Improving productivity of scavenging poultry in Indian villages by the use of improved hatching egg management[1]

D.N. Shindey[1], LR Singh[1], C.A. Conroy[2], and N.H.C. Sparks[3]

[1] *BAIF Development Research Foundation, Dr. Manibhai Desai Management Training Centre, Dr. Manibhai Desai Nagar, Pune - 411 052 India*

[2] *Livelihoods and Institutions Group, Natural Resources Institute, University of Greenwich, Central Avenue, Chatham Maritime, Kent, ME4 4TB, UK*

[3] *Avian Science Research Centre, Animal Health Group, SAC, West Mains Road, Edinburgh, EH9 3JG, UK*

Abstract

So-called village or scavenging poultry systems are characterised by low-inputs. However they are often an important source of income for the poultry keepers, particularly for the poorest of the poor and more specifically women. Village poultry products (i.e. eggs and meat) may be consumed by the poultry keepers or their family or used for sacrifice, but invariably the products will be traded in one form or another. Losses may occur at several stages of village production but data from an earlier study indicated that there was considerable scope to improve the percentage of chicks that hatched from each clutch of eggs incubated in the summer months and, to a lesser extent, the winter months also. Two interventions were evaluated in the Indian state of Rajasthan; candling and a modified egg storage container that used evaporative cooling to try and reduce the temperatures experienced by the eggs when they were stored prior to being incubated. Candling eggs during the cooler winter months showed 28 per cent of the eggs to be apparently infertile. Eggs were also candled during the summer months of two consecutive years. The increased summer ambient temperatures were associated with an increase in apparent infertility (to 41 and 43 per cent in the first and second summer respectively). The percentage hatch of all eggs laid from the summer control treatment ranged from 39 to 40 per cent, whereas the comparable figures for the cooled storage treatment ranged from 59 to 61 per cent. Notably the comparable winter figure was 59 per cent - very similar to the figure achieved for the cooled storage treatment. The biological mechanisms that may underpin these data are discussed, as are the implications for these findings.

Introduction

Scavenging poultry systems tend, as the name implies, to be low-input systems and in part because of this they can be found in most African and Asian villages (de Haan, 1999, Rangnekar and Rangnekar, 1999; Kumtakar and Kumtakar, 1999). Poultry have an innate ability to scavenge for feed and, unlike goats or cattle, are relatively inexpensive to

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purchase, reproduce easily and have a relatively short reproductive cycle (~6 months to sexual maturity and a three-week incubation period). Consequently the poorest, landless people can own poultry (Conroy *et al.*, 2004). Indeed it is notable that irrespective of the relative wealth of the poultry keeper's family it is often the women in a family that will be responsible for the poultry. Unlike some animal products poultry also benefit from the relatively few cultural restrictions that affect the consumption of poultry products. Thus there is a ready market for the eggs and the meat from the hen, either as a commodity to be sold or for use by the family as a gift, sacrifice or as a source of food (and, in the case of eggs, feed for oxen etc). It is not surprising, therefore, that many agencies have sponsored projects aimed at improving the productivity of these 'walking banks' (Rangnekar and Rangnekar, 1999).

The size of traditional scavenging poultry flocks owned by both African and Asian poultry keepers appear to be very similar, suggesting that the limits to flock expansion are similar on both continents. While factors such as the feed resource are likely to influence flock size it is probable that disease is one of the main constraints. Thus when flocks are routinely vaccinated against diseases such as Newcastle disease the average flock size increases (Alders and Spradbrow, 2001). Attempts have been made to enable village poultry keepers to produce poultry under semi-intensive systems of production. In essence members form a cooperative with themselves taking on specialists roles and forming structures not dissimilar to those seen in an integrated company (e.g. pullet rearer, egg producer, feed seller, vaccinator, egg seller). This approach, pioneered and developed by Danida (the Danish International Development Agency), has come to be known as the Bangladesh model – named after the country in which most of the development was undertaken. While this model has many advocates it is the view of the authors that there is still a role for the traditional scavenging poultry model and that in some circumstances it is preferable to the Bangladesh model (Conroy *et al.*, 2004). This paper focuses, therefore, on the traditional system, however, many of the issues addressed are equally applicable to the semi-intensive system.

While the focus is on the traditional scavenging system, that is not to say that there is nothing to be learned from the best exponents of commercial poultry production, be it extensive or intensive. A sentiment often expressed by these producers is that it is 'attention to detail' that will make the difference. This is, however, arguably at odds with the view of many scavenging poultry keepers who consider their poultry to be of little or no value until they reach the point of use, be it for trade or home use (Rangnekar and Rangnekar, 1999). This attitude may stem from the sporadic outbreaks of disease that affect scavenging poultry, many of which can decimate a flock. Unfortunately this can make it difficult to persuade poultry keepers to make even small investments in their poultry, including not vaccinating their birds against the main diseases, such as Newcastle Disease, and not using an anthelmintic to reduce the number of endoparasites carried by the bird.

It is appropriate, therefore, to consider where in the production system the biggest losses occur and to identify those that may be addressed by simple low input (in terms of both finances and time) interventions.

Having gathered detailed production data over a period of 18 months on many flocks (down to and including the level of the individual bird) in the Indian State of Rajasthan we have identified that hatchability during the summer months falls significantly. Hatchability data are important because they are a key indicator of the success with which farmed poultry reproduce. Hatchability is normally expressed as a percentage of the total number of eggs incubated that produce a viable chick, or the percentage of the fertile eggs incubated that produce a viable chick. These two measures are often referred to as 'hatch of all eggs set' and 'hatch of all fertile eggs set' respectively. It is important when considering hatchability data to be clear about which of these two data sets is being considered, as they are influenced by different criteria. The 'hatch of all eggs set' figure is determined by both the fertility of the egg (a flock management issue) and the success of the incubation process. In contrast the 'hatch of all fertile eggs set' figure should be solely an indicator of the success of the incubation process. Under typical commercial conditions the average hatch of all eggs set and all fertile eggs would be 84 and 90 per cent respectively (Cobb, 1997). The poor hatchability associated with the summer months resulted in poultry keepers placing fewer eggs for incubation. In addition, of the eggs that were placed a significant number failed to produce a viable egg and represented a waste of resource and time.

It was decided, therefore, to investigate the way in which the hatching eggs were handled prior to incubation because it is common practice for Indian village poultry keepers to store eggs before they are incubated. This was considered to be important because the conditions under which an egg is stored can have a significant effect on its hatchability (Walsh *et al.*, 1995). Optimal storage conditions for hatching eggs are 15°C at 75 per cent relative humidity with the egg being stored for no more than seven days. Of these three parameters it is the control of temperature (i.e. maintaining storage temperature below the physiological zero (27°C)) that is the most important factor. However, for most village poultry-keepers, the storage of eggs under controlled environmental conditions is not possible and in the warmer months of the year the ambient temperature will regularly exceed the critical, as far as egg storage is concerned, temperature of 27°C. Our hypothesis, therefore, was that 'the poor hatchability associated with eggs stored during the warmer months of the year could be improved by storing the eggs under conditions that provided a lower and more stable temperature than the ambient temperature'.

The opportunity was taken to evaluate another intervention, candling. Candling is a technique that is used widely as a means of assessing fertility and embryo development (Delany *et al.*, 1999). The only equipment that is essential to candle eggs is a bright light source (such as is provided by a good quality torch) and a darkened room or similar in which the eggs can be assessed. Candling allows eggs that will not produce a viable embryo (e.g. infertile eggs, eggs that contain an embryo that has died during the first hours of incubation and eggs that have cracked shells) to be removed after the first week of incubation so that they may be used as food, livestock feed or sold. If eggs are not removed at this stage they often become contaminated with spoilage organisms or pathogens and even if uncontaminated the internal quality will have deteriorated such that these eggs are almost always thrown away.

Materials and methods

The study was undertaken in Udaipur District of Rajasthan, India. This district was chosen because village poultry keeping is an important livelihood activity for many households in this location and a non-governmental organisation (NGO), BAIF, has, for many years, been involved in working with the villagers in this district. The initial egg handling study was undertaken with 10 poultry keepers from Jaganathpura village who were trained in candling using a locally designed battery operated candler. During the period 15 November 2002 to 15 February 2003 hatching eggs were candled and marked with different colours to signify either fertilised or unfertilised eggs. All eggs were incubated to allow the accuracy of the candling to be assessed. A further two candling trials were carried out between the months of February and June 2003 and March and July 2004.

A study using a modified egg storage container was undertaken in the summer months of 2003 and 2004, with 12 and 40 poultry keepers, respectively, to see if the summer hatchability figures could be raised to that of the winter figures (data from the winter period of 2002-2003).

Eggs were either stored in the traditional way (control group) or, for the modified storage treatment group, in a half-moon shaped bowl (*Tagari/Gamela*). The traditional method of storage would consist of eggs being placed in a covered storage area in a bowl or similar receptacle. Modified storage involved the use of evaporative cooling to both reduce the air temperature around the eggs and to reduce the variability in temperature fluctuations. Evaporative cooling was achieved by filling a bowl (later modified by the poultry keepers to a woven basket lined with a jute sack) with a mixture of earth and sand that was kept moistened with water. A piece of jute bag was placed on the sand, the eggs being placed on the bag and then covered with a cotton cloth or a woven basket. The bowl was suspended from the roof supports inside a building or placed on a shelf or ledge in a building. The temperature in the vicinity of the eggs and in the egg store room (ambient) was recorded daily from 08.00 to 10.00 h with a maximum and minimum thermometer. When the hen stopped laying all the eggs were incubated under the hen, as per existing traditional practice. All eggs were candled to confirm fertility. The numbers of eggs that hatched viable chicks, that contained dead-in-shell embryos or that had spoiled (infertile or bacterial rot) were recorded.

Results

In the first candling study 72 per cent of all the eggs laid were fertile while the remainder (28 per cent) were infertile (Table 1). The error associated with the candling (i.e. the number of eggs misidentified as either fertile or infertile) was less than one per cent. In the second and third trials, which took place in the warmer summer months (unlike the first study that took place during the cooler winter months), the number of infertile eggs increased to 41 and 43 per cent respectively.

The incubation data are presented in Table 2 with data being presented according to intervention, season and year. It is apparent from Table 2 that the data for the summer (2003) are unbalanced (with data for only two 'control' birds being available compared to 10 for the cooled storage treatment). The data for the following year are more balanced with data for 34 and 40 birds being included for the control and intervention respectively. The percentage hatch of all eggs laid from the summer control treatment range from 39 to 40 per cent, whereas the comparable figures for the cooled storage treatment ranged from 59 to 61 per cent. Notably the comparable winter figure was 59 per cent - very similar to the figure achieved for the cooled storage treatment. The hatch of all fertile egg data is less consistent, with the summer (2003) control treatment achieving a relatively high hatch rate compared with the control treatment for 2004.

Table 1 *Effect of candling and season on the number of eggs recovered from the incubation process*

Treatment	No. of birds	No. of eggs laid	No. of eggs unsuitable for incubation (infertile or early embryo death, cracked shell)	% of eggs unsuitable for incubation (no or early embryo death, cracked shell)
Winter (2002-03)	8	106	30	28
Summer (2003)	10	122	50	41
Summer (2004)	34	368	158	43
Mean Summer	-	-	-	42

Table 2 *Effect of cooled storage during the summer months on hatchability*

Treatment	No. of birds	No. of eggs laid	No. of fertile eggs laid	% eggs laid that were fertile	No. chicks hatched	% hatch of all eggs incubated	% hatch of all fertile eggs incubated
winter (2002-03)	8	106	76	72	63	59	83
summer control (2003)	2	28	12	43	11	39	92
summer modified (2003)	10	122	72	59	72	59	100
summer control (2004)	34	368	210	57	146	40	70
summer modified (2004)	40	437	318	73	268	61	84

Discussion

There were two key findings from the candling studies. The first notable point was that between approximately 20 and 40 per cent of all eggs incubated were unsuitable for incubation and could be potentially removed from the process for sale, barter, consumption or similar. Secondly, it seems (based on limited data) that the level of infertility increases significantly during the summer months.

The implications of this first point are relatively straightforward – candling presents an opportunity to significantly increase the number of eggs available for purposes other than hatching. In addition, by removing eggs unable to hatch after the first week of incubation the number of eggs under the hen can be reduced. At worst this should not have a negative effect, however, it is likely that there will be positive benefits, including:

1. The hen will be better able to cover those eggs that remain, so providing a more uniform temperature profile
2. There will be fewer eggs in the nest and hence
3. There should be less egg-to-egg contact
4. The hen will not be distracted at the end of the incubation period by eggs that will not hatch when time would be better spent by the hen with her chicks.

This technique was relatively easy for the poultry keeper to carry out and in the present study would have allowed the recovery of a significant proportion of the eggs laid for use either as a food or feed source or for sale or barter. The use of candling as a means of recovering eggs for human consumption and as a mean of improving hatchability should be vigorously promoted. It has the advantage of being simple, relatively inexpensive and, potentially, could make a significant contribution to nutrition and income generation through selling of infertile eggs by the poultry keeper and family.

If our hypothesis regarding hatchability rates in the hot season was correct we would expect to see two effects. Firstly the cooled egg storage treatment would have a higher apparent fertility compared with the control - the cooled storage possibly approximating to the fertility recorded during the cooler winter months. Secondly we might expect to see similarly different hatchability data, again with the cooled storage data approximating to the winter data.

It can be seen that in any one year the cooled storage treatment was associated with apparently better fertility and hatchability data when compared with the comparable control treatment. There was also a tendency for the winter fertility and hatchability levels to be higher than the summer control treatments though the data sets for the winter and summer (2003) are relatively small.

It is appropriate to reflect at this point that candling, while used across the world as a measure of fertility, is more accurately an indication of embryo development post 48 h. Embryos that die within ~48 h of incubation commencing are not detectable by candling. This is because candling relies upon the disruption of transmitted light by the embryo and its extra-cellular membranes and these structures are relatively insignificant during the first few days of incubation. If, therefore, the seasonal effect is real then there are three possible explanations. Firstly the warmer ambient temperatures have a negative effect on the mating process (e.g. frequency of copulation is reduced, sperm quality is reduced); secondly the percentage of fertile eggs laid is unaffected but there is increased embryo mortality between the time the eggs are laid and days 2-4 day of incubation and an associated higher mortality later in the incubation period. The third possibility is a combination of one and two. From the data above, and given that fertility is fixed before the egg leaves the bird and cannot be affected by treatment, it seems probable that the second scenario may explain our data. That is to say that the cooled storage technique is protecting the blastoderm during the storage period from temperatures in excess of 27ºC (i.e. physiological zero). At temperatures above physiological zero the embryo continues to develop and, unless this temperature is maintained the embryo may die as it can only survive storage in a relatively undeveloped (some 60,0000-120,000 cell stage) state. The trend towards an improved hatchability of fertile eggs (which eliminates the apparent fertility effect) would be consistent with the embryo being stored under better conditions and as a consequence less embryo abnormalities occurring during the incubation process.

Conclusion

It appears from the data presented that cooled egg storage has the potential to have a significant effect on the number of chicks hatched during the warmer summer months and consequently can improve productivity. Unlike candling, the cooled storage technique is a new concept but it has the advantage of being a relatively simple and low-cost intervention and hence it should be evaluated more extensively.

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