such as temperature, relative humidity (RH), and the presence of strong smelling substances or other food items in the storage place. Eggs stored at 27 to 29 ^{o}C for 7 to 10 days will show deterioration changes similar to the same eggs stored at minus 1 ^{o}C and 85 percent RH for several months. The changes are due to water loss, carbon dioxide (CO_2) and the absorption of volatile odours from the environment.

Moisture loss

Since an egg contains about 74 percent water and the shell is porous, eggs readily lose moisture. A weight loss of 2 to 3 percent is common in marketing and is seldom noticed by the consumer. When losses exceed this level, the air cell is noticeably enlarged by shrinkage in the contents of the egg. This loss is reduced if the storage humidity is high and the temperature is reduced. Coating the eggs with oil and other substances can also reduce the loss. The ideal conditions for egg storage are about minus 1 ^{o}C and between 80 to 85 percent RH. At storage temperatures of 10 ^{o}C and above, the optimum RH is 80 percent. There is a risk of mould spoilage when the RH is too high. Paper pulp egg trays or other packing materials that readily absorb moisture will accelerate moisture losses from eggs. A temperature as low as 10 °C is unlikely to be practical in rural areas of many developing countries. Temperatures between 10 and 15 °C are more practical, but even then, care should be taken when moving the eggs from cool storage into the outside air with its higher temperature, which often causes condensation to form on the shell, with consequent risks of mould and "rot" growth.

Microbiological spoilage

The contents of the egg are usually sterile when the egg is laid. The main cause of contamination is the washing of eggs. Wetting the shell allows micro-organisms on the shell to penetrate and multiply inside. Common indications are green, black and red "rots", mustiness and sourness. The bacteria causing these effects cannot penetrate the shell if it is kept dry. If eggs do become wet through condensation, for example after removal from a cool store into a warmer room, bacteria may then be able to penetrate the shell.

Tainting

Eggs, especially yolks, are easily tainted by strong odours, from such sources as disinfectants, soaps, diesel, kerosene, petrol, paint, varnish and wood preservatives. Other foods, such as onions and citrus products, can taint eggs after only a few days of exposure.

EGG QUALITY CONTROL AND MAINTENANCE

Maintenance of egg quality is a major problem for those involved in egg marketing. The importance of using good packing, storage and transport methods to preserve quality is addressed in other sections below.

Eggs soiled by droppings or the contents of leaking or broken eggs spoil faster than clean eggs. Only good quality eggs should be sent to the market. The simplest way of sorting is to divide the eggs into three categories: cracked, dirty and clean. The cracked eggs should be eaten or sold locally for immediate consumption. The dirty ones should be cleaned and sold locally for consumption within a few days, while the clean eggs can be sent to the major marketing outlet. In some areas, eggs of certain colour or sizes are preferred, and the eggs should be sorted for these qualities.

Production factors affecting egg quality

The main production factors affecting egg quality are:

- breed and age of the flock;
- type of feed;
- incidence of disease;
- management control of the laying flock; and
- management control of the handling of eggs.

Breed and age of the laying flock

The effect of breed on the egg is inherent in many aspects, including the colour, thickness and texture of the shell, the incidence of blood spots, and the amount of thick albumin. While commercial breeders pay constant attention to these factors, there is little that farmers can do to control them.

After the first season of egg production, hens produce eggs of poorer shell quality and poorer egg white thickness, even though the eggs are larger in size. The rate of egg production is also lower. For these reasons as well as the high meat value of the carcass of the older hen in most developing countries, it is advisable to replace the hens after 12 to 18 months of lay.

Type of feed

A balanced diet supplied to intensively housed chickens must supply sufficient nutrients to enable the hen to produce an egg with a good shell thickness and good egg yolk colour. A high level of yellow maize, leaf or grass meal will ensure a good yolk colour. Calcium carbonate in some form (limestone or shell) must be supplied (for more detail, see Chapter 3 on Feed Resources and Chapter 4 on General Management). This is either mixed in the ration or fed as a separate supplement on a free-choice basis. It is often quite practicable to have a separate container in a pen with shell or limestone inside.

Fish meal with a high fish oil content fed in the diet can give fishy flavours to eggs produced by hens on those diets.

Incidence of disease

The diseases Infectious Bronchitis (IB) and Newcastle Disease both affect egg quality. They cause the hens to lay eggs with misshapen shells and poor quality thick white. IB induces groove-like marks along the long axis of the eggshell.

Management control over the laying flock

In many developing countries, there is a belief that a rooster is necessary to stimulate hens to lay. This is not true. The presence of an active male causes the eggs to be laid as fertile eggs (containing an embryo chick), and this reduces the storage stability of the egg. Even after the male is removed, all eggs laid are fertile for up to six weeks because sperm is stored and released from specialised cavities in the hen’s oviduct. If fertile eggs are in demand, then cocks should be placed with the hens. Non-fertilized eggs have a much longer shelf life than fertilized eggs and are more suitable for the market.

Dirty eggs can be reduced in number. For hens in deep litter systems, the nest box litter must be clean and replaced regularly. Frequent collection of eggs under any housing management system, and at least four times a day in the hot humid tropics, will reduce the incidence of dirty eggs.

Management control over egg handling

Temperature control

The most effective way to preserve egg quality is to store eggs between 10 and 15 ^{o}C during all handling, transport and marketing phases. Insulated containers and/or vehicles can maintain cool temperatures during long-distance transport. Even an outer layer of straw in a basket will help. In hot weather, and where there is no cool storage system, eggs should be transported to market at least every third day. Eggs should never be left standing in the sun or in a very hot room. Air conditioning or even an electric fan is advised whenever practicable. However, as air conditioning has the negative effect of drying out the egg contents as well as the advantageous effect of cooling, wet sacks should be placed as curtains in the cool store to alleviate this dehydrating effect. If fans or air conditioning are not available, then shaded well-ventilated rooms or underground cellars should be used.

Treatment of dirty eggs

An egg’s shell has a natural protective coating (cuticle) that resists the entrance of bacteria and retains moisture inside. Washing eggs with water removes this protection, and thus washed eggs should be eaten as soon as possible. Whether eggs are wet- or dry- cleaned, they should be sold separately from naturally clean eggs, as their storage life is shorter. The cuticle from the shell is a protein-fat substance, and the lack of a cuticle can therefore be detected with a simple ultraviolet (UV) lamp. Washed eggs (without a cuticle) are red in colour under UV-light, while a blue colour indicates that the cuticle is still present.

Dry cleaning

Even with good flock management, some eggs will get dirty. The risks of allowing water to touch the shell have already been mentioned. Dry cleaning systems are preferred. Rubbing lightly with fine sandpaper or a rough cloth is better than wet cleaning. Cloth-backed sandpaper or emery paper can be wrapped around a block of foam rubber for dry cleaning by hand. Steel wool and nylon dishwashing or bathroom scrubbing aids are also quite suitable. Care should be taken not to remove too much of the protective cuticle layer which covers the shell. Only the dirty patches should be cleaned. There are also motor-driven dry-cleaners commercially available. The simplest model consists of a spinning wheel of foam rubber. A mixture of glue and sand is applied periodically to the foam wheel. The operator holds the egg against the spinning foam wheel to clean it.

Wet cleaning

Washing of eggs is only suggested under very well-controlled conditions. The concern is to ensure that the washing water temperature (38 to 43 ^{o}C) is never below that of the egg. This avoids the wash water being sucked into the egg through the shell pores by the action of the egg contents shrinking (as happens if the egg is in contact with cooler water). In addition, the washing machine must be able to monitor the detergent/sanitizer/disinfectant/antiseptic levels in the water to ensure that they are optimal. Only special types of non-tainting chemicals can be used. The water itself must be changed frequently. After washing, the shell should be pasteurised by dipping the eggs in water at 82 ^{o}C for a few seconds, then dried quickly with warm air before packing. The eggs must also be clearly labelled as “washed”. Washing done in this way is complex and expensive, and is therefore only justified in large operations, although even then it involves risks.

EGG QUALITY GRADING

Interior quality

Candling

Opening the egg by breaking it is the only accurate way to fully check the interior quality. This can only be done on a limited sample basis. “Candling” can show some aspects of internal quality without breaking the shell. It consists of inspecting the egg in a beam of light strong enough to penetrate the shell and illuminate the contents. Various types of lamps can be used but the essential features are similar. An incandescent-type bulb of 25 to 50 watts is enclosed in a casing with light exiting through a round hole about 3 cm in diameter against which the egg is held and turned. The casing usually has another hole to provide light for the operator to see the egg container if the room is very dark. By rotating the hand-held egg close to the hole in the candler, the yolk and egg white quality can be estimated by their movement. Experienced operators can candle 24 eggs per minute. The main points to observe are summarised in the following paragraphs.

White

Egg white (albumin) characteristics showing good egg quality are thick albumin fullness and albumin transparency. When the thick albumin sack is strong and healthy, it is full and confines the yolk within the various layers of egg white. As the thick albumin sack deteriorates, its contents leak into the thin albumin cavity. The yolk then moves more freely, increasing the risk that it might touch the shell and be contaminated by micro-organisms from outside the shell. A healthy albumin is also transparent. It can become discoloured or cloudy due to rot or overexposure to hot water (partial coagulation) in washing.

Yolk

Yolk characteristics showing good egg quality are confinement within the thick albumin, a small spherical shape, orange-yellow colour and the absence of spots. As described in the above paragraph, yolk confinement within the albumin protects the yolk from outside contaminants. A small spherical shape indicates a strong yolk membrane. When the egg is exposed to high temperatures and dehydration, the yolk deteriorates and grows larger and flatter. Consumers prefer yolks of orange-yellow colour without spots. Spots on the yolk can indicate: embryo development (reddish colour); blood from the hen's ovary and "meat" bits from the oviduct released during egg formation (red and brown, respectively); moulds (grey or black); or bacterial rots (blue, violet, green or red). Although consumers prefer yolks with no spots, the only spots that pose any health risk are mould and rot spots.

Air cell

Air cell characteristics showing good egg quality are small size, shallow depth and fixed position at the blunt end of the egg. Small size and shallow depth indicate very little loss of moisture from the egg contents, which in turn indicates freshness (or that the eggs have been stored under good conditions). A fixed position at the blunt end of the egg indicates that the membranes surrounding the air cell have not been damaged (for example, by rough handling).

There is usually a correlation between the depth of the air cell and other quality aspects. However an egg stored at high temperature and high humidity may show a good air cell depth (as the high humidity maintains the egg moisture) but it may have deteriorated otherwise (as a result of the high temperature).

Air cells can be deflated completely or become unfixed and mobile within the egg. The air cell can become filled with albumin if part of the inner shell membrane is broken. If the membrane is merely weakened, the air cell may move freely around the egg. These mobile air cells are often caused by transporting eggs on rough roads or by the egg being stored small end upwards. The egg could be otherwise quite fresh.

Shell quality

Before candling, eggshell quality is assessed, and eggs that are dirty, cracked, thin, rough or misshapen are processed accordingly (procedures regarding shell quality are addressed extensively in the above section on production factors affecting egg quality).

EGG SALE OPTIONS: GRADED SIZE OR TOTAL PACKAGE WEIGHT

Eggs can be sold by graded size or by total package weight. Selling by graded size involves weighing each egg individually and grading the eggs within certain weight ranges (commonly Small, Medium and Large). They are then packed in cartons of 10 or 12 eggs, and sold according to a price per graded size. Selling by total package weight involves packing the eggs without size grading, and selling the package according to a price per kilogram (like almost all other food products).

Consumers in the more developed countries are accustomed to buying eggs graded by size and boxed into cartons. Grading eggs by size requires complex machinery for grading and packaging, as well as monitoring and testing of all grading machines, and sample monitoring of the various grades at retail outlets.

In developing countries without the capital or administrative capacity to undertake such extensive monitoring tasks, the better option is to sell eggs by total package weight. If a market weighing scale is used to weigh foods such as rice or maize, then it can also be used to weigh eggs so that they can be sold by package weight. Selling eggs by package weight also simplifies the situation where standardization of containers and grades has not yet been developed. It also makes price comparisons between different types of food items much easier for the consumer.

Eggs in most developing countries are sold by quantity rather than by weight, which penalizes the producer of larger eggs. As local breeds of hens usually lay uniformly small eggs, this is not a significant problem. However, as the market grows and a demand develops for different sized eggs based on the availability of commercial hybrids (laying larger eggs) in peri-urban areas, the decision to sell eggs by graded size or by total package weight must be faced.

EGG TRANSPORT

The four concerns regarding egg transport are:

- Protection against **mechanical damage,** which can be achieved by avoiding excessive shaking, especially where roads are bad, and by using spring suspensions on bicycle carriers.
- Protection against **poor egg handling**, which can be achieved by providing convenient loading levels to make lifting easier.
- Protection against **tainting odours.**
- Protection against exposure to **high temperatures** in transport.

Egg packing methods

Eggs can be packed with a padding of rice husks, wheat chaff or chopped straw in firm-walled baskets or crates. This greatly reduces the risk of shell damage in transport. In Iran, long flat boxes, each containing about 1,000 eggs cushioned in chopped straw, are commonly used for the transport of eggs to the capital from a distance of up to 1 000 km. The boxes are transported in trucks over rough roads, but breakages seldom exceed five percent. The main difficulty with such systems is in standardizing the number of eggs per container. Consignors and receivers will otherwise spend much time counting eggs and repacking to ensure that the correct number has been received for payment.

The standard type of transport egg packing container is the 30-egg tray, which is made of paper pulp holding six rows of five eggs each. The trays are stackable either when full or empty. A standard box of 360 eggs (30 dozen) is made up of two stacks, each comprised of six trays. Washable plastic reusable trays are also available. Cases are usually made of wood. Half-cases to hold 180 eggs (15 dozen) are also common and are usually made of corrugated cardboard.

Quality preservation during transport

Permissible temperature ranges depend on the duration of transport time. In Europe, the temperature recommendation for two to three day transport in refrigerated vehicles is between -1 ^{o}C to 3 ^{o}C. In developing countries, however, refrigerated vehicles are not widely available. Even when available, precautions are needed to avoid moisture condensation on eggs removed from the cool container to the warm moist air of the retailing environment.

Fans blowing air towards the eggs across a container of salt and ice is a cooling system that has been used in Pakistan for egg transport by rail for the 1 600 km trip from Peshawar to Karachi, where outside summer temperatures can range from 38 °C to 47 °C.

Refrigerated transport is expensive. In estimating the costs of establishing such a system, the volume of trade for refrigerated goods is an important consideration. The capital cost may be spread over five years to prepare the costing. Transport of other taint-compatible produce with the eggs should be considered; as should the prospect of back-loading with other goods, which may not necessarily require refrigeration.

Public transport such as rail or bus is the most common means of transport in developing countries. Awareness of the special needs for egg transport as addressed above will assist the operator in preserving the quality of the eggs no matter what the type of transport.

EGG STORAGE

All egg storage systems must meet the following requirements:

- Water loss by evaporation to be minimized.
- Mould and bacteria growth to be minimized.

- Interior quality to be maintained (indicated by a good proportion of a thick white, a firm, rounded yolk and good flavour in both).

The first two requirements can be met (for storage periods of three to five months) by: coating eggs with oil or waterglass (sodium silicate); immersing eggs in limewater (calcium hydroxide solution); or putting eggs in dry storage (using such materials as bran, peat dust, soda lime, salt and wood ash). However, all three of the above requirements can only be met by refrigeration, which is the best storage method, if available.

Following below are descriptions of some of the traditional egg storage methods used in the absence of refrigeration. The first two systems rely on evaporative cooling, which is only effective in the hot dry tropics. The hot humid tropics do not allow sufficient evaporation to occur, and thus there is much less of a cooling effect. Where none of these storage systems can be used, there is no way to slow the inevitable drop in egg quality, and the eggs should therefore be transported to the consumer as quickly as possible.

Clay pot

Eggs are placed in a clay pot buried in the ground up to its neck, in a shaded area. The pot is covered tightly so that no water gets into the pot. The ground around the pot is watered, but without leaving puddles of water. Straw or a mat is placed in the pot to cushion the eggs and to keep them above any water that seeps into the container. The eggs are put in the pot as soon as they are collected, and covered with a cloth and damp straw. Due to the evaporative cooling effect, the inside of the pot is often five to six Celsius degrees cooler than the outside air temperature. A variation of this method, used in the Sudan, is to bury an earthenware pot in the ground to half its height. A 7 cm layer of mixed sand and clay is packed around the pot up to its neck, and kept wet by sprinkling water on it. The inside of the pot is lined with grass. The eggs inside are covered with a thin cloth to allow air circulation. Evaporative cooling in Sudan’s hot dry climate often reduces the egg temperature to up to eight-Celsius degrees below that of the air outside. Eggs are turned daily to prevent the yolks touching the shell, which would accelerate the decaying process.

Wet sack cooler

This is another method utilising the evaporative cooling principle. The sack material is kept wet by having a tray of water above the hanging sack, into which the neck-edge of the sack material is dipped, keeping the sack wet. A slightly more sophisticated system uses perforated pipes connected to a water tank. To prevent mould formation, the sacking is pre-soaked in a solution of copper sulphate ($CuSO_4$), using 60 g of crystals in four litres of water.

Oil coating

A thin film of oil on an eggshell fills its pores and reduces evaporation and thus spoilage of the egg contents. Using a wire basket, the eggs are dipped into slightly heated oil, about 11 °C warmer than the eggs. Special odourless, colourless, low viscosity mineral oils can be used. If these are not available, then any light mineral oil or almost any cooking oil that doesn’t easily turn rancid serves the purpose. To reuse the oil, it is cleaned through a filter and heated to 116 °C to sterilize it. Four litres of oil coats about 7,000 eggs. Oiled eggs last for at least three weeks (longer if kept at 10 ^{o}C, or less at temperatures above 21 ^{o}C). For high temperature storage, eggs should be oiled four to six hours after laying.

Waterglass paste

Waterglass is a paste or ointment of sodium silicate in water. It is rubbed onto the hands and then the egg is rolled between the two waterglass-coated hands to transfer a waterproof coating of waterglass paste to the eggshell.

Waterglass solution

For 100 eggs, a 25-litre pot or jar is used, and 5.3 litres of previously boiled (and then cooled) water are mixed with 0.5 litres of waterglass. The eggs are placed in the pot and covered with the waterglass solution. The pot is covered and kept in a cool, shaded place. The eggs keep for one to six months.

Limewater solution

Limewater is a solution of calcium hydroxide [$Ca(OH)_2$], a mild alkali. The main ingredient is burnt lime (also known as quicklime). The chemical name of this is calcium oxide (CaO). It is also known as *choon* in Bangladesh, and is a common ingredient of the betel nut mixture chewed by people in many tropical countries. Calcium oxide is made by burning limestone ($CaCO_3$) in a hot fire. Carbon dioxide (CO_2) is driven off from the limestone, leaving CaO behind as a white powder. Dissolving this calcium oxide in water makes limewater. The resultant solution of calcium hydroxide is only partly soluble, and the insoluble portion will settle to the bottom of the container.

Six litres of limewater is made by stirring 2.3 kg of calcium oxide into six litres of boiled (then cooled) water. It is allowed to stand overnight so that the insoluble portion settles. The eggs and the clear part of the limewater solution are placed in a pot, covered and kept cool. The eggs last more than a month. In the years prior to 1970, eggs were commonly transported from Bangladesh (formerly East Pakistan) to Pakistan (formerly West Pakistan) on a train journey of about a month, in high temperatures. The eggs were stored in earthenware jars containing limewater and maintained their quality well.

Hot water immersion

Immersion in hot water for carefully controlled lengths of time has a pasteurizing effect, which kills the embryo in fertile eggs, destroys some of the bacteria on the shell and stabilizes the quality of the egg white. The difficulty is to achieve this without coagulating some of the egg white. Equivalent effects are achieved with any of the following temperature-time combinations:

35 minutes at	49 ^oC
15	54 ^oC
10	59 ^oC
5	60 ^oC

This method requires special equipment and supervision.

Salt and wet clay or ashes

Eggs are coated in a mixture of salt and wet clay or ashes which allows them to keep for one month. This method has been practised for centuries in China.

Cooked rice and salt

Eggs are covered with a mixture of cooked rice and salt, which allows them to keep for six months. This method has been practised for centuries in China.

Lime, salt, wood ashes and tea

Eggs are covered with a layer of lime, salt and wood ashes mixed with a tea infusion, which allows them to keep for several years. This method has been practised for centuries in China.

Chapter 10
Research and Development for Family Poultry

Research and development in the field of Family Poultry (FP) must first examine the social, cultural and technical constraints faced by this sector, and then observe how these have been addressed in past efforts and whether the lessons are being applied in currently ongoing efforts. While holding this perspective, the need for further research, training and extension must then be assessed in the light of a clear understanding of what the overall development objectives are, and what place FP has in achieving them. Having provided background in the preceding nine chapters, this final chapter takes the reader through these concluding stages.

SOCIO-CULTURAL CONSTRAINTS TO DEVELOPMENT

A sociological appraisal is essential in determining strategies for development. Technical and economic appraisals are also necessary, but are insufficient on their own. Socio-cultural factors contribute to the wide variety of response of livestock keepers even under identical economic conditions. Many socio-cultural factors affect livestock production. For example, some communities ban ducks, as they are presumed dirty and destructive to drinking water supplies. Some communities regard pigeons as a sign of peace and concord. In such communities, the presence of pigeons is regarded as a good omen, and their departure would presage disaster. In other communities, pigeons are regarded as an evil omen, since they are used by native doctors in sinister rituals.

Another socio-cultural constraint to poultry development is the value placed upon poultry for use at ceremonies and festivals or even as a source of income in times of need but not as a source of daily food nor as a regular source of income. Some regard chickens as their pets or part of the family, thus it is only the arrival of an important unexpected visitor that could allow their use as food, although they can be sold without regret and the money utilised.

Another major constraint to poultry production is the high value placed upon crop production rather than livestock production. This affects the willingness to put much time, expense and effort into livestock production. Theft is also a great constraint. Villagers who have lost all their poultry to theft may be reluctant to face the expense of starting again.

Another constraint is the social norm that determines ownership of livestock. Typically, where crop farming is the men’s main activity, keeping livestock is perceived as a peripheral activity relegated to women and children. However, when the number of livestock increases, men usually take over the activity.

It should not be assumed that socio-cultural factors can be changed. However, by incorporating socio-cultural factors into development strategies, the programmes and technologies may encounter less resistance. Development programmes, which combine local knowledge with western science, yield strategies which are culturally more acceptable. Socio-cultural factors are thus not seen as a problem, but rather as a factor to be considered or used in finding a solution (Olawoye and di Domenico, 1990).

TECHNICAL CONSTRAINTS TO DEVELOPMENT

The most common FP flock size of between 5 to 20 birds seems to be the limit that can be kept by a family without special inputs in terms of feeding, housing and labour. These small flocks scavenge sufficient feed in the surroundings of the homestead to survive and to reproduce. Any significant increase in flock size often leads to malnutrition if no feed supplement is provided. In addition, larger flock sizes must forage at greater distances, which may involve damage to neighbours’ vegetable gardens. Any move to fence in or enclose the poultry then involves the need to provide a balanced ration. Larger flock sizes can easily arise once mortality is reduced through vaccination and improved hygiene. Flock size can rapidly increase to the point where the feed requirement exceeds the available Scavengable Feed Resource Base (SFRB) in the area around the dwelling (For more detail on the SFRB concept, see Chapter 3 “Feed Resources”). At this stage, either supplementary feeding or a semi-intensive system of management is required. If balanced feed, day-old hybrid chick and vaccine input supplies (and markets) are available and well organized, and then intensive poultry management systems may be a viable option. There have been many attempts to take short cuts to development and to start immediately with the semi-intensive system.

FAO consultation 1987

A wide range of approaches to improve FP production has been tried. An FAO Expert Consultation on Rural Poultry Development in Asia was held in Bangladesh in March 1987, to review these approaches in order to identify the reasons for success or failure. A major issue during the workshop was to clearly define the different systems of rural poultry production. There was confusion in terminology between the low-technology scavenging systems of Bangladesh, Myanmar and Bhutan, and the small semi-intensive or intensive production systems (a few hundred birds) kept in India, Malaysia and Indonesia.

Table 10.1 The effect of rural poultry improvement on production, reproduction and off-take per hen/year

Production system	Nº of eggs/hen/year	Nº of year-old chickens	Nº of eggs for consumption and sale
Traditional	20 – 30	2 - 3	0
Step 0: Scavenging: no regular water or feed, poor night shelter			
Improved Traditional	40 – 60	4 - 8	10 - 20
Step 1: offered water and supplementary feed, improved shelter, care in first weeks, ND vaccination			
Step 2: as in step 1 plus further feeding, watering, housing; treatment for parasites, additional vaccinations	100	10 - 12	30 - 50
Step 3: (semi-intensive) as in step 2 with improved breeds and complete diets	160 – 180	25 - 30	50 - 60

Source: Bessei, 1987

These differences motivated the FAO consultation facilitator (Bessei, 1987) to classify the various poultry production systems in Asia (Table 10.1, above). The table shows the logical evolution from Step 0 to Step 3, and the Consultation agreed that many development projects had failed because they did not recognise the constraints present at the different steps of development. The constraints themselves (shown in Table 10.2) show the need for awareness raising in the farmers to recognise the needs of their poultry for regular watering and feeding, cleaning of the poultry night house and care of the young chicks. The Consultation recommended that the first critical step for rural poultry development is the encouragement and support of farmers to change their traditional system. Taking into consideration the chronic shortages of personnel and transport affecting extension services in the developing countries, the Consultation emphasized the importance of selecting pilot farms to serve as models as they can have a multiplier effect on the neighbouring farms and villages.

Perhaps because of the variety of understandings of rural poultry development, many of the methods suggested seem more suited to the development of small units of intensive poultry production. The methods reflect the procedures required for transfer of new technology or total replacement of existing practices. For instance, incentives were required to encourage farmers to participate in the programmes, perhaps indicating that the programmes were not consistent with the priorities of the farmers. Selection of farmers was also identified as a major factor in determining the success or failure of a development programme. Incentives can often lead to the selection of farmers not genuinely interested in poultry production. To ensure the selection of authentic candidates, the following procedure was recommended:

- The extension service should select farmers already known to be particularly interested in poultry production.
- Incentives should never be given in cash.
- Incentives should always be associated with certain commitments by the farmers (for example, equipment for poultry houses should be provided only if the farmer has constructed the poultry shed at his own cost).
- Supplies of inputs such as day-old chicks, fertile eggs, feed and vaccines should be made at cost price.

The pilot farm method risks failure if a large amount of foreign input (such as equipment and construction materials) is needed to establish it because neighbouring farms can become discouraged by the fact that they are unable to procure the same equipment.

Table 10.2 Technical constraints and training requirements for family poultry development

Constraint	Training Measures required
Disease risk	Advice on sanitation and health; training vaccinators.
Predators	Advice on predator control.
Housing	Advice on improved poultry housing.
Feed and water	Advice on locally available feed ingredients and their combinations; making of feeders and drinkers; regular provision of feed and water.
Genetic potential	Introduction of improved indigenous (and if necessary, exotic) breeds and advice on special management.
Marketing	Advice on egg handling and storage, and training of farmers in group management and marketing.

Source: Bessei, 1987

In order to be effective in the process of technology and information transfer, pilot farms should be charged with special duties, which bring them obligatorily in contact with the other poultry keepers. Pilot poultry farmers have been successfully trained in Bangladesh and Burkina Faso to vaccinate chickens and guinea fowls, respectively. Pilot farmers can also be used to provide improved lines or to raise pullets for distribution so that a number of farms in the surrounding area will be regularly served with inputs and information.

Attempts to by-pass the phases as described by Bessei (1987) usually fail, and it appears that the transitory phases (especially Steps 1 and 2 as described in Table 10.1) are important if the development is starting from the traditional scavenging system. It has been noted that even in successful poultry development programmes, the supply of feed and veterinary products often lags behind the increase in flock size, especially if it is organized by the government extension service. The use of non-governmental organizations (NGOs) and private entrepreneurs is a better alternative.

INFPD and the 1998 FAO e-conference

The International Network for Family Poultry Development (INFPD) started as the African Network for Rural Poultry Development (ANRPD), and was established during an international workshop on rural poultry development held in November 1989 in Ile-Ife, Nigeria. The name was changed to INFPD at a meeting that took place in M'Bour, Senegal, in December 1997 (Sonaiya, 2000). INFPD is mainly an information exchange network. One of its objectives is to encourage higher standards of research and development that can sustainably increase the productivity of the FP subsector. This is achieved through providing advice and collecting data and detailed information about FP production systems. Information is disseminated through a trilingual (English, French and Spanish) newsletter, produced twice yearly and distributed electronically (with a printed version for members without email facilities) with the assistance of FAO.

In December 1998, FAO held the first INFPD/FAO electronic conference on FP, which proved so popular and interactive that it was extended until July 1999. The introductory paper to this conference addressed the issue of research and development options for FP (Sonaiya *e. al.,* 1999). The layout of this important introductory paper was:

- Research options for family poultry development.
- Prospects for development.
- Development approaches.
- Breeding and reproduction (evaluation and selection of indigenous breeds).
- Evaluation and adaptation of imported breeds to hot climates.
- Feed research and development.
- Health management.
- Entrepreneur development.
- Information management.

All papers, comments and discussions are available on the FAO/INFPD website. The constraints and issues facing FP that were recognized by the e-conference are:

Disease

Newcastle disease (ND) constitutes the most serious epizootic poultry disease in the world, particularly in developing countries. No progress has been made in controlling ND in free-ranging village flocks, which represent more than 80 percent of the total poultry population. Several recent surveys in Africa showed high rates of seropositivity in the absence of vaccination. In developing countries, ND occurs every year and kills an average of 70 to 80 percent of the unvaccinated village hens (Branckaert *et al.*, 2000). It is very difficult to organize vaccination campaigns covering free-range birds. The main constraints are:

- the difficulty of grouping together an adequately large number of birds in order to obtain an efficient vaccination rate;
- the possibility of disease cross-contamination arising from birds of various ages being raised together; and
- the difficulty of maintaining an efficient cold chain for proper vaccine quality preservation.

Diseases make poultry production a risky venture. FP producers using the free-range extensive system acknowledge this risk, and reduce its impact on the household economy by having small flocks. ND is a major disease problem for all FP producers wherever the disease exists. Vaccination of the flock against ND is very important and provides a basis for further development.

It is worth repeating that the reluctance of farmers to invest in poultry production is not due to a lack of resources but to the risk of disease outbreaks and mortality. Killer diseases like ND regularly decimate village flocks. In traditional farming systems, farmers often live close to the survival limit, so they naturally avoid risks. Minimizing risk ranks higher than increasing output. A key component of FP development is the control of the most important diseases. Regular vaccination is a prerequisite for any improvement in FP production.

Although the control of ND is the key constraint, there are other disease constraints, which rise in importance as soon as higher-ranking constraints are eliminated. Many poultry development projects have failed because only one constraint was tackled or, when more than one constraint was considered, the importance of other problems was poorly understood. Many projects concentrated either on disease control or on genetic improvement. There is no doubt that vaccination reduces mortality, but in one particular project, in certain periods, mortality due to predation was as high as 70 percent and the effect of vaccination was further negated by a secondary constraint of poor housing (Bourzat and Saunders, 1987). Generally, the costs of an isolated vaccination campaign cannot be justified unless actions to improve housing and feeding are also taken.

Predators

Predators such as snakes, rats, dogs, cats, foxes, racoons and birds of prey represent the main causes of predator losses, especially in young birds. Human beings can also represent another important predator for adult birds. Proper shelter should be constructed using locally available materials, and predators should be trapped, hunted or repelled by specific plants (Branckaert *e. al.,* 2000). For example, in Nigeria, sliced garlic (*Allium sativum*) is placed around poultry houses to repel snakes.

Analysis of mortality in FP flocks in Thailand (Thitisak, 1992) showed that the first four months of life are critical for the growing chicks. The mortality of chicks during this period often rose to 60 percent (Matthewman, 1977) even in flocks vaccinated for ND. In Africa, while various other diseases such as Salmonellosis or coccidiosis affected the chicks during the first two months of age (Chabeuf, 1990), the most important cause of mortality between two and four months of age was predation, by dogs, cats, hawks and snakes, which caused up to 70 percent mortality (Bourzat and Saunders, 1987). Overnight housing is an important way to reduce this loss, and can utilize locally available materials of reasonable cost.

Feeding

Feed is also an input of major concern and the supply of adequate feed supplement is critical. The nutrient intake of scavenging birds varies from place to place according to the seasons, the crops grown and the natural vegetation available. In field experiments, feed supplements, including household waste (cooked potatoes, yams or cassava tubers), and oilseed cakes, have a positive effect on egg production and body weight of scavenging birds.

Careful attention should be given to ensuring adequate feed resources. Feed represents 60 to 80 percent of the input cost in the intensive commercial poultry sector. In Low Income, Food-Deficient Countries (LIFDCs), a surplus of cereals is generally not available. It is therefore not advisable to develop a wholly grain-based feeding system. The recommended policy is to identify and use locally available feed resources to formulate diets that are as balanced as possible (Branckaert . *et al.,* 2000).

Full *ad libitum* feeding of a balanced ration is essential for poultry intensively managed in confinement, even on a small scale. The usual recommendation is for commercially manufactured feed, but many farmers find it too costly and not in regular supply. The by-products of processing of local crops (brans, and oil and seed cakes) can be used as both energy and protein sources (see Chapter 3 “Feed Resources”) but on their own cannot make a balanced ration. More research is needed on local feed resources as sources of trace elements, minerals and vitamins, especially from leaves, fruits, algae, fungi and other available materials. However, even with this knowledge, the skills of a well-equipped and experienced nutritionist are needed to formulate least-cost balanced rations.

Breeding (genetic potential)

Indigenous or local breeds are generally raised in FP production systems. These birds are exposed to natural selection from the environment for hardiness, running and flight skills, but not for egg production. Hens are thus poor layers, but good mothers (except for guinea hens). When farmers contemplate the adoption of a more intensive poultry production system, they are eager to purchase more productive birds. There is a need to find the best method to provide them with such birds, and the options are:

- to supply hybrid strains, which requires the presence of well-managed hatchery facilities and (grand) parent stock, or
- to supply pure-bred breeds, which allows the farmer to renew his flock and to remain independent from external suppliers. Unfortunately, pure-bred breeds are becoming more difficult and more expensive to purchase, and produce fewer eggs than hybrids. (Branckaert *et al.,* 2000).

Genetic improvement has been considered a high priority in poultry development projects. Usually vaccination programmes are carried out during genetic upgrading programmes, but feed supply to the improved birds has not received sufficient attention. Thus it has not been possible to exploit the superior genetic potential of the improved birds.

Marketing

Poultry products in most developing countries, especially in Africa, are still expensive. The marketing system is generally informal and poorly developed. Unlike eggs and meat from commercial hybrid birds (derived from imported stock), local consumers generally prefer those from indigenous stocks. The existence of a local market offering good sales opportunities and adequate transport facilities are obvious prerequisites for FP development. As most consumers with greater purchasing power live in and around cities, intensification of poultry production should be initiated in peri-urban areas or, at least, in areas having a good road network (Branckaert *et al.,* 2000).

Traditional dealers and middlemen, who collect eggs and birds from the villages, facilitate the marketing of FP products in most developing countries. Such traditional marketing structures are often overlooked, bypassed or criticised. There has been a regrettable tendency in some countries to use government extension services or parastatals to market family poultry products. This practice should be discouraged as it is not sustainable.

Farmer organizations

Organizing FP farmers is not an easy task, for several reasons. Flock sizes are small and birds are maintained with minimal land, labour and capital inputs. Thus farmers generally consider FP a secondary activity compared with other agricultural activities. Nevertheless, it is essential to develop producer groups, which give members easier access to essential inputs (such as feed, improved breeds, medicine, vaccines and technical advice) and to credit, training, transportation and the marketing of poultry products. Producer groups also encourage more educated people to initiate FP farming as a secondary activity (conducted at the family level using medium-sized flocks), as well as facilitating the development of associated activities such as market gardening, which can utilize poultry manure and help to reduce or remove household waste and pests (Branckaert *et al.,* 2000).

Farmers should be allowed to develop the market structures most suitable for them. Often women’s groups prove to be effective in marketing eggs along with other products at local markets. Such groups should be encouraged and supported if they exist, but their establishment solely for FP may be unnecessary and unviable.

In a case study in the region of Niamey, Niger (Kobling, 1989), it was shown that smallholdings (less than 20 hens) of layers, which were situated beyond 2.5 km from a main paved road, could supply eggs and meat to the city market at competitive prices. Villages much farther from the main routes could supply live birds competitively but not eggs. Eggs are not an important food item at the village level, as it is a relatively high-priced protein food, and thus marketing may require cooperative efforts by producers to transport eggs to larger towns. Possibilities for this include using existing commercial trading channels or opening new channels such as those through producer associations, cooperatives, women’s groups or young farmer associations. The establishment of specialized poultry production cooperatives has proved difficult in many places, and socio-economic factors play an important part in this.

Training and management

As was emphasized at the beginning of this chapter by Bessei (1987), technical skills need to be considered at both farmer and extension officer levels. Training is essential in the areas of disease control, housing, equipment, feeding, genetic improvement and marketing. A basic knowledge of specific features of poultry anatomy and physiology is also important, to provide a basis for understanding the above topics. Housing and management could be improved through appropriate farmer training, preferably conducted on-farm. Local craftsmen could be trained to manufacture small equipment, such as feeders and drinkers (Branckaert *et al.*, 2000).

RESEARCH LESSONS LEARNED FROM COMPLETED PROJECTS

Genetic upgrading

This was the earliest and most commonly favoured FP development strategy, and has been adopted and supported by many donors from the 1960s onwards. It has usually involved substantial investment in government infrastructure (in terms of establishing farms and buildings to multiply stock numbers), and less investment in training village farmers or developing distribution networks for vaccine and medicine. The Cockerel Exchange Programme (CEP) represented the traditional approach, in which cockerels from exotic strains were reared up to 15 to 20 weeks of age, usually in government poultry farms, and then exchanged with local cockerels owned by FP households, which kept small flocks and were requested to remove or exchange all local cockerels. In addition, sometimes the flocks of the farmers (or of the whole village), were vaccinated against ND, and the farmers were given advice on poultry feeding and housing.

In the Machakos district of Kenya, an evaluation by Ballard (1985, as cited in Mbugua, 1990) of the performance of hens upgraded through a CEP in 1977 (using a layer hybrid strain cockerel) showed an increase in egg production of about 30 eggs per hen in a flock of nine hens and one cock (Table 10.3).

Table 10.3 Production increase per hen of a nine-hen flock in Kenya

Per hen, per year	Local hens (before)	Improved hens (after)
Eggs per hen	57	87
Eggs for consumption and sale	41	63
Eggs for hatching	16	24
Chicks hatched	11	17
Birds for consumption and sale	3.2	4.9

Source: Ballard, 1985 (as cited in Mbuga, 1990)

The CEP method is criticised mainly because the raising of cockerels in government farms is costly, and exposure of the intensively raised cockerels to village conditions leads to considerable adaptation problems with resulting mortalities of 50 percent or more. Also, local cockerels are not always removed, as the farmer (quite rightly in many cases) distrusts the survival and mating ability of the exotic cockerel. The presence of the local cocks reduces the effectiveness of the attempt at genetic improvement, as they are easily able to compete for the favours of the local hens against the exotic breed cocks.

In view of the problems of the CEP, other methods have been developed, including the distribution of chicks, pullets and hatching eggs of improved breeds. A comparison of the relative efficiency of these upgrading methods (ter Horst, 1987), based on the number of "improved" day-old chicks produced in the village over three years, showed that the distribution of hatching eggs was the most cost-effective method (as shown in Table 10.4 below).

Table 10.4 Efficiency of strategies for improving poultry production

Strategy	Percent increase
Distribution of pullets	15
Exchange of cockerels	17
Distribution of day-old chicks	67
Distribution of hatching eggs	100

Source: ter Horst, 1987.

In operation, hatching eggs of selected lines are sold to families raising poultry. Local broody hens hatch the eggs. The chicks are raised by the hens and adapt easily to the environment. The distribution of hatching eggs is thus the least costly and most efficient method of genetic upgrading. This method has the following advantages and disadvantages.

Advantages of distributing hatching eggs:

- The eggs represent a low project cost, compared with pullets or cockerels.
- The eggs convey 100 percent of genetic improvement, compared with cockerels or pullets, which contribute only 50 percent when crossed with local birds.
- The young chicks are raised under natural conditions from day-old age, and develop or learn scavenging ability.

Disadvantages of distributing hatching eggs:

- Cockerels are generally more appreciated and accepted by the poultry farmers. This hampers the introduction of improved breeds through distribution of hatching eggs in the same area.
- Transport of hatching eggs under rough conditions and with unsuitable packaging reduces hatchability.
- The total replacement of local chickens by improved birds of exotic origin leads to: a loss of biodiversity of the local poultry population; a loss of brooding and hatching ability in the hen; and a breakdown of the self-sustained system of reproduction at the village level. These are serious problems and must also be considered.

The words that follow come from a prominent Nigerian livestock expert, (Suleiman, 1990), but they reflect the growing appreciation of the genetic and environmental resources placed in the care of all people of all countries: “Perhaps the time has come for us to redefine the ideology for the development of African agriculture and indeed the entire economy. African agricultural ideology appears to be based on the premise that the genetic resources indigenous to the continent are inferior to those found elsewhere and as such they must be replaced or diluted to a large extent by genetic materials foreign to the continent. Similarly, we have viewed our environment as hostile and, in fact, a direct threat to our existence. These postures have prevented us from capitalising on the strengths of our genetic and environmental resource endowments. We must move from a position of emphasizing the weaknesses of our resource endowments to one of amplifying their positive aspects, while seeking to overcome the weaknesses inherent in them.”

Vaccination

Protection against Newcastle Disease requires three vaccinations during the six-month growing phase of pullets and cockerels. Depending on local conditions, between two and three vaccinations per year are needed for adult birds. Because of the limited resources of government veterinary services, it is necessary to build networks of private veterinarians, veterinary assistants and vaccinators to provide preventive veterinary care in remote rural areas, and to ensure a reliable supply of vaccines (with a cold chain for the storage and distribution of conventional vaccines). In Bangladesh, the Department of Livestock Services established such a cold chain from the vaccine production laboratory to the village level in 1984. Within three years, 4 500 poultry farmers (especially women) were trained as village poultry vaccinators. The full cost of vaccination was charged to poultry producers in order to sustain the full cost of vaccine production and distribution. When it is possible to extend this fee to partly cover an extension service, it can result in the creation of a partly privatised poultry extension service. Such a system, financed by vaccination fees and the sale of exotic birds to farmers, was established in Sao Tome and Principe.

Strategy combinations

A combined approach, including vaccination against ND, the provision of a regular water supply and feed supplements (household waste) and special care for the young chicks during the first weeks of life (for example, through improved night shelters and creep feeders), increases the number of eggs laid by about 100 percent as well as increasing the number of chickens raised per hen/year to between 10 and 12.

The introduction of genetic improvement, in combination with further improvement in feeding (compound feed), housing (semi-confinement) and health (full vaccination and anti-parasites), will again increase egg production by approximately 50 percent and egg weight by 60 percent.

RESEARCH LESSONS LEARNED FROM CURRENT PROJECTS

Some countries have had successes in developing FP systems. In Egypt, the *Fayoumi* District Cooperative has raised the productivity and incomes of village FP producers. It distributes improved *Fayoumi* local birds and produces supplementary feed at its own feed mill using mostly local ingredients. It also assists farmers in marketing their eggs and birds.

In Malaysia, small flocks of poultry are fed on “Domestic Feed”, a reduced-price feed marketed by feed millers with a lower “nutrient density” (balanced for all nutrients, but lower in energy because of the inclusion of low-energy ingredients such as rice or wheat bran) than commercial broiler diets. In 1986, village egg and poultry meat production in Malaysia was estimated at 150 million eggs and 17,000 tonnes of meat, accounting for five percent of total egg production and seven percent of total poultry meat. Due to a high demand for village poultry meat, some of the backyard village poultry flocks have evolved into relatively large-scale commercial village chicken producers. Some of these farms rear between 2 000 and 15 000 young stock, which are then sold for growing under the traditional extensive system.

In Uganda, duck meat production rose from 600 to 3,500 tonnes in the 12 years between 1980 and 1992. This was achieved by improving health care in the traditional small-scale FP units, with the result that average mortality decreased from over 40 percent in 1980 to less than eight percent in 1994 (Country Profile 1994).

The Bangladesh model (FAO e-conference 2002) and research topics

In Bangladesh, there has been a significant effort over the past 20 years to develop the FP system. The Bangladesh model was the subject of the second FAO/INFPD electronic conference on FP “The Bangladesh model and other experiences in FP development”, which was held in May-July 2002. All papers, comments and discussions were compiled and presented on the

FAO/INFPD website (http://www.fao.org/ag/aga/AGAP/LPA/ fampo1/fampo.htm.) within two months of the conference conclusion.

What was not covered in the e-conference about the Bangladesh situation was more detail on their views on research priorities and what progress they have made. Bangladesh determined five areas for research potential in FP:

- disease;
- feeding;
- breeding;
- marketing and socio-economics; and,
- management and production.

These are close to the same categories outlined above under the Technical Constraints section. Under the above five headings, the Bangladesh Department of Livestock Services poultry research committee suggested protocol outlines for research proposals in FP (those marked below with an asterisk were regarded as being of top priority as of October 2000), under the Bangladesh government's poultry model FP improvement programme, which is currently (1998-2005) aided by the Asian Development Bank and Danida in two ongoing overlapping projects.

The protocol outlines were intended as guidance for formulating detailed research proposals or study proposals for post-graduate degrees or activities of research institutions or NGOs. The protocol outlines are detailed below:

Disease

- Disease prevalence study (epidemiology):
  - host bird (age, sex and breed);
  - morbidity and mortality;
  - management and feeding;
  - spatial and temporal factors;
  - parasitism and feed consumption efficiency; and
  - vaccine and vaccination failure.
- In-depth study of major serious diseases:
  - identification, characterization and virulence of the causal agent;
  - serological characterization; and
  - pathogenicity.
- Development of a disease-control strategy based on vaccination:
  - vaccination schedule;
  - maternal antibody and its effects on immunization; and
  - establishment of diagnostic networks.
- Development and improvement of vaccination:
  - development of vaccine types using local vaccine;
  - comparative study of local and imported vaccines;
  - comparing of heat tolerance selection in present ND vaccines with the use of I2 or V4 strains; and
  - use of heat-tolerant ND I2 seed vaccine produced in district veterinary laboratories using eggs from the same district.
- Study of disease prevalence in different locations and the seasonal effect of these on different breeds and breed combinations.
- Study of the quantification of semi-scavenger losses associated with the main diseases, including possible remedial measures against these diseases.

Feeding

- Study of the possibilities of protein banks, and the cultivation of Ipil-ipil (*Leucaena)*, duckweed and snails at the smallholder FP level.
- Study of year-round nutrient availability for scavenging chicken under model key rearer conditions.
- Study of year-round protein production from various conventional and unconventional resources:
  - manure-based duckweed production in shallow ponds with clean and polluted water sources;
  - protein supply from leaves, such as cassava, *Leucaena, Sesbania,* and *Glyrecidia;* and
  - animal protein supply, for example from blood meal, rumen microbes, earthworms, insects, hatchery by-product waste, and leather by-products.
- Study and nutritional evaluation of various feed ingredients used for feeding poultry under semi-scavenging conditions:
  - chemical composition;
  - nutritive value from feeding trials; and
  - preservation of feedstuffs.
- Study of the effective optimum level of supplementation for semi-scavenging birds in different agro-ecological conditions, for all age groups of birds:
  - effect of supplementing protein meal (vegetable and animal protein);
  - effect of supplementing energy-rich feed (both conventional and unconventional); and
  - effect of supplementing minerals with ingredients (both conventional and unconventional).
- Nutrient recycling through manure-based protein production under semi-scavenging conditions:
  - energy flow of the FP farm (conventional and improved systems); and
  - protein economy (traditional FP and improved systems).
- Study of how much and what combination of feed ingredients is most economical as a feed for Model Key Rearers in different environments, seasons and regions.
- Study of the utilization of non-conventional feed ingredients, such as tealeaf waste, duckweed, poultry litter, earthworms and insects (cultivated and natural), as protein sources for semi-scavenging poultry.
- Study of the amount and composition of available feeds for scavenging and their seasonal and regional variations.
- Study of the available Scavenger Feed Resource Base and the optimum chicken number density for sustainable semi-scavenging in the FP rearing system under Bangladesh socio-economic conditions.
- Comparison of crop-contents and feed weigh-back systems using the cafeteria system of feed supplementation.
- Study of whether the cultivation of such chicken feed as earthworms, maggots, termites and cockroaches can be incorporated within the FP small-scale livestock development (SLD) system.
- Study of how industrial by-products such as those from breweries and fish processing plants can be used as supplementary feed for the semi-scavenging FP model.

Breeding

- Comparative profitability studies between: two commercial cross-breeds (locally marketed as *Harco* and *Nera*, both derived by crossing Rhode Island Red (RIR) and Barred

Plymouth Rock [BPR]); and also between the locally bred *Sonali* (RIR and *Fayoumi*); and pure “local” *Fayoumi* (an Egyptian breed multiplied in Bangladesh without artificial selection pressure, in confinement management conditions for the past 20 years); under both FP traditional scavenging and FP semi-scavenging (feed supplemented) systems.

- According to previous studies and research, the *Sonali* was found to be superior in terms of meat and egg production, disease resistance and overall profitability in both the FP traditional scavenging and semi-scavenging systems. This research was undertaken by the Department of Livestock Services, the Bangladesh Livestock Research Institute (BLRI) (both supported by the now-completed Danida-assisted Small-scale Livestock Development project [SLDP-1], and the Bangladesh Agricultural University (BAU). Further study is planned to determine what type of selection index should be applied to the parent stocks, and under what type of environment, in order to improve its efficiency and performance under the semi-scavenging system. The parent stocks are the *Fayoumi* and RIR. This is related to a protocol suggested in the Marketing and Socio-economics category below.
- Crossing of dominant Naked-Neck breeds with *Fayoumi* or RIR for higher egg production and meat production, disease resistance and profitability in scavenging and semi-scavenging systems.
- Crossing of Naked-Neck breeds with *desi* (local indigenous breeds), for increasing both size and brooding capacity.
- Development and maintenance of grandparent stock, to maintain the breeding efficiency of RIR and *Fayoumi*.
- Study of the performance of different breed combinations under various environments, feeds and disease situations.
- Conducting of stock density trials of different breeds and breed combinations, to determine the optimum FP flock size for best productivity.
- Comparing the performance of commercial breeds with the *desi* and other “home-made combinations” made by Key Rearers, using broody hens under FP traditional and semi-scavenging systems.

Marketing and Socio-economics

- Study of the impact of the Participatory Livestock Development project (PLDP) activities (expected duration 1998-2003) on income generation, employment and poverty in rural Bangladesh.
- Study of the impact of the SLDP concept on the nutritional health of women and young girls at the village level. An M.Sc. study on this subject has already been completed by a post-graduate student of the Royal Veterinary and Agricultural University (KVL), Denmark (Nielsen, 2000).
- Study of the nutritional status and effect on work capacity, as well as body mass ratios of both mother and children, in households using the FP semi-scavenger system, compared with those using the traditional FP system.
- Comparative cost and returns analysis of poultry production under the scavenging and confinement poultry farming systems.
- Study of the changing role of women in livestock rearing under PLDP.
- Study of the demand and supply of poultry products, identifying the constraints to successful market operations.
- Study of the development of market intermediaries (middlemen) and their constraints in the project areas.
- Study of the effect of NGO modes of operation on the participation in and extension of poultry model practices.

- Study of the socio-economic impact of smallholder poultry production when combined with such other activities as vegetable production and fish-culture.
- Comparative studies of the economy of egg and meat production between the scavenging and commercial systems. Examination of the economics of raising cockerels of *Fayoumi* and *Sonali* at the village level.
- Assessment of the extent to which PLDP and SLDP-1 were able to address the “gender gaps” in the socio-economic situation of Bangladesh, as well as determining how and where earnings from poultry were spent (for example, in social, health or education areas).
- Study of the actual rate of interest faced by the beneficiaries of the various Poultry Model enterprises, and by the different NGOs partnered in PLDP.

Management and production

- Economic use of home-made heaters and fuels for artificial brooding and incubating systems.
- Determination of the optimum construction and design of a suitable low-cost brooder-rearing house, using the raised slatted bamboo floor (*macha*) system. Use of materials of various types, thicknesses and costs, with a view to providing the best ventilation with reasonable durability.
- Use of appropriate items of equipment for hatching and rearing of chicks by broody hens.
- Provision of low-cost appropriate accommodation with security measures for exotic birds of the Model Key Rearers.
- Provision of low-cost lighting facilities for the Model Breeders.
- Choice of low-cost suitable litter materials.
- Determination of the optimum number of day-old chicks to be hatched for best manageable profitability by the Model Mini-Hatchery, by adopting improved appropriate technology devices. Determining the reasons for difficulties that some farmers encounter with this type of enterprise.
- Comparative study of slatted floor and deep litter systems for the Model Breeder unit.
- Conducting of density trials using different breeds or breed combinations to determine the optimum FP flock size.
- Study of the profitability of the broody hen (*desi*) for producing day-old chicks and as caretakers of exotic chicks as foster mothers, and the negative or positive effect on the scavenging behaviour of the chicks.
- Determination of the optimum number of eggs that can be brooded by unit weight or feather density of the *desi* hen, and then the number of chicks that can be successfully reared up to eight weeks of age per *desi* hen, using the creep feeder system of supplementary feeding for growing chicks.
- Study of the effect on the Model Key Rearers’ economy if *desi* hens are kept together for brooding purposes.

Bangladesh model - research in progress

A report on results (completed in mid-2002) from the field-based part of the M.Sc. students’ research related to the production and health of rural scavenging poultry in Bangladesh was produced (Permin, 2002) by Danida’s Network for Smallholder Poultry Development (NSP) for an INFPD workshop held in Bangladesh in November 2002. Eight post-graduate veterinary and animal production graduates (with field experience in government service in Bangladesh) conducted FP field research (under the Danida and AsDB-assisted PLDP project) towards their M.Sc. (from KVL, Denmark), in the 10-month period from July 2001, in cooperation with the:

- Department of Veterinary Microbiology, The Royal Veterinary and Agricultural University (KVL);
- Department of Animal Science and Health, KVL;

- Danish Institute of Agricultural Sciences;
- Institute for Anthropology, University of Copenhagen;
- Bangladesh Agricultural University;
- Participatory Livestock Development Project in Bangladesh; and
- Danida.

This effort represents the first time that animal scientists and veterinarians have worked together on solving problems directly related to rural poultry production under the difficult logistic conditions in the northwestern districts of Bangladesh covered by PLDP. It is also the first time that problems identified in the field by Danida-supported livestock projects (PLDP and SLDP) in Bangladesh have been fed back to the educational system in Denmark, creating the basis for a new M.Sc. course in rural poultry production and health, supported by a number of research and educational institutions in Denmark and hosted by the Royal Veterinary and Agricultural University in Copenhagen. It is envisaged that the results will be passed on to responsible parties in government and NGOs working on rural development in Bangladesh, thereby enabling an adjustment of the present activities to the ultimate beneficiaries, the poor farmers.

The eight research projects covered a range of important problems relating to scavenging and semi-scavenging poultry production in Bangladesh, notably relating to disease and production aspects. The following list of the eight M.Sc. research project titles is not presented in order of importance, but in connected areas of relevance.

- Helminthosis of free-range chickens in Bangladesh, with emphasis on prevalence and effect on productivity.
- An epidemiological and experimental study of Newcastle Disease in village chickens of Bangladesh.
- Isolation and pathogenic characterizations of Infectious Bursal Disease (IBD) virus isolate from an outbreak of IBD in a rural poultry unit in Bangladesh.
- A longitudinal study of the causes of mortality of chickens in parent stock flocks of the Department of Livestock Services of Bangladesh, with a special emphasis on *Escherichia coli* infection.
- Effect of vitamin A supplementation on vitamin A status, growth parameters and disease resistance of layer type chickens in Bangladesh.
- A study of the effect of feed supplementation on the laying hen under the rural conditions of Bangladesh.
- A study of the effect of feeding systems on the egg production of *Fayoumi* hens of *Model Breeding* units under the PLDP project in Bangladesh.
- A study of the egg production performance of different breeds and breed combinations of chicken in semi-scavenging systems in the PLDP project.

The Malawi model

Based on a Danida-sponsored study tour to Bangladesh in 2000 (Chinombo *et al.*, 2001), the Malawi Department of Animal Health and Industry learned that the Bangladesh smallholder poultry model is designed as an integrated system to provide the necessary supplies and services to establish an enabling environment for sustainable smallholder FP semi-scavenging production. The FP model consisted of smallholder farmers with small flocks of hens supported by a number of enterprises, all available in the village, to provide inputs and services needed to maintain these flocks. NGO-initiated and motivated farmer groups supported the model. Awareness programmes, training and access to micro-credit was provided to the beneficiaries, the majority of whom were women.

The sustainability of the Bangladesh model relies on a unique implementing organizational structure, involving groups of FP smallholder women farmers, micro-credit, NGOs and government institutions. The study team suggested to their government that the model be replicated in Malawi, with appropriate modification to suit prevailing conditions. For example, Malawi has a much lower population density than Bangladesh and a less developed NGO infrastructure. It was therefore recommended that the Bangladesh model, comprising eight income-generating elements, should be simplified. Results from the Malawi situation analysis (participatory rural appraisal) in the Danida project area showed that the poorest of the poor did indeed exist in the pilot area. By using the criteria of the farmer's perspective, it was found that 37 percent of all households belonged to this poorest segment. It was also found that female-headed households constituted 60 percent of the poorest segment. The analysis further revealed that poultry keeping has a high preference as an income-generating activity, in fact the highest among all livestock categories. The relative status of the importance of different types of livestock was ranked as: sheep, cattle, pigs, goats and chicken.

The Danida-ENRECA experience in Africa

The abbreviation ENRECA is derived from the Danida objective for the EN-hancement of RE-search CA-pacity in Developing Countries. This is a programme concept of Danida's (Danida-KVL, 2002) in Africa, and involves one poultry project in the United Republic of Tanzania. The immediate aims of the ENRECA programme are to strengthen:

- collaboration on planning and implementation of locally embedded research activities relevant to the national development of the developing countries;
- education at Ph.D. and M.Sc. level;
- the research environment, including such physical facilities as laboratories, libraries and communication facilities; and
- the dissemination of research results to end-users locally as well as internationally.

There are other new FP projects planned for student thesis work in the areas of:

- Newcastle Disease epidemiology in rural poultry production (United Republic of Tanzania);
- disease resistance of rural chicken (United Republic of Tanzania);
- feeding - baseline data and management strategies (Malawi);
- disease interaction - IBD in ducks and chickens (Kenya); and
- *Haemophilus paragallinarum* infection in rural chicken (Uganda).

Initial results from Enreca's Phase 1 (1996-99) in the United Republic of Tanzania are available on the web site <http://www.poultry.kvl.dk/Research/Projects.htm> for the project: "Improving the health and productivity of the rural chicken in Africa", which has formed the basis on which priorities were laid out for a second phase of the project. In terms of collaborative research, the objectives of Phase 2 of the project are to:

- determine optimal and efficient management, feeding and disease control systems under rural conditions, and to implement such systems in selected villages;
- identify and breed the most promising indigenous local chicken Haplotypes (ecotypes), in terms of disease resistance and productivity;
- develop a sustainable Newcastle Disease vaccine campaign under field conditions;
- study and explore the marketing strategy of rural chicken products, to identify and classify the different poultry management systems which exist in the study region and to examine the social, cultural and geographic determinants of these systems; and
- train extension workers and rural farmers in better, but affordable, management, disease control methods and marketing strategies.

Phase 2 of the project is focused on obtaining knowledge of optimal management conditions for FP rural chicken production in Africa. In continuation of this, a Phase 3 will be proposed within three years, to focus on promoting better poultry management practices and disease control, specifically Newcastle Disease control at the village level and on a wider scale (whole districts rather than just a few villages). In addition, and most importantly, Phase 3 will focus on developing village cooperative societies, modelled on the Livestock and Poultry development projects in Bangladesh. In phase 3, models for establishing such cooperatives will be tested in the United Republic of Tanzania, Uganda, Malawi and Kenya, in collaboration with government extension staff and scientists from agricultural, veterinary and social sciences. The farmer cooperatives will have farmers and farmer groups specialized in four production areas:

- producing affordable feeds using locally available feed ingredients;
- raising breeding stock and hatching chicks;
- rearing chicks up to eight weeks of age;
- raising chickens for egg production, sale of eggs and later sale of culls; and /or
- raising chickens for meat under semi-intensive production systems.

RESEARCH, TRAINING AND EXTENSION NEEDS

The achievement of FP development objectives requires a concerted effort, incorporating research, development and training. A coherent strategy should emphasize, but not be limited to, the following:

- identification of research requirements and programmes, at both the strategic and adaptive levels;
- identification of development efforts for the two target groups: rural and peri-urban;
- delivery of technological assistance to producers with regard to input supply and product marketing; and
- continuous training and retraining of technical staff involved in smallholder FP production at all levels.

In many developing countries, only commercial small-scale intensive (broiler and layer) chicken production is part of the agriculture curriculum in schools. FP chicken production and the production of other poultry species are not considered at any level. For the development of FP production, it is important that this subject be included in the regular education and training schemes of agricultural generalists, as well as livestock and poultry specialists. It is also important that more research on the problems of FP producers be initiated, as this is a precondition for the successful development of FP production. Poultry and livestock specialists in Low Income, Food-Deficient Countries (LIFDCs) must come to accept that the family poultry system is of significant economic and social importance to their countries and is worthy of coordination, examination, intervention and development.

In the past, too much emphasis was given to the development of an autonomous poultry extension system, while the links between poultry production and other agricultural services were neglected. Even if the specialized poultry extension system is well organized and working effectively, its impact on the very large number of smallholder FP keepers (particularly in rural areas) will be very low. This is because government budgets can provide for only a few poultry extension specialists. It is therefore necessary to establish links between poultry specialists and established institutions such as general agricultural extension services, veterinary services, agricultural colleges and NGO services. It is important to revise the strategies and activities of existing poultry farms and stations, so that a considerable part of their capacity is devoted to indirect extension through general extension services.

A study of agricultural training and educational institutions in Africa (FAO, 1984) showed that livestock training facilities were mainly concentrated in North Africa and some West African countries. This means that some African countries do not have the institutional capacity to meet their manpower needs for livestock research, extension and development. It is important that national training institutions be strengthened through utilizing the manpower and training facilities available in other countries. The inauguration of a Regional Poultry Training Programme is an example of such cooperation. The international FP development programme of Danida's Network for Smallholder Poultry Development (NSP) is commendable in its scope, and is committed to the education and training of national scientists and experts in the field. The Fellowships and Networks section later in this chapter presents more details on the NSP foundation, structure, objectives and activities.

Transfer technology (extension) methodologies

Transfer technology (extension) methodologies (Branckaert *et al.,* 2000) should include a communication strategy for Small livestock Projects for a Food Production (SPFP) framework. A strategy is a systematic process which takes into account the project objectives, the results to be achieved and the technical activities to be carried out. In a participatory planning strategy, it is necessary to identify the needs of the stakeholders and target groups, in order to:

- determine shared values and knowledge and the advantages of the project to be implemented;
- identify the strengths and weaknesses of the topics to be disseminated and identify appropriate tools /media and methodologies;
- assess the constraints (such as limited resources) which are likely to limit the range of alternative actions;
- assess opportunities and threats;
- consider all alternative proposals given to achieve the objectives;
- select the plan which appears to have the greatest chance of achieving the objectives;
- implement the plan and its activities; and
- periodically monitor, evaluate and revise the plan /activities.

A good extension methodology should include a systematic, rational and pragmatic approach to planning, implementing, managing, monitoring, and evaluating effective technology transfer to farmers. An information and extension programme such as the Strategic Extension Campaign (SEC) fits these criteria. FAO’s Research, Extension and Training Division (SDR), has recommended this SEC package to AGA for the needs of FP extension. The methodology emphasises the importance of people's participation in strategic planning and systematic management and implementation of information, extension and training programmes. Its training and extension strategies and messages are especially developed from the results of a participatory problem identification process regarding the causes or reasons for non-adoption, or inappropriate practices, of a given recommended technology or innovation.

SEC activities are geared to narrowing the gaps between existing and desired knowledge, attitudes, and appropriate practice levels of the target beneficiaries regarding the technology recommendations. The SEC programme is carried out over a relatively short time period, and aimed at increasing the awareness and knowledge level of target beneficiaries and altering their attitudes and behaviour so as to encourage a favourable adoption of given ideas or sustainable technologies. It follows a systems-approach, which starts with a survey of the target public's Knowledge, Attitude and Practice (a KAP survey), the results of which are used as planning inputs and benchmark baselines for evaluation purposes.

For more detail on how to identify the problems to be faced and overcome in using the SEC (Strategic Extension Campaign) approach, the reader is referred the full text of the paper (Branckaert *et al.,* 2000).

Target populations

The primary target beneficiaries should be the poorest households, women (in particular widows and female-headed households), the disabled (often as a result of civil conflict), women's groups and schools.

Women

Rural women carry out a fundamental role in agricultural production, rural development and food security. FAO studies and statistics show that women produce between 60 and 80 percent of food in Africa and Asia and approximately 40 percent in Latin America. In many regions, women are also responsible for the management of small livestock, including reproduction. An appropriate approach to working with women and poultry will not only boost productivity and reduce work time, workload and strain, but also promote the transfer of appropriate technology knowledge, tools and skills.

Numerous disparities persist regarding the participation of rural women in poultry production. Undoubtedly they face greater difficulties than men with regard to access to input resources (such as land and credit, among others) and to services designed to increase productivity, for example, research, technology transfer and extension services. Training programmes for women should be planned taking into account their socio-cultural traditions and their high illiteracy rate. In many regions, such programmes should also consider the training of women as extension workers, in order to effectively reach this important target audience.

Youth

During FAO World Food Day (1999), the theme "Youth against hunger" was given considerable attention, together with the significant role that youth can play in food security. An important message from this event is that given adequate training, education and support, young people can become active partners in helping to meet the World Food Summit goals of halving the number of the hungry by the year 2015.

In terms of technology transfer, many government agricultural extension services include rural youth programming as an integral part of their overall work to help women, men and young farmers apply new practices. An even larger number of NGOs, through extension-type programmes, work to assist youth audiences in the use of improved agricultural technology.

Some of the features of rural youth programmes that make them particularly valuable include their ability to successfully promote the application of technology, such as poultry production, to improve agricultural production on a sustainable basis. Experience has shown that young people are usually more open to new ideas and practices than adult farmers. Most programmes also focus on the start-up of agricultural and rural-based non-agricultural income-generating activities. Any attempt to enhance the knowledge, skills and experience of young people, and increase their access to resources through rural youth programmes, will have an immediate impact on food security.

Rural youth programming, as a technology transfer mechanism, has the potential to overcome some of the major constraints related to expanding FP production in developing countries mentioned earlier in this paper, such as training, management, group organization, disease control, feeding, genetic improvement and protection against predators.

There are already some experiences in developing countries related to the training and education of rural young people in the area of poultry, that, if supported more fully and expanded to other countries, could contribute significantly to more efficient and effective egg and meat production.

Through community-based non-formal educational programming, rural youth gain the necessary knowledge, skills and experiences enabling them to be productive today, as well as to become better farmers for the future. It is essential for farmers to have some knowledge of basic agricultural science related to their daily work. Without this knowledge, the technology often manipulates farmers, often forcing them to act in ways they do not understand, which can be a severe hindrance to effective technology transfer.

Individual and group poultry project activities have been a part of youth programming in some countries for many years. There are two primary ways of reaching young people in rural areas. One is through community-based rural youth programmes, which target out-of-school rural young people. The other is using the rural schools by incorporating agricultural topics as an integral part of the regular curriculum or as extracurricular activities.

Basic poultry science is easily adapted to either community-based groups or school programmes. The most effective way to work with youth in a practical way, either in the community or the schools, is through non-formal education methodology using a hands-on, experiential approach to learning. Community youth members learn such things as basic poultry anatomy and physiology through structured group learning activities and then apply the knowledge to practical experiences, planning and carrying out individual and group small-scale poultry projects.

Where proper facilities are available, small-scale poultry projects can be carried out on the school grounds. Students can learn first-hand many of the practical aspects of raising chickens. The study of embryology by hatching chicken eggs is particularly well suited to the classroom. Much can be learned by students from the incubation and hatching of chicken eggs. Experience around the world has shown that this activity generates much interest and excitement among young people as they anxiously wait 21 days for the eggs to hatch.

One of the constraints to expanded FP production in developing countries is the difficulty of helping farmers organize themselves into groups and associations. This is not a problem where farmers as youth had the experience of being a member of a community or school agricultural club. Belonging to a formal group offers the young person experiences of democratic action with elected officers and structured decision-making. The communication and leadership skills gained enable youth to make immediate contributions to their communities. These skills also help them accept formal and informal leadership roles in community and farmers' organizations as adults.

Through school and community-based rural youth programmes dealing with FP production, youth learn and practice knowledge and skills related to sanitation, vaccination, housing construction using low-cost naturally available materials, predator control, adequate nutrition, improved breeds of chickens and alternative marketing strategies.

As a mechanism for technology transfer, youth programmers, when given adequate support, can make a significant contribution to expanding FP production in developing countries. Young people learn basic principles and sound practices of raising poultry through practical, hands-on projects and activities, enabling them to successfully start and maintain a small enterprise in an efficient and effective manner, thus contributing to food security.

Disabled - handicapped

During the past decades in many developing countries, civil wars, international conflicts and the dissemination of mines (with their terrible consequences), along with the propagation of handicapping diseases and the increase in traffic accidents, have been responsible for a considerable increase in the number of disabled persons.

For the disabled, FP raising represents a valuable occupation, providing excellent revenue and enabling them to rejoin the social community. Many disabled persons are literate and can thus easily be approached and trained.

Rural workers

Whatever their gender or age, livestock vaccinators, extension workers and rural development agents need some basic socio-cultural information in order to improve their impact in technology transfer.

The vaccinator needs to know the reasons for the non-adoption of the technology and must be prepared to provide the farmer with a relevant demonstration or explanation. The extension worker should develop extension and training programmes according to the farmer's knowledge and information need. Finally, the development agent should be able to explain the positive advantages for the rural community in having members develop income-generating activities. Specific training programmes and teaching materials, using appropriate media, should be produced to cover these requirements.

RESEARCH DATA REQUIREMENTS

In anticipation of development assistance under the Special Programme For Food Security (SPFS), FAO provided guidelines for FP field surveys and research (Mack, 1998). Any research or Participatory Rural Appraisal undertaken for FP should ensure that the following list is consulted regarding data collection:

- number of households owning poultry;

- average flock size and breed type;
- flock structure: number of laying hens, cocks, chicks and immature birds;
- average number of eggs laid per clutch and number of clutches per year;
- use of eggs (hatching, sale or home consumption);
- details of any seasonal variation in production or mortality;
- use of male birds and cull hens (sale or consumption);
- selling price (and seasonality) of live birds and eggs at the farmgate and local market;
- estimated income from sale of live birds and eggs;
- estimated production costs (for example, vaccines and feed);
- type of housing provided;
- feeding regime;
- disease control /vaccinations (type and frequency);
- estimates losses (through disease, predators and theft);
- access to goods and services (extension, input supply and marketing);
- perceived constraints; and
- opportunities for expansion.

Sources of information

Sources for this data could include livestock and agricultural census figures and Veterinary Department records, including:

- vaccination campaigns;
- number of vaccines given;
- supply of locally produced and imported vaccines and their costs; and
- subsidies.

Veterinary Departments should have information on the major epizootic and parasitic diseases that occur in a country, and increasingly there are sections dealing with epidemiology. The Ministry of Agriculture, poultry research institutes and parastatal organizations are sources of information on the technology available, past development experience and the supply of breeding stock, usually from state farms.

Another information source is FAO country production data, which is based on government-submitted information and locally undertaken household surveys or Participatory Rural Appraisals. Other sources include universities, nutrition and home economic departments, the Agricultural Census Office, NGOs and bilateral agencies.

National crop data allows for the use of conversion factors to estimate the supply of agro-industrial by-products and broken grains. Availability is always a concern as these products have many alternative demands, and cost is an important factor. Reports on availability of non-conventional feeds often indicate these alternative uses. Import statistics can give an indication of the level of self-sufficiency for the major animal food products, including eggs and poultry meat. Government household surveys, agricultural census data and local rural appraisal surveys may also provide information on levels of household consumption. If a commercial stock-feed sector exists, they may provide additional information on:

- type of goods (such as feeds, chicks, drugs and vaccines) and services (such as veterinary, public health and abattoirs) that are available and how accessible they are;
- disease situation; and
- supply and demand of feed ingredients.

DEVELOPMENT CONSIDERATIONS

Many agricultural policy-makers (including livestock specialists) believe that the smallholder poultry system should be considered only as a means of subsistence, and as such needs no coordination, examination, intervention or development. Such notions must be challenged and changed.

Since FAO's first technical assistance project (BGD/79/003) for FP in Bangladesh in 1979, FAO (AGA) has identified, formulated, backstopped and monitored (with the financial assistance of UNDP and the FAO Technical Cooperation Programme [TCP]), many projects supporting FP development activities. The countries involved have included Bangladesh, Burundi, the Democratic Republic of Congo, the Democratic People's Republic of Korea, Ethiopia, the Gambia, Honduras, Maldives, Madagascar, Myanmar, Nigeria, the Philippines, Rwanda, Somalia, the United Republic of Tanzania, Turkey, Viet Nam and Zimbabwe.

The FAO Special Programme for Food Security (SPFS) was launched in 1994 by the FAO Director-General to respond to the urgent need to boost food production. In 1997, improved household poultry production - either peri-urban or rural - was identified as a key element in the overall SPFS approach, and as a major activity of the SPFS diversification component.

The SPFS presently covers 40 countries in Africa, Asia and Latin America. It is rapidly expanding, with more than 60 countries expected to join it during the next few years. The collaboration between SPFS and INFPD will grow simultaneously. The development of South-South cooperation in the field of rural FP is encouraged through the use of Technical Cooperation between Developing Countries (TCDC) experts. Since 1997, important support has also been provided by FAO's Telefood programme. Up to US$10 000/group has been distributed for small-scale FP projects in several countries (Branckaert *et al.*, 2000).

Productivity objectives

What is required to maximize the productivity of family poultry production systems? First, the whole web of interdependent factors affecting the overall activities of the family farming system, along with their advantages and constraints, must be fully understood. It is certain that village production will continue as long as there are villages, but various aspects of the production system need to be carefully modified. For example, it is now known that vaccination against Newcastle Disease can improve chick survival rate from 30 up to 70 percent; simple housing and other predator protection is required for chicks and young growers; supplementary feeds are important; and other poultry species such as ducks, guinea fowls, pigeons and quails need to be considered.

FP is a vehicle for rural development, income-generation and nutritional enhancement. It is clear that the presence of flourishing industrial peri-urban poultry farms does not negate the need for a parallel FP system in rural areas. Priority must be placed on the development of appropriate technologies, the provision of extension services, farmer training, input and output transportation, markets and credit supply.

It is not appropriate to concentrate entirely on boosting food production at all costs without concern for who produces the food and with what type of management system. FP systems reflect the need to increase job opportunities, stimulate the development of associated non-farming, rural activities and generate benefits that accrue equally to all segments of society, urban as well as rural.

Fellowships and networks

Development is an ongoing process that requires feedback and constant interaction between operators and the knowledge network, both local and international. The restructuring of the agricultural and livestock extension system towards this approach is an important strategy in poultry development. FAO's Travelling or Visiting Fellowships and regular consultations on poultry development are other examples.

INFPD

The International Network for Family Poultry Development (INFPD), which is supported by FAO, can play a useful role in this regard by promoting:

- exchange and distribution of publications;
- participation in regional and international congresses; and
- the organization of biannual workshops on specialised topics.

The role of the INFPD was expanded from its African focus in 1997, and in December of that year, the first international workshop "Issues in Family Poultry Development Research: Current Concepts in Family Poultry Development Research" was held in M'Bour, Senegal. Proceedings of the workshop (Sonaiya 2000) are also available at:

www.fao.org/ag/aga/AGAP/LPA/fampo1/proceed.htm

Danida's Poultry Network

Danida's "Danish Network for Poultry Production and Health in Developing Countries" was established as a concept in Denmark in 1997 and then renamed the "Network for Smallholder Poultry Development" (NSP) when it became operational in August 1999. The objective of the NSP is "poverty alleviation and improved welfare of the moderate and extreme poor in rural areas". To achieve this, the overall scope of work for the NSP coordination unit is to initiate and coordinate resource bases related to village poultry production in the Danida programme countries (and in Denmark) and to build institutional capacity to implement poultry projects. The coordination unit will promote and carry out research, education and planning of projects, based on experience with the FP smallholder concept in Bangladesh and other countries. This will ensure that necessary education, training, and research will be integrated into the Danida development sector programmes or funded as independent activities. The coordination unit assists in fund-raising for these activities from Danish and international sources. Further information can be found on the website: <http://www.poultry.kvl.dk>

Socio-economic objectives

To develop effective strategies for family poultry development, some inefficient aspects of traditional production must be replaced by more suitable methods. The main socio-economic objectives of FP development should be to:

- increase rural and peri-urban labour productivity and family incomes through increasing poultry productivity; and
- ensure a high level of food security and raise nutritional levels of rural and peri-urban families.

Development strategies

The overall aims of development are to reduce poverty and improve income and nutrition. To develop effective strategies for FP development, traditional but inefficient methods of production must be replaced by more suitable measures. The main objectives of such strategies should be:

- improving food supply;
- creating income and employment opportunities for rural populations;
- conserving environmental resources;
- maintaining biodiversity; and
- promoting respect for socio-cultural values.

Abbreviations and Conversions

AfDB	African Development Bank
AsDB	Asian Development Bank
BAU	Bangladesh Agricultural University, Mymensingh
BCRDV	Baby Chick Ranikhet Disease Vaccine
BLRI	Bangladesh Livestock Research Institute, Savar
DLS	Directorate of Livestock Services
FAO	Food and Agriculture Organization of the United Nations
GoB	Government of Bangladesh
GVC	Government Veterinary College
IBD	Infectious Bursal Disease (Gumboro disease)
IBDV	Infectious Bursal Disease Vaccine
IFPRI	International Food Policy Research Institute
KVL	The Royal Veterinary and Agricultural University (*Den Kongelige Veterinære Landbohøjskole*)
LIFDC	Low Income, Food-Deficient Countries
ME	Metabolisable Energy
ND	Newcastle Disease (RD: Ranikhet Disease)
NDV	Newcastle Disease vaccine
NGO	Non-Governmental Organization
NN	Naked Neck (Local breed)
NSP	Network for Smallholder Poultry Development (Danida)
PLDP	Participatory Livestock Development Project
RIR	Rhode Island Red (American poultry breed)
SFRB	Scavengeable Feed Resource Base
Sonali	Bangladeshi poultry breed (“The Golden bird”)
SPFP	Small livestock Projects for Food Production (FAO)
SPFS	Special Programme for Food Security (FAO)
TCDC	Technical Cooperation between Developing Countries (FAO)
TCP	Technical Cooperation Programme (FAO)
Uppazila	sub district, formerly a *thana*
Velogenic	highly virulent ND

Conversions

Linear measure

Feet to metres x 0.3048; 3 feet is 0.91 m or 91 cm

Stock Density

Square feet/bird to Birds/square metre uses an inverse relationship with the multiplier of 0.0929sq.m = 1 sq.ft. Using a calculator, the formula is:

0.0929 M+ then [sq.ft/bird] x, MR, =, /, /, 1, = gives [birds/sq.metre] or

0.0929 M+ then [birds/sq.metre], x, MR, =, /, /, 1, =, gives [sq.ft/bird]

For example: 4.0 sq.ft/bird = 2.7 birds/sq.m

Energy

There are 4.1868 megajoules (MJ) or kilojoules (kJ) per megacalorie (Mcal) or kilocalorie (kcal) of energy. The joule is the newer metric format to measure energy.

Example 1: a feed with a metabolisable energy (ME) value of 2300 kcal ME/kg is now stated as 9.6 MJ ME/kg (2300 x 4.1868 / 1000).

Example 2: a SFRB per household of 468 Mcal of ME is now stated as 1960 MJ of ME.

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This technical guide promotes sustainable small-scale, family based poultry production. It gives a comprehensive review of all aspects of small-scale poultry production in developing countries and includes sections on feeding and nutrition, housing, general husbandry and flock health. Regional differences in production practices are also described. The guide provides the technical and scientific "building blocks" needed to develop sustainable programmes for small-scale poultry production. It will be of practical value to those keeping or planning to keep poultry and as a valuable technical reference for poultry specialists, researchers, students and those interested in broader rural development issues.

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