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Original Research

A Comprehensive Study on Conventional Poultry Production System in Mizoram

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Abstract

Backyard system of poultry production has been followed by the farmers of Mizoram and so far there is no proper studies concerning the different areas of village poultry production. The study on village poultry production was conducted in three districts of Mizoram and the farmers (n= 126) were selected by using a multi stage sampling procedure. The data on different aspects of village poultry production system like purpose of farming, housing, feeding practice, flock characteristics, production performance, mortality, medication and vaccination were collected, compiled, tabulated, analyzed and discussed. Women work force was more in village poultry management and majority had flock size more than 8 and 36.89% of chicken population were under three weeks of age. Cross bred birds were more in villages and rearing system followed was semi scavenging system. Diseases were the primary cause of mortality and farmers were practicing ethno veterinary medicines for curing the diseases.

Keywords: Backyard, Mizoram, Poultry, Production, Village

Introduction

Poultry production in Mizoram is dominated by village poultry or backyard poultry production. In India, the backyard poultry production shows a steep increase in growth from 217.49 million in 2012 to 317.07 million in 2019 (45.78% growth) (20th Livestock census). India holds 3.10% of total poultry in the world and the fifth largest egg producer (APEDA, 2020). Poultry by products are produced in large quantities at poultry industries which have different uses and it support the economic growth of the country (Mishra *et al*., 2015). The total poultry population in Mizoram is 20,31,406 and among that 20,18,495 are backyard poultry (20th Livestock census). Back yard poultry production uses family labour and birds are confined within a fenced yard or within an overnight shelter (Uro, 2019). Semi intensive or semi scavenging system is referred to as the back-yard system when birds are partly confined for feeding and watering (Badi *et al*., 2012). Back yard poultry rearing is intended for egg and meat purpose of the family and for supplementary income. It provides protein through low input system which is 30% or more of all protein consumption.

In most of the developing counties, only little research and development works have been done on backyard poultry despite their higher numbers (Robert and Robyn, 2012). The present work aimed to understand the existing backyard poultry production system and major constraints in Mizoram. The findings might help in designing as well as implementing poultry development programmes that ultimately benefit the rural people of the state.

Materials and Methods

A survey was conducted in three districts (four villages from each district) of Mizoram *viz*. Aizawl, Kolasib and Mamit. The annual rainfall was estimated to be 208 cm and temperature ranged from 11-29°C. List of poultry owners was collected from Veterinarians working under the state Government and subject matter specialists of Krishi Vigyan Kendra working in the area. A multistage sampling procedure was used and a total of 126 back yard poultry farmers from 12 villages in three districts were selected and preliminary data were collected by using pre-structured questionnaire. Moreover, the selected village chicken farmers were having different flock size along with cooperative nature and good communication skill.

A cross sectional study was carried out spanning for a period of one year and recorded the house hold characteristics, flock size, age groups, breed, purpose of poultry rearing, housing system, feed and feeding system, production performances and causes of poultry loss. Excel spread sheet was used for statistical analysis of the study.

Results and Discussion

Household

Household characteristics of village poultry farmers were depicted in Table 1. In a household, mainly women were involved in rearing the chicken flocks. Works like cleaning, feeding and egg collection were done by women and this was also recorded by earlier workers (Sankhyan *et al*., 2013). Among the selected farmers (n=126), females were 94 (74.60%) and 32 were males (25.40%). Poultry keeping is a vital part of microenterprises maintained by women consisting of agriculture, animal husbandry and horticulture. Beesabathuni *et al*. (2018) suggested the out grower and enterprise development models may be implemented in backyard poultry system for enhancing egg yields, to achieve self-sufficiency and to provide better returns for farmers. Uneducated village poultry farmers were less in Mizoram due to high literacy rate in the state (91.30%) (Census, 2011). Vishwambhar and Lalrinpuia (2017) opined that food accessibility indicators such as literacy (70.60%) and working population (agriculture) are high in Mizoram and poultry farming is 20% among per capita livestock.

Flock Size

Out of 126 numbers of farmers, 89 (70.63%) farmers were found to be consistently engaged in poultry farming. Among these farmers, 76 (60.32%) farmers were having large flock (>8) and 13 (10.32%) were having medium flock (5-8) as detailed in Table 1. Ram *et al*. (2017), in their study at Manipur, observed that medium scale poultry farming is more than the large scale but the criteria observed for differentiation of small, medium and large scale were different.

Table 1: Household characteristics of village poultry farmers

Variable	Category	District						Total (n=126)	
		Aizawl (n=51)		Kolasib (n=34)		Mamit (n=41)			
		Number	%	Number	%	Number	%	Number	%
Age	Young (<25y)	12	23.53	7	20.59	14	34.15	33	26.19
	Middle (25-50 y)	31	60.78	23	67.65	21	51.22	75	59.52
	Old (>50y)	8	15.69	4	11.76	6	14.63	18	14.29
Sex	Male	11	21.57	10	29.41	11	26.83	32	25.4
	Female	40	78.43	24	70.59	30	73.17	94	74.6
Education	Illiterate	3	5.88	2	5.88	3	7.32	8	6.35
	Read & Write	8	15.69	3	8.82	5	12.2	16	12.7
	Primary	19	37.25	14	41.18	15	36.59	48	38.1
	Middle	9	17.65	7	20.59	8	19.51	24	19.05
	High school and above	12	23.53	8	23.53	10	24.39	30	23.81
Family size	Small (<5)	12	23.53	8	23.53	13	31.71	33	26.19
	Medium (5-8)	23	45.1	18	52.94	21	51.22	62	49.21
	Large (>8)	6	31.37	8	23.53	7	17.07	31	24.6
Occupation	Animal Husbandry & Agriculture	15	29.41	12	35.29	15	36.59	42	33.33
	Service	3	5.88	1	2.94	3	7.32	7	5.56
	Business	9	17.65	3	8.82	5	12.2	17	13.49
	Daily wages	6	11.76	6	17.65	8	19.51	20	15.87
	Combination	18	35.29	12	35.29	10	24.39	40	31.75
Experience	<3 y	9	17.65	7	20.59	4	9.76	20	15.87
	3-6y	16	31.37	10	29.41	12	29.27	38	30.16
	>6y	26	50.98	17	50	25	60.98	68	53.97
Land holding	Marginal (<1 ha)	34	66.67	8	23.53	24	58.54	66	52.38
	Small (1-2 ha)	15	29.41	23	67.65	15	36.59	53	42.06
	Medium (4-10 ha)	2	3.92	3	8.82	2	4.88	7	5.56
Flock size	Large (<8)	34	66.67	20	58.82	22	53.66	76	60.32
	Medium (5-8)	7	13.73	3	8.82	3	7.32	13	10.32
	Small (1-5)	10	19.61	11	32.35	16	39.02	37	29.37

Age Groups

It was observed that the flock comprised with highest proportion of chicks (36. 89%) including below 3 weeks (21.42%) and 4-8 weeks (15.47%) followed by hen (22.30%), pullet (15.74%), cock (13.04%) and cockerel (12.03%) as given in Table 2. Overall flock size was 23 among 60 numbers of selected farmers. The flock size recorded in this study was higher than 9.2 (range 5-26) as reported by Mekkonen (2007). However, Abdelqader *et al*. (2007) reported that average flock size was 41.6 (+/-32.9) chickens per household. The variation in flock size might be due to suitability of farming, breeds and presence of factors causing chicken loss like diseases, predators *etc*. However, the flocks with size less than 8 were purposively omitted from the study.

Breed

Cross bred poultry like Giriraja were preferred by 57 (45.24%) farmers besides the traditional preference of Aseel by 30 (23.81%), local ecotypes by 16 (12.70%) and mixed group of poultry by 23 (18.25%) farmers. Cross bred varieties were well adapted in village poultry production system although they were given little care and management. Their ability to scavenge made them ideal poultry to keep under village poultry production system. On the contrary to the present finding, earlier workers opined that indigenous chicken form the largest proportion of small holder's village poultry production system (Moges *et al.*, 2010). Replacement of indigenous chicken by

cross bred birds was probably causing the dilution of the indigenous poultry genetic resources (Hunduma *et al.*, 2010).

Table 2: Age wise population of village chicken

Category	Aizawl (n=51)				Kolasib (n=34)				Mamit (n=41)				%	No.
	1	2	3-5	6-10	1	2	3-5	6-10	1	2	3-5	6-10		
Hen	7.84 (4)	27.45 (14)	54.90 (28)	9.80 (5)	11.76 (4)	26.47 (9)	55.88 (19)	5.88 (2)	17.07 (7)	24.39 (10)	51.22 (21)	7.32 (3)	22.30 (126)	3.3
Cock	35.29 (18)	45.10 (23)	19.61 (10)	-	38.24 (13)	47.06 (16)	14.71 (5)	-	31.71 (13)	48.78 (20)	19.51 (8)	-	13.04 (126)	1.93
Pullet	19.61 (10)	49.02 (25)	29.41 (15)	1.96 (1)	29.41 (10)	44.12 (15)	26.47 (9)	-	31.71 (13)	43.90 (18)	19.51 (8)	4.88 (2)	15.74 (126)	2.33
Cockerel	50.98 (26)	33.33 (17)	15.69 (8)	-	58.82 (20)	29.41 (10)	11.76 (4)	-	48.78 (20)	31.71 (13)	17.07 (7)	2.44 (1)	12.03 (126)	1.78
Chick (0-3 wk)	21.57 (11)	23.53 (12)	39.22 (20)	15.68 (8)	17.65 (6)	26.47 (9)	44.12 (15)	11.76 (4)	24.39 (10)	29.27 (12)	36.59 (15)	9.76 (4)	21.42 (126)	3.17
Chick (4-8 wk)	31.37 (16)	41.18 (21)	23.53 (12)	3.92 (2)	32.35 (11)	44.12 (15)	20.59 (7)	2.94 (1)	31.71 (13)	41.46 (17)	24.39 (10)	2.44 (1)	15.47 (126)	2.29
Total													100	14.8

Purpose of Rearing

Poultry were reared for producing replacement stock by 52 (41.27%) farmers followed by selling by 30 (23.81%), consumption by 20 (15.87%) and common purpose by 24 (19.05%) farmers. The Aseel chicks were sold at high price as most of the birds were used as game bird. Similarly, the eggs produced were used for hatching by 41 (32.54%) farmers, consumption by 25 (19.84%), selling by 24 (19.05%) and common purpose by 36 (28.57%) farmers. Alem *et al*. (2014) recorded that the female headed household use poultry for meat consumption (40%), egg production (35%), parent stock replacement (7.5%) and generation of additional income (10%). The findings in the study area showed that eggs were primarily used for hatching and chicken for breeding followed by selling and consumption due to high demand of coloured eggs among the non-vegetarian tribal people in the state.

Housing System

Table 3: Housing systems practised in village chicken production

Variable	Category	District						Total (n=126)	
		Aizawl (n=51)		Kolasib (n=34)		Mamit (n=41)			
		Farmer	%	Farmer	%	Farmer	%	Farmer	%
System of rearing	Scavenging	1	1.96	1	2.94	2	4.88	4	3.17
	Semi scavenging	40	78.43	28	82.35	31	75.61	99	78.57
	Enclosure	10	19.61	5	14.71	8	19.51	23	18.25
Night shelter	Bamboo basket	17	33.33	13	38.24	15	36.59	45	35.71
	Separate house	25	49.02	15	44.12	20	48.78	60	47.62
	Sharing house	8	15.69	5	14.71	4	9.76	17	13.49
	Roosting on tree	1	1.96	1	2.94	2	4.88	4	3.17
Type of floor	Concrete	4	7.84	4	11.76	5	12.2	13	10.32
	Earth	10	19.61	9	26.47	8	19.51	27	21.43
	Bamboo/wood	36	70.59	20	58.82	26	63.41	82	65.08
	Roosting on tree	1	1	1	2.94	2	4.88	4	3.17
Litter provision	Yes	34	66.67	24	70.59	26	63.41	84	66.67
	No	17	33.33	10	29.41	15	36.59	42	33.33
Type of litter	Rice hulls	6	17.65	5	20.83	6	23.08	17	20.24
	Leaves/Straw	14	41.18	11	45.83	10	38.46	35	41.67
	Gunny bags/clothes	14	41.18	8	33.33	10	38.46	32	38.1

Most of the farmers 99 (78.57%) were practicing semi scavenging system of rearing followed by enclosure rearing 23 (18.25%) with supplementary feeding and scavenging 4 (3.17%) as given in Table 3. However, majority of the farmers provided night shelter to the birds in separate house 60 (47.62%) made up of locally available materials and others kept birds in various night sheltering places like bamboo basket 45 (35.71%), perches inside the house 17 (13.49%) and roosting on tree 4 (3.17%). The separate houses were mostly constructed with little efforts using locally available materials like bamboo, wood, aluminium sheet, polythene and gunny bags. But predators and diseases were more in these types of housing systems. The house and floor made up of bamboo, wood and earth maintained in unhygienic condition predisposed the birds to diseases. Dampness and improper cleaning in moist and humid environment caused by heavy rainfall in the study area also contributed to diseases. Alders *et al*. (2018) opined that elevated houses built with locally available materials can reduce the chance of predation.

Feed and Feeding System

Majority of the farmers practised supplementary feeding to the birds reared under semi scavenging (78.57%) and enclosure (18.25%) system of rearing which is shown in Table 4. Twice in a day feeding was practised by 86(68.25%) farmers and 36 (28.57%) farmers practiced feeding thrice a day during the rainy season from June to September. Feed stuff was mostly produced using kitchen left over by 82 (65.08%) households and food grains like rice and maize by 10 (10.32%) households. Commercial feed was used by 18(14.29%) farmers that rose cross bred variety. Nine (7.14%) farmers used mixed feed. Mixed type of poultry feed was reported in a study conducted by Mbuza *et al*. (2016) at Rwanda. Water was provided *ad libitum* by all the farmers.

Table 4: Different feeding systems practised in village chicken production

Variable	Category	District						Total (n=126)	
		Aizawl (n=51)		Kolasib (n=34)		Mamit (n=41)			
		Farmer	%	Farmer	%	Farmer	%	Farmer	%
Feeding system	Scavenging	1	1.96	1	2.94	2	4.88	4	3.17
	Semi scavenging	40	78.43	28	82.35	31	75.61	99	78.57
	Enclosure	10	19.61	5	14.71	8	19.51	23	18.25
Type of supplement	Food grain	5	9.8	3	8.82	5	12.2	13	10.32
	Food left over	33	64.71	23	67.65	26	63.41	82	65.08
	Commercial	8	15.69	4	11.76	6	14.63	18	14.29
	Mixed	4	7.84	3	8.82	2	4.88	9	7.14
	Scavenging	1	1.96	1	2.94	2	4.88	4	3.17
	Twice	34	66.67	24	70.59	28	68.29	86	68.25
	Thrice	16	31.37	9	26.47	11	26.83	36	28.57
	Scavenging	1	1.96	1	2.94	2	4.88	4	3.17
Feeding practice	Feeding trough	35	68.63	23	67.65	27	65.85	85	67.46
	Unused utensil	15	29.41	10	29.41	12	29.27	37	29.37
	Scavenging	1	1.96	1	2.94	2	4.88	4	3.17
Watering	Commercial trough	9	17.65	4	11.76	5	12.2	18	14.29
	Broken utensil	15	29.41	10	29.41	17	41.46	42	33.33
	Wood/Bamboo trough	25	49.02	18	52.94	17	41.46	60	47.62
	Available sources	2	3.92	2	5.88	2	4.88	6	4.76
Cleaning Frequency	Frequently	15	29.41	10	29.41	12	29.27	37	29.37
	Occasionally	25	49.02	18	52.94	20	48.78	63	50
	Rarely/never cleaned	11	21.57	6	17.65	9	21.95	26	20.63

Production Performance

Production of eggs and its hatchability and survival of chicks were the main criteria of flock productivity in village

poultry production. The production and reproduction performances were recorded under existing manage mental condition and mentioned in Table 5.

Table 5: Production performance of village chicken

Parameter	Aizawl (n=51)	Kolasib (n=34)	Mamit (n=41)	Total (n=126)
Age at first lay (Month)	6.76	6.5	6.39	6.55
Clutch/year	4.03	4.06	3.85	3.98
Egg/Clutch/Hen	18	19	17.25	18.08
Egg/Hen/Year	70.5	75.15	65.41	70.35
Egg weight	42.5	42.75	41.25	42.17
Hatchability	70.5	75	73	72.83
Chick mortality (%)	55	51.25	48.75	51.67
Adult mortality (%)	7.5	8.25	9.5	8.42

Age at First Laying

It is found that first laying of eggs occurred at 6.55 months of age. The cross bred chicken attained sexual maturity earlier than local ecotypes and Aseel breed. Similar studies by different workers indicated a range of age in sexual maturity of female birds such as 7.07 months (Mekonnen, 2007) and 6.88 months (Badhaso, 2012) in Ethiopia.

Egg Production

The average numbers of clutches/year were 3.98, ranging from 3-5 which was slightly higher than finding of Mekonnen (2007) (3.70) from Ethiopia. The average number of eggs/hen/clutches was 18.08 with a range from 12-30. Mekkonen (2007) recorded lower number (14.90) of eggs/clutch/hen in village poultry. The overall mean annual egg production was 70.35 with a range from 35-150. Gueye (2003) reported 37–95 eggs/hen in village poultry production system. The study showed early maturity in village poultry with slightly more number of clutches/year/hen, number of eggs/clutch/and total eggs/hen/year which might be due to the preference of cross bred variety in addition to Aseel and local ecotypes. Moges *et al.*(2010) reported that low production of local chicken ecotypes was due to late sexual maturity and low genetic potential where as Padhi (2016) reported that production potential of native ecotypes in the tropics is low only under small holder farmer's management conditions and with better housing, feeding and health care production increased appreciably. The annual egg production in a flock is influenced by egg production/ hen/clutch, clutch size and proportion of matured hens in a flock besides breed wise genetic potential and managemental conditions. In Ethiopia, a breeding programme for enhancement of the output based on egg production, body weight and survival of indigenous birds were done both in research station and field (Wondmeneh *et al.*, 2016). The average weight of egg was found to be 42.17g, ranging between 38-60g. Halima (2007) also reported the average egg weight of 42.80g in semi scavenging system. However, Badhaso (2012) reported that egg weight of chicken might vary between 38-56g depending on management system.

Hatchability

The average hatchability of village chicken egg was 72.83%. Similar observation was also reported by Moges *et al.* (2010).

Mortality

Overall chick mortality was found to be 51.67%. The mortality was comparatively lower than the earlier findings of Tandell and Ogle (1996) (61%). The adult mortality in village chicken was recorded as 8.42%. In contrast to the present finding, Badhaso (2012) reported much higher adult mortality of 20-30%.

Medication and Vaccination

Vaccination against common viral diseases were not practised as reported by 119 (94.44%) farmers whereas 7 (5.56%) farmers practiced vaccination against Newcastle disease that reared Aseel breed and cross bred chicken (Table 6). Although, Newcastle disease was the major cause which periodically devastated the flocks, vaccination was not practiced due to lack of awareness, non-availability of vaccine, lack of storage facility and large doses vials

than requirement which imparted high cost.

The gaining popularity of cross bred and Aseel bird farming lead to self-medication by 38 (30.16%) farmers with broad spectrum antibiotics, vitamins, minerals and coccidiostatics based on their previous experience. Traditional treatment (ethno veterinary) had been a common practice among the tribal farmers and 23 (18.25%) farmers used local herbs namely capsicum/chilli (*Capsicum annum*), turmeric (*Curcuma longa*), amla/sunhlu (*Phylanthus emblica*) and lemon juice (*Citrus macroptera*) more particularly against Newcastle diseases during outbreak and as prophylaxis. The study revealed that only 30.95% village poultry owners received veterinary services in the form of advisory services and training. Selam and Kelay (2013) reported that 48.30% farmers practiced self-medication and 80% farmers practiced indigenous medicines like lemon, garlic, chilli, local alcoholic drink etc. Eswaran *et al.* (2018) described about the successful treatment of birds suffering from Newcastle disease with a ground mixture of *Cuminum cyminum* seeds, *Phyllanthus amarus* and A*llium cepa* pulp mixed in jaggery thrice a day along with water containing *Cuminum cyminum* @ 10g/litre for five days.

Table 6: Medication and vaccination practices in village chicken

Treatment & Vaccination		District						Total (n=126)	
		Aizawl (n=51)		Kolasib (n=34)		Mamit (n=41)			
		Farmer	%	Farmer	%	Farmer	%	Farmer	%
Treatment	Self	14	27.45	12	35.29	12	29.27	38	30.16
	Veterinary service	20	39.22	3	8.82	16	39.02	39	30.95
	EVM*	7	13.73	8	23.53	8	19.51	23	18.25
	Untreated	10	19.61	11	32.35	5	12.2	26	20.63
Vaccination	Yes	1	1.96	2	5.88	4	9.76	7	5.56
	No	50	98.04	32	94.12	37	90.24	119	94.44

**Ethno Veterinary Medicine*

Constraints

Diseases were recorded as the top ranked and economically most important constraint in village poultry production followed by predation as shown in Table 7. Selam and Kelay (2013) opined that predation (91.90%) and different diseases (86.40%) were major causes of mortality in poultry in addition to inclement weather (0.6%) and mismanagement (0.6%). Occurrence of diseases (Newcastle disease, fowl pox, coccidiosis and respiratory tract infection) and predation were also perceived as major constraints in earlier studies by Sambo *et al.* (2015) and Sharif and Ahmad (2018). Rats, snakes and foxes were the most commonly identified predators and were more prominent during the rainy season when vegetation was increased around the homestead. The incidence/ outbreak of diseases were beginning with the late summer and start of rain and persisting to distress the flock during the rainy season because of erratic temperature, elevated humidity and wind along with inappropriate hygiene and nutrition. The farmers perceived the cyclical (seasonal) endemic nature of diseases like Newcastle disease, fowl pox and coccidiosis resulting in heavy mortality in birds in monsoon and summer with over all chick mortality of 51.67% and adult mortality of 8.42%. High chick mortality (below 8 weeks) due to overload of diseases and predators hindered the consistent rearing of large sized flock.

Table 7: Constraints of village chicken production

No.	Constraints	Frequency	%	Rank
1	Diseases	126	100	First
2	Chick mortality	105	83.33	Second
3	Predators	95	75.4	Third
4	Lack of improved variety	70	55.56	Fourth
5	Lack of financial support	55	43.65	Fifth
6	Lack of Veterinary Service	55	43.65	Fifth
7	Lack of knowledge	42	33.33	Sixth
8	Shortage of space	33	26.19	Seventh
9	Poor hygiene	14	11.11	Eighth

Conclusion

Development of village poultry production may significantly improve the family nutrition and income, employment generation and women empowerment in the hilly tribal state of Mizoram. It can be enhanced by the systematic input of need oriented technical knowhow based on poultry research and extension. Village poultry production is a kind of microenterprise that helps in women empowerment.

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Conflict of Interests

There is no conflict of interest.

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References

1. Abdelqader, A., Wollny, C., & Gauly, M. (2007). Characterization of local chicken production systems and their potential under different levels of management practice in Jordan. *Tropical animal health and production*, *39*(3),155-64.
2. Agricultural and Processed Food Products Export Development Authority (APEDA). (2020). Poultry products. http://apeda.gov.in/apedawebsite/SubHead_Products/Poultry_Products.htm
3. Alders, R. G., Dumas, S. E., Rukambile, E., Magoke, G., Maulaga, W., Jong, J., & Costa, R. (2018). Family poultry: Multiple roles, systems, challenges, and options for sustainable contributions to household nutrition security through a planetary health lens. *Maternal and Child Nutrition*, *14*(Suppl 3), e12668.
4. Alem, A. T., Yayneshet, G. T., & Aklilu, A. H. (2014). "Socio-economic characteristics of poultry production in lowland and midland agro-ecological zones of central Tigray, Ethiopia." *International Journal of Livestock Production*, *2014*, 71-80.
5. Badhaso, B. (2012). The status of indigenous chicken production and marketing system in Ethiopia. *Addis Ababa*. https://en.engormix.com/poultry-industry/articles/status-of-indigenous-village-chicken-production-poultry-production-in-ethiopia-t35476.htm
6. Besbes, B., Thieme, O., Rota, A., Guèye, E. F., & Alders, R. G. (2012). Technology and programmes for sustainable improvement of village poultry production. *Alternative systems for poultry: Health, welfare and productivity*, 110-127.
7. Beesabathuni, K., Lingala, S., & Kraemer, K. (2018). Increasing egg availability through smallholder business models in East Africa and India. *Maternal & child nutrition*, *14*, e12667.
8. Census of India. (2011). Literacy rate among Indian states. Office of the Registrar General & Census Commissioner, India, Ministry of Home Affairs, Government of India.
9. Eswaran, A. M., Mekala, P., Vadivoo, V. S., & Sukumar, K. (2018). Incidence of Newcastle disease in desi chicken and its control through ethno veterinary medicines. *Journal of Pharmacognosy and Phytochemistry*, *7* (6), 1418-1419.
10. Guèye, E. F. (2003). Information dissemination for family poultry research and development. *Livestock Research for Rural Development*, *15*(2), 1-10.
11. Halima, H., Neser, F. W. C., van Marle-Koster, E., & De Kock, A. (2007). Phenotypic variation of native chicken populations in northwest Ethiopia. *Tropical animal health and production*, *39*(7), 507-513.

12. Hunduma, D., Regassa, C., Fufa, D., Endale, B., & Samson, L. (2010). Major constraints and health management of village poultry production in Rift Valley of Oromia, Ethiopia. *Global Veterinaria, 5* (10), 6-10.
13. Livestock Census (2019). Department of Animal Husbandry and Dairying. Government of India. http://dadf.gov.in/sites/default/filess/20th%20Livestock%20census-2019%20All%20India%20Report.pdf
14. Mbuza, F., Manishimwe, R., Mahoro, J. Simbankabo, T., & Nishimwe, K. (2016). Characterization of broiler poultry production system in Rwanda. *Tropical Animal Health and Production*, *49***,** 71–77.
15. Mekonnen, G. (2007). Characterization of smallholder poultry production and marketing system of Dale, wonsho and loka abaya weredas of southern Ethiopia. *Awassa College of Agriculture, Hawassa University (MSc thesis)*.
16. Mishra, J., Biswas, S., Sarangi, N. R., Mishra, R. P., Kumar, N., & Mishra, C. (2015). Efficient Utilization of Poultry By-Products for Economic Sustainability: The Need of the Hour. *International Journal of Livestock Research, 5* (8), 1-9.
17. Moges, F., Abera, M., & Tandelle, D. (2010). Assessment of village chicken production system and evaluation of the productive and reproductive performance of local chicken ecotypes in Bure district, a North West Ethiopia. *African Journal of Agricultural Research, 5* (B), 1739-1748.
18. Padhi, M. K. (2016). Importance of Indigenous Breeds of Chicken for Rural Economy and Their Improvements for Higher Production Performance. *Scientifica, 2016*, 1-9.
19. Ram, D., Singh, M. K., & Laishram, J. M. (2017). Training Needs Assessment of Poultry Farmers in Imphal West and Imphal East of Manipur, *India. International Journal of Current Microbiology and Applied Sciences*, *6*(9), 2218-2227.
20. Robert, P., & Robyn, A. (2012). Introduction to village and backyard poultry production. *Alternative Systems for Poultry: Health, Welfare and Productivity*. 97-109.
21. Sambo, E., Bettridge, J., Dessie, T., Amare, A., Habte, T., Wigley, P., & Christley, R. M. (2015). Participatory evaluation of chicken health and production constraints in Ethiopia. *Preventive Veterinary Medicine, 118*(1), 117–127.
22. Sankhyan, V., Katoch, S., Thakur, Y. P., Dinesh, K., Patial, S., & Bhardwaj, N. (2013). Analysis of characteristics and improvement strategies of rural poultry farming in north western Himalayan state of Himachal Pradesh, India. *Livestock Research for Rural Development, 25* (12), 211.
23. Selam, M., & Kelay, B. (2013). Causes of village chicken mortality and interventions by farmers in Adas district, Ethiopia. *International Journal of Livestock production*, *4* (6), 88 -94.
24. Sharif, A., & Ahmad, T. (2018). Preventing Vaccine Failure in Poultry Flocks. In *Immunization-Vaccine Adjuvant Delivery System and Strategies*. IntechOpen.
25. Snedecor, G. W., & Cochran, W. G. (1994). Statistical Methods. 8th Edition. Iowa State University Press. Ames. Iowa, USA.
26. Vishwambhar, S., & Lalrinpuia, V. (2017). Food security status in rural areas of Mizoram, Northeast India. *Journal of Mountain Science*, *14*(4), 795-805.
27. Uro, T. W. (2019). Implementation of poultry production activities: A review. *International Journal of Advanced Research in Biological Science*, *6*(12), 19-34.
28. Wondmeneh, E., Waaij, E. H. V., Udo, H. M. J., Tadelle, D., & Arendonk, J. A. M. V. (2016). Village poultry production system: Perception of farmers and simulation of impacts of interventions. *African Journal of Agricultural Research, 11*(24), 2075-2081.

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