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IMPROVING BACKYARD POULTRY-KEEPING: A CASE STUDY FROM INDIA

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Abstract

A research project has been investigating the production problems facing backyard poultry-keepers in two locations in rural India, Udaipur District in Rajasthan and Trichy District in Tamil Nadu, and seeking to work with poultry-keepers to address some of them. Backyard poultry-keeping is a significant livelihood activity for many poor rural families in India, and for women in particular. A baseline survey of 90 backyard poultry-keepers provided a general overview of socio-economic factors, practices and constraints. Serious problems were identified in both locations, and particularly in the Udaipur villages, with high mortality rates in chickens and poor hatchability rates. In both locations the project found that for the period under investigation predation was a more important cause of mortality than disease. On-farm trials to improve hatchability rates found technologies based on locally available materials to be effective. A survey of the poultry-keepers' agricultural knowledge and information systems identified their main sources of information and the most useful media for reaching them.

Research findings

- *There are variations in scavenging poultry systems (e.g. in terms of main uses of birds, severity of constraints), between different ethnic groups and between the landed and the landless.*
- *The productivity of scavenging poultry systems tends to be low, with high mortality rates and low hatchability rates.*
- *Newcastle disease (ND), which is widely believed to be the main constraint affecting scavenging chickens in India, was not the major cause of mortality in the project locations: the main cause was predation, by birds of prey and mammals.*
- *There is considerable scope for improving the productivity of scavenging systems with low-cost interventions, and this may enhance their robustness in the face of a burgeoning commercial poultry sector.*
- *Effectively conveying extension messages to potential users will require the use of mass media (radio in particular, but also newspapers and television) and the social infrastructure of women's self-help groups.*

Policy implications

- *The emphasis of poultry research and extension should better reflect the priority needs of poor poultry-keepers, and extension efforts should be broadened and give greater emphasis to non-disease issues (notably predation and hatchability) than is currently the case.*
- *Thorough and objective appraisals of needs and constraints should be carried out by agencies involved in poultry development, and the appropriateness of ND vaccination campaigns vis-à-vis other kinds of interventions should be reviewed in the light of the findings.*
- *Identifying the information needs, sources and preferred media of the poorer groups and women can increase the likelihood of extension messages reaching them and reduce the likelihood of dissemination and extension strategies reinforcing existing socio-economic differences within rural communities, and marginalising the poor and women yet again.*
- *There is a need for flexibility in communication and extension strategies to take account of differences (e.g. between districts, villages and groups); a 'one size fits all' approach is not appropriate.*

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Acronyms

ACIAR	Australian Centre for International Agricultural Research
AKS	Ayyanar Kovil Salaikadu
AKIS	Agricultural Knowledge and Information Systems
BAIF	Bharatiya Agro Industries Foundation
DANIDA	Danish International Development Agency
DFID	Department for International Development (UK)
ILDP	Integrated Livestock Development Project
LIFE	Livestock Improvement Federation (India)
ND	Newcasttle Disease
NGO	Non-Governmental Organisation
PULDEP	Pudukkotai Livestock Development Project
SDC	Swiss Agency for Development and Cooperation
SHG	Self-Help Group
TANUVAS	Tamil Nadu University of Veterinary and Animal Sciences

IMPROVING BACKYARD POULTRY-KEEPING: A CASE STUDY FROM INDIA

1 INTRODUCTION

Poultry is one of the fastest growing segments of the agricultural sector in India today. While the production of agricultural crops has been rising at a rate of 1.5–2% per annum, that of eggs and broilers has been rising at a rate of 8–10% per annum (Mehta et al., 2003). National annual consumption is 37 billion eggs and one billion broilers. Estimates of income elasticity for meat and eggs strongly suggest that consumption of these products can be expected to continue to grow strongly. Per capita consumption of eggs in rural areas is less than half that in urban areas (Mehta et al., 2003).

Trends in the poultry sector provide a striking example of how sector growth does not necessarily go hand in hand with poverty reduction. Family poultry (or the 'traditional scavenging' system), which is based almost entirely on native birds, has been by-passed by the poultry revolution, with virtually all the growth occurring in the large-scale 'confined and intensive' (or industrial) sub-sector. By contrast, traditional poultry-keeping appears to be a stagnant low-productivity sub-sector. The percentage of native birds in the total poultry population has dropped from 50% about 30 years ago to about 10% now (Rangnekar and Rangnekar, 1999). The poultry sector is, in effect, a dualistic one: the barriers to entering the industrial/intensive sub-sector are high, preventing poor producers from doing so.

Nevertheless, the meat of family-produced scavenging chickens is much more highly valued (by rural and urban dwellers, rich and poor) than that of industrially produced birds, with prices per kg live weight being 50–100% higher for the former, because its taste and texture are considered superior. It is the equivalent of an 'organic' chicken in western Europe, and has a lower fat content than industrially produced birds. This may mean that the traditional system is robust against competition from industrial production units, particularly when incomes and demand for poultry meat are rising rapidly, but research is needed to confirm this. Research into improving the traditional scavenging system would further strengthen it against competition from the industrial poultry sector. Provided that it generated low-cost technologies, it would also be inherently pro-poor, as backyard poultry-keeping is practised primarily by poorer groups, and specifically by women.

There has been relatively little research in India on village chickens, regarding both constraints and technological improvements that could be affordable to the resource-poor. Instead, research (much funded by commercial producers) has focused on intensive production systems. What limited research there has been on scavenging poultry has focused primarily on 'improved' breeds, as was reflected in several papers presented at a national seminar in December 2002 (Devegowda et al. (eds), 2002).

A research project managed by the Scottish Agricultural College, and with socio-economic inputs from the Natural Resources Institute, has been making a modest contribution to filling the research gap by looking at other aspects of improving scavenging systems.

The project, which began in late 2000, has been investigating the production problems facing poultry-keepers in two locations in rural India, and working with poultry-keepers to address some of them. It is funded by the UK's Department for International Development's (DFID) Livestock Production Programme. The locations, both semi-arid, are Udaipur District in Rajasthan and Trichy District in Tamil Nadu. The Bharatiya Agro Industries Foundation (BAIF) and Tamil Nadu University of Veterinary and Animal Sciences (TANUVAS) are the collaborators in the respective districts.

The two project locations are quite different as far as poultry-keeping is concerned. In the Udaipur project villages the local people are primarily poor tribals, and there is no organised market for chickens. By contrast, in Trichy the poultry-keepers belong to a range of castes and wealth categories. Chickens from this area are highly prized for their superior taste. There is a well-developed commercial market, with traders visiting villages and local markets to purchase birds for sale in urban centres 30–150 km away.

2 PROJECT METHODOLOGY

Selection of villages and respondents

In Trichy District, Tamil Nadu, the general project area was chosen partly because the state veterinary services were working closely with poultry-keepers there, and were interested in cooperating with the project team in the research; and partly because it was reasonably accessible from Namakkal, where the TANUVAS researchers are based. The TANUVAS team itself did not have a previous record of working regularly in villages in Trichy, so the cooperation of the veterinary services was seen to be important in helping the team to establish a good rapport with the villagers.

The team identified three categories of backyard poultry-keepers in this district prior to the survey. It was decided to work in one or more villages in which all three categories were present. This would enable the team to be relatively confident that any differences found between the three groups could be attributed to the nature of their poultry-keeping systems, rather than other extraneous factors (e.g. distance from poultry market). Peruganur village satisfied this criterion. More recently, the project has been working in a second village, Ayyanar Kovil Salaikadu (AKS), which was selected because it also satisfied this criterion, and also because it is less well-connected than Peruganur, and

hence would provide a more representative picture.

The three categories of poultry-keepers were:

- Category 1 = small and marginal farmers whose home and poultry are adjacent to their agricultural land.
- Category 2 = small and marginal farmers whose home and poultry are separate from their agricultural land, i.e. in a nucleated settlement.
- Category 3 = landless people who live in a colony (hamlet), with poultry kept in and around the house.

The mean flock sizes of these three groups differed, as can be seen from Table 1, the largest being those of Category 1 (C1), and the smallest belonging to Category 3 (C3).

Table 1 Mean flock sizes in the project villages

Type of bird*	Udaipur villages	Trichy villages					
		Category 1		Category 2		Category 3	
		P†	AKS‡	P	AKS	P	AKS
Layers	2.0	2.8	2.1	1.9	2.0	1.0	0.9
Cocks	0.9	1.7	2.6	1.9	1.5	0.3	0.9
Total	2.9	4.5	4.7	3.8	3.5	1.3	1.8

* Immature birds (chicks, pullets and growers) have been excluded here, as they are present in flocks for shorter periods and there are seasonal fluctuations in their numbers.
† Peruganur
‡ Ayyanar Kovil Salaikadu

In Udaipur District, Rajasthan the project team decided to work in three villages of Baghpura block, since BAIF had a strong operational presence in this block, where it was implementing a European Union-funded rural development project. The people living here are predominantly tribal, mainly belonging to the Bhil tribe. The project planned to work through women's self-help groups (SHGs) in this project area, so the respondents selected were primarily members of these groups. The mean flock size in these villages was somewhere between those kept by C2 and C3 poultry-keepers in the Trichy villages.

Baseline survey

In its early stages (February–April 2001) the project undertook a structured baseline survey of 30 poultry-keepers in each location to obtain a general overview of practices and constraints (Conroy et al., 2003). In Udaipur, 10 poultry-keepers were selected in each of the three project villages; while in Trichy 10 poultry-keepers from each of the three categories in Peruganur were interviewed. Subsequently, in April 2004, another 30 poultry-keepers were surveyed in AKS, Trichy District (again 10 from each category). Most of the respondents were women, since they are usually responsible for all aspects of poultry-keeping.

The principal survey method was an interview schedule. In addition, to collect information about hatchability and mortality the survey used a new technique, which we have called the participatory clutch history method (Conroy, 2005). This information was obtained by getting the owner to recall what had happened to one or more specific clutches in her/his flock during the previous 6–9 months, and to record this information on a chart placed on the ground. Since many poultry-keepers are illiterate, the chart was based on symbols, rather than words and numerals (e.g. use of stones to indicate numbers). They would start (see Figure 1) by showing the number of eggs laid, then the numbers of eggs or birds at various stages, and ultimately the number reaching marketable age and retained in the flock. The 17 subsequent rows indicated possible explanations for removal from the flock, both deliberate (e.g. consumption, sale) and accidental (mortality due to disease, particular types of predator, etc.); and any removals were recorded in the appropriate row and column.

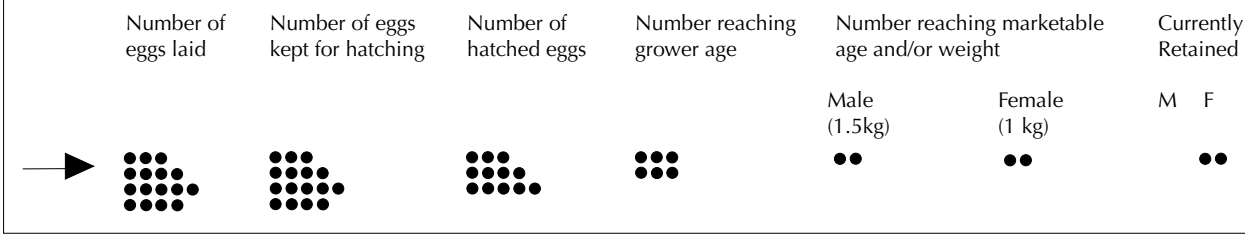
Monitoring programme

After the survey a one-year monitoring programme, beginning in July 2001, was established in villages in the two locations to collect further information about poultry production and productivity. Birds were tagged by members of the research team, who then visited the villages and owners every two weeks. The programme, which covered 2056 birds in Udaipur and 1445 birds in Trichy, monitored weight gain and mortality and its causes. In addition, dead birds were examined for the presence of internal parasites: 94 birds were examined in slaughterhouses in Tamil Nadu, and 40 birds were sacrificed and examined in Udaipur at the state government's Regional Disease Diagnostic Centre.

Trials – topics and methods

The project has been investigating ways of addressing some of the problems that were identified through the baseline survey and the monitoring programme. In late 2002 and during 2003 and 2004 participatory trials were implemented in the Udaipur villages; and an on-station trial was carried out in Tamil Nadu in 2003. The trials tested technologies for improving the hatchability

Figure 1 Top rows of participatory clutch history chart, with example



of eggs, and for controlling gastro-intestinal parasites. The project investigated the effect of locally available plant materials (particularly those with a high tannin content) on the worm burden of the birds. In Udaipur, the grains of a naturally occurring plant (*Centretherum anthelminticum*) were tested; and in Tamil Nadu an on-station trial examined the effect of sorghum grain on growth rates. However, only the hatchability-related trials are reported on here in any detail:

Hatchability

The baseline survey revealed (see Table 5) that 25–30% of eggs laid in the Udaipur villages failed to produce chicks, and this led the research team to explore this issue further. Failure to produce chicks could be due to: the eggs not being fertilised; the embryo dying during embryogenesis; or to the egg being contaminated with bacteria. In principle, eggs that are sterile, or in which the embryo has died before the egg is incubated, can be consumed or sold, but the villagers were unable to distinguish them from fertilised eggs. Candling, the shining of a bright light through the shell, allows the stage of embryo development to be approximated, and thereby enables eggs that will not produce a viable embryo to be removed early on in the incubation period (4–7 days), and consumed or sold (Delany et al., 1999). Candling is widely used in the poultry industry, but the concept was new to the villagers. The only equipment necessary is a good light source (such as is provided by a good quality torch) and a darkened room or similar in which the eggs can be assessed. Commercial candling equipment tends to be mains-operated. Mains electricity was not available in the Udaipur project villages, so the team developed and tested a cheap battery-operated technology made from locally available materials (torch and metal box).

In 2002 two young males from poultry-keeping families in one of the Udaipur project villages were given training in identifying infertile and fertile eggs using this technology, and a further two were trained in 2003. To monitor the efficacy of the procedure, the eggs identified as fertile or infertile after candling were marked with different colours then incubated. The trial was carried out from 15 November 2002 to 15 February 2003 (Sparks et al., 2004).

All the eggs were incubated to allow the accuracy of the candling to be assessed. As candling is known to be effective this was primarily a demonstration trial rather than a research trial. It was not considered necessary, therefore, to include large numbers of eggs. Two more trials were carried out in the summers of 2003 and 2004, which are described in the next section.

Hatchability in the summer

Poultry-keepers in Udaipur reported that in the summer months (March–June), during the latter half of which temperatures can reach more than 40 °C, the percentage of spoiled eggs increased. It is well known in poultry science that high temperatures (> 27°C) can increase the incidence of abnormal embryos and the percentage of embryos that die during incubation. Thus, the project team hypothesised that this was the cause of the poor hatchability and tested another simple technology, based on locally available materials, that had the potential to reduce and stabilise the temperature of the eggs.

The technology involved evaporative cooling. An iron bowl of a type used by the local people was filled with an earth/sand mixture kept moistened with water. A piece of jute was placed on the sand, to prevent the eggs coming into direct contact with the water (which might cause contamination); the eggs were placed on the jute then covered with a cotton cloth or woven basket. The bowl was placed either on a shelf or ledge or on the floor, inside a family building. When the hen stops laying, all the eggs are placed under her, according to the traditional practice. The project conducted a pilot trial in February–May 2003 with two groups of poultry-keepers to test this technology, in which all the eggs were candled first to confirm fertility. The ambient temperature in the vicinity of the eggs and in the egg store room was recorded daily between 8 and 10am with a maximum and minimum thermometer. The numbers of eggs that hatched viable chicks, that contained dead-in-shell embryos or which had spoiled (infertile or bacterial rot) were recorded. The 2003 trial showed promising results, and so was repeated on a larger scale, with more birds and eggs, in March–June 2004.

Survey of poultry-keepers' agricultural knowledge and information systems

In March/April 2004, a communications survey was undertaken, the purpose of which was to improve the poultry-keepers' understanding of agricultural knowledge and information systems (AKIS)[1], so that the project's extension materials and strategy could be optimised. It aimed to identify, inter alia, their sources of agricultural information and their preferred media for receiving information. The project team was aware that relying solely on conventional (mainly government) extension services to disseminate information about project findings to resource-poor poultry-keepers (especially women) would not be an effective approach, due to various biases in the Indian livestock extension system (Matthewman et al., 1998). It was decided, therefore, to develop a more broadly based strategy, tailored to the preferences and circumstances of the poultry-keepers in the project locations.

Previous research has shown that there are often distinct gender and socio-economic differences in the degree and nature of access to information within and between communities (Subedi and Garforth, 1996; Rees et al., 2000). In particular, work in many countries has shown that the resource-poor also tend to be information-poor (Garforth, 2001b). Thus, the survey was designed to take account of the fact that different groups of livestock-keepers (e.g. farmers, landless, men, women) may have different AKISs. By identifying the information needs, sources and preferred media of the poorer groups and women, communication research of this kind can reduce the likelihood of dissemination and extension strategies reinforcing existing socio-economic differences within rural communities, and marginalising the poor and women yet again.

The survey used a combination of group PRA methods and structured individual interviews. This was similar to the methodology used in another AKIS study in Eritrea (Garforth, 2001a; Garforth et al., 2003). The individual interviews were carried out first, then the group methods were used. The two PRA methods used were information mapping and linkages diagrams and agricultural timelines. In the former, villagers identified their sources of agricultural/livestock information at each of various levels (e.g. village, panchayat, block and district). In the latter, they identified technological changes that had taken place in their agricultural and livestock systems during the previous half century or so, and the sources of innovations (where known).

3 REASONS FOR KEEPING POULTRY

As part of the baseline survey, respondents were asked to rank their reasons for keeping poultry, according to their relative importance. The rankings differed substantially between the two locations; and differences were also identified between the three sub-groups in Tamil Nadu.

Peruganur, Trichy

In Peruganur, most C1 poultry-keepers said that their main reason for keeping poultry is to generate income (see Table 2). The other main reason given was for home consumption. These two factors accounted for all of the first-ranked reasons, and six of the 10 secondary rankings. The other factor that featured as a secondary main reason was 'ready source of income', i.e. as a savings bank to provide cash to meet contingencies.

Among C2 poultry-keepers income and home consumption were again almost the only reasons given in the top two rankings, but in the case of this group home consumption is more important than income. The rankings are slightly different again among C3 poultry-keepers. Income and home consumption are each cited four times as the most important reason. 'Ready source of income' is the most frequently mentioned secondary reason, suggesting that for this particularly poor group poultry are significant as a disposable asset in the event of contingencies.

Data from the clutch histories show the actual importance of different uses of poultry for the three categories, as summarised in Table 3. They show that the proportion of birds sold was approximately the same for C1 and C2, and substantially less for C3. In percentage terms home consumption was much higher in C3 than in the other two groups, as were 'sacrifice' and 'gifts'. However, the C1 poultry-keepers tend to have much larger flocks than the C3 group, and the actual numbers of birds consumed at home by C1 and C3 poultry-keepers are similar.

There is a reasonable degree of consistency between the information in the two tables. The main anomaly is that most C2 poultry-keepers said that home consumption was the most important reason for keeping poultry, but in percentage terms they consume less poultry than C1 poultry-keepers.

Table 2 Peruganur villagers' main reasons for keeping poultry

	C1		C2		C3	
	1	**2**	**1**	**2**	**1**	**2**
Income*	7	3	3	6	4	1
Home consumption	3	3	7	3	4	1
Ready source of income		4		1	1	5

* Refers to planned and regular income-generation, whereas 'Ready source of income' refers to sudden unplanned sales to generate income to cope with unforeseen contingencies, such as illness in the family.

Table 3 Disposal of market-age birds from Peruganur

	C1 (117 birds) %	C2 (110 birds) %	C3 (82 birds) %
Sold	70.7	71.8	47.6
Home Consumption	7.9	4.6	18.3
Sacrifice		4.5	9.7
Gift		0.9	9.8
Retained as stock	21.4	18.2	14.6

Udaipur villages

In Udaipur, 'income' is only mentioned once as a reason for keeping poultry (see Table 4). Home consumption is easily the most frequently given principal reason, followed closely by 'for guests'.

Table 4 Udaipur villagers' reasons for keeping poultry

	C1	C2	C3	Total
Income	0	1	0	1
Home consumption	21	2	5	28
Gifts	1	2	0	3
Sacrifice	3	3	10	16
For guests	2	14	11	27
Ready source of cash	2	8	4	14
Total	29	30	30	99

4 CONSTRAINTS: FINDINGS OF THE BASELINE SURVEY AND MONITORING PROGRAMME

The baseline survey (Conroy et al., 2004) identified serious constraints on productivity in both locations. Respondents were generally aware of the causes of mortality. In the case of predation-induced mortality, they usually knew the types of predators. However, in a few cases they said they did not know, and sometimes they may have been guessing. Landless labourers may sometimes not have known whether a bird had been lost to a predator or been stolen, given that they are away from their village during the day. Although reliability can be an issue when using recall methods (like the clutch history), the monitoring programme, in which causes of losses were recorded every two weeks, produced similar results.

Table 5 Baseline findings on egg spoilage and mortality rates

	Trichy – Peruganur %	Trichy – AKS %	Udaipur %
Spoiled eggs	18.2	27.9	27.3
Mortality (pre-grower for Trichy birds; during first 6 months for Udaipur birds), of which:	23.1	35.2	41.9
• Disease	7.0	2.2	16.6
• Predation	14.7	31.8	21.9
• Accident & other	1.3	1.2	3.5
Total losses* +	41.3	63.1	69.2

* Spoiled eggs plus mortality
\+ The spoilage and mortality data are not strictly summable – they are not percentages of the same totals, as one relates to eggs laid and the other to birds hatched. They have been aggregated here simply to give an overall picture of the severity of the losses, to facilitate comparisons between each group or village.
\- Discrepancies between total mortality rates and the sum of the components are due to rounding up of decimal figures

In Trichy, losses were greater in the remoter village, AKS. For AKS the percentage of eggs spoiled and the overall mortality rate were more similar to those of the Udaipur villages than to Peruganur (see Table 5). For four of the five project villages the clutch history data from the baseline survey showed that predation was a more important cause of mortality than disease, and the monitoring programme produced similar findings. One difference is that in Udaipur the mortality rate from disease is far higher than in the Trichy villages.

The project team anticipated that predation-induced mortality might be higher in AKS than in Peruganur. This was because AKS is situated adjacent to a hilly area, where it was hypothesised that numbers of mammalian predators (e.g. fox, wild cat) and birds of prey would be higher.

Mortality data from the monitoring programme in Trichy (Table 6) were generally consistent with those obtained through the baseline survey in Peruganur. The overall mortality rate was quite similar, and predation was more important than disease, but the gap between predation and disease mortality rates was much greater than that found by the baseline survey.

Predation: the neglected killer

In Trichy predation mortality, documented by clutch histories as part of the baseline survey, was attributed exclusively to wild birds in Peruganur, mainly large birds of prey such as kites but also small birds of prey. Crows were involved much less frequently. Bird predators also predominated in AKS, but wild cats accounted for 14% of predation deaths, and snake and mongoose were also involved.

Table 6 Mortality in Peruganur during the 2001–2 monitoring programme

No. of birds	Total mortality	% mortality	Predation deaths No.	%	Disease deaths No.	%	Other deaths No.	%
1445	392	27.1	263	18.2	60	4.1	69	4.7

In the Udaipur villages it appears that by far the most important predator was the crow, which killed more chicks than all the other predators combined. The mongoose was also a significant predator, and wild cats were the third most important. Subsequent discussions with poultry-keepers in Udaipur revealed further information about predation, including the following:

- Only chicks are taken by crows, not older birds.
- Almost all predation occurs during the daylight hours when chickens are scavenging outdoors.
- In the rainy season mammals (mainly mongoose, fox) kill more chickens than birds of prey do, because they are able to take advantage of the cover provided by seasonal vegetation.
- Conversely, in the dry season, birds of prey are able to take more chickens than mammals are, because of the lack of vegetative cover.

Disease

Diseases found in the Tamil Nadu project area included: Newcastle disease (ND), fowl pox and fowl cholera. In Udaipur the diseases present were not identified: analysis of blood samples from sacrificed birds showed that ND, Marek's disease, infectious bursal disease, salmonellosis (pullorum disease) and spirochaetosis were not present (Bhardwaj and Bhatnagar, 2004).

Newcastle disease is a highly infectious viral disease that causes more mortality in poultry than any other in most tropical countries. Depending on its virulence, an outbreak of ND can cause up to 100% mortality. Vaccines used by commercial producers are not suitable for use in village-based systems for a number of reasons (e.g. the dose size is too large, the vaccines need to be kept cool). However, more appropriate vaccines have been developed by projects sponsored by the Australian Centre for International Agricultural Research (ACIAR). The labour costs of applying conventional injected vaccines in a scavenging system are high, and the logistical challenge can be considerable: Each and every bird of an appropriate age needs to be vaccinated; and frequent repeat visits (e.g. monthly) are needed, as new birds reach the appropriate age for vaccination. The ACIAR vaccines are thermostable, can be administered through eye drops, drinking water or cooked white rice, and require fewer visits to the village.

Interestingly, in the three Udaipur project villages there have been no outbreaks of Newcastle disease during the four years that the project has been working there. ND serology (HI test) was done on 151 samples from three villages, none of which showed the presence of antibodies against ND. This indicates that the birds had had no exposure to ND and had not been vaccinated against it (Bhardwaj and Bhatnagar, 2004).

Gastro-intestinal parasites

Worm counts carried out on dead birds as part of the monitoring programme showed that gastro-intestinal parasites were present in a large proportion of the birds in both locations. They were present in 80 out of

94 birds in Tamil Nadu (Pennycott, 2004) and 36 out of 40 in Udaipur (Bhardwaj and Bhatnagar, 2004). In Udaipur, the major worm burden was due to cestodes (in 26 birds), followed by nematodes (in 10). There was huge inter-bird variability in the numbers of worms present. Although worms do not usually kill the birds, they can weaken them significantly, making them more susceptible to death by other causes. In Udaipur, villagers were taken to the laboratory where the worm counts were done, and were very interested to observe the presence of worms, of which previously they had been unaware.

Socio-economic differences

In the Trichy villages egg spoilage rates were markedly lower for Category 1 poultry-keepers (see Table 7). The reasons for this difference are not known. However, one possible explanation is that, as C1 birds are kept adjacent to the owners' fields (whereas C2 and C3 birds are kept at houses in a nucleated settlement), they have a more nutritious diet. Their egg shells are thus stronger and less prone to cracking and the accompanying risk of contamination.

5 RESULTS OF ON-FARM TRIALS

Candling study

In the first study, which was carried out during the winter months, 71.7% of all the eggs laid were fertile, the remainder being infertile or cracked or not identified as fertile (Table 8). The degree of error associated with the candling (i.e. the number of eggs misidentified as either fertile or infertile) was <1%. Thus, candling enabled people to remove eggs that would not have hatched, and to consume or sell them; whereas if they had been left in the clutch (as usual) they would have become spoiled and unusable. Of the eggs that did not hatch, candling identified 50% of them as having cracked shells.

Table 7 Category-wise egg spoilage rates in Trichy villages

Village	Category 1 %	Category 2 %	Category 3 %
Peruganur	12.1	18.5	24.8
AKS	23.6	36.1	34.5

Egg storage study

Of the fertile eggs available for hatching in the first trial (2003) 97% of the chicks in the modified storage trial and 69% of the control group hatched (see Table 9). In the second trial (2004) the equivalent figures were 84.3% and 69.5% respectively. The results provide clear evidence that the modified storage of eggs did improve the overall hatchability of the eggs set.

These data are consistent with the hypothesis that keeping the temperature of the egg during storage below physiological zero (27°C) would reduce the incidence of abnormal embryos and the percentage of embryos dying during the first and last weeks of incubation. In this respect it is notable that the minimum room temperature during storage tended to exceed physiological zero and the maximum temperature was often in excess of 32°C (see Table 10). However, it is also possible, although not measured during this study, that some of the improvement in hatchability resulted from a decrease in the water lost from the egg during storage (owing to the higher humidity levels around the egg).

6 FINDINGS OF AKIS/ COMMUNICATIONS SURVEY

The survey found that there were substantial gender differences in information sources and preferred media

Table 8 Udaipur candling trial results, winter 2002–03

No. of birds	No. of eggs laid	Identified fertile eggs		Identified Non-Fertile/Cracked/ Unidentified		No. of chicks hatched eggs	Hatch % against laid	Hatch % of fertile	Benefits (% of eggs saved)
		No.	%	No.	%				
8	106	76	71.7	30	28.3	63	59	83	28

Table 9 Effect of cooled egg storage on hatchability (Udaipur)

Treatment	No. of birds	No. of eggs available for hatching	No. of eggs identified as fertile	No. of chicks hatching from fertile eggs		% of live chicks hatching from fertile eggs
2003 trial				Live	Died	
Using cooled egg storage technology	10	122	72	70	2	97.0
Using normal storage conditions	2	28	16	11	5	69.0
2004 trial				Live	Died	
Using cooled egg storage technology	40	437	318	268	50	84.3
Using normal storage conditions	34	368	210	146	64	69.5

for receiving agricultural information, as is evident in the following sections. In Trichy there were also differences between farmers and landless poultry-keepers. One factor contributing to this is differences in literacy rates. In the Udaipur villages, 85% of the men were literate (defined as able to sign their own name), but only 40% of the women. In the Trichy villages, 10 out of 12 men and women from farming households were literate, but literacy rates were lower for landless people, especially women.

Information sources at different levels

The information diagrams referred to at the end of Section 2 showed that most sources are local, i.e. at or within the village, particularly for women (see Table 11).

Table 10 Minimum and maximum temperatures[1] during egg cooling trial, Udaipur

Trial period	Temperature during laying		Temperature during hatching	
	Min	Max	Min	Max
2003 (March- May)				
Treatment group	30	34	29	36
Control group	28	34	28	34
2004 (March-June)				
Treatment group	29	34	38	42
Control group		Not available		

[1] Readings were taken every 24 hours, between 8 and 10 am , using a maximum and minimum thermometer.

Main sources of agricultural information

Trichy

Individual interviews revealed that almost all (11 out of 12) landless women in the two Trichy villages saw other family members as their main source of agricultural information, whereas half or more of the landless men in AKS and Peruganur saw farmers and radio respectively as their main source. Family members were also a main source for half of the women from farming households in the two villages, whereas radio was the most frequently mentioned main source for landed men and women combined.

Udaipur

In the Udaipur village of Saradit, the remoter of the two study locations, the main source of information for both men and women was BAIF. There was more variation in Baghpura: The women there also relied on BAIF but the men most frequently cited the agriculture department. The other source, cited frequently by both women and men, was local traders.

Table 11 Quantitative summaries of information diagrams for Trichy District

Level	Male farmers	Female farmers	Male landless	Female landless
District	3	1	2	1
Block	11	5	4	2
Panchayat	8	6	4	2
Village	17	14	14	13
Total	39	26	24	18

Table 12 Farmers' ratings of usefulness of different media

Media	Udaipur				Trichy			
	20 women		20 men		12 women		12 men	
Written	**Useful**	**DK***	**Useful**	**DK**	**Useful**	**DK**	**Useful**	**DK**
Leaflets	1	13	8	7	2	6	7	2
Posters	19	0	18	0	2	5	7	2
Booklets	2	12	8	4	2	6	7	2
Newspapers	6	0	9	0	3	5	9	0
Wall paintings	5	0	12	0	1	5	7	1
Electronic	**Useful**	**DK**	**Useful**	**DK**	**Useful**	**DK**	**Useful**	**DK**
Radio	19	1	19	0	10	2	10	2
Television	12	1	16	0	6	4	8	4
Video/film	12	1	16	0	0	12	0	12
Trainings, etc.	**Useful**	**DK**	**Useful**	**DK**	**Useful**	**DK**	**Useful**	**DK**
Farm visit	15	5	19	1	2	0	8	3
Field day	1	15	14	6	1	2	8	3
Training	6	12	10	9	1	4	7	4
Puppet show (U)/ theatre(T)†	20	0	19	1	0	0	7	3
Meetings	**Useful**	**DK**	**Useful**	**DK**	**Useful**	**DK**	**Useful**	**DK**
Self-help group	15	1	13	5	7	0	3	3
Village organisation/ Panchayat‡	12	3	18	1	4	0	10	0
Cooperative	1	16	7	11	3	0	11	0
Social meeting	18	0	20	0	5	0	10	0

* Don't know

† The questionnaires for the two districts were slightly different, in that 'puppet show' was included in Udaipur where such shows are traditional, the equivalent in Trichy being 'theatre'.

‡ In Udaipur people were asked about village organisations, whereas in Trichy they were asked about the local panchayat.

Respondents' ratings of different media

Respondents were asked whether or not they found particular media useful as sources of agricultural information. Table 12 provides a comparative summary of the findings for farmers in the two districts. Respondents had three possible responses: useful, not useful, or don't know. The table records the numbers of people responding 'useful' or 'don't know' for any given medium, from which the 'not useful' responses may readily be calculated.

Written media

It can be seen from Table 12 that in Udaipur posters were easily the most popular of the written media for both women and men, whereas in Trichy five of the 12 women, and two of the men, were unfamiliar with this medium as a source of agricultural information. In Udaipur, most men also found wall paintings useful. In Trichy the most popular written medium for men was newspapers, which were also cited quite often in Udaipur. In both districts, more men than women found written media useful, partly because fewer women have been exposed to certain written media and hence have no view on them; and possibly also due to higher literacy rates among men.

Electronic media

Radio was the most popular electronic medium for men and women in both districts, followed by television which was mentioned by more men than women. Video/film was as frequently cited in Udaipur as television, by both men and women, whereas in Trichy it was not cited at all. This was because, of the project villages, only the people in Udaipur had experienced this medium, probably through BAIF's work. Women were generally as familiar with the electronic media as the men.

Training, etc.

In both districts 50% or more of the men rated all four training-related media as useful, while women were generally not so positive. Only a small minority of Trichy women rated any of the media as useful. In Udaipur more than half the women cited only two of the media, farm visits and puppet shows, as useful. These two media were also the ones most frequently cited by the men. A substantial number of women and men said they did not know whether field days and trainings were useful or not.

Meetings

More men than women were positive about meetings generally. The one exception was self-help group (SHG) meetings, about which more women than men were positive. This is probably because the membership of most SHGs is restricted to women. A few men in each location did not know whether SHG meetings were useful or not. The vast majority of men in Trichy regarded the other three types of meetings as useful. The same was true of their counterparts in Udaipur, except that only a minority were positive about cooperative meetings.

7 DISCUSSION

Differentiation within scavenging poultry systems

The contrasting situations in Trichy and Udaipur, and the differences between the three categories of poultry-keepers in Peruganur, show that it can be inappropriate to generalise about the nature of scavenging poultry systems, even in the same locality. The reasons why people keep poultry may differ, as may the seriousness of constraints. Hence the emphasis given to different types of intervention may need to vary from one place or group to another.

Reasons for keeping poultry and implications for interventions

There are marked differences between the Trichy and Udaipur findings. In Udaipur, the fact that income is mentioned only once reveals the non-commercial nature of backyard poultry production in this district (see Table 13). By contrast, it was mentioned 25 times by the Peruganur villagers. Keeping chickens as a ready source of cash is also less frequently cited in Udaipur than in Trichy. The main reasons for keeping poultry in Udaipur were home consumption (28) and for guests (27), the latter being a lower priority than the former for most people. For guests was cited only four times in the top three rankings in Peruganur. In both study locations home consumption is the most frequently mentioned reason.

Table 13 Reasons for keeping poultry

	Peruganur	Udaipur villages
Income	25	1
Home consumption	27	28
Gifts	2	3
Sacrifice	10	16
For guests	4	27
Easy to manage	1	0
Ready source of cash	21	14

There could be a few factors contributing to the fact that income is a low priority in the Udaipur villages. The high priority attached to providing chicken for guests, and to a lesser extent their use in sacrifices, suggests that cultural factors are very important. It may also be the case that the high rates of mortality and spoiled eggs mean that there are relatively few birds available for sale. There is certainly a demand for local poultry meat in the area, prices being 50–100% higher than for commercial broilers, so it is not difficult to sell a bird. During 2003 and 2004 two shops opened in Baghpura town (one as a direct result of the involvement of the owner in the research project), whereas previously there was no such outlet for chicken in the area.

Information about people's reasons for keeping chickens should be obtained at an early stage where poultry development programmes or interventions are being planned, as they have major implications for the nature and sequencing of interventions. In a situation

like that of the C1 and C2 poultry-keepers in Trichy, where 70% of birds are sold, people may be ready and willing to increase expenditure on effective commercial products. By contrast, in places where the sale of birds is uncommon, and is not an important reason for keeping them, villagers have less incentive to adopt interventions that require expenditure, such as commercial veterinary products or high quality feeds.

The relative importance of various constraints

This project has highlighted the importance of certain constraints that merit greater attention from poultry researchers and development organisations than they have received to date, notably poor hatchability rates and high levels of predation-induced mortality. One hatchability issue requiring further research is the high incidence of cracked shells, the causes of which are not known. When the shell is cracked it is unlikely that the embryo will survive the incubation process.

Predation

Some people have expressed surprise at our finding that predation causes more mortality than disease. However, this is not the first study in India to note that predation is a serious constraint. A livestock development project funded by the Danish International Development Agency (DANIDA) in Koraput, Orissa, found that predation was 'an important problem', and noted that the main predators were crows, foxes, hyenas and wild cats (Das et al., 2003). It has also been reported that in Madhya Pradesh predation is the second most important cause of mortality, after ND (Mohapatra, 2003). Another survey, conducted in five districts of the tribal belt in Western India (along the interstate boundaries of Rajasthan, Madhya Pradesh and Gujarat) concluded that disease (especially ND) was the main cause of mortality, followed by predation (including theft) (Rangnekar and Rangnekar, 1999). However, none of these three references provides quantitative data on the relative importance of different causes of mortality, and it is not readily apparent whether such data was collected.

Given the importance of predation-induced mortality, predation prevention measures deserve more attention from poultry research and development professionals. 'Improved housing' is the solution usually proposed by livestock scientists. However, since predation normally takes place during the daylight hours, when the birds are scavenging, for the solution to be effective scavenging would have to cease. This would require the owners to bring feed to the birds, thereby incurring labour and/or cash costs, which poor poultry-keepers might consider to be undesirable or not feasible, and which a bio-economic modelling exercise (assuming 20% predation mortality) found to be unprofitable (Udo et al., 2002). Fortunately, keeping birds in confinement is only one of several possible measures. Others suggested by poultry-keepers in Udaipur include providing cover (e.g. a bunch of thorny branches on the ground) for chicks against crows, and destroying the burrows of mongooses near to the home.

Newcastle disease

Newcastle disease is regarded by many poultry scientists as the main cause of mortality in scavenging chickens. This perception has not been confirmed by the project's experience (over a four-year period), suggesting that the importance of ND varies from location to location and may be overestimated in some instances. In the absence of prior exposure or protective vaccination, ND may kill more than 70% of a flock. The effects of sporadic losses due to ND on a traditional low-input scavenging system are difficult to quantify unless data have been collected over a period of several years, so that the frequency of outbreaks is known. Nevertheless, based on our data for a period of four years, we believe that over a period of say 10 years ND is unlikely to be the major constraint to production in the project locations, predation and poor hatchability having a greater impact. We recommend that similar studies to ours be undertaken in other countries and locations to collect empirical data on the relative importance of different constraints; and that, if the findings are similar, this should be taken into account in research and development programmes targeting backyard poultry.

Use of egg technologies

Candling

Poultry-keepers were quick to understand the candling technology, and to recognise the fact that it makes eggs available for consumption which would otherwise have been left to hatch and eventually become spoiled. Some of the villagers who were trained in its use are now providing a candling service to others, under which the client pays them in kind, giving them half of the infertile eggs that have been 'saved' as a result of the candling. In an ideal scenario the technology would be mass-produced by an entrepreneur so that it could be widely distributed to anyone wishing to purchase it, and training in its use would be widely available.

The use of candling should be vigorously promoted by those involved in providing advice and training to poultry keepers. It has several advantages over many poultry-related interventions, namely: the technology is simple and relatively inexpensive; the benefits are visible and fairly immediate; and it can make a significant contribution to the nutrition of the poultry-keeper and family.

Cooling technology

Development of the cooling technology went though an iterative process. Initially, clay pots were used, but these had a tendency to crack; so then locally available iron pots were used (as in the 2004 trial). Although the latter proved to be effective, reed baskets lined with cloth have been used more recently. One advantage of these is that evaporation may also occur through the side of the container, leading to greater cooling than the iron pot technology: they may also be cheaper. The materials required to construct the variants of this technology are low cost and/or locally available in Udaipur villages, which suggests that it could be widely adopted. In other parts of the country, or among other ethnic groups,

some further adaptive research may be required using whatever types of containers, or materials for making them, are found in a given region. Non-governmental organisations (NGOs) or government extension staff should be open to testing different options, and making modifications where necessary.

Poultry development through the 'Improved Scavenging Model'

Our research, together with the experiences of other poultry development initiatives in India, suggests that there is plenty of scope for improving the traditional scavenging system with simple, low-cost technologies – the 'Improved Scavenging Model'. We believe that it would be easier to make these kinds of improvements to the scavenging system than to replace it with a semi-intensive system, in which the birds are partially or fully confined. The latter kind of system has been widely promoted in Bangladesh, and hence is sometimes called the 'Bangladesh model', but to function effectively it requires intensive support services over a period of many years. Thus, it can only be implemented effectively where these conditions are satisfied or where strong support is available to create the conditions. The requisite components include: formation of village groups, the existence of a credit and savings facility/system input supply services (vaccine/medicine, feed, parent stock), and breeders and hatcheries.

Two projects in India have demonstrated that there is major potential for increasing the benefits from the traditional scavenging system. In Koraput District, Orissa, the DANIDA-sponsored Integrated Livestock Development Project (ILDP) undertook poultry development activities in 100 villages, including disease control (deworming, and vaccination against ND and fowl pox), predator control (e.g. clearing of bushes around the village) and improved housing, management and feeding systems (Das et al., 2003). Training of village specialists was also a major component of the project. Over a period of six years, the numbers of birds in the project area roughly doubled, mainly due to a doubling (from two to four) of the numbers of hens per household, but also due to an increase in the number of households keeping chickens. The 'survivability percentage' of chickens in one of the four blocks increased from 40.5% to 62%, and the mean numbers of birds sold by each household nearly quadrupled. The second project, also DANIDA-sponsored, this time in Tamil Nadu, is called the Pudukkotai Livestock Development Project (PULDEP), which operated from 1989 to early 2004 (Rajarethinam, 2004). The approach was similar to that taken by ILDP, and the project resulted in almost a doubling of the bird populations (Rajarethinam, pers. comm.). Productivity and production impacts like these result in substantial increases in household incomes, and improved nutrition.

We also believe that there is a need for a graduated or phased approach, except in situations where intensive support is available over a long period of time (at least 10 years), in which case the Bangladesh model may be feasible. For example, if the 'Improved Scavenging Model' were applied in Udaipur-type situations, characterised by high mortality and relatively poor hatchability, it would be sensible to begin any poultry development programme by addressing these problems, with measures requiring little, if any, cash (Step 1). Subsequently, ways of improving the marketing of birds could be identified (Step 2); and, once effective market channels had been identified or established, interventions requiring higher expenditure or levels of organisation (e.g. supplementation using commercial feeds, ND vaccination) could be considered (Step 3).

We suggest ND vaccination should come later because it is difficult to organise and apply effectively, and requires ongoing repeat visits. This is because all the birds must be vaccinated, otherwise there may be reservoirs of infection, and these can lead to vaccine breakdown. Birds of different ages need to be vaccinated at the appropriate time, so one visit to a village will not be enough: visits may need to be fortnightly or even weekly. Relying on poultry-keepers to bring the birds to the veterinary officer for vaccination is unlikely to be effective.

Agricultural knowledge and information systems

The research findings confirmed what previous studies (Matthewman et al., 1998) had suggested, namely that government extension services generally make only a limited contribution to meeting the technology information needs of resource-poor smallstock-keepers. The findings also show that most written media for disseminating agricultural information either do not reach resource-poor farmers and livestock-keepers, or are regarded by them as not being useful. This is hardly surprising in situations where such groups have low literacy rates.

The survey showed that there are significant variations in information sources and media preferences, both between the villages and the two districts. This was also found to be the case in similar studies done in Eritrea (Garforth, 2001a), Kenya (Rees et al., 2000) and Uganda (Ramirez and Quarry, 2004). This finding highlights the need to have a flexible extension and dissemination strategy that takes account of such variations, rather than relying on the kind of uniform 'one size fits all' approach taken by some extension services and systems in the past.

The survey, like previous studies, also found marked gender differences in people's access to information sources, and in their preferred media for receiving agricultural information. Radio was one medium to which most men and women had access, and which was favoured by both. This was also a finding of studies in Eritrea and Uganda (Garforth et al., 2003).

The survey was designed – in its selection of districts and states (both less developed and more developed), villages (remote as well as well-connected) and individual respondents (farmers and landless, men and women) – to cover as broad a range of groups and situations as the project's limited resources allowed. Clear patterns and differences have been found in relation to most of these parameters. Nevertheless, we cannot say that these findings are representative of the two states, or

even of the two districts. In fact, the Udaipur findings are probably not representative, because the villages covered have clearly been strongly affected by the presence for several years of an agricultural and rural development project (managed by BAIF and funded by the European Union).

The purpose of the survey was to guide the project in designing its dissemination strategy and products, and to make sure that they are tailored to the requirements of poultry-keepers and intermediaries (government veterinarians, NGOs, etc). It has served this purpose well, and we recommend that other livestock research projects undertake similar surveys, unless relevant information is already available for the areas concerned.

Dissemination plans

The project is producing a number of booklets for extension workers in the two project states, covering management of eggs, predation control and health control.

In addition, it is planning to reach poultry-keepers directly through a combination of materials. The project's dissemination plans have sought to use media and information sources suitable for poor rural people, especially women, taking account of the findings of the AKIS survey.

The AKIS survey highlighted the importance of radio as a medium, for women as well as men, in both Tamil Nadu and Rajasthan. As a result, the project team in Tamil Nadu worked with the local All India Radio station to produce a series of 20 programmes, each lasting 15 minutes, on various aspects of backyard poultry. The programmes were broadcast in autumn 2004, and had a potential audience of several million people in nine of the state's 30 districts. A similar series is being considered for Udaipur.

In Udaipur posters, which the AKIS showed nearly all men and women considered to be useful, are being prepared for distribution to villagers and also to other NGOs with an interest in poultry development. They will rely primarily on pictorial content rather than words, so that they are meaningful to illiterate people. Other media, such as newspaper articles and puppet shows, are also being considered in Udaipur. Women's SHGs are seen as an important channel through which to disseminate information in various forms, such as posters, and some training of SHG representatives is planned (see below).

BAIF Development Research Foundation works in other parts of Udaipur District (Kotra, Sarada and Salumber blocks), and in other districts of south Rajasthan where family poultry is important (Banswara, Dungarpur and Chittorgarh). It has drawn up plans to disseminate information about the project's findings in these locations, by: (i) using the media and sources mentioned above; and (ii) providing training to NGOs, government officials and SHG representatives. Tribal, rural and watershed departments of government have funds for farmer training that could be used. In Tamil Nadu, funding is being sought to promote the project findings further through a federation of NGOs, the Livestock Improvement Federation (LIFE), in five of the southern districts there.

REFERENCES

Bhardwaj, B. and Bhatnagar, C.S. (2004) 'Influence of Parasitic Infestation in Desibirds – Experiences in Udaipur'. Paper presented at the 3rd national seminar on rural poultry for adverse environment, 25–26 February, 2004, Tamil Nadu, India.

Conroy, C. (2005) *Participatory livestock research: A guide*. London: ITDG Publishing.

Conroy, C., Sparks, N., Chandrasekaran, D., Ghorpade, A., Acamovic, T., Pennycott, T., Natarajan, A., Anitha, K., Pathan, R.L. and Shindey, D.N. (2003) *Key findings of the baseline survey on scavenging poultry in Trichy and Udaipur districts, India*. Ayr, Scotland: Scottish Agricultural College.

Conroy, C., Sparks, N., Chandrasekaran, D., Natarajan, A., Anitha, K., Sharma, A, Singh, L.R. and Shindey, D.N. (2004) 'Understanding livestock-keepers' agricultural knowledge and information systems: A case study from India'. Paper presented at the international workshop on enhancing the contribution of small livestock to the livelihoods of resource-poor communities, 15–19 November 2004, Masaka, Uganda.

Das, K., Biswal, A., Khuntia, A., Parida, J. and Kar, G.C. (2003) 'Status of village poultry production in Koraput District – ILDP experiences', pp. 14–26 in State level workshop: Poverty alleviation through poultry production in Orissa, 15–16 December, 2003. Bhubaneswar, Orissa. Fisheries and Animal Resources Development Department, Government of Orissa, and Indo-Swiss Natural Resources Management Programme.

Delany, M.E., Tell, L.A., Millam, J.R. and Preisler, D.M. (1999) 'Photographic candling analysis of the embryonic development of orange-winged Amazon parrots (Amazona amazonica)'. *Journal of Avian Medicine and Surgery*, Vol. 13, No. 2, pp. 116–23.

Devegowda, G., Yathinder, P.V., Krishnamurthy, T.N. and Kumar, V. (eds) (2002) 2nd national seminar on rural poultry for adverse environment, Bangalore 2002, 11th–12th December 2002. Bangalore: University of Agricultural Sciences.

Garforth, C. (2001a) 'Agricultural knowledge and information systems in Eritrea: A study in sub-zoba Hagaz, March 2001'. Report to FAO. Reading, UK: the University of Reading.

Garforth, C. (2001b) 'Extension strategies for the resource poor: Global experience', in S. Ramkumar, S.V.N. Rao, C. Garforth and K. Waldie (eds) Landless livestock farming: Problems and prospects. Proceedings of the workshop held on 29 January 2001 at Rajiv Ghandi College of Veterinary and Animal Sciences, Pondicherry, India. Pondicherry: RAGACOVAS.

Garforth, C., Khatiwada, Y. and Campbell, D. (2003) 'Communication research to support knowledge interventions in agricultural development: Case studies from Eritrea and Uganda'. Paper presented at the Development Studies Association Conference, Glasgow, 10–12 September 2003.

Matthewman, R., Ashley, S. and Morton, J. (1998) 'The delivery of information to livestock farmers in India: A case study', in F. Dolberg and P.H. Petersen (eds) Maximising the influence of the user: *Alternatives to the training and visit system – Proceedings of a workshop*. Copenhagen: DSR Forlag.

Mehta, R., Nambiar, R.G., Delgado, C. and Subramanyam, S. (2003) Annex II: Livestock industrialization project: phase II – Policy, technical, and environmental determinants and implications of the scaling-up of broiler and egg production in India. IFPRI-FAO project on livestock industrialization, trade and social-health-environment impacts in developing countries.

Mohapatra, S.C. (2003) 'Family poultry production in tribal belts of Madhya Pradesh and Maharashtra', pp 34–6 in State level workshop: Poverty alleviation through poultry production in Orissa, 15–16 December, 2003, Bhubaneswar, Orissa. Fisheries and Animal Resources Development Department, Government of Orissa, and Indo-Swiss Natural Resources Management Programme.

Pennycott, T. (2004) 'The health of village poultry – An overview'. Paper presented at the 3rd national seminar on rural poultry for adverse environment, 25–26 February, 2004, Tamil Nadu, India.

Rajarethinam, P. (2004) 'Pudukkotai livestock development project: An alternative service delivery system to reach the poor', in J. Morrenhof, V. Ahuja and A. Tripathy (eds) *Livestock services and the poor: Papers, proceedings and presentations of international workshop held at Bhubaneswar, India, October 28–29, 2002*. Bern, Switzerland: SDC, and Rome: FAO.

Ramirez, R. and Quarry, W. (2004) 'Communication strategies in the age of decentralisation and privatisation of rural services: Lessons from two African experiences'. *Agricultural Extension and Network Paper* No. 136. London: Overseas Development Institute.

Rangnekar, S. and Rangnekar, D.V. (1999) *Family poultry production in tribal belt of western India*. Free Communication No. 5. First INFPD/FAO electronic conference on family poultry production.

Rees, D., Momanyi, M., Wekundah, J., Ndungu, F., Odondi, J., Oyure, A.O., Andima, D., Kamau, M., Ndubi, J., Musembi, F., Mwaura, L. and Joldersma, R. (2000) 'Agricultural knowledge and information systems in Kenya – Implications for technology dissemination and development'. *Agricultural Extension and Network Paper* No. 107. London: Overseas Development Institute.

Sparks, N., Acamovic, T., Conroy, C., Shindey, D.N. and Joshi, A L. (2004) 'Management of the hatching egg'. Paper presented at XXII world poultry congress, June 8–13, Istanbul.

Subedi, A. and Garforth, C. (1996) 'Gender, information and communication networks: Implications for extension', *European Journal of Agricultural Education and Extension*, Vol. 3, No. 2, pp. 63–74.

Udo, H., Asgedom, A. and Viets, T. (2002) 'Modelling the impact of interventions in village poultry systems', pp. 237–46 in N.C. Kyvsgaard and J. Monrad (eds) Livestock, community and environment. Proceedings of the 10th international conference of the associations of institutions of tropical veterinary medicine Copenhagen: AITVM.

ENDNOTE

1 An AKIS can be defined as: the organisations, individuals and processes involved in the generation and modification of knowledge, and in the transmission and exchange of information, relating to agriculture (Garforth et al., 2003).