

# **Management practices at Poultry Demonstration Centres for boosting backyard farming system in Ramban district of Jammu & Kashmir, India: A review**

## **Abstract**

The Backyard poultry farming is an age-old practice in India and plays an important role to reduce poverty among the most under-privileged sections of the Jammu & Kashmir, particularly in far flung areas of rural J&K, India. There is not any specific arrangement required for backyard poultry farming and is mostly popular in backward and resource-deprived areas of J&K and provides rural families with good source of income, healthy food sources in terms of meat and eggs. Backyard poultry farming improves the status of women in rural communities, creates jobs for rural residents, and closes the gap between supply and demand for chicken products, such as meat and eggs. The high mortality rate among chicks due to frequent disease outbreaks, lack of a framework, lower potential of Desi chickens, lack of scientific information, predation, hunger, climate change, and year-round fluctuations in feed supply and price are some of the major drawbacks of backyard poultry farming in J&K. This farming needs to be improved because it is the best way for J&K's marginal and small farmers to supplement their income with relatively little investment. Nonetheless, the J&K government has started 29 projects under the Holistic Agriculture growth Programme (HADP), of which P25 is only focused on the growth of poultry in J&K.

Backyard poultry farming results in socio-economic development, nutritional and livelihood security, empowerment of women etc. among rural people. Birds are kept mostly on scavenging system, where they acquire their feeds through natural foraging, kitchen wastes etc. Rural poultry farming has been responsible to produce 40 per cent meat and 44 per cent egg requirement in J&K. Chicken eggs and meat are the only cheapest and best sources of protein, vitamin and minerals with high biological value for rural poor and marginal sections of people. The additional income earned from indigenous chicken farming has improved their socio-economic stability.

**Key words:** Backyard poultry, poultry meat, eggs, Indigenous chicken, livelihood security, women empowerment, Holistic Agriculture Development Programme (HADP)

## **Introduction**

“Livestock farming is one of the quickest developing sectors in Indian agribusiness and inside livestock sector, the poultry production in India is showing overwhelming development in spite of a few difficulties experienced in the field conditions. Poultry is one of the quickest developing sectors of the farming area in India with around 8% development rate per annum. The poultry sector in India has experienced a change in perspective in structure and activity which has been its change from a backyard activity into a significant agribusiness-based industry over a period of four decades. Currently the total poultry population in our country is 851.81 Million numbers (increased by 16.81%) out of which 317.07 Millions (37.22 %) are backyard poultry” (Annual Report, DAHD, 2023-24) and egg production is around 138.38 billion during 2022-23 (Annual

Report, DAHD, 2023-24). “Backyard poultry production has shown a tremendous growth rate of 45.78% from last census as compared to commercial poultry (total commercial poultry is 534.74 million) which has increased only by 4.5%. The current per capita availability is around 101 eggs per year” (Annual Report, DAHD, 2023-24). The poultry meat production is estimated to be 4.06 million tonnes (Annual Report, DAHD, 2023-24), which is around 50% of total meat production. However, it is lower than the suggested level of consumption of 182 eggs and 11 kg poultry meat per person per annum by Indian Council of Medical Research. “The poultry sector has got a vital position both in providing work and also contributing a significant extent to the national GDP. Poultry meat is being considered as the best and cheap source of animal protein in many developing countries” (Raveloson, 1990). “In rural areas backyard poultry can be profitably promoted in far flung villages of J&K, as commercial broiler poultry production is usually being preferred in urban and peri-urban areas due to the easy market availability, which has resulted in eradication of malnutrition. Poultry farming in J&K has resulted in mitigation of poverty and creation of lucrative employment in vast rural areas especially in the hilly districts of Jammu division like district Ramban (Figure 3). Market rates (per kg live weight) for backyard poultry is always higher than that of commercially produced broiler birds” (Singh and Pani, 1986). “In current scenario there is great surge in demand of desi or indigenous poultry breed in urban areas due to its better taste, highly nutritious, rich flavor and acceptability among the consumers, which are mostly reared in backyard system” (Conroy *et al.*, 2005; Saikia *et al.*, 2023). “Eggs are cheap and easily available source of protein, Vitamin-A, Vitamin B, Riboflavin, Iron and Zinc” (Drewnowski, 2010). “Chicken and chicken products are excellent sources of some important nutrients such as Vitamin-B12, which reduces child mortality and also improves the maternal health” (Scane, 2007). In spite of the fact that backyard poultry is the most intense hotspot for backup salaries for landless poor ranchers, it has consistently been dismissed. There are plenty of facts to express the role of rural backyard poultry farming in uplifting the food and nutritional security of the poorest households and reducing the livelihood insecurity (Dolberg, 2004). About half (49.5%) of the indigenous chicken farmers meet their day to day expenses by selling their chicken and eggs in J&K (Islam *et al.*, 2021).

### **Backyard Poultry in India and J&K**

“Backyard poultry production system is described as a low input or no input business and is characterized by indigenous night shelter system, scavenging system” (Okot, 1990), natural hatching of chicks (Singh and Pani, 1986), poor productivity of birds (Rashid *et al.*, 1995), local marketing (Rehman, 1995) and no health care practice. “The rural family poultry or village poultry system is known as backyard poultry in India. It can be also considered as a type of organic farming as birds are raised exclusively on natural conditions. It can also be considered as an eco-friendly approach as it provides manure for farmer’s field and also controls pests in field” (Selvam, 2004).

“Backyard poultry production in India is an older farming practice, being practiced since decades. It is an integral component of 89 per cent of the total rural livestock holders in India” (Joshi *et al.*, 2019). It has been a great source of protein and an additional source of income for

the rural farmers (Raveloson, 1990). “But currently with better government policies and better field level extension activities, backyard poultry has shown good growth since last decade and it can further be pushed forward to provide better livelihood and nourishment to rural poor. India has tremendous potential in organic poultry because of the existence of traditional backyard system. India has nearly 70% of its population living in rural areas. However, in the present scenario most of the commercial poultry production is concentrated in urban and peri-urban areas. Just 25% population living in urban areas consumes about 75-80% of eggs and poultry meat. Indigenous poultry are in great demand in urban market as well as in their habitats, as they are considered tastier with high nutritive value as compared to commercial broiler chicken, this makes backyard poultry a profitable business. Free range and small scale semi commercial backyard poultry production can be advantageously promoted in rural areas, as the large commercial poultry production continues to be concentrated in urban and periurban locations. It can be used as a powerful tool for alleviation of rural poverty, eradication of malnutrition and creation of gainful employment in vast rural areas” (Deka *et al.*, 2013). Government of J&K has launched 29 projects under Holistic Agriculture Development Programme (HADP) in which P<sup>25</sup> is exclusively for roadmap for poultry development in J&K. Under which Horti-Poultry Model (Figure 1) poultry birds are reared in open in the orchards. A subsidy of 1.5 lac is provided to the farmers for rearing of 500-layer birds (Free Range Unit-Figures 4&5).

“Poultry production provides to the 5 million people direct or indirect employment in India” (CARI, 2011). “India is the home for many breeds of native chicken like Kadaknath, Aseel, Nicobari, Danki, Tellicherry, Haringhata Black etc, which are still popular among the rural and tribal areas for back yard/free range farming” (Chatterjee and Raj kumar, 2015). “The native chicken varieties adopted in free range backyard conditions for centuries contribute about 11% of total egg production in India” (Kumaresan *et al.*, 2008). In rural areas of India and J&K, chicken reared in backyard are mostly Desi type with low egg and meat production. Specific varieties of birds are available for rearing for meat or eggs like Kashmir Favorolla, Kadaknath (Figure 6), Aseel, Nicobari, Danki, Chabro and few varieties for both (dual purpose). Having realized the importance of backyard rural poultry farming in India, several research organizations have developed different backyard chicken varieties. The two rural chicken varieties i.e. Vanaraja and Gramapriya developed by the Directorate of Poultry Research (DPR) have reached throughout the nation. The birds are performing extremely well in low input system.

“About 75% of Indian poultry produce is being consumed by 25% population. Share of poultry meat in India is highest as compared to other species (BAHS, 2019). It has been estimated that under moderate growth scenario of 6% per annum in the Country’s GDP, by 2030, the demand for meat and eggs is likely to shoot up to 5.9 and 9.5 MMT, respectively” (CARI, 2011). India requires both mass production as well as production by masses (Kumaresan *et al.*, 2008). Thus with the help of appropriate approach and technology, the backyard system of poultry rearing can also be transformed to a successful organic venture.

“India has a vast scope for promotion of organic farming in the export. Production of organic chicken meat is easier as compared to other livestock meat due to its short production cycle and lower production cost” (Biradar *et al.*, 2011). “The existence of traditional backyard poultry farming can be used as a platform for organic poultry farming in India, where no harmful residues existed in eggs and meat. Backyard poultry farming is an eco-friendly approach, where birds can exhibit their normal and natural behavior. Village poultry production is ecofriendly and does not compete for scarce land resources” (Mekonnen, 2007). Indigenous or local breeds or breeds developed with organic and free range may be used for organic poultry farming (Singh *et al.*, 2019).

### **Benefits of Backyard Poultry Farming**

Some of the advantages of backyard poultry farming are: 1. Negligible feed cost (Pathak and Nath 2013). 2. Minimum land, labour and capital is required (Rathet *et al.*, 2015). 3. Provides income to the rural households especially women (Das *et al.*, 2008). 4. Integrates well with other agricultural operations like horticulture. 5. Manure (15 chickens produce around 1-1.2 kg of manure/day). 6. Better price 7. Generate employment in rural areas and help in checking migration of people to urban areas. 8. Skilled labour not required. 9. Availability of egg & meat even in remote rural areas (Panda *et al.*, 2008). 10. Conservation of native germplasm. 11. Alleviates malnutrition (Mapiyeet *et al.*, 2008). 12. Fulfill the increasing demand of protein (Khan and Bidabadi, 2004). 13. “In addition to money, poultry also control pest and provide manure, they are used in festivals, ceremonies treating illness and for meeting social obligations” (Alders, 2004).

### **Types of Backyard Poultry Production System in India**

#### **1. Scavenging back yard poultry**

No specific feeding is required in this system. Few numbers of hens are reared by each family (mostly women). Birds are in free range during day time and are housed during night time.

#### **2. Semi scavenging back yard poultry**

Small poultry flocks that are being raised partly under an intensive system of management and partly under free range system with the scavenged feed accounting for a substantial part of the total feed consumed. Low input and low cost birds with improved productivity recommended. Small size poultry farm started under this system, capacity upto 100 to 500 birds. It fulfills the requirement of part time self-employment.

### **Constraints of Backyard Poultry Farming**

“Mortality due to higher incidences of disease and outbreaks was one of the major constraints in backyard poultry production” (Mandal *et al.*, 2006). “The most important disease that affects birds under free range farming is the Newcastle (Ranikhet) disease” (Horst, 1988). Various other constraints are lack of financial support and high cost of inputs/chicks (Mandal *et al.*, 2006), lack of technical know-how (Deka, 2013), lack of feed ingredient, low hatchability/ early chick mortality/ non-availability of day old chicks round the year (Deka, 2013), lack of deworming and vaccination of the birds (Khandait *et al.*, 2011), attack of predators and early chick mortality.

### **Suggestions for obtaining high returns from backyard poultry farming**

Some of the suggestions are: a) Protect birds from predators-use nets for fencing. b) Provide additional concentrate feed if available. c) Provide clean and fresh drinking water. d) Provide optimum space to avoid overcrowding and disease spread. e) Proper vaccination, deworming and veterinary care. f) Regular disinfection of poultry house and surrounding. g) For appropriate flock size scavengable feed resource base method should be applied. h) Get registered under Holistic Agriculture Development Programme (HADP) and avail the benefits under free range unit scheme. And register yourself on Daksh Kisan portal (<https://dakshkisan.jk.gov.in/>) and get all the valuable information regarding backyard poultry farming. The farmers can also avail benefits of Integrated Poultry Development Scheme (IPDP) for Broiler production.

### **Management of Backyard Poultry**

Poultry can be reared for egg production in small numbers in free range conditions if plenty of natural feed resources are available. But if the local demand is for meat, they can be reared in large number under intensive/semi-intensive conditions by providing all inputs similar to commercial broilers. These birds need to be reared under proper nursery management up to 6 weeks and later they may be released in free range after 6 weeks of age.

### **Incubation and Hatching Management**

“Indigenous birds lay eggs three times a year. Lays 10-20 eggs in a single clutch and 65% of them hatch into chicks. Women collect the eggs and place them all in the nest for hatching. Women keep special care for preparation of warm nest for the eggs by placing a straw on bamboo or broken earthen pot. The nesting place was generally located in isolated dark corner of the house to avoid any disturbance. Generally (8-10) eggs were set under each broody hen and after 21 days, chicks were hatched out” (Mandal *et al.*, 2006). Nest is placed at height to keep eggs safe and away from predators. When the chicks make noise this makes the farmer know the hatching has taken place and help the chicks to come out of shell if required. After hatching, the chicks were generally removed on the second or third day from the broody hens and allowed to scavenge with their mother. Chicks from hens are kept in kachha house prepared by using locally available materials viz. wood, mud, broken bricks, tiles and wire net. Women spend some time on poultry, all they have to provide a night shelter and release them in the morning to scavenge and are usually fed on kitchen waste. To avoid predators they keep poultry on roof or inside house. As such no specific housing is required, only a night shelter is required. Litter material is also not provided.

### **Preparation for Arrival of HatchatPoultry Demonstration Centre**

All the portable equipments are cleaned and washed then dipped in a suitable disinfectant as per manufacturer’s instruction and then sun dry for a day. All the organic material is removed by spraying 5 to 10% formalin. Heat treatment-burning of floor, is also done to reduce the chances

of coccidiosis. Fumigation- 20 gm of KMnO<sub>4</sub> + 40 ml formalin for 100 cu feet. Then the shed is kept vacant for 7 to 10 days.

Before one day of arrival of hatch the temperature of shed is maintained through Bukharis or by Electric heaters. Storage of sufficient amount of portable water. Drinking water for chicks is soft, clear, fresh, clean, colourless and free from any kind of odour. Contaminated water is mostly responsible for a number of diseases like Colibacillosis, Coccidiosis, Salmonellosis, Enteritis, Ascitis, Septicaemia, Hepatitis etc. Plain Newspapers are used for the first 3-5 days of hatch. Afterwards rick husk is used as litter material. Feeders and drinkers are placed for feeding and drinking.

### Brooding Management at Poultry Demonstration Centre

Day old chicks (Chabro) are transported from Belichara Jammu Hatchery or Hatchery at Udhampur in Boxes with carrying capacity of 60 per box around 4000 chicks per hatch (Figure 2). Brooding management is done for first week of age to maintain the required body temperature (90 to 95°F) with relative humidity of 50-65% (Table. 1), as high humidity can lead to wet litter, which can cause high ammonia levels and coccidiosis at poultry demonstration centre. Brooding management is very important to check early mortality. During the first week, chicks are fed with the feed provided by the Joint Director Poultry Jammu. Chicks are reared upto the 3<sup>rd</sup> week and sold during the 4<sup>th</sup> week.

S.No.	Age	Temperature	Chicks (g)
1	1st Week	35.0°C ( 95°F )	11-17
2	2nd Week	32.2°C ( 90°F )	33-44
3	3rd Week	29.4°C ( 85°F )	53-68
4	4th Week	26.7°C ( 80°F )	67-94

**Table 1. Temperature Requirement of Chicks and Amount of feed (g) required at different age groups.**

However, brooding in the rural areas under backyard poultry farming is done in the nest with chicks and hen inside house or safe place to keep them warm. In first week of hatching chicks are fed finely ground rice and clean water. Mother keeps guard of chicks from adult poultry and other potential threats.

### Lighting

24 hours lighting is provided during brooding period, followed by 23 hours and one-hour darkness per day until marketing. For brooding period intensity of one-foot candle or 11 Lux units at birds eye level. *i.e* provide one 40 watt incandescent (round) bulb at 2.4 metres height with reflector for every 20 sq.m area. After the brooding period, about 5.5 Lux or 0.5 foot candle at bird's eye level.

Artificial lights are used for lighting at poultry demonstration centres. Bulbs of 25 to 40 watts are used 7 ft. above the floor and 8 to 12 ft. apart. But artificial lights are not used in kachha house made for backyard poultry especially in rural areas. They exclusively rely on day light when the chicks are allowed to scavage. However, in newly established free range units under

HADP Programme artificial lights are provided to enhance growth and to stimulate egg production in layer birds.

The use of artificial lights stimulate egg production during winter season (October to March).Layers need a certain level of light intensity for 14 to 17 hours per day to achieve maximum egg production. For broiler from 6 to 8 weeks of age, 18 hours light is most efficient for efficient growth. Again, use of two hours on and one hour off duringnight claimed some improvement in feed efficiency, growth rate and marginal saving in electricity.

### **Litter**

The litter is the most important aspect of the poultry production. In poultry demonstrationcentres for first 3 days news papers are provided after that rick husk and saw dust is utilized as litter material. The most important factor in the management of litter is especially the moisture percentage which should be between 20 to 25 percent. Litter material is removed after sale of hatch to the rural farmers and the poultry centre is cleaned and disinfected for new hatch.

In newly established free range units, wood shavings, saw dust, rice husks, wheat straw and dry local grasses are commonly used as litter material. However in some rural areas litter material is not provided in backyard poultry farming.

### **Equipment**

Feed and water is provided in feeder and waterer with carrying capacity of 1.5 to 2 kgs at the poultry demonstrationcentres. Feeder and watererare placed above the litter material with a guard over the waterer to keep birds out of it. Extreme caution is taken to avoid contamination, spillage of water and wetting of litter.

However in backyard poultry farming water is provided in earthen pots, broken buckets etc. Feeding rely upon the scavengeable feed resources and household waste supplemented with a little quantity of feed.Egg/Meat production in backyard poultry farming depends on season's availability of feed and availability of termites, grain from sowing, harvesting byproducts, snails, worms, fodder tree leaves, insects, seeds, grass, grain from sowing, harvesting by-products, waterplants and non-traditional feed materials.

### **Vaccination**

TABLE 2:Following vaccination schedule is followed at poultry demonstration centre.

S.No.	Age	Disease	Route	Dose
1	Day-old	Marek's disease HVT-strain	Subcutaneous (S/C) at hatchery	0.2 ml
2	5-7 days	Ranikhet disease, Lasota/B1/F strain	Intraocular/Intranasal or drinking water	1-2 drops
3	12-14 days	Infectious Bursal disease (IBD) 'MB' intermediate strain	Eye drop Or Drinking water	1-2 drops





Figure 1.Horti-Poultry Model under HADP Programme. Figure 2.Hatch at Poultry Demonstration Centre.



Figure 3. Backyard Poultry Farming in Ramban.. Figure 4.Free Range Unit established under HADP Programme



Figure 5.Free Range Unit established under HADP Programme Figure 6.Kadaknath Chicken.

### Diseases

“Diseases are always a big risk to the poultry farmers. In Backyard poultry farming, disease problems become more pronounced as the bird are kept in open with higher incidence of diseases. As the birds come into closer contact with each other and the faeces as less or no litter



material is used, they become more exposed to infection. Coccidiosis is the most serious disease in poultry. It can be reduced by keeping litter clean and dry. Birds should be vaccinated for Ranikhet Disease with Ranikhet vaccine. As protective measures, farmers should buy their chicks from flock known to show a very low incidence of diseases, which is without any cure. Chicks should be grown on clean litters and it is advisable to sell all the old birds after 1 year of production” (Biradar et al., 2011).

“Poultry houses should be cleaned before placing a new batch and raise them away from the adult flocks. Bio-security measures should be strictly followed to minimise introduction of diseases (All In All Out system should be followed). Infectious germs can be transmitted through all available things like air, feed, water, workers etc. and the important function of bio-security is to prevent the entry of germs causing diseases through these things. Some of the important function of bio-security concerning the prevention of diseases include proper selection of sites, restricted entry of visitors and vehicles, proper storage of feed and feed ingredients, feeding, watering, disposal of sick birds, vaccination programme, personal hygiene of the farm workers etc” (Biradar et al., 2011).

### **Deficiency Diseases**

Mainly two deficiency diseases were observed during the rearing of hatch and was cured by providing essential minerals and vitamins (Supplements) in the feed and drinking water.

**Thiamine (Vitamin B1) Deficiency:** Thiamine plays an important role in the carbohydrate metabolism and normal functioning of the nerves. Symptoms of thiamine deficiency developed quickly in young birds. In most of the birds the head is pulled towards its back as a result of paralysis of extensor muscles, similarly paralysis of extensor muscles of legs causes the bird to sit on hocks. Pulling of the head towards back i.e. Star Grazing Appearance.

**Riboflavin (Vitamin B2) Deficiency:** This vitamin is essential for normal metabolism in body. Its deficiency affects nerves, body growth etc. Important symptoms include inward curling of the toes and sitting on the hocks i.e. Curled Toe Paralysis.

### **Sale of Poultry Birds**

“The birds are sold during 4<sup>th</sup> week at Poultry Demonstration Centres to the local farmers for rearing under backyard poultry system. Then the birds are reared for egg or meat purpose depending upon the demand of that particular area. The rate of desi eggs in market is higher than the commercial ones. Similarly, birds are either sold live or dressed. Common people and hoteliers prefer a bird weighing around 1 kg body weight (live). Therefore, when a chick gets the optimum weight i.e., 1kg to 1.5 kg, it should be sold as per the market requirement” (Biradar et al., 2011).

### **Conclusion**

The birds' low performance was caused by the rural poultry owners' lack of understanding of proper management, breeding, and feeding techniques. Extension programs are

therefore conducted in backyard poultry farming in order to increase the knowledge and proficiency of poultry owners regarding new technology and suggested procedures, thereby enabling them to maximize productivity and, in turn, income. As a result, the emphasis is on giving this industry the right kind of support, including financial aid, genetic stocks and enhanced technologies, scientific guidance, extension, and awareness, especially regarding biosecurity measures. The farming approach incorporates improved indigenous bird varieties and crosses with superior germplasm that are well suited to the local agroclimatic conditions. Government of J&K under Holistic Agriculture Development Programme (HADP) has launched Daksh Kisan portal (<https://dakshkisan.jk.gov.in/>) which empower farmers and agripreneurs by providing access to high-quality training and educational resources. Daksh Kisan portal offers a comprehensive Learning Management System (LMS) with over 121 courses, featuring multi-lingual videos and learning material in four languages. Farmers can get all the valuable information regarding backyard poultry farming to achieve their farming and agripreneurship goals.

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#### **References:**

Alders, R. G. 1996. Facilitating women's participation in village poultry projects: experiences in Mozambique and Zambia. *Proceedings of the 20th World's Poultry Congress*, New Delhi, India **3**:441-447.

Anonymous., 2023-24. Annual Report Department of Animal Husbandry, Dairying and Fisheries. Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi.

BAHS. Basic Animal Husbandry Statistics-2019. Department of Animal Husbandry, Dairying and Fisheries. Ministry of Agriculture, Government of India, Available from, 2019.

Biradar, C.S., Dodamani, M.S., Inamdar, B.K. and Murasalogi, A.J. 2011. Organic poultry farming in India- issues and approaches. *Veterinary World* **4**(6):273-277.

- CARI. CARI perspective plan-Vision-2030. ICAR Central Avian Research Institute. 2011.
- Chatterjee, R.N. and Rajkumar, U. 2015. An overview of poultry production in India. *Indian Journal of Animal Health* **54**:89-108.
- Conroy, C., Sparks, N., Chandrasekaran, D., Sharma, A., Shindey, D. and Singh, A. 2005. Improving backyard poultrykeeping: a case study from India. *Agricultural Research & Extension Network* **146**.
- Das, S.C., Chowdhury, S.D., Khatun, M.A., Nishibori, M., Isobe, N. and Yoshimura, Y. 2008. Poultry production profile and expected future projection in Bangladesh. *Journal of World's Poultry Research* **64**(1):99-117.
- Dekaj, Pankaj., Borgohain., Rupam. and Binapani. 2013. Status and constraints of backyard poultry farming amongst tribal community of Jorhat district in Assam. *Asian Journal of Animal Science* **8**(2):86-91.
- Dolberg, Frands., 2004. Review of Household Poultry Production as a Tool in Poverty Reduction with Focus on Bangladesh and India, in Ahuja, Vinod (Editor), *Livestock and Livelihoods: Challenges and Opportunities for Asia in the Emerging Market Environment*, National Dairy Development Board, India and Pro-Poor Livestock Policy Facility (South Asia Hub) of FAO.
- Drewnowski, A. 2010. The nutrient rich food index helps to identify healthy, affordable foods. *American Journal of Clinical Nutrition* **91**:1095-1101.
- FAO. 2004. Small-Scale Poultry Production Technical Guide. FAO Animal Production and Health.. ISSN 1810- 1119(available at <http://www.fao.org/3/a-y5169e.pdf>). Rome (Italy).
- Horst, P. 1988. Native fowl as reservoir for genomes and major genes with direct and indirect effects on productive adaptability. *Proceedings of World's Poultry Congress*. Nagoya, Japan **18**:99-105.
- Islam, R., Kalita, N., Sapkota, D., Sheikh, I.U., Mahanta, J. D. and Sarma, M. (2021). Characterization of Free-range Indigenous Chicken Production System in North-East India (Assam). *Journal of Animal Research* **11**(1): 59-70.
- Joshi, S. K., Udgata, J. and Satpathy, S. 2019. Prospects of backyard poultry farming in India. *Poultry Punch* **36**(1): 40-48.
- Khan, A.A. and Bidabadi, F.S. 2004. Livestock Revolution in India: Its Impact and Policy Response. *South Asia Research* **24**(2):99-122.
- Khandait, V.N., Gawande, S.H., Lohakare, A.C., Dhenge, S.A. 2011. Adoption level and constraints in backyard poultry rearing practices at Bhandra district of Maharashtra (India). *Research Journal of Agricultural Science* **2**(1):110-113.
- Kumaresan, A., Bujarbaruah, K.M., Pathak, K.A., Chettri, B., Ahmed, S.K. and Haunshi, S. 2008. Analysis of a village chicken production system and performance of improved dual purpose chickens under a subtropical hill agro-ecosystem in India. *Indian Journal of Animal Health* **40**:395-402.

- Mandal, M.K., Khandekar, N. and Khandekar, P. 2006. Backyard poultry farming in Bareilly district of Uttar Pradesh, India: An analysis. *Livestock Research for Rural Development* **18**:101.
- Mapiye, C., Mwale, M., Mupangwa, J.F., Chimonyo, M., Foti, R. and Mutenje, M.J. 2008. A research review of village chicken production constraints and opportunities in Zimbabwe. *Asian-Australas Journal of Animal Science* **21**:1680-1688.
- Mekonnen, G.M. 2007. Characterization of small holder poultry production and marketing system of Dale, Wonsho and Loka Abaya weredas of Southern Ethiopia. A thesis submitted to the Department of Animal and Range Sciences, Awassa College of Agriculture, School of graduate studies, Hawassa University Awassa, Ethiopia.
- Okot, M.W. 1990. A cooperative approach to small-holder poultry production in Uganda. In: CTA Seminar Proceedings, Smallholder Rural Poultry Production, Thessaloniki, Greece. **2**:249-253.
- Panda, A.K., Raju, M.V.L.N. and Rama, Rao. 2008. Poultry production in India: opportunities and challenges ahead. *Poultry Line* **8**:11-14.
- Pathak, P.K. and Nath, B.G. 2013. Rural poultry farming with improved breed of backyard chicken. *Journal of World's Poultry Research* **3**:24-27.
- Rashid, N., Barua, A. and Bulbul, S.M. 1995. A study on the performance of Khaki Campbell, Desi and Khaki, Campbell X Desi ducks with and without extra feeding under rural condition of Bangladesh. *Journal of Animal Science* **8**:375-378.
- Rath, K.R., Mandal, K.D. and Panda, P. 2015. Backyard poultry farming in India: a call for skill upliftment. *Journal of Recent advances in Science* **4**:1-5.
- Raveloson, C. 1990. Situation et contraintes de l'aviculture villageoise à Madagascar In: CTA Seminar Proceedings, Smallholder Rural Poultry Production, Thessaloniki, Greece **2**:135-138.
- Rehman, S. 1995. A study of social and economic aspects of livestock owning Gujjar and Bakarwal tribe of Jammu and Kashmir. Ph.D. Thesis, Division of Extension Education, IVRI, Izatnagar.
- Scane, C.G. 2007. Contribution of Poultry to Quality of Life and Economic Development in the Developing. *World's Poultry Science Journal* **86**(11):2289-2290.
- Selvam, S. 2004. An economic analysis of free range poultry rearing by rural women. *Indian Journal of Poultry Science* **39**(1):75-77.
- Singh, D.P. and Pani, P.K. 1986. Aseel's background and foreground, *Poultry Guide* Feb:53-60.
- Singh, D.V., Mishra, A., Singh, S.R.K. and Athare, T. 2019. Impact of backyard poultry rearing on living standards of tribal community in Kandhamal district of Odisha, India. *International Journal of Current Microbiology and Applied Science* **6**:3908-3914.
- Saikia, Ashim Kumar, Gunjan Gogoi, Prajwalita Pathak, Manoranjan Neog, Prasanna Kumar Pathak, and Rafiqul Islam. 2023. "Comparative Performances of Improved Poultry Varieties

under Backyard Rearing System in Dhemaji District of Assam”. International Journal of Environment and Climate Change 13 (8):2111-17. <https://doi.org/10.9734/ijecc/2023/v13i82169>.

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