CHARACTERIZATION OF INDIGENOUS CHICKEN AND THEIR MANAGEMENT PRACTICES IN HASSAN DISTRICT

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CERTIFICATE

This is to certify that the thesis entitled **"CHARACTERIZATION OF INDIGENOUS CHICKEN AND THEIR MANAGEMENT PRACTICES IN HASSAN DISTRICT"** submitted by **Mr. Vinay, M., I D No. MHVK 1907** for the award of the degree of **MASTER OF VETERINARY SCIENCE** in **LIVESTOCK PRODUCTION AND MANAGEMENT** of the Karnataka veterinary, Animal and Fisheries Sciences University, Bidar, is a record of bonafide research work carried out by him during the period of his study in this university under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles.

Hassan

February, 2022 **(Dr. M. C. SHIVAKUMAR)**

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(Dr. SURESH, B. N.)

DEDICATED TO MY PARENTS,

WIFE, DAUGHTERS, MY GUIDE,

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LIST OF ABBREVIATIONS

%	:	per cent
>	:	More than
<	:	Less than
USD	:	United States Dollar
BC	:	Before Christ
i.e.	:	That is
mt	:	Meter
g	:	Gram
kg	:	Kilogram
BAHS	:	Basic Animal Husbandry Statistics
mm	:	Milimeter
cm	:	Centimeter
NBAGR	:	National Bureau of Animal Genetic Resources
µ	:	Micrometer
LB	:	Light brown
B	:	Brown
DB	:	Dark brown

Introduction

I. INTRODUCTION

Among the global poultry resources, chickens serve as the most suitable and economically dominating avian species, particularly in rural areas of developing nations, because they are much easier to handle. Breeds comprised of regionally adapted stocks evolved over millions of years are being replaced at a quicker pace by contemporary industrial stocks. Chicken breeds (*Gallus gallus*) account for the great majority of avian breeds (63%), followed by ducks (11% – excluding Muscovy ducks), geese (9%), and turkeys (5%) (Besbes *et al.*, 2007).

Poultry is one of the fastest growing sectors in Indian livestock industry with a growth rate of eight per cent per annum. Prior to 1960's most of poultry population constituted indigenous chicken or "native" chicken and improved layers were only five per cent. Noticeable change in poultry industry begun during the 1970's with introduction of improved strains and varieties (Sreenivasaiah, 2006). India is the third largest egg producing and fourth largest broiler producing country in the world with an estimated production of 103.3 billion eggs and 4.1 million tons of broiler meat (BAHS, 2019). According to 20th livestock census (2019) poultry population in our country is 851.81 million, out of which 317.07 million poultry belong to backyard poultry which increased by 45.5% from 2012 to 2019. Total egg production in country is 103.3 billion and backyard poultry contributes 18.41 billion which constitute about 17.8 per cent (BAHS, 2019). This reflects the increase in demand for meat and eggs of native chicken and reason may be taste, flavor, aroma and availability.

The largest egg producing state in India is Andra Pradesh (19.1%) followed by Tamil Nadu (18.2%) and Telangana (13.2%). The overall poultry population in

Karnataka is 59.5 million, an increase of 11.33 per cent over the 2012 population and contributes 5.8% of total egg production in country with per capita availability of eggs is 95 which is more than national average of 79 (Livestock census, 2019). Estimates from the All-India Poultry Breeders Association indicate that poultry contributes for USD 17.31 billion of total India's gross value and satisfies the hungers of 50 million people through direct and indirect employment (Kolluri *et al*., 2021).

Across the country, indigenous hens are mostly kept in free range and backyard production methods with little or no adequate housing. Free range and backyard systems have modest input and output. Birds can be easily managed by women, children and elders of households. In recent years because of increased demand for their meat and eggs, indigenous chicken production has gained more attention. Indigenous chicken farming is distinguished by a local night shelter system, scavenging, natural chick hatching, and low bird output. Indigenous birds use kitchen waste, agricultural byproducts, and unconventional scavenging feed resources to efficiently convert into animal proteins such as egg and chicken meat for human consumption, alleviating protein malnutrition in poor rural families. Indigenous chicken meat is in great demand among consumers because to its attractive taste, strong flavour, firm texture, low fat cholesterol and lack of antibiotic residues (Zhao *et al*., 2007: Chen *et al*., 20008). The indigenous chicken plays important role to improve the socioeconomic status of the conventional farmers as it is a user-friendly enterprise with low-cost initial investment, but high economic return along with improving protein deficiency of poor people (Sonkar *et al*., 2020). In India, 72.22 per cent of the population lives in rural regions, and around 89 per cent of rural livestock owners grow poultry as a significant supplemental source of cash income (Khandait *et al*., 2011).

Despite the fact that indigenous and nondescript chicken play a vital part in backyard poultry farming two major limiting factors are poor egg yield and slower growth rates. This might be owing to a lack of suitable breeding programmes for developing indigenous birds for better and more efficient production. Furthermore, there is variability among indigenous chicken in terms of body weight, plumage colouring, plumage distribution, comb type, shank and skin colour, which promotes the adaptation of these breeds to our country's different climatic circumstances. As a result, indigenous chickens have yet to be completely studied for improved development and body features. There is also a need to define indigenous chickens since they were a gold mine of key genes for improving high producing germplasm with tropical adaption and disease resistance.

The indigenous chicken contains an abundance of genetic variety, as well as a number of genomes and significant genes of tropical importance. India and neighbouring nations are said to be the native homeland of Red Jungle Fowl (Gallus gallus), from which modern domestic birds descended (Sudhir Naik, 2021). However, a total of 19 kinds of chicken have been recognised and recorded in India as native breeds. Aseel, Kadaknath, Ghagus, Nicobari, Ankaleshwar, Bursa, Chitagong, Denki, Daothigir, Haringhatta Black, Kalashthi, Kashmir Faverolla, Miri, Punjab Brown, Tellichery, Mewari, Kaunayen, Hansli and Uttara are among them Tripura black, Titri, Teni, Brown Desi, and other lesser-known indigenous chicken ecotypes were also reported (Haunshi and Rajkumar, 2020).

The indigenous chicken population has been drastically diluted in recent years as a result of introduction of exotic breeds, as well as crossbreeding programmes for economic reasons. As a result, the replacement of indigenous breeds with exotic or

commercial breeds of chicken may be connected to an alarming loss of these distinctive qualities threatening the indigenous poultry genetic resource which is critical for future social and economic development (Malvika *et al*., 2019).

Ghagus is the only NBAGR registered chicken breed found in Karnataka and it is distributed in Kolar and adjoining parts of Bangalore districts. The phenotypic characteristics of other local chickens in Karnataka have been studied in the divisions of Mysore, Bangalore, Belagaum, and Gulbarga. Here attempt has been made to study the native chicken phenotypic characteristics of Hassan district as well as their management strategies. This will aid in the exploration of the utility of native chicken in order to produce new types with improved adaption and production potential. Also, it will help to assess the existing situation of indigenous chicken production systems and aid developing a sustainable village chicken production system for development program involving several stakeholders.

Keeping this in view the present study was designed with the following objectives:

1. Characterization of indigenous chicken in different agro climatic zones of Hassan district.
2. Documentation of back yard poultry production systems followed in different agro- climatic zones of Hassan district.

Review of Literature

II. REVIEW OF LITERATURE

2.1 Classification of domestic chicken

Domestic chickens belongs to genus Gallus, which comprises of four morphologically diverse species (i) The red jungle fowl (*Gallus gallus*), which has a geographical distribution encompassing mainland south and southeast Asia; (ii) Grey junglefowl (*Gallus sonneretti*) which can be found in west and south India; (iii) Ceylon or Sri Lankan junglefowl (*Gallus lafayetti*), which is widely present in Sri Lanka and (iv) Green jungle fowl (*Gallus various*) found in Jawa and neighbouring Indonesian islands (Lawal and Hanotte., 2021).

The red jungle fowl is polytypic, featuring five recognized subspecies.

1. G. g. murghi: found in Kashmir, north and north-east India
2. G. g. spadiceus: found in northwest India, Nepal, Bhutan, Bangladesh, Myanmar and south west China
3. G. g. jabouillei: Found in south China, north Laos and north Vietnam
4. G. g. gallus: found in east Thailand, Cambodia, central and south Laos, central and south Vietnam.
5. G. g. bankiva: Found in east Jawa.

2.1.1 History domestication of chicken

Domestication of chickens may be traced back to 2500 BC from the Indus Valley civilisation and even earlier to the ancient neolithic age of 6000 BC from

China. Following domestication, chickens migrated from Asia to Europe, Africa and America resulting in a diverse chicken population that may be divided into conventional, standardized breeds and chosen lines (Rajkumar *et al.*, 2021).

According to archaeological evidence, domesticated chickens existed in China 8000 years ago. Domestication might have occurred independently in India, or tamed birds could have been brought from Southeast Asia. Histories of cock fighting in India dating back 3000 years show that chickens have traditionally been a part of culture. Genomic investigations have suggested that numerous maternal origins can be found in Southeast, East and South Asia, but the haplotype found in the America, Europe, Middle East and Africa appears to have evolved in the Indian subcontinent (Alders, 2012).

All modern breeds of chicken are descended from the Aseel or Malay breed, while the modern domestic fowl (Gallus gallus murghi) is said to be descended from the Red Jungle fowl (Acharya and Bhat, 1984).

Today's genetically varied populations are the product of a long-term evolutionary process that has resulted in adaptations to various environmental circumstances and a wide variety of human requirements. The major causes contributing to today's populations were varied in each case and included founder effects, natural selection, migration, mutation and human selection (Dessie *et al*., 2012).

The globally distributed species Gallus gallus has been most thoroughly characterized for distinct morphological and metric quantitative characteristics, as well as biochemical and genetic markers in recent decades. In comparision to the

other jungle fowls, comparative studies of four representatives of the Gallus genus and chicken breeds revealed that Gallus gallus is the closest species to chickens for most characteristics investigated (Moiseyava *et al*., 2012).

It is estimated that traditional family-based production methods still account for more than 80 per cent of the worldwide poultry population and provide up to 90 per cent of total chicken products in certain countries.

2.1.2 Global indigenous chicken status

Around half of the world's chicken population is concentrated in Asia, with the remaining quarter in Latin America and the Caribbean. Europe and the Caucasus account for another 13 per cent of the world's flock, with Africa accounting for the remaining seven per cent (Ariza *et al*., 2021).

According to Dessie *et al.* (2012) more indigenous chickens are concentrated around the tropics and they also reported phenotypic characteristics of native chicken in Egypt, Ethiopia, Indonesia, Malaysia, Nigeria, Naked neck of Cameron and South Africa. They also summarized the characteristics of Kadaknath, Aseel, Naked neck and Sikkimese frizzle of India.

The majority of contemporary breeds seen in Europe and North America today were established in the late nineteenth century by breeding for display characteristics utilizing both local and imported stock (Crawford, 1995).

More than 90 per cent of rural families in most developing nations raise one or more poultry species (chickens, ducks, guinea fowls, geese, pigeons, etc.) and all rural communities are active in indigenous chicken production. Indigenous chicken

husbandry is an effective system for supplying high-quality protein to the world's rapidly expanding human population and also giving additional revenue to resource-poor small farmers particularly women (Gueye., 2005).

Sheik *et al*. (2018) reported that 72.22 per cent of the Indian population lives in rural parts and around 89 per cent of rural livestock households raise indigenous chicken as a significant supplemental source of cash income and which is contributing 30 per cent to the national egg production. Indigenous chicken raising plays an essential part in meeting the need for stress-free and residue-free chickens.

The Indian birds are largely non-descript and have limited utility as layer birds. All across India, a vast number of chickens of all sizes, shapes and colours, most of which resemble jungle fowls, may be found. They have a variety of appearances depending on where they were bred (Yadav *et al*., 2017).

Sonaiya (1996) explained system of rural poultry farming uses the least amount of land, labour and capital. The birds feed on forage for the majority of their food utilising materials that are no longer immediately valuable to man. It is a low-cost production method that accounts for a substantial portion of the rural economy.

Laenoia *et al*. (2015) described indigenous chicken have long been a component of farmers' traditional rural lifestyles. There are backyard fowls, which are a mix of diverse breeds, sexes and ages and are handled by small scale farmers in rural regions. When compared to commercial or exotic varieties the production of indigenous chicken is relatively low. They are, nevertheless extremely well suited to their surroundings being resistant to illnesses and harsh climates.

Native chicken in the tropics may live and produce despite erratic feed and water supplies and minimal healthcare. Local chickens are slow growers and poor layers of tiny sized eggs. They play an important role in rural families as a source of high-quality animal protein and emergency financial revenue, as well as in the sociocultural life of the rural community. They are however, excellent mothers and good sitters and exceptional foragers who are robust and have inherent immunity to common illnesses. Native chicken's modest body size is a favourable trait in tropical and subtropical environments and their plumage colour helps in protecting themselves against predators (Padhi, 2016). Similarly, Haunshi and Rajkumar (2020) reported indigenous chickens (IC) were formerly the basis of poultry production in the country's rural and tribal areas. Across the country, indigenous chicken production is mostly done in free range and backyard systems with little or no adequate housing and with least amount of input and output.

lal *et al*. 2021 also described indigenous chicken production as a low-cost industry with strong economic returns that can be readily handled by family women, children and the elderly. Rural poultry farming is frequently regarded as a good way to get out of poverty. These give high-value food and income to the poorest segments of society, including landless labour, small and marginal farmersand produce self-employment.

2.1.3 Indigenous chicken breeds, classification and distribution in India

According to National Bureau of Animal Genetic Resource, there are 19 registered chicken breeds in India. These breeds are phenotypically different in feather morphology, feather distribution, plumage colour and pattern, shank colour, comb type and colour, skin colour, eye colour and other characters. The classification

of Indian chicken breeds, as well as their distribution and important features are described.

Table 2.1 Classification, distribution and features of Indian chicken breeds

Breeds	Distribution	Important Features
Heavy breeds		
Aseel	Central, Western and Southern India	They possess pea combs, wattles and ear lobes are bright red and the beak is hart, The body is round and short with broad breast straight back and close. Annual egg production is 92
Chittagong / Malay	Eastern India	Good game bird, plumage colour primarily bay, chestnut, gray, roan, palomino, black, etc, have large eyes
Daothigir	Assam	Plumage colour is mostly black interspersed with white feathers. Comb is red, single, erect and large in size. Annual egg production is 60.
Danki	Andhra Pradesh	Plumage colour: mainly brown followed by black. Cocks have shining bluish black feathers on wings, breast, tail and thighs. The neck is darker compared to the rest of the body. Wattles are absent. Comb is red, pea type and compressed, Annual egg production is 25 - 35.
Ghagus	Karnataka and Andhra Pradesh	The plumage colour is mainly brown followed by black. The colour pattern is usually patchy in males and spotted in females. Shining bluish black feathers are found on the breast, tail and thighs of cocks. The neck is covered with golden feathers. Wattles are absent. Comb is red and pea or single type. Annual egg production: 45– 60.
Tellicherry	Kerala	Plumage color is black with a shining bluish tinge on hackle, back and tail feathers. Comb is red, single and large in size. Annual egg production is 60 – 80.
Punjab brown	Punjab and Haryana	Plumage colour is mostly brown and the pattern is usually solid but is sometimes spotted or striped. Males in particular have black spots/stripes on their neck, wings and tail. The comb is red or single type and erect in position. Annual egg production: 60 – 80.

Light breeds		
Ankleshwar	Gujarat	Comb shape is single, rose-coloured, in females. Annual egg production: 81
Busra	Gujarat and Maharashtra	Plumage is mostly white mixed with black feathers on the neck, back, tail and reddish-brown feathers on shoulders and wings. Comb is red, single, small to medium in size, standard weight of cock and hen ranges from 0.85 to 1.25 kgs and 0.8 to 1.20kgs respectively. Lays about 40-55 eggs annually.
Harringhatta black	West Bengal	Jet black in colour with red comb and wattles while the shanks are white in colour. A small bodied-black bird with typical features of a layer. Annual average egg production is 130.
Kadaknath	Madya Pradseh	Plumage varies from silver and gold-spangled to bluish-black without any spangling. The skin, beak, shanks, toes and soles of feet are slate like in colour. The comb, wattles and tongue are purple, the black pigment is the result of melanin deposition, annual egg production is 80.
Kashmir faverolla	Jammu and Kashmir	They are small sized birds with small single combs and wattles. Feathered comb is the peculiarity of this breed. primarily reared for meat.
Miri	Assam	Plumage colour is white or brown or black. Single comb with red colour. Adult body weight is 1.53 to 4.95 kgs. Annual egg production: 60 – 70, This bird is reared by the Mishing or Miri Tribes of Assam.
Nacked neck	West coast of India	Birds have elongated body with long neck and legs. The predominant plumage color is black followed by brown neck, breast and thighs are generally bare, hard and rose red colored in fighting cocks. Body weight is 1 to 1.5kg. Annual egg production is 80-164.
Nicobari	Andaman and Nicobar Islands	Brownish matte in colour. Comparatively a smaller sized, short legged bird, good layer among native breeds.
Kalasthi	Andhra Pradesh	Plumage colour is bluish black but brown birds are also noticed. The colour pattern is generally patchy in males and spotted in females. Wattles are absent. Comb is red, pea type and compressed.

Non descriptive types		
Brown desi	Uttar Pradesh	Black and brown mixed plumage
Tani	Uttar Pradesh	Black and brown mixed plumage
Titri	Uttar Pradesh	Black and brown mixed plumage

Source: Mohapatra and Panda (1981) and Alok Kumar Yadav *et al*. 2017.

2.2 Field study

2.2.1 Farmer's profile

2.2.1.1 Gender and caste of Indigenous chicken rearing farmers

Women are the main owners of rural poultry farming (Okitoi *et al*., 2007). Ogunlade *et al*. (2013) studied socioeconomic status of women involved in rural poultry production and reported that poultry rearing is a very familiar activity among rural women in many developing countries including India. Dumrya *et al*. (2015) reported that 76 per cent of poultry owners in Sundarban area of West Bengal are women and 46 per cent General caste people rear indigenous chicken followed by 24 per cent scheduled caste 22 per cent other backward caste and 8 per cent scheduled tribe people.

Sourav (2013) did survey in Murshidabad district of West Bengal and found that 48.1 per cent of women are involved in chicken rearing. He also reported that majority of poultry keepers belonged to other backward caste i.e. OBC (84.4%), followed by scheduled caste (8.8%), general caste (6.3%) and scheduled tribe (0.6%).

In a survey of villages in Kannur and Kozhikode districts of Kerala, Kumar *et al*. (2013) reported that 89.06 per cent of women are involved in poultry rearing practices. Mandal *et al*. (2006) did survey on backyard poultry farming and reported

that majority of respondents belonging to general caste (57.5%) followed by Schedule caste (21.67%), Schedule tribe (12.5%) and OBC (8.33%) in Bareilly district of Uttar Pradesh. Islam *et al*. (2021) reported that 83 per cent of women from different agro-climatic regions of Assam were involved in indigenous chicken rearing.

2.2.1.2 Land holding pattern of indigenous chicken rearing farmers

Mandal *et al*. (2006) reported the land holding pattern of poultry keepers in Bareilly district of Uttar Pradesh that 47.92 per cent had less than one hectare, 20 per cent had 1-2 hectare and 27.08 per cent are landless farmers.

As per Dumrya *et al*. (2015) 54.2 per cent of native poultry keepers had less than one acre of land followed by 11.4 per cent had more than one acre and 34.4 per cent poultry keepers had no land in Sundarban region of West Bengal.

Findings of Rajakumar (2013), in the Bangalore division of Karnataka, revealed that 9.22 per cent of indigenous chicken owners have more than 5 acres of land, 29.28 per cent had more than 2 acres of land, 40.95 per cent are marginal farmers with less than 2 acres of land and 20.55 per cent were landless farmers.

Gopinath (2013) studied the land holding pattern of indigenous chicken rearing farmers and reported that 32.11 per cent were having 2 to 5 acres of land 25.16 per cent had more than 5-acre land, 20.05 per cent had less than 2 acre of land and 22.66 per cent were landless laboures.

As per Vij *et al*. (2015) 34 per cent of poultry keepers were landless and owned approximately 35 per cent of the birds, while 48 per cent had up to 0.5 acres of land and owned approximately 45 per cent of the birds and farmers with 2–5 acres of

land owned approximately three per cent of the birds in the Nadia district of West Bengal.

A study by Veerannagowda (2020) in Belgaum division of Karnataka, recorded that 24 per cent of chicken keepers were landless labourers who owned around 30 per cent of the birds, while 40 per cent owned approximately 40 per cent of the birds and possessed up to 0.5 acres of land. The farmers owning 2-5 acres of land had a maximum flock size but they owned only around two per cent of the bird population.

2.2.1.3 Occupation of indigenous chicken rearing farmers

Islam *et al*. (2021) did a survey in four agro-climatic regions of Assam and reported that 39.50 per cent of poultry keepers were depend on agriculture and animal husbandry, 36.50 per cent on agriculture and 19.50 per cent people were Agriculture laboures. As per Mandel *et al*. (2006) occupation of 52.92 per cent of poultry keepers was labour work followed by agriculture (22.50%) and animal husbandry (14.58%) in Bareilly district of Uttar Pradesh. Likewise, Sharma (2018) in his study on indigenous poultry farmers' occupation in Jammu district of Jammu and Kashmir reported that 32.50 per cent depend on Agriculture, 30 per cent were laboures. 15.10 per cent were service people, 13 per cent depend on business and 10 per cent farmer's occupation was animal husbandry.

2.2.2 Average flock size of indigenous chicken

Table 2.2 showing the average flock size of indigenous chicken in different places as per respective authors.

Table 2.2 Flock size

Place of study	Type of bird	Author	Average Flock size
Namakal, Tamilnadu	Indigenous chicken	Selvam (2004)	6.80
Assam	Miri bird	Vijh *et al*. (2005a)	25.20
Jammu and Kashmir	Kashmir favorella	Tantia *et al*. (2005a)	6.50
Andrapradesh	Kalahasthi	Vijh *et al*. (2005b)	13.60
Meghalaya	Indigenous chicken	Gupta *et al*. (2006)	15.85 ± 1.60
Bareilly	Uttar Pradesh	Mandal *et al*. (2006)	4.69
Gujarat	Ankaleshwar	Tantia *et al*. (2006 a)	5-10
Assam	Daothigir	Vij *et al*. (2006 b)	23.00
Uttarkhad	Local hill fowl	Kumar and Kumar (2007)	7.55
Kerala	Tellichery	Vij *et al*. (2007)	5.50
Andaman and Nicobar Islands	Nicobari fowl	Chatterjee and Yadav (2008)	4.40
Kumi district in Eastern Uganda	Indigenous chicken	Kugonza *et al*. (2008)	13.00
Bangalore division, Karnataka	Indigenous chicken	Rajakumar (2013)	18.77±0.12
Mysore division, Karnataka	Indigenous chiken	Gopinath (2013)	18.51
West Bengal	Harringhata Black	Vij *et al*. (2015)	8.86
South-western Ethiopia	Indigenous chicken	Welelaw Edmew *et al*. (2018)	10.43±4.3
Belgaum division, Karnataka	Indigenous chicken	Veerannagowda (2020)	23.07 ± 0.17
Gulbarga division, Karnataka	Indigenous chicken	Sudhir Naik (2021)	6.68± 0.08

2.2.3 Flock structure and rearing chicken with other livestock

Mcainsh *et al*. (2004) studied traditional chicken farming in Zimbabwe and has reported that the cock to hen ratio was 1:6. The average number of adult hens per family was four, while 12% of farmers maintained two or more cocks. Furthermore, for flocks older than 12 weeks, the proportion of female chickens was higher (79%) than males (21%).

In Miri birds, Vijh *et al*. (2005a) found 11 males and 14 females raised at their home tract of Assam per household.

According to Vij *et al*. (2007), the Busra chicken flock was composed of 48 per cent chicks, 39 per cent hens and 13 per cent cocks.

Kugonza *et al*. (2008) observed that the average flock size of indigenous chickens per family in the Kumi area of Eastern Uganda was three cocks, six hens and four chicks.

Kumar (2009) found that the per household flock pattern in native birds of Kozhikode and Kannur districts of Kerala was chicks 1.59±0.30, grower males 0.11±0.05, grower females 0.34±0.11, adult males 0.66±0.12 and adult females 2.67±0.20.

Gopinath (2013) observed average flock composition in indigenous chicken in Chamarajanagar, Mysore and Mandya districts of Mysore division as chicks, 6.97± 0.13; grower male, 3.64±0.10; grower female, 3.50±0.06; mature male, 3.47 0±06; adult female, 2.98±0.06.

In the Bangalore division of Karnataka state, Rajakumar (2013) reported that the average flock size composition of indigenous chicken in Chikkaballapur, Bangalore Rural and Ramanagar districts was chicks, 6.94±0.09; grower male, 2.12±0.01; grower female, 3.17±0.05; adult male, 1.83±0.02; adult female, 4.67±0.04.

In the Belagaum division, Veernnagowda (2020) stated that the average flock size composition of indigenous chicken in Bijapur, Belegaum and Dharawad districts was chicks, 6.93±0.72; grower male, 4.55±0.06; grower female, 5.04±0.05; adult male 1.89±0.02; adult female, 4.66±0.03.

Average number of chicks observed by Sudhir Naik in the Gulbarga division in 2021 was 6.68 ±0.08. The average for grower male (9 to 20 weeks) was 2.03±0.02, whereas the average for grower females was 2.64±0.02.

Sharma *et al*. (2018) reported that 35.83 per cent of indigenous chicken owners owned the cattle, 11.6 per cent rear horse or mule 8.33 per cent rear goat and 4.17 per cent rear sheeps along with poultry. In Kannur and Kozhikode districts of Kerala 23.4 per cent rear indigenous chicken along with cattle, 17.2 per cent had both cattle and goat and 12.5 per cent rear goats (Kumar *et al*. 2013).

2.2.4 The goal of raising indigenous chickens

Kashmir Faverolla was bred for egg and meat in the Jammu and Kashmir districts of Ananatnag, Baramullah, Kupwara, Srinagar and Pulwana, as per Tantia *et al*. (2005a).

The tribal people in Assam raised Miri birds solely for egg and meat consumption during social and religious rituals, according to Vijh *et al*. (2005a).

Vijh *et al*. (2005b) reported that Kalasthi birds were mostly maintained for meat during festivals in Andhra Pradesh.

Vij *et al*. (2005) discovered that Danki birds in Andhra Pradesh were mostly utilised for game and meat and the Danki chicken eggs were retained for incubation.

In field research on Daothigir birds in the Assam region, Vij *et al*. (2006b) found that the birds were primarily maintained to fulfill domestic meat and egg requirements.

Iqbal and Pampori (2008) documented the aim of raising indigenous Kashmir chickens for self-consumption in the traditional method.

According to Kugonza *et al*. (2008), in Uganda, local chicken was mostly farmed for household revenue and domestic use. Chickens were traded for goats and animals in certain homes.

Kumar (2009) found that in the Kerala districts of Kozhikode and Kannur, the per centage of birds kept for both marketing and self-consumption was 21.87 per cent male and 7.81 per cent female.

In the Chamba area of Himachal Pradesh, Thakur *et al*. (2012) stated that farmers have kept local indigenous chickens mostly for their own food and also for sale.

In Bangalore division of Karnataka, Rajakumar (2013) research survey reported 45.94 per cent of indigenous chicken farming for home consumption, 6.89 per cent for marketing purposes and 47.17 per cent for combined home consumption and marketing purposes. Similar to this Gopinath (2013), reported the aim of growing

indigenous chicken in the Mysore division was for sale 6.55%, own consumption 54.9%and both 38.5%.

According to Veerannagowda's (2020) survey, 45.17 per cent of farmers grow indigenous birds for their personal use, 8.22 per cent for solely marketing and 46.61 per cent for both.

Sudhir Naik (2021) found that the per centage of birds bred for sale was 10.53, for personal use was 26.50 and for combined sale and own consumption was 62.96 in the Gulbarga division.

2.2.5 Housing practices

As per Mcainsh *et al*. (2004), Zimbabwe's small holder chicken population used to be on a wide free-range system with extra shelter at night close to the animal shed.

Aseel birds are only confined in kuthcha and thatched homes at night according to Pandey *et al*. (2005) and are allowed to roam freely during the day.

Miri birds raised in backyard farming were released during the day and protected at night, according to Vijh *et al*. (2005a).

Badubi *et al*. (2006) performed a survey and discovered that 64.3 per cent of farmers did not offer any shelter for chickens, whereas just 35.8 per cent of farmers did. The shelters were composed of 2.8 per cent corrugated iron, 5.3 per cent thatch and 29.6 per cent various materials such as plastic bags and wire net.

Punjab brown birds raised in backyard systems were released in the morning for scavenging in the area and housed at night. Approximately 10 per cent of farmers restrict their birds both during the day and at night (Vijh *et al*., 2006a).

Daothigir birds were reared in an open area where they could roam freely in the forest and eat available feed in the form of grains, seeds, foliage, insects and other insects. They then returned to the owner's house in the evening (Vij *et al*., 2006b).

The Nicobari birds were primarily bred in free range/scavenging on the Andaman and Nicobar group of islands (Vijh *et al*., 2006). The birds meet their nutritional needs for maintenance and reproduction in and around the homes, surrounding forests and nighttime refuge next to other animal sheds or human houses.

According to Tantia *et al*. (2006a), the Ankleshwar birds bred in a free range/backyard system were given a tiny shelter adjacent to the home to protect them from predators.

To save money on feed, indigenous chicken keepers in Uttarakhand used confined housing with grazing in open areas, according to Kumar and Kumar (2007). During the night, a common shelter was provided together with other cattle. The Tarai and Bhabar nomads, on the other hand, practiced solely free-range rearing.

Tellicherry birds were bred on a free-range basis in their home tract in Northern Kerala, according to Vij *et al*. (2007) and were given refuge at night in wooden coops at their house.

Gopinath (2013) reported that 78.27 per cent indigenous chicken rearing farmers provide housing for indigenous chicken in Mysore division of Karnataka.

Islam *et al*. (2021) reported in four agro-climatic regions of Assam that 63 per cent provide housing along with owner residence followed by 26.5 per cent provide separate housing.

As per Vij *et al*. (2015), the Harringhata Black breed is mostly grown in conventional backyard systems with no provision for bird shelter and is kept on a free-range basis.

Farmers in the Dharmapuri area of Tamil Nadu did not offer separate housing and relied on the backyard way of raising, as per Thangadurai and Shanmugam (2019). During the night the birds seek refuge on nearby trees.

2.2.6 Separate shelter to indigenous chicken

Local chicken in Zimbabwe were kept in coops built of wooden poles, branches, or bricks with one or more sides with mesh wire doors. Thatch, iron sheets, asbestos sheets and canvas are common roof materials and no litter items were detected within the pens/houses (Mcainsh *et al*. 2004).

According to Pandey *et al*. (2005) Aseel birds are maintained in kutcha and thatched homes at night and in a free-range system during the day.

During the night, the Kashmir Faverolla birds were supplied with separate housing with a thatched roof and mud flooring, as per Tantia *et al*. (2005).

Vijh *et al*. (2005b) revealed that Kalasthi bird housing was in an open space, with the birds permitted to spend their evenings on trees or roof tops but the fighting cocks were housed separately in baskets.

Danki birds were housed in both confined and open areas, as per Vij *et al*. (2005). Aggressive cocks were kept in homes with thatched roofs and wooden posts to keep the sun out.

Miri birds were only housed in bamboo cages at night, as per Vijh *et al*. (2005a). According to Vij *et al*. (2006a), the shelters built for Punjab brown chickens were tiny and primarily constructed of mud (68%), bricks (30%) and wood (2%). Vijh *et al*., (2006) reported Nicobari birds primarily slept at night and their shelters were built of low-cost local materials. Birds were also known to spend the night on trees.

According to Kumar and Kumar (2007), mountainous farmers in Uttarakhand employ confinement houses, litter floors and wooden cages to raise indigenous hill fowls. Local resources were used to construct the homes, which were primarily wire mesh.

Almost all farmers in north-west Ethiopia provided night protection for native chickens, as per Halima *et al*. (2007b): in part of the kitchen (l.36%), in the main home (39.07%), in hand-woven baskets (7.29%), in bamboo cages (1.51%), or in a separate shed constructed for hens (50.77%).

According to Vij *et al*. (2007), Tellicherry chickens were housed in wooden homes raised two to three feet above ground level. Nicobari birds were only given shelter at night, according to Chatterjee and Yadav (2008). Small, low-cost homes were constructed using locally accessible materials. Birds were occasionally cornered in the house along with the owner's home or other livestock.

Das *et al*. (2008) reported that chicken shelters in Bangladesh's rural areas are often built of locally accessible materials such as wooden barks, bamboo, mud, or mud bricks. As per Iqbal and Pampori (2008), in the traditional way of farming, native chickens of Kashmir were offered night shelter in the form of tiny and basic homes and in backyard rearing, in addition to night shelters, a fenced backyard was also provided.

Findings of Rajakumar (2013) revealed that 83.83 per cent of farmers do not offer separate homes solely for the birds. However, 16.27 per cent of farmers supplied defined house space constructed from locally accessible resources in Bangalore division of Karnataka.

As per Vij *et al*. (2016), Kaunayen birds from Imphal valley of Manipur are confined at night in single-story enclousers composed of wood or bamboo and wire mesh. As per Veerannagowda's (2020) study, the majority of farmers in the Belgaum division (70.50%) do not offer separate homes for their birds. However, 29.50 per cent of farmers supplied dwellings with available resources.

Sudhir Naik (2021) performed survey research in Gulbarga division and found that the proportion of separate housing facilities supplied by farmers in Gulbarga division was 18.06 per cent in Bidar, 23.23 per cent in Gulbarga and 16.84 per cent in Koppala.

2.2.7 Hatching system

According to Ondwasy (2006), to keep eggs from decaying, keep them in a clean, dry area. Because viable eggs expand slowly, eggs older than 14 days should not be utilised for hatching. Iqbal and Pampori (2008) discovered that the number of

eggs under the hen in Kashmiri indigenous chickens for hatching is 12-14 and that the best months for hatching are February – March and August – September.

Vijh *et al* (2006) reported that paddy straw and wood shavings was used as a bedding material in Miri birds of Bangladesh.

According to Sankhyan *et al*. (2013) in Himachal Pradesh's northwestern Himalayan state, the average hatchability and survival (up to 6 weeks) shown in their study were 82.6 per cent and 68.3 per cent, respectively. The majority of farmers used their own eggs for hatching and hatching egg selection is typically based on indigenous knowledge and experience.

According to Sethi (2007) the inhabitants of Orrisa have indigenous knowledge of Elongated eggs with point ends hatching male chicks and eggs with rounded ends hatching female chicks. This notion may be found in nearly every region in Orissa.

Rafiqul Islam *et al*. (2021) documented in four different agro-climatic zones of Assam that selection of hatching eggs was not practiced by 68 per cent of the farmers, while the remaining practiced selection of eggs before incubation. The survey also indicated that the average number of eggs laid per broody hen or duck was 13.59±0.23.

McAinsh *et al*. (2004) reported in Zimbabwe, brooding chicken nests are typically put outside the chicken house and raised at least 1.5 mt. Nests might be made of wood, circular woven straw, cardboard boxes, or buckets. Grass was commonly used as nesting material.

Kumar *et al*. (2013), documented in Kannur and Kozhikode districts of Kerala, the nest box materials used in natural incubation include plastic cans (21.9%), rubber baskets (17.2%) and steel mortar pans used in construction works (14.1%), broken earthen pots (12.5%), wooden crates used in vegetable packing (9.4%) and baskets made of areca palm spathes (1.6%); while, 23.4 per cent of the farmers set the eggs directly on the floor, 14.1 per cent of farmers use no nesting material within the nest box, The remaining used sand, paddy husk, straw, clothing, ash or coir fiber and the per centage is 51.6, 15.6, 12.5, 3.1, 1.6 and 1.6 respectively.

2.2.8 Egg production

2.2.8.1 Egg laying cycles per year

Singh *et al*. (2000) reported that it takes four months for an Aseel bird to complete one laying cycle and three laying cycles in one year. According to Vij *et al*. (2005) a Danki hen's laying cycle lasts at least four months, with an average of two to three cycles per year.

As per Vij *et al*. (2006b), Daothigir birds take three and half to four months to complete one laying cycle, hence the number of cycles per year ranged from three to three and half. Vij *et al*. (2007) reported the length of one laying cycle in the Tellicherry breed of chicken ranges from 3.7 to 4 months, with a mean of three cycles each year.

Kalitha *et al*. (2011) reported that indigenous chicken of Assam hens requires three months to complete one laying cycle, with an average of four cycles per year. As per Ravi Kumar (2011) the Aseel has an average of three to four cycles every year.

According to Gopinath (2013), the indigenous chicken of Karnataka's Mysore division has an average of 2.8 to 2.97 cycles every year. Vij *et al*. (2015), reported that clutch size (days) of the Harringhatta Black chicken was 5.98±0.51 and the clutch interval (days) was 2.21±0.32. As per Welelaw Edmew *et al*. (2018) indigenous chickens from SouthWestern Ethiopia have an average of 3.74±1.3 cycles per year.

Veerannagowda (2020) reported that egg cycles per year varied from 2.22±0.02 in Dharawad to 2.60±0.02 in Bijapur and 2.65±0.02 with over all mean 2.48 in Karnataka's Belgaum division. Sudhir Naik (2021) reported the number of cycles each year ranged from 1.99±0.03 in Koppala to 2.35±0.03 in Gulbarga. The aggregate average number of cycles observed in the Gulbarga division was 2.19±0.02.

2.2.8.2 Egg output per cycle and year

Table 2.3 summarizes the yearly egg production in numerous indigenous native breeds, as well as their egg output per year and egg production each cycle, as reported by various authors. Annual egg production in Indian native chicken ranged from 25 (Danki) to 148 eggs (Nicobari) with the number of eggs each cycle ranging from 10 to 20.

2.2.9 Marketing of birds

Vijh *et al*. (2006) reported that age of marketing for Nicobari cocks was nine months and twenty-four months for hens. As per Kalitha *et al*. (2011), the selling age of Assamese indigenous birds is five months for cocks and twelve months for hens.

Kumar *et al*. (2013) reported that culling age of female indigenous birds in Kannur and Kozhikode district of Kerala was three years.

Table 2.3 Egg production per cycle and per year in indigenous chicken under field condition

Author	Breed	Eggs per year	Eggs / per cycle
Singh *et al*. (2000)	Aseel	33.17	10-12
Pandey *et al.* (2005)	Aseel	30-36	10-12
Vij *et al*. (2005)	Danki	25-35	10.60+0.48 (8 to 12)
Bhuiyan *et al*. (2005)	Desi chicken of Bangaladesh	45-50	-
Vijh *et al*. (2005a)	Miri	62	15-25
Tantia *et al*. (2005a)	Kashmir faverolla	60-85	-
Vijh *et al*. (2005b)	Kalasthi	34	11.30
Tantia *et al*. (2005b)	Ghagus	45-60	15-20
Badubi *et al*. (2006)	Botswana indigenous	-	15
Vij *et al*. (2006a)	Punjab Brown	-	-
Vij *et al*. (2006b)	Danki	-	10.60±0.48
	Kalasthi		11.3±0.39
	Ghagus		17.34±0.69
Tantia *et al*. (2006a)	Ankleshwar	79.35±0.29	-
Vij *et al*. (2006b)	Daothigir	60-70	20.0±1.02 (15 to 28)
Vijh *et al*. (2006)	Nicobari Brown / Black/ White	148.7±1.09	-
Vij *et al*. (2007)	Tellicherry	-	20-25
Kumar and Kumar (2007)	Local hill fowl of Uttarakhand	90 to 150	-
Das *et al*. (2008)	Desi chicken of Bangladesh	35-40	-
Iqbal and Pampori (2008)	Kashmiri	-	12-15

Author	Breed	Eggs per year	Eggs / per cycle
Kalitha *et al*. (2009)	Indigenous chicken of Assam	62.60±1.56	12.96±0.29
Haunshi *et al*. (2010)	Aseel	36.23 (40wk)	
	Kadaknath	49.40 (40wk)	
Kalitha *et al*. (2011)	Indigenous chicken of Assam	50-60	
kumar (2011)	Aseel	30-60	10-12
Gopinath (2013) Indigenous chicken of Mysore division	Chamarajnagar	46.79±0.65	16.00±0.18
	Mysore	44.43±0.62	15.29±0.13
	Mandya	41.58±0.61	14.92±0.13
Rajakumar (2013) Indigenous chicken of Bangalore division	Chikkaballapur	52.21±0.61	17.48±0.06
	Bangalore rural	54.27±0.59	17.97±0.05
	Ramanagar	48.07±0.61	16.16±0.10
Jha *et al*. (2013)	Desi	(40Wk) 1183±3.72 (72wk) 61.83±4.83	
Bett *et al*. (2014) Indigenous chicken	Bangladesh		14.8±0.46
	Sri Lanka		19.2±1.26
	Vietnam		12.9±0.19
	Pakistan		23.6±1.71
	Total Mean		16.0±0.37
Negassa *et al*. (2014)	Indigenous chickens Southeastern Ethiopia		15.4±2.34
Anitha *et al*. (2014) Varieties of native breeds	Varayankozhi	62	
	Velumbikozhi	54	
	Pullikozhi	71	
	Karumbikozhi	30	
	KooriKozhi	82	
	Chembankozhi	73	
Vij *et al*. (2015)	Harringhata Black	45 with brooding 98 without brooding	12.32±0.19
Mohyeldein *et al*. (2015)	Sudanese Nativechicken		11.56
Vij *et al.* (2016)	Kaunayen	35	10-12
Karuna *et al*. (2017)	Aseel	62	
Roy *et al.* (2018)	Haringhata Black	129 (72 weeks)	
Welelaw *et al*. (2018)	Indigenous chicken of South-Western Ethiopia	54.6±13	14.8±3.56

Author	Breed	Eggs per year	Eggs / per cycle
Veerannagowda (2020) Indigenous chicken of Belagaum division in Karnataka	Bijapur	39.80 ± 0.42	15.40 ± 0.10
	Belagaum	48.27 ± 0.48	18.65 ± 0.17
	Dharawad	37.78 ± 0.31	17.11 ± 0.09
	Overall mean	41.95 ± 0.26	17.05 ± 0.08
Sudhir Naik (2021) Indigenous chicken of Gulbarga division in Karnataka	Bidar	44.85± 0.11	15.72± 0.06
	Gulburga	45.29± 0.13	14.70± 0.06
	Koppala	44.39± 0.11	14.20± .007
	Overall mean	44.84± 0.07	14.87± 0.04

Gopinath (2013) reported that marketing age of male indigenous birds in Mysore district was six months and seven months in Mandya district of Karnataka.

As per Veerannagowda (2020) on marketing age of birds, the average age of female birds at marketing was 8.99±0.08 months in Dharawad district, 11.97±0.06 months in Bijapur district and 12.45±0.07 months in Belgaum district. The mean age of male bird culling ranged from 8.280.06 months in Dharawad district to 9.34±0.17 months in Belgaum district and 9.51±0.05 months in Bijapur district.

Islam *et al*. (2013) reported that the most culling age of male female indigenous birds were was seven months followed by one to two years of age in Assam.

2.2.10 Consumer preference

Bet *et al*. (2011) observed in a study on local hens in Kenya that customers had a poor preference for black chickens since they were usually employed in witchcraft.

Muhukambele (2019) found that in Tanzania, when it came to plumage colour, more than half of customers favoured mixed colour plumage chicken mostly for aesthetic reasons followed by brown colour plumage. Black chickens were less preferred because they were related with local traditional beliefs that black chickens were utilized for witchcraft.

Islam *et al*. (2013) reported that demand for indigenous chicken was more during festival seasons in different agro-climatic regions of Assam.

2.2.11 Purpose of rearing

The majority of farmers bred the birds for their personal use of eggs and meat which were then sold in excess as a source of subsidy money primarily by women.

Tantia *et al*. (2005 a) reported that Kashmir Faverolla were raised for egg and meat production.

Vij *et al*. (2005) reported Danki birds in Andhra Pradesh were mostly used for meat and game.

According to Vijh *et al*. (2005a), Miri birds were raised solely for egg and meat consumption during social and religious occasions by the tribal people.

According to Vijh *et al*. (2005b), Kalasthi birds in Andra Pradesh are mostly kept for meat and their value for egg production is restricted due to their low laying capability (30 to 40 eggs per year). Cocks, on the other hand, were employed for combat.

As per Vijh *et al*. (2006), Nicobari fowl of Andaman and Nicobar Islands were mostly employed for eggs due to their best laying capability among the indigenous chicken breeds in India with supplementary feeding under a free-range mode of raising.

Iqbal and Pampori (2008) documented the traditional method of breeding indigenous Kashmir chickens solely for personal use.

Kumar (2009) reported the per centage disposal method of surplus male and female birds for personal use in Kerala's Kozhikode and Kannur districts was 50 and 7.81 birds, respectively.

Rajakumar (2013) found that the per centage of indigenous chicken reared for personal use was 47.17 in Chikkaballapur, 45.33 in Bangalore Rural, 45.33 in Ramanagar and 45.94 overall. According to a survey conducted by Veerannagowda (2020) in the Belgaum division, the per centage of farmers rearing indigenous chicken for their own consumption was 45 per cent in Bijapur, 43.5 per cent in Belagaum and 47 per cent in Dharawad, with the overall mean of the 45.17 per cent in Belgaum division.

2.2.12 Egg consumption and marketing

According to Mcainsh *et al*. (2004) Zimbabwean farmers raised chicken for both marketing and domestic use. Vijh *et al*. (2006) reported that Nicobari fowl of Nicobar Island was largely reared for egg purposes since it produces more number of eggs among known indigenous chicken breeds of India even under free range conditions with supplementary feeding. These eggs were either consumed by themselves or sold to generate revenue. As per Vij *et al*. (2006c) findings Danki birds are utilised for game, usually grown for commercial and meat purposes but eggs are not marketed.

Kumar and Kumar (2007) reported that the goal of raising native hill fowl in Uttarakhand was to generate both egg and meat for sale or for cultural and religious purposes. As per Das *et al*. (2008), the traditional free range, backyard and scavenging chicken maintained by women and children in rural Bangladesh contributes significantly to family income in addition to home consumption of egg and meat.

Kugonza *et al*. (2008) reported that local chicken was primarily reared in Uganda to provide household revenue as well as for domestic consumption. Chickens were traded for goats and calves in certain homes.

Iqbal and Pampori (2008) documented the objective of producing indigenous Kashmir chicken for self consumption as well as sale in backyard rearing. Kumar (2009) found that in Kerala's Kozhikode and Kannur districts, the per centage of birds kept for exclusive selling and self-consumption was 21.87 per cent male and 7.81 per

cent female. According to Thakur *et al*. (2012), the farmers have kept local indigenous chickens for their own food as well as for sale.

Gopinath (2013), reported that objective of growing indigenous chicken in Mysore division was 6.55±0.67% for sale, 54.94±1.66 % for own consumption and 38.5±1.26 % for both. As per Rajakumar (2013), the proportion of birds kept for both self consumption and marketing was 44.50 in Chikkaballapur, 48.83 in Bangalore Rural, 48.17 in Ramanagar and overall mean is 47.17.

According to Vij *et al*. (2015), the Harringhata Black breed is raised in the traditional backyard system and is mostly maintained by women (99.7%). They have kept both for meat and eggs for their own consumption as well as a source of income. As per the survey of the Veerannagowda (2020) in the Belgaum division found that 45.83 per cent of farmers in Bijapur, 49 per cent in Belgaum and 45 per cent in Dharawad raise indigenous birds for both selling and personal use. The total mean value was 46.61 per cent.

According to a survey done by Sudhir Naik (2021), the per centage of farmers rearing indigenous chicken only for sale was 10.21 (Bidar), 11.46 (Gulbarga) and 9.12 (Koppala), the per centage of farmers rearing indigenous chicken for own consumption was 24.29 (Bidar), 30.24 (Gulbarga) and 24.56 (Koppala) and the per centage of farmers rearing indigenous chicken for both rearing and own consumption was 65.49 (Bidar), 57.64 (Gulbaraga) and 66.31 (Koppala)

2.2.13 Feeding practices

Vijh *et al*. (2005a) reported that Miri birds were not provided specialized feed but were free to forage in their surroundings. According to Vij *et al*. (2006b)

Daothigir birds scavenge freely in the woodland region for grains, seeds, foraging foliage, insects and other natural feed sources. As per Vij *et al*. (2007) Tellicherry chickens in Kerala scavenge and consume accessible grains, seeds, plantsand insects in the field. Mandel *et al*. (2006) reported in Bareilly district of Uttar Pradesh that all farmers rearing indigenous chicken follow scavenging system of rearing.

As per Pankaj *et al.* (2013) management practices of indigenous chicken in tribal villages of Assam were 100 per cent semi-intensive rearing.

Mcainsh *et al*. (2004) discovered that, apart from scavenging feed resources, Zimbabwean farmers offered modest supplementation to hens, consisting of domestic trash and some homegrown feed such as maize, sorghum, millet and pumpkin seeds.

Observations of Rajakumar (2013) revealed that 75.95 per cent of farmers fed extra grains to birds on a regular basis, while the remaining 24.05 per cent did not. When compared to Chikkaballapur per centage of farmers in Ramanagar (80.34) and Bangalore Rural (78.34) consistently contributed additional grains (68.66).

Veerannagowda (2020) revealed that the majority of farmers in the Belagaum Division (72.50 %) offered additional grains to indigenous birds; remaining (27.50%) did not supply any extra rations. In comparison to the Bijapur district, farmers in Belgaum (70.33%) and Dharawad (81.33%) contributed supplemental rations on a regular basis (65.83%).

Farmers offered extra grains or supplementary feed in addition to scavenging birds in Bidar, Gulbarga and Koppala districts respectively with a per centage of 65.94, 73.00 and 70.97 in Bidar, Gulbarga and Koppala (Sudhir Naik 2021).

2.2.14 Vaccination of native chicken, ethno-veterinary medicine usage and Constraints for rearing indigenous chicken

In a field study by Rajakumar (2013) found that 36.38 per cent of farmers vaccinated against ND on a regular basis; the proportion was greatest in Chikkaballapur (62.16%), followed by lesser immunization in Bangalore Rural (27.00) and Ramanagar (21.00%).

Tantia *et al*. (2005a) reported that Kashmir Favorolla birds were immunized against Ranikhet and chicken cholera. Tantia *et al*. (2005b) stated that Ghagus birds have been immunized against fowl pox and Ranikhet. Vijh *et al*. (2005b) found similar observations in Kalasthi birds, as did Vij *et al*. (2006b) in Daothigir birds.

As per study by Gopinath (2013) in mysore division of Karnataka that only 39 per cent of farmers rearing indigenous chicken follow vaccination for their flock.

Veerannagowda (2020) reported that vaccination against ND was carried out on a regular basis by 54.00 per cent of farmers in the Belagaum division; the proportion was greatest (64.17%) in Dharawad, followed by Bijapur (57.00%) and Belgaum (40.83%).

Vinothraj *et al*. (2019) reported majority of farmers in Erode district of TamilNadu were using ethno-veterinary medicines like pepper, onion and cumin to treat the birds. As per Gueye (1999) 35 per cent poultry keepers in Nigeria, 58 per cent in Tanzania, 59 per cent in Gambia, 79 per cent in Botswana and 59 per cent in Mozambique use ethno-veterinary medicines in African continent.

Thakur *et al*. (2013) studied in Chamba districts of Himachal Pradesh on management practices adopted by indigenous chicken rearing farmers and reported that 84.90 per cent of farmers use garlic and onion as a ethno-veterinary medicines to treat diseases in birds.

Kumar *et al*. (2013) reported that 31.3 per cent of farmers use indigenous knowledge to treat birds followed by 20.3 per cent use allopathic, 15.6 per cent use combination of both and 32.8 per cent have not used any medicines in Kannur and Kozhikode districts of Kerala.

Mandel *et al.* (2006) reported that major constraints for rearing indigenous chicken in Bareilly district of Uttar Pradesh was infectious disease followed by predator attack. Predator attack was the major constraint for indigenous chicken rearing in Jammu district of Jammu and Kashmir (Sharma *et al.* 2018). As per Sumanta *et al*. (2015) in Sundarban region of west Bengal incidence of diseases are the major constraint for indigenous chicken production followed by predator attack.

Thakur *et al*. (2013) reported that major constraints for rearing indigenous chicken in Chamba district of Himachal Pradesh was predator (83.01%) followed by loss of crops by birds (41.50%) and diseases (17.89%).

2.2.14.1 Not vaccinating to any diseases

Mcainsh *et al*. (2004) found that Zimbabwean farmers did not vaccine their chickens against any illness. According to Vijh *et al*. (2005a) tribals breeding Miri birds in Assam not follow vaccination and other health care protocols.

Vij *et al*. (2005) stated that majority of farmers never vaccinate their Danki birds against illness. Vijh *et al*. (2006) reported in Nicobari chicken that they are relatively resistant to illnesses such as Ranikhet, Marek's, infectious Busral disease, Salmonella, Escherichia coliand Coccidiosis. Vaccination against any poultry illness was not generally done.

Kumar and Kumar (2007) observed that farmers in Uttarakhand's Kumaon area who raise native hill fowls did not participate in any vaccination scheme. As per Vij *et al*. (2007), no disease vaccination was conducted in Tellicherry chickens in Kerala. According to Chatterjee and Yadav (2008), Nicobari birds were not typically vaccinated against poultry diseases. Iqbal and Pampori (2008) revealed that negligible, no vaccination or medicine was used in traditional raising and in backyard rearing was used by the owners of Kashmiri native chickens.

As per Vij *et al*. (2015), the most of Haringhata Black breed poultry farmers did not vaccinate their birds against any poultry illnesses.

2. 3 Morphological or phenotypic characterization

In the field investigation, the physical characteristics of indigenous chicken were documented using the NBAGR proforma. The literature on the morphological characteristics of indigenous chicken is reported here.

2.3.1 Feather Morphology

As per NBAGR, feather morphology is classified as normal, frizzled and silky.

Negusie Dana *et al.* (2010) reported 81.4 per cent normal feather distribution and 18.6 per cent silky feather distribution in native birds of Ethiopia.

Gopinath (2013) reported 100 per cent normal feather morphology in both male and female indigrnous chicken of Mysore, Mandya and Chamarajnagar districts of Mysore division. Rajakumar (2013) documented 100 per cent normal per cent feather morphology in either sex of indigenous chicken in Bangalore rural division of Karnataka.

In Belgaum district, Veeranagowda (2020) reported 94.5 per cent normal feather morphology and 5.5 per cent frizzled morphology in either sex of indigenous chicken.

2.3.2 Feather Distribution

As per NBAGR feather distribution was classified as normal, naked neck, feathered shank and feet and crest type.

Rajakumar (2013) reported that 96.63 per cent and 96.88 per cent normal feather distribution in male and female indigenous chicken of Bangalore division of Karnataka. He also reported 2.33 per cent of male and 1.83 per cent of females had naked neck type of feather distribution.

In Mysore division of Karnataka Gopinath (2013) reported that 95.03 per cent normal feather distribution and 4.95 per cent naked neck feather distribution in both male and female indigenous chicken.

Veeranagowda (2020) conducted a study on phenotypic characteristics of indigenous chicken in Belgaum district and found 77.40 per cent normal and 22.58 per cent naked neck feather distribution in male male birds. Similarly, he also reported 18.33 per cent naked neck feather distribution in female indigenous chicken.

2.3.3 Plumage colour

The expression of plumage colour is a genetically determined trait in which dominance, epitasis and other gene interactions will contribute to the final phenotype (Smyth, 1990).

According to Acharya and Bhat (1984), the plumage colour of Tellicherry chickens ranged from black to grey and, in a few cases unusual blended colour combinations.

Mcainsh *et al*. (2004) reported in Zimbabwean chicken have black plumage but varies in appearance due to traits such as crested heads or bare necks.

Singh and Singh (2004) found that the plumage coloration of local chickens in Bareilly, Uttar Pradesh was blackish and brownish with extended mixed colorations in males and females.

As per Bhuiyan *et al*. (2005), desi chickens from Bangladesh have black plumage (75%) and red plumage (25%). Tantia *et al*. (2005a) found no distinct plumage colours in Kashmir Faverolla birds. The birds' plumage was a combination of jet black, dark brown, golden and pure white.

Vijh *et al*. (2005a) documented in Miri birds of Assam have no conventional plumage colour, with the majority of them being white, followed by black and brown and some birds having mixed plumage colour.

According to Tantia *et al*. (2005b), Ghagus birds have brown plumage that is followed by black plumage. Kalasthi birds have bluish black plumage that is followed

by brown plumage. Cocks had shiny blue-black feathers. The neck was lengthy and adorned with gold feathers (Vijh *et al*. 2005b).

The most often seen plumage colour in Danki chickens was brown, followed by black, while some birds exhibited red, white, or golden yellow plumage. The Cocks had gleaming bluish black feathers on their wings, breast, tail and thighs (Vij *et al*., 2005).

As per the reports of Duguma (2006) the feather colour of three Ethiopian indigenous chicken in the Horro ecotype chicken population 25.7 per cent had red brown plumage, 21.8 per cent had white, 19.5 per cent had red and 13.2 per cent had black. The proportions of red, grey, black and white plumage in the Tepi ecotype chicken population were 29.9 per cent, 29.5 per cent 16.2 per cent and 11.4 per cent, respectively. In the Jarso ecotype, the proportions of different plumage colours were 21.5 per cent red, 21.0 per cent grey, 18.7 per cent white and 15.5 per cent red brown.

Badubi *et al*. (2006) observed plumage colour in Tswana chickens and found that it was generally multi-coloured but mostly black (22.4%), followed by brown red (14.4%), silver (11.9%) and metallic green (11.4%). In Nicobari fowls, Vijh *et al*. (2006) noticed black plumage tinged with brown tint, as well as black and white.

According to Vij *et al*. (2006a) the plumage colour of the native Punjab Brown chicken is predominantly brown. Some black or white birds with a gold patch on their neck, wings and tail were also spotted. Tantia *et al*. (2006a) reported the Ankleshwar breed's plumage colour that they had a wide range of white or light grey with brown and golden hues and golden yellow plumage was prevalent in cocks and black gold in hens. Vij *et al*. (2006b) described the Daothigir bird's plumage as black mixed with

white feathers, white with black or brown hues, black or brown feathers on the wings and tail and golden yellow or brown feathers on the neck and back.

The native chicken of Bangladesh has black, black brownish, multicolor, white with black tips, red brownish, white with red stripes and brown plumage colours in 5, 33.33, 11.67, 28.33, 18.33, 1.67 and 1.67 per cent of the population investigated, respectively (Faruque *et al*., 2010).

Kumar and Kumar (2007) discovered that the plumages of native hill fowls in Uttarakhand were predominantly white, brown and black. However, spotted white and black plumages, as well as mixed colour plumages were also observed. Yousef and AL-Yousef (2007) observed the plumage colour differences in Saudi Arabian Baladi hens found in the Kingdom's Western provinces. They reported that the most common plumages were white, red, brown, black and grey/golden with per centage distributions of 18, 21, 22, 20 and 17 accordingly.

Halima *et al*. (2007) observed a wide range of plumage colour variation in local chicken populations in north-west Ethiopia. White, grayish and red plumage was found in 25.49, 22.3 and 16.4 per cent of the hens tested, respectively. The rest had a wide range of plumage hues, including black, multi-coloured, and black with white tips, red brownish and white with red striped plumage.

Although few birds had golden plumage blended with bluish feathers on the neck in Tellicherry chicken, Vij *et al*. (2007) found black with a brilliant bluish tint on hackle, back and tail feathers.

Study conducted by Khan (2008) revealed that nine different plumage colours in the Aseel breed which included black, white, red, brown, spotted, wheaten, grey,

golden and blue golden yellow. The Kadaknath breed featured a basic black plumage with pencilled yellow, brown and solid black neck feathers. Other natural nondescript chicken populations in India had multi-coloured plumage, consisting of a combination of brown, yellow and black.

Iqbal and Pampori (2008) found colourful plumage in Kashmir favoralla, an indigenous chicken. The majority of the population surveyed had barred (55%), black (35%) and white (10%) plumage.

Chatterjee and Yadav (2008) investigated white, brown and black plumages in Nicobari birds and found that black plumage with a brown tip was the most prevalent.

Kumar (2009) studies the plumage colour of native chicken in Kerala and reported, male plumage colour was red (47.22%), black (19.44%), brown (16.67%), white (5.56%), gold (5.56%) and multi-color (5.56%), whereas female plumage colour was black (41.46%), brown (38.41%), white (12.20%), multi-color (4.27%) and gold (3.66%). The total values of plumage colour reported in descending order of prevalence were black (37.50%), brown (34.50%), white (11.0%), red (8.5%), multi-color (4.5%) and gold (4%). Iqbal and Pampori (2008) revealed that the plumage colour of Kashmir's native chickens was barred (55%), black (35%) and white (10%).

Faruque *et al*. (2010) observed that indigenous chickens in Bangladesh have brownish black (33%) plumage, white with black tips (28.33%) plumage, brownish red (18.33%) plumage, multicolor (11%) plumage and black plumage (5%).

Kaur *et al*., (2010) studied the plumage colour of native hill birds in the Central Himalayan area. Male birds possessed feathered shanks with a mixture of

plumage colours that included blackish brown gold (49%), blackish brown (29%), blackish golden (14%), blackish red (5%) and blackish white (3%). Female birds were mostly black (21%), brown (15%), dusty brown (3%) and almond (3%).

Negussie *et al*. (2010) documented plumage colour in an Ethiopian native chicken population and found that males had 18.7, 4.1, 39.3 and 11.6 per cent white, black, red and brown plumage, while females had 14.2, 10.0, 3.2 and 26.1 per cent white, black, red and brown plumage, respectively. In terms of feather morphology, they observed that 81.4 per cent of the feathers were normal and 18.6 per cent were silky. They said that the physical features evaluated were relevant in defining diverse populations of indigenous chicken in various parts of Ethiopia.

Gopinath (2013) recorded the average proportion of colour in indigenous chicken in Mysore division of Karnataka state which had white (9.97%), black (15.07%), blue (0.85%), red (20.34%), brown (18.04%), gold (7.24%) and mixed (28.44%).

Rajkumar (2013) recorded that the plumage colour of indigenous male birds in Bangalore division of Karnataka was white, blue, black, red, brown and multi colour with per centage of 3.85, 2.90, 23.92, 15.81, 31.84 and 21.85 respectively where as in females white, blue, black, red, brown and multi colour with per centage of 3.81, 5.61, 24.20, 13.28, 31.73 and 21.30 respectively.

Moreda *et al*. (2014) studied the plumage colour in indigenous birds of Ethiopia's south west and south regions as black (2%), black with white tips (2.1%), brown (32.8%), brown with white and black stripes (11.8%), grey mixture (14.4%), red (5.1%), red brown with black (14.4%) and white (10.3%).

Study conducted on indigenous Bangladesh chicken revealed that non descript desi, cap heads and bare neck with per centage of 86, 10 and 4 respectively. The plumage colours were black, white, yellow, red, grayish, multi-colour, black and white, red brown, white and red and others with a percentage of 15, 5, 4, 8, 3, 24, 12, 10, 2 and 17 respectively (Tabassum *et al*. 2014).

As per Vij *et al*. (2015), the Haringhata Black breed in West Bengal has black coloured plumage in both sexes. Some cocks sported brown feathers on their necks and wings.

Rotimi *et al*. (2016) found complete white (12.89%), complete brown (29.01%) and complete black in local hens of Gwer-West Local Government Area of Benue State, Nigeria (10.05%). Normal (88.49%), frizzled (5.31%) and bare neck feathers were seen (6.20%).

Vij *et al*. (2016) reported that the most common plumage colour among Kaunayen birds is black, followed by brown or Red.

As per Assefa and Melesse (2018), the indigenous chicken of South Western Ethiopia has normal (93.5%) and smooth skin (6.5%). morphology of feathers. These local hens had a regular feather distribution (86.7%), a bare neck (10.0%) and a crest (3.2%). According to their findings, the most common plumage colour of local chicken was brown (32.8%), followed by a grey combination (14.4 %) and red-brownish with black (14.4%). Kumar *et al*. (2018) found that the plumage colour of the Uttara breed of chicken is primarily black with a feathered shank.

Otecko *et al*. (2019) observed the plumage patterns in indigenous Kenyan chickens were mixed (70.5%), barred (13.1%), plain (9.4%) and mottled (6.3%).

Frizzled (2.9%) and crested (7.5 %) feather morphology was observed. The distribution of feathers seen was a bare neck (5 %) also (4.8%) of feathered shank birds was noticed.

Veerannagowda (2020) found that the general proportion of plumage colour in male chicken in Belagaum division birds was blue (2.96%), white (4.81%), multi colour (15.93%), red (18.52%), black (27.41%) and brown (30.37%). Females were blue (2.04%), white (3.70%), multi-coloured (19.82%), red (20.00%), black (26.30%) and brown (28.15 %).

Sudhir Naik (2021) observed and reported the total plumage colour in males of the Gulbarga division was white (1.08%), blue (0.81%), black (12.46%), red (20.2%), brown (15.71 %), gold (8.94%) and multi-color (40.8 %). The greatest per centage of plumage colour observed in males during the survey was multicolor (40.08%), followed by red (20.2%) and blue is the lowest reported (0.81 %). The total plumage colour reported in females was white (5.95%), blue (1.45%), black (24.93%), red (11.13%), brown (33.17%), gold (7.26%) and multi colour (16.11 %). Brown was the largest per centage of plumage colour reported in females (33.17%), followed by black (24.93%) and blue had the lowest per centage recorded (1.45%).

2.3.4 Plumage pattern

The primary plumage pattern refers to the zonal or regional distribution of black pigment on the body, which might contain many feather tracts or as few as one. Secondary patterns impact the distribution of melanin within individual feathers (Kimball, 1953).

Bhuiyan *et al*. (2005), observed plumage pattern in desi chickens from Bangladesh and reported they had no distinct pattern (61%), whereas some birds displayed lace feather pattern (17%). Tantia *et al*. (2005a) described the Kashmir Favorolla chicken's plumage pattern as solid to dull striped and speckled.

Vij *et al*. (2005) reported that male Danki birds have a patchy primary plumage pattern while females are spotted. Some of the birds had a distinct pattern on their feathers.

As per Vijh *et al*. (2005a), the majority of Miri birds have solid primary plumage patterns, although others have spotted and striped plumage patterns. Tantia *et al*. (2006a) observed that the Ankaleshwar birds' plumage was striped or speckled with golden yellow feathers with black ends. Vijh *et al*. (2006) stated that Nicobari birds had a solid plumage pattern, but Daothigir birds had a striped or spotted plumage pattern.

Vij *et al*. (2006a) observed in native Punjab Brown birds have a complete brown pattern, although they can also be spotted or striped. In cocks, black dots or stripes were seen on the neck, wings and tail. In contrast to the rest of the body, the neck was dark with brown or gold colour.

Kaur *et al*. (2010) studied plumage pattern in feathered male local hill fowls which had a solid plumage pattern (56%), followed by solid spotted (14%), stripped (13%), dull (12%), barred (3%) and solid stripped (2%). Female birds on the other hand had a solid plumage pattern (46%), followed by dull (23%), stripped (11%), patchy (6%), dull stripped (6%), barred (4%) and spotted (4%). As per Ravi Kumar (2011), Kadaknath birds have a silver and gold spangled to bluish black plumage

pattern. Malik and Singh (2013) found that native Tripura black chickens have plumage patterns of pure black (65%) and black with red colour on the neck area (35%).

Rajakumar (2013) reported that male birds classified into seven groups based on their major plumage pattern solid (52.62%), dull (17.26%), patchy (15.57%), barred (6.23%), mottled (3.83%), stripped (2.91%) and spotted (1.15%). Females had seven varieties, with the most common being solid (41.58%), followed by dull (20.03%), patchy (15.99%), mottled (9.04%), stripped (6.38%), spotted (3.83%) and barred (3.40%). The bulk of male birds (44.79%) had solid red secondary plumage, followed by self-black (23.19%), mottled (20.92%), lacing (3.75%), barred (3.46%), self-white (3.04%) and self blue (0.83%). Females had the highest per centage of self red (30.88%), followed by mottled (27.34%), self black (20.49%), lacing (11.59%), barred (4.31%), self white (3.80%) and self blue (1.57 %).

Gopinath (2013) reported that the majority of the plumage pattern in the Mysore region of Karnataka was solid followed by patchy, stripped, spotted, barred and mottled patterns. The majority of the birds phenotypically had a self red pattern followed by self black, self white, lacing, barred, mottled and self blue.

Vij *et al*. (2015) documented the Harrighatta Black breed in West Bengal has black-colored plumage. The plumage pattern was consistent.

Rotimi *et al*. (2016) found brown with spotted black (15.55%), black with spotted white (12.71%) and white with spotted black (15.55%) in native hens of Gwer-West local Government area of Benue State, Nigeria (19.79%).

Veerennagowda (2020) reported classification of males based on overall plumage pattern revealed that 34.44% of the birds were solid colour, 24.81% were dull, 3.33% were stripped, 5.18% were patchy, 6.66% were spotted, 8.52% were barred and 17.04% were mottled. Females were classified based on overall main plumage pattern as 32.40 per cent solid, 23.89 per cent dull, 5.0 per cent stripped, 3.33 per cent patchy, 6.67 per cent spotted, 12.22 per cent barred and 16.48 per cent mottled in Belgaum division of Karnataka. He also reported secondary plumage pattern self –red, self-black, self-white, self-blue, barred and mottled in indigenous chicken.

Sudhir Naik (2021) found that the overall per centage of plumage pattern of male birds documented in the Gulbarga division under study were solid (51.27%), dull (29.37%), patchy (10.50%), mottled (4.10%), barred (3.45%), spotted (1.31%) and in descending order. Female bird plumage patterns were observed in the following order: dull (46.43%), solid (32.55%), mottled (9.88 %), barred (7.52%), spotted (2.18 %), patchy (1.44%).

2.3.5 Skin, shank and eye colour of indigenous chicken.

Summaries on colour of skin, shank and eye in indigenous chicken are explained in Table 2.4

Table 2.4 Skin, shank and eye colour of breeds of indigenous chicken.

Breed	Skin colour	Shank colour	Eye colour	References
Danki	White or pinkish white with rosy red markings on the breast, thigh and wings	Mostly yellow or greyish in black-coloured birds	Brown eyes with red coloured ring	Vij *et al*. (2005)
Miri	White or yellow	White or yellow	Brown	Vijh *et al*. (2005a)
Kashmir Favorolla	White	Predominantly yellow (96%), black (4%)	-	Tantia *et al*. (2005a)
Kalashti	White or pinkish	Grayish or yellow	-	Vijh *et al*. (2005b)
Ghagus	-	Yellow	-	Tantia. *et al*. (2005b)
Punjab brown	White	Yellow	-	Vij *et al*. (2006b)
Ankaleshwar	Yellow or pinkish	Yellow	Black	Tania *et al*. (2006a)
Daothigir	Pink	Yellow	Red	Vij *et al*. (2006a)
Nicobari	Pinkish white	Pinkish white	-	Vijh *et al*. (2006)
Tellicherry	Greyish	Blackish grey	Blackish red	Vij *et al*. (2007)
Kadaknath	Black	Black	-	Ravikumar (2011)
Harringhatta black breed	Off –White	Blackish grey or yellow	Brownish red	Vij *et al*. (2015)
Aseel	White 98% Yellow 2%	Yellow 65%, black 19% and white 16%	Black 99% White 1%	Rajkumar *et al*. (2017)

Table 2.5 Skin, shank and eye colour of indigenous chicken

Breed	Skin colour	Shank colour	Eye colour	References
Local hill fowl of Uttarakhand (Uttara Fowl)	White and yellow	White, black, pink yellow	Yellow and black, brown and black and grey and black	Kumar and Kumar (2007)
Native chicken of Bangladesh	-	White, black, yellow, green	-	Faruque *et al*. (2010)
Local hill fowl of Central Himalayan region	Yellow	Black yellow	Brown black, grey black, orange black, black and grey brown	Kaur *et al*. (2010)
Tripura black native chicken	Whitish pink	Light yellow (53%) Blackish grey (47%)	Black (97%) light black (3%)	Malik and Singh (2013)
Indigenous chicken of Mysore division of Karnataka	Yellow (92%) White (8%)	Yellow (84%) Black (8%) White (6%) Green (2%)	Brown (90%) grey (10%)	Gopinath (2013)

Breed	Skin colour	Shank colour	Eye colour	References
Indigenous chicken of Bangalore division of Karnataka	White (97.5%) Yellow (2.5%)	Yellow (93%) Black (4%) White (2.5%) Green (0.5%)	Brown, black and grey	Rajakumar (2013)
Indigenous chicken of Bangladesh	White (89%) Yellow (9%) Not definite (2%)	Black (36%) White (52%) Yellow (10%) White and red (2%)	-	Tabassum *et al*. (2014)
Native chickens of Eastern Samar, Philippines	White (92%)	Grey (41%) Yellow (18%) White (24%) Black (15%)	orange (43%) yellow (38%)	Jay P. Picardial *et al*. (2015)
Native chicken of GwarWest area of Nigeria		White (41.16%) Yellow (27.23%) Black (31.61%)		Rotimi *et al*. (2016)
Indigenous chicken of Kenya	Cream, White andYellow	Cream, White and Yellow		Newton O. Otecko et al. (2019)

Breed	Skin colour	Shank colour	Eye colour	References
Indigenous dwarf chicken of Bangladesh	White – 90% Yelow – 10%	Black - 27.78%, Slate -23.33%, Yellow- 22.22%, Yellowish - 16.67% and White - 10.00%	Black – 100%	Ferdaus *et al*. (2016)
Indigenous chicken of South Western Ethiopia	Yellow (44.8%) Black (3.5%) White (25.4%) Pink (26.4 %)	White (28.5 %) Grey (15.97%) Yellow (44.7%) Black (5.7%) Blue (5.1%)		Hailu Assefa and Aberra Melesse (2018)
Indigenous Birds of Belagaum division	White - 4.81%(M), 4.25 (F) Yellow-95.18%(M), 95.73% (F)	Yellow-87.77(M), 89.62(F) White - 3.70(M), 2.21(F) Black - 6.29(M), 6.29(F) Green - 2.22(M), 1.84(F)	Grey -37.77 (M), 37.38 (F) Brown 55.55(M), 53.70(F) Black 6.66(M), 8.88(F)	Veerannagowda (2020b)
Indigenous chicken of Gulbarga division	White-76.99%(M), 83.54% (F) Yellow- 23.01% (M), 16.46% (F)	Yellow-77.30% (M), 78.83%(F), White-11.35%(M), 8.47%(F), Black-9.20%(M), 10.65%(F), Green- 2.15%(M), 1.95%(F)	Brown-57.36% Black-9.20% Grey-34.44%	Sudhir Naik (2021)

2.3.6 Ear lobe colour, comb colour and type, wattles colour of indigenous chicken

Table 2.6 Summary of the earlobe color, comb color and size, comb type (%) and wattles color in the characterized indigenous breeds of chicken

Breed	Earlobe color (%)	Comb color	Comb type (%)	Wattle color, presence/absence (%)	Author
Tanzanian local chicken	Red 65, white 35		Rose 12, Single 88	-	Msoffe *et al*. (2001)
Desi chicken of Bangladesh	Red (80) and white (20)	Bright red (59) and pale (41)	Single (97)		Bhuiyan *et al*. (2005)
Danki	Red	Red; large in cocks than hen	Mostly pea but single and strawberry in few		Vij *et al*. (2005)
Aseel	Red		Single, Pea, Rose and V shape		Pandey *et al*. (2005)
Miri	Most red	Red	Single		Vijh *et al*. (2005a)
Kashmir favorolla	White (93)	Mostly red	Mostly single		Tantia *et al*. (2005a)
Kalasthi	Red	Red	Pea or mixed type or single	Red small in size	Vijh *et al*. (2005b)
Botswana local chicken			Single (90.4), rose (4.9), pea (1), walnut (1.3), multiple (0.4)		Badubi *et al*. (2006)
Ghagus	Majority red	Red	Single or pea	Red, small in size	Tantia *et al*. (2005b)

Breed	Earlobe color (%)	Comb color and size (%)	Comb type (%)	Wattle color, presence/absence (%)	Author
Punjab brown	Brown or white or grey			Red, lage in males and small in females	Vij *et al*. (2006a)
Daothigir	Almost red, white or white mixed with red		Single, large in males and small in females	Red, large in size	Vij *et al*. (2006b)
Nicobari		Red	maximum single; rarely pea comb	Pinkish	Vijh *et al*. (2006)
Local hill fowl of Uttarakhand				Pinkish	Kumar and Kumar (2007)
Tellicherry	Red with white markings; sometimes creamy white	Red, but blackish red in typical birds	Single, large in size in males and small in hens	Red	Vij *et al*. (2007)
Bursa	White or brown			Red, small to medium size	Vij *et al*. (2007)
Kashmiri Favaoroll a	White (91) Red (9)	Always red	Single (71) Rose (20) Pea (9)		Iqbal and Pampori (2008)
Native birds of Kozhikode and Kannur districts of Kerala	White (7.50) Red (18.50) White and Red (64.00) Yellowish white (1.00) White, Red & Black (0.50) Red and Yellow (7.50)	Black (1.50) Red (87.00) Yellow (2.50) Blackish red (9.00)	Single (97.50) Pea (2.50)	Red (90.00) Blackish Red (9.00) Yellow (1.00)	Kumar (2009)
Indigenous chicken of Ethiopia			Single 15.6, Rose 23.7, Pea 56.8, Walnut 2.2, Duplex 1.5		Nigussie *et al*. (2010)

Breed	Earlobe color (%)	Comb color and size (%)	Comb type (%)	Wattle color, presence/absence (%)	Author
Aseel		Red, small	Pea	Absent	Ravi kumar (2011)
Kadaknath		Purple	Single	Purple	Ravikumar (2011)
Tripura black native chicken	Red	Bright (91%) Dull red (9%)	Single (83%), rose (12%), others (5%)	Red	Malik and Singh (2013)
Indigenous chicken of Bangalore Division of Karnataka	Red	Red	Single (95%) and Pea comb (5%) in Ramanagar district of Karnataka. In Chikkaballapur Dist. Pea comb (69%) In Bangalore Rural dist., Pea comb (80%)	Red	Rajkumar (2013)
Indigenous chicken of Mysore Division of Karnataka	Red	Red	Single comb (99%)	Red	Gopinath (2013)
Indigenous chicken of Bangladesh	Black (32%), Red (16%) Red brown (2%) White and red (47%) Others (3%)		Single (99%) Pea (1%)		Tabassum F. *et al*. (2014)
Harringhatta Black breed	Red and white	Red	Single and small in size	Red (74%)	Picardial *et al*. (2015)

Breed	Earlobe color (%)	Comb color and size (%)	Comb type (%)	Wattle color, presence/absence (%)	Author
Indigenous chicken (South western Ethiopia)	Rose (26.3%), Single (63.2%) Pea comb (8.8%) Walnut (1.8%)	Red - 60.8% Gray - 4.3% Black -5.15% White -15.6% Yellow 14.2%	-	-	Assefa and Melesse (2018)
Indigenous chicken (Kenya)	Single (most common), Strawberry Buttercup, Cushion, Pea, Rose and Walnut.	Red and Pale (common). Black, Grey, Yellow	-	Pale, red	Otecko *et al*. (2019)
Indigenous birds of Belagaum division (Karnataka)	Male Red- 99.25% White - 0.74% Female Red – 100% White - Nil	Red – 100%	Single comb Male-73.33 Female-73.51 Pea comb Male-22.2 Female-22.03 Rose comb Male - 4.44 Female-4.44	Present Males-38.51% Females-43.51% Absent Males-61.47% Females-56.47%	Veerannagowda (2020b)
Indigenous birds of Gulbarga division (Karnataka)	Red (100%) in Males and Females	-	Single comb Male-98.5% Female-93.48% Rose comb Male- 0.3% Femal-0.72% Pea comb Male-1.2% Female-3.5%	Present Male-95.4% Female-90.07% Absent- Male-9.74% Female- 4.6%	Sudhir naik (2021)

2.4. Additional visible and quantitative characteristics

2.4.1 Shank length

Msoffe *et al*. (2001) observed a mean shank length of 9.7 and 12.7 cm for 84 mature female and male chicken birds reared in different ecotypes of Tanzania under a free-range system.

Tantia *et al*. (2005a) recorded a mean shank length of 9.00±0.76 cm in cocks and 7.50±0.58 cm in hens, with a combined sex average of 7.74±0.87 cm in the Kashmir Favorolla breed of chicken.

Chatterjee and Yadav (2008) recorded that brown Nicobari fowls had a mean shank length of 3.7±0.06 cm, black Nicobari fowls had a mean shank length of 3.7±0.06 cm and white Nicobari fowls had a mean shank length of 3.8±0.1 cm. Faruque *et al*. (2010) showed that males, females and mixed sex native chickens had average shank lengths of 9.63cm, 9.20cm and 9.23cm, respectively. Haunshi *et al*. (2009) found 84.56±0.99 mm shank length in males and 66.82±0.46 mm in females of the Miri breed of chicken.

Dana *et al*. (2010) observed that the shank length of 225 indigenous chickens in five Ethiopian ecotypes was 9.1±1.1 cm in males and 7.0±0.7 cm in females. Haunshi *et al*. (2010) recorded shank lengths of 125.3±0.9 mm in cocks, 101.9±0.6 mm in hens and 109.2±1.1 mm in pooled sex of Aseel breed of chicken and 108.4±0.8 mm in cocks, 89.7±0.5 mm in hens and 94.8±0.8 mm in pooled sex of Kadaknath breed of chicken. Kalitha *et al*. (2011) measured the shank length of Assamese indigenous chickens to be 7.07±0.01 cm in males and 6.11±0.01 cm in females.

Padhi *et al*. (2012) reported a shank length of 67.30 mm, 93.07mm, 110.79mm, 115.95mm in males and in females 62.95 mm, 85.95mm, 101.64mm and 109.08mm in females of Ghagus Chicken breed at 8^{th}, 12^{th}, 16^{th} and 20th week respectively whereas 64.54mm,88.57mm, 104.45mm and 111.64mm in pooled sex.

Gopinath (2013) reported the average shank length in male indigenous chickens at 20 weeks of age was 82.98±0.94 mm in Mandya district, 86.00±0.83 mm in Mysore district and 92.61±0.26 mm in Chamarajanagar districts of Karnataka's Mysore division. Similarly, at 20 weeks of age, the average shank length in female indigenous chickens was 72.82±0.53mm in Mysore, 74.26± 0.52 mm in Mandya and 75.76±0.65 mm in Chamarajanagar districts. At the 20th week of age, the mean shank length of mixed sex was 78.11±0.62 mm in Mandya district and 84.72±0.75 mm in Chamarajanagar district of Karnataka.

Rajakumar (2013) stated that at 20 weeks of age, the average shank length in male indigenous chickens was 97.28±1.58 in Chikkaballapur district, 86.06±0.44 mm in Ramanagar and 97.56±1.29 mm in Bangalore Rural districts of Karnataka's Bangalore division. Similarly, the average shank length of female indigenous chickens at 20 weeks of age was 76.73±0.66 in Chikkaballapur district 69.02±0.42 mm in Ramanagar and 77.20±0.49 mm in Bangalore Rural district in Bangalore division of Karnataka. The mean shank length for mixed sex at 20th week of age 82.26±1.05 in Chikkaballapur district, Ramanagar district was 77.24±0.64 mm and 81.14±0.87 in Bangalore rural district.

Assefa and Melesse (2018) observed that the shank length of 720 indigenous chickens of more than one year age in South Western Ethiopia was 9.4±1.6 cm in males and 7.6±1 cm in females. Thangadurai and Shanmugam (2019) measured shank

lengths of 8.21±0.84 cm, 9.10±1.422cm and 10.35±1.85 cm in the adult Local Variety, Gramapriya and TANUVAS Aseel chicken breeds, respectively.

2.4.2 Keel length

Chatterjee *et al*. (2007) recorded keel lengths of 6.89±1.12 cm and 8.40±1.04 cm for the combined sex in the Kadaknath and Aseel breeds, respectively. Haunshi *et al*. (2010) measured the keel length of the Miri breed of chicken to be 103.41±1.15 mm in males and 88.79±1.19 mm in females.

Rajakumar (2013) revealed that the keel lengths of male indigenous chickens in the Bangalore division of Karnataka were 132.31±2.45 in Chikkaballapur district, 122.61±0.69 mm in Ramanagar district and 132.43±2.29 mm in Bangalore Rural district at 20 weeks of age. Similarly, females had values of 113.34±1.01 in Chikkaballapur district, 108.45±0.64 mm in Ramanagar district and 116.95±0.81 mm in Bangalore rural district and combined sexes had values of 118.44±1.25 in Chikkaballapur district, 115.28±0.68 mm in Ramanagar district and 119.94±0.96 mm in Bangalore rural district in Karnataka.

Gopinath (2013) measured the keel length and the mean keel lengths in males of indigenous chickens in Mysore division of Karnataka at 20th week of age were 75.58±0.87 mm in Mandya district, 78.50±0.82 mm in Mysore and 83.06±0.24 mm in Chamarajanagar birds. Similarly, in females, the values were 66.14±0.52 mm in Mysore, 68.46±0.52 mm in Mandyaand 68.65 mm in Chamarajanagar district, but in mixed sex, the values were 71.55±0.67 mm, 71.69±0.57and 76.31±0.66 mm for birds of Mysore, Mandya and Chamarajanagar, respectively.

According to Assefa and Melesse (2018), the keel length of indigenous chickens in South Westren Ethiopia was 13±1.5 cm in males and 11.1±1.3 cm in females.

2.4.3 Breast angle

Chatterjee *et al*. (2007) reported the breast angle of Kadaknath birds which was 70.5±8.01 degrees while Aseel birds had a breast angle of 81.7±0.71 degrees. Gopinath (2013), found the breast angle of male birds in the Mysore division of Karnataka was 84.38±0.46 degrees in Mandya and 85.21±0.28 degrees in Chamarajanagar district during the 20th week of age. Similarly, it was 79.36±0.29 degrees in Chamarajanagar and 84.19±0.24 degrees in Mandya district for females and 82.47±0.30 degrees in Chamarajanagar and 84.27±0.24 degrees in Mandya district for mixed sex.

At the 20th week of age, the breast angle of male birds in the Bangalore division of Karnataka was 84.28±0.62 degrees in Ramanagar, 82.78±0.23 degrees in Chikkaballapura and 78.30±0.93 degrees in Bangalore rural district. Similarly, females had 78.62±0.66, 82.94±0.54 and 86.81±0.64 degrees in Chikkaballapur, Bangalore Rural and Ramanagar districts, whereas mixed sex had 84.04±0.49, 73.87±0.58and 77.10±0.47 degrees in Ramanagar, Chikkaballapur and Bangalore Rural districts of Karnataka (Rajakumar, 2013).

Singh and Pathak (2016) measured the breast angle in Kadaknath and Aseel birds which was 70.45° and 81.65°, respectively. Results of Veerannagowda *et al*. (2020) the breast angle in indigenous birds of the Belagaum division at 20 weeks of

age was 78.54±0.20° in Bijapur, 80.96±0.23° in Belagaum and 80.53±0.16° in Dharawad, with an overall average of 80.00±0.12.

2.5 Body weight of indigenous chicken from different authors are mentioned in table 2.7

Table 2.7 Body weight of adult indigenous chicken under free range system

Author	Breed	Cock	Hen	Pooled
Msoffe *et al*. (2001)	Tanzanian local chicken	2100±202.7 g	1442±71g	
Msoffe *et al*. (2001)	Tanzanian local chicken	2261.50±12 g	1471.10±60g	
Vij *et al*. (2005)	Danki	3.12±09 kg	2.2±0.06kg	
Vijh *et al*. (2005a)	Miri			1.525±0.048 kg
Tantia *et al*. (2005a)	Kashmir favorolla	1.875±0.318 kg	1.415±0.31 kg	
Vijh *et al*. (2005b)	Kalasthi			1.716±0.365 kg
Tantia *et al*. (2005b)	Ghagus	2.16±0.25 kg	1.43±0.8 kg	
Badubi *et al*. (2006)	Botswana local chicken	1994.4±695 g	1546.2±428 g	
Vij *et al*. (2006a)	Punjab Brown	2.16±0.25k g	1.43±0.81k g	
Tantia *et al*.(2006a)	Ankleshwar	2.15±0.94k g	1.57±0.04k g	
Vij *et al*. (2006b)	Daothigir	1.79±0.13k g	1.63±0.00.13 k g	

Author	Breed	Cock	Hen	Pooled
Vij *et al*. (2006c)	Danki	3.115±0.092 kg	2.223±0.064 kg	
	Kalasthi	2.48±0.13 kg	1.85±0.102 kg	
	Ghagus	2.16±0.25 kg	1.433±0.8 kg	
Vijh *et al*. (2006)	Nicobari brown	1.79±0.13 kg	1.63±0.13 kg	
	Nicobari black	1.200 kg	0.9 to 1.00 kg	
Thakur *et al*. (2006)	Kadaknath	1701±10.39 g	1445±8.17 1534±7.16 g	
Kumar and Kumar (2007)	Hill fowl of Uttarakahand			1537.50±33.60
Vijh *et al* (2007)	Red Jungle fowl	700-1100 gm	500-750 g	
Vij *et al*. (2007)	Tellicherry	1.62±0.16 kg	1.21±0.10 kg	
Vij *et al* (2007)	Busra	1.11±0.06 kg	0.98±0.06 kg	
Iqbal and Pampori (2008)	Kashmiri	1.820±0.25 kg	1.350±0.22 kg	
Kalitha *et al*. (2009)	Indigenous chicken of Assam	1345.79±39.65 g	1034.18±17.02g	
Nigussie *et al*. (2010)	Indigenous chicken of Ethiopia	1612.00g	1266.00g	
Thakur and Parmar (2011) (52wk Megnar dist)	Kadaknath	1765±11.74g	1491±8.15g	1576±7.05 g

Author	Breed	Cock	Hen	Pooled
Thakur and parmar (2006)	Kadaknath (52wk Jobat dist)	1637±9.04 g	1398±8.20 g	1479±7.16 g
Kalitha *et al*. (2011)	Indigenous chicken of Assam	1.44±0.0 kg	1.14±0.01 kg	
Ravi Kumar (2011)	Aseel	3 to 4 kg	2 to 3 kg	
	Kadaknath	1.5 kg	1 kg	
Banerjee (2012)	Native fowl (West Bengal)	1.251±143 kg	1.062±123 kg	
	Native fowl (Sikkim)	1.760±132 kg	1.080±112 kg	
Bett *et al*. (2014) Indigenous chicken	Bangladesh Indigenous chicken	1.1±0.27 kg	0.9±0.17 kg	
	Sri Lanka Indigenous chicken	2.0±0.09 kg	1.6±0.08 kg	
	Vietnam Indigenous chicken	2.6±0.09 kg	2.0±0.06 kg	
	Pakistan Indigenous chicken	2.0±0.06 kg	1.5±0.04 kg	
	Total Mean	1.9±0.04 kg	1.5±0.03 kg	
Vij *et al*. (2015)	Harringhata Black breed	1283.7±60.66 g	1120.6±17.98 g	1133.8±17.24 g
Vij *et al* (2016)	Kaunayen	3.01±0.06 kg	2.32±0.09 kg	
Deka *et al*. (2017)	Indigenous Chicken			1024.31±10.21 g

Author	Breed	Cock	Hen	Pooled
Thakur *et al* (2006)	Indigenous chicken, Himachal Pradesh	1.7 kg	1.65 kg	
Karuna *et al*. (2017)	Vanaraja			3.22 kg at 48th wk
	Gramapriya			2.5 kg at 48th wk
	Aseel			1.5 kg at 48th wk
Gawande *et al* (2007)	Indigenous chicken Assam	1349.49±24.33 g	1041.66±18.95 g	
Edmew *et al*. (2018)	Indigenous chicken of Southwestern Ethipoia	1.45 kg		
Assefa and Melesse (2018)	Indigenous Chicken of South western Ethiopia	1.68±0.2 kg	1.42±0.2 kg	
Yadav *et al*. (2017)	Ghagus	2.16±0.25	1.43±0.81	
Sharma. *et al*. (2018)	Srinidhi (40^{th} wk and 52^{nd} week)			2964.03±21.24 g 3464.27±22.37 g
	Vanaraja (40^{th} wk and 52^{nd} week)			2969.61±18.08 g 3501.87±21.32 g
	Desi (40^{th} wk and 52^{nd} week)			1269.31±9.01 g 1419.47±16.14 g

Author	Breed	Age	Cock	Hen	Pooled
Thangadurai and Shanmugam. (2019)	Local Variety	30th wk			1020.37±18.96 g
		40th wk			1100.00±13.64 g
		50th wk			1200.12±17.48 g
	Gramapriya	30th wk			1450.82±17.45 g
		40th wk			1800.56±21.25 g
		50th wk			2100.23±24.52 g
	TANUVAS Aseel	30th wk			1250.64±17.82 g
		40th wk			1400.14±17.25 g
		50th wk			1900.23±19.85 g
Saravanam *et al* (2020)	Kolli hills area of indigenous chicken, Tamil Nadu		0.78 to 1.03 kg	0.61 to 0.95 kg	

2.6 Egg quality traits

2.6.1 Egg weight

Table 2.8 shows the average egg weight recorded for indigenous chicken breeds raised free range. Average egg weight in the Ankleshwar breed is 35 g and 54 g in the White Nicobari breed. Results of Jha *et al*. (2013) at AICRP on Poultry Breeding, College of Veterinary Science and Animal Husbandry., Birsa Agricultural University, Ranchi, Jharkhand determined that the average pullet egg weight in 358 desi birds was 30.82±0.58 g, while the average egg weight analysed at the 40th week was 42.89±2.37 g.

According to table 2.8, the average egg weight range was 36 g in Mizoram native fowl and 56 g in Uttarakhand local hill fowl.

2.6.2 Internal egg quality traits

Table 2.8.1 review the internal egg quality features such as albumen index, yolk index, shell thickness (mm), shell weight (g), Haugh Unit Score (HUS) and shape index reported from several indigenous chicken breeds kept free range.

Table 2.8 Average egg weight, shape index and egg colour of indigenous chicken breeds under free range conditions

Author	Native breed	Egg weight(g)	Shape index	Egg shell colour
Singh *et al*. (2000)	Aseel	41		
Msoffe *et al*. (2002)	Tanzania local chicken	41.6±0.40		
Fayeye *et al*. (2005)	Fulani	40.73		
Vij *et al*. (2005)	Danki	46.16±1.72		
	Kalasthi	42.91±1.94		
	Ghagus	40.25±2.39		
Vijh *et al*. (2005a)	Miri	42.06±0.17		LB- 62 %; B- 37 %; DB- 1%
Tantia *et al*. (2005a)	Kashmir favorolla	45.76±1.94		
Iqbal and Pampori (2008)	Indigenous Kashmir chicken	46.06±3.96	73.54	Brown (77.1 %); White (22.9%)
Kumar (2009)	Native birds of Kozhikode and Kannur districts of Kerala	42.19±1.09		
Kalitha *et al*. (2009)	Indigenous chicken of Assam	37.80±0.65 (Tribal) 38.69±0.69 (non-Tribal)		
Singh *et al*. (2009)	Local hill fowl of Uttarakhand	52.03±0.90	74.87±0.54	
Yadav *et al*. (2009)	Local fowl of UP	52.95±0.59	74.23±0.61	
Islam and Datta (2010)	Indogenous chicken of Bangladesh	40.04±2.52		

Author	Native breed	Egg weight(g)	Shape index	Egg shell colour
Vijh *et al*. (2005b)	Kalasthi	42.91±1.94		LB- 36 %; B-45 %; DB-19 %
Tantia *et al*. (2005b)	Ghagus	40.25±2.39		Majority Brown
Badubi *et al*. (2006)	Botswana indigenous	48.5±5.7		
Parmar *et al*. (2006)	Kadaknath	42.33	74.35	
Vij *et al*. (2006a)	Punjab Brown	46.0±1.19		LB- 60.7 %; B-25 %; DB-14.3 %
Tantia *et al*. (2006a)	Ankleshwar	35.09±0.14		Cream- 65 %; B-33.4%
Vij *et al*. (2006b)	Daothigri	44.42±1.35		
Vij *et al* (2006c)	Danki	46.16±1.72		
	Kalasthi	42.91±1.94		
	Ghagus	40.25±2.39		
Vijh *et al*. (2006)	Nicobari brown	50.93±0.91		
	Nicobari black	52.01±0.83		
	Nicobari white	54.39±0.87		
Vijh *et al* (2007)	Red Jungle fowl	26.18		
	Tellicherry	40.02±0.94		
	Busra	31.56±1.40		
Iqbal and Pampori (2008)	Indigenous Kashmir chicken	46.06±3.96	73.54	Brown (77.1 %); White (22.9%)
Kumar (2009)	Native birds of Kozhikode and Kannur districts of Kerala	42.19±1.09		

Author	Native breed	Egg weight(g)	Shape index	Egg shell colour
Kalitha *et al*. (2009)	Indigenous chicken of Assam	37.80±0.65 (Tribal) 38.69±0.69 (non-Tribal)		
Singh *et al*. (2009)	Local hill fowl of Uttarakhand	52.03±0.90	74.87±0.54	
Yadav *et al*. (2009)	Local fowl of UP	52.95±0.59	74.23±0.61	
Islam and Datta (2010)	Indogenous chicken of Bangladesh	40.04±2.52		
Mohanthy and Nayak (2011)	Local fowl of Orissa	36.47(54wk)		
Kalitha *et al*. (2011)	Indigenous chicken of Assam	35.27±0.15		
Banerjee (2012)	Native fowl (West Bengal)	40.4±1.8		
	Native fowl (Sikkim)	43.6±2.5		
Gopinath (2013)	Chamarajanagar	38.90±1.84		
	Mysore	39.40±1.40		
	Mandya	40.10±0.54		
Rajakumar (2013)	Chikkaballapur	40.73±0.81		
	Bangalore rural	43.79±0.70		
	Ramanagar	39.83±0.43		
Kumar *et al*. (2013)	Tellicherry	41.81±0.46		
Anithaa *et al* (2014)	Varayankozhi	49		
	Velumbikozhi - Pullikozhi	60.5		
	Karumbikozhi	57.76		
	KooriKozhi	45.5		
	Chembankozhi	44.3		

Author	Native breed	Egg weight(g)	Shape index	Egg shell colour
Vij *et al*. (2015)	Harringhata Black	36.53±1.07		
Vij *et al* (2016)	Kaunayen	42.43±0.27		
Karuna *et al* (2017)	Aseel	41		
Edmew *et al*. (2018)	Indigenous chicken of Southwestern Ethiopia	43.9±4.7		
Kumar *et al*. (2018)	Desi	45.3		
	Gramapriya	50.8		
	Vanaraja	51		
Roy *et al* (2018)	Haringhata Black	47.6		
Thangadurai and Shanmugam (2019)	Local Variety	45.12±1.28		
	Gramapriya	51.12±0.58		
	TANUVAS Aseel	53.23±0.74		
Veerannagowda (2020b)	(Indigenous birds of Belagaum division)	46.58±0.70	75.40±0.55	Creamy - 8.89, Light brown- 35.18, brown-55.12
Sudhir Naik (2021)	Indigenous birds of Gulbarga division	42.25±0.23	74.17±064	-

Table 2.8.1 Internal egg quality traits in indigenous chicken breeds under the field conditions

Author	Breed	Shell weight (g)	ST (mm)	Albumen index	Yolk index	HUS	Shape index
Fayeye *et al*. (2005)	Fulani	5.12	0.58	-	-	75.53	-
Vij *et al*. (2005)	Danki	5.73	0.40±0.001	0.059±0.002	0.275±0.01	66.81±2.54	-
Vijh *et al*. (2005a)	Miri	-	0.30±0.001	0.102±0.007	0.445±0.002	81.64±0.32	-
Tantia *et al*. (2005a)	Kashmir Favorolla	5.8±1.4	0.25+0.007	0.068±0.001	0.47±0.036	68.81±2.19	-
Vijh *et al*. (2005b)	Kalasthi	5.02±0.3	0.37±0.001	0.05±0.00	0.35±0.02	76.79±2.93	-
Tantia *et al*. (2005b)	Ghagus	-	0.35±0.007	0.069±0.001	0.389±0.001	76.79±2.93	-
Parmar *et al*. (2006)	Kadaknath	-	0.31	0.0703	0.37	73.77	73.93
Vij *et al*. (2006a)	Punjab Brown	5.4±0.21	0.33±0.007	0.10±0.006	0.41±0.005	76.35±1.16	-
Tantia *et al*. (2006a)	Ankleshwar	5.64	0.30±0.001	0.008±0.006	0.36±0.001	83.68±0.02	-
Vij *et al*. (2006b)	Daothigir	5.09±0.21	0.33±0.009	0.068±0.005	0.29±0.01		-
Vij *et al*. (2006c)	Danki	-	40.45±1.40(µ)	0.059±0.002	0.275±0.013	66.81±2.5	-
	Kalasthi	-	37.09±1.19(µ)	0.055±0.00	0.351±0.02	68.81±2.19	-
	Ghagus	-	34.86±0.70(µ)	0.069±0.00	0.389±0.00	76.79±2.93	-
Vijh *et al*. (2006)	Nicobari Brown	5.84±0.12	-	0.094±0.006	0.29±0.01	-	-

Author	Breed	Shell wt (g)	ST (mm)	Albumen index	Yolk index	HUS	Shape index
Vijh *et al*. (2006)	Nicobari Black	6.00±0.20	-	0.078±0.004	0.30±0.01	-	-
Vij *et al*. (2007)	Tellicherry	-	29.22±0.98(µ)	0.061±0.007	0.32±0.017	69.07±3.48	-
Vij *et al*. (2005)	Danki	0.059±0.002	0.275±0.01	0.40±0.001	5.73	66.81±2.54	-
Vijh *et al*. (2005a)	Miri	0.102±0.007	0.445±0.002	0.30±0.001	-	81.64±0.32	-
Tantia *et al*. (2005a)	Kashmir Favorolla	0.068±0.001	0.47±0.036	0.25+0.007	5.8±1.4	68.81±2.19	-
Vijh *et al*. (2005b)	Kalasthi	0.05±0.00	0.35±0.02	0.37±0.001	5.02±0.3	76.79±2.93	-
Tantia *et al*. (2005b)	Ghagus	0.069±0.001	0.389±0.001	0.35±0.007	-	76.79±2.93	-
Parmar *et al*. (2006)	Kadaknath	7.03(%)	37.07(%)	0.31(%)		73.77	73.93
Vij *et al*. (2006a)	Punjab Brown	0.10±0.006	0.41±0.005	0.33±0.007	5.4±0.21	76.35±1.16	-
Tantia *et al*. (2006a)	Ankleshwar	0.008±0.006	0.36±0.001	0.30±0.001	5.64	83.68±0.02	-
Vij *et al*. (2006b)	Daothigir	0.068±0.005	0.29±0.01	0.33±0.009	5.09±0.21		-
Vij *et al*. (2006c)	Danki	0.059±0.002	0.275±0.013	40.45±1.40(µ)	-	66.81±2.5	-
	Kalasthi	0.055±0.00	0.351±0.02	37.09±1.19(µ)	-	68.81±2.19	-
	Ghagus	0.069±0.00	0.389±0.00	34.86±0.70(µ)	-	76.79±2.93	-
Vijh *et al*. (2006)	Nicobari Brown	0.094±0.006	0.29±0.01	-	5.84±0.12	-	-
Vijh *et al*. (2006)	Nicobari Black	0.078±0.004	0.30±0.01	-	6.00±0.20	-	-
Vijh *et al*. (2006)	Nicobari White	0.071±0.003	0.34±0.01	-	6.63±0.12	-	-

Author	Breed	ST (mm)	Shell wt (g)	Albumen index	Yolk index	HUS	Shape index
Vij *et al* (2007)	Busra	37.73±1.47(µ)	3.95±0.15	0.059±0.007	0.352±0.012	73.66±4.04	-
Iqbal and Pampori (2008)	Kashmiri	-	4.63±0.56 71	0.071 0.455	-	73.54	-
Gopinath (2013)	Chamarajanagar	0.357±0.011	4.90±0.23	0.034±0.003	0.339±0.006	67.50±1.40	75.36±1.35
	Mysore	0.338±0.009	5.30±0.17	0.045±0.001	0.283±0.005	70.10±0.88	73.59±1.79
	Mandya	0.334±0.003	5.25±0.20	0.046±0.002	0.283±0.004	70.40±0.76	75.26±1.02
Rajakumar (2013)	Chikkaballapur	0.39±0.011	-	0.066±0.002	0.380±0.015	76.70±1.065	73.69±1.53
	Bangalore rural	0.39±0.014	-	0.068±0.003	0.396±0.003	75.60±0.60	74.64±0.84
	Ramanagar	0.42±0.012	-	0.077±0.003	0.358±0.005	77.30±1.52	76.45±0.82
Vij *et al*. (2015)	Harringhata Black	-	-	0.07±0.00	0.47±0.04	-	-
Vij *et al.* (2016)	Kaunayen	0.36±0.01	5.04±0.14	0.07±0.01	0.38±0.01	76.88±2.35	-

2.7 Mortality in indigenous chicken

Diseases and predation were the leading causes of death among Zimbabw ean chicken. The birds, wild cats, household dogs, and occasionally snakes and rats were the main predators (Mcainsh *et al*., 2004). According to Pandey *et al*. (2005) the mortality rate in Aseel birds was fairly high (%) up to one week of age, whereas the adult mortality rate was 13 per cent. Vij *et al*. (2005) revealed from survey research that mortality in the Danki breed ranged from 20 to 30 per cent up to eight weeks of age. Vijh *et al*. (2005a) found that 11% mortality rate in the first four weeks of life in the Miri breed of chicken. In native Ethiopian chicken, Halima *et al*. (2006) found death rates ranging from 7.4 to 33.5 per cent from day old to four weeks, 1.5 to 6.2 per cent from five to eight weeks and 8.5 to 39.8 per cent from 20 to 22 weeks.

Gupta *et al*. (2006) found an average mortality rate of 22.3-52.73 per cent in Meghalayan native chicken. Vij *et al*. (2006b) stated that mortality was very low and virtually nil in Daothigir birds. Vij *et al*. (2007) reported that mortality was low or nil in Tellicherry chickens under free range conditions.

Gawande *et al*. (2007) studied the performance of indigenous chicken in rural Assam and found that 25.15 per cent of mortality in tribal area and 23.66 per cent in non-tribal area. Yousef and AL-Yousef (2007) observed 58 per cent chick mortality in Saudi Arabian Baladi hens during the first week and 21 per cent during the growth phase. Furthermore, under field conditions, they observed death rates of 63 per cent in the winter and 37 per cent in the summer.

Olwande *et al*. (2009) has found that 50 per cent of deaths in chicks are due to diseases and predation in southern Kenya under extensive system of rearing

indigenous chicken. Doley *et al*. (2009) has reported 14.35±1.02 per cent mortality under intensive and 17.13±1.21 per cent mortality under extensive systems in indigenous chickens from North - Eastern India up to 52 weeks of age.

As per Alders *et al*. (2010), New Castle disease is widespread in many countries, is a significant constraint for village chicken production, and can cause mortality ranging from 50 to 100 per cent.

Kumar *et al*. (2016) studied the mortality pattern in indigenous chickens from Kerala's Northern Midland agro-climatic zone and found that 69.38 per cent of death occurred between day-old to 72 weeks of age. He also mentioned that major cause of mortality was predation followed by diseases.

Islam *et al*. (2021) conducted survey in four agro-climatic regions of Assam and found that 78.5 per cent of mortality in indigenous chicken under free range system is due to diseases, 15.6 per cent is due to predation and 6 per cent by senility.

Table 2.9 Poultry population of Hassan district as per 20th livestock census

S. No	Taluk	Rural			Urban			Total
		Indigenous	Improved	Commercial	Indigenous	Improved	Commercial	
1	Alur	27461	715	74000	631	0	0	102807
2	Arakalgud	61278	48	0	1412	145	62	62883
3	Arasikere	50723	3316	814019	2920	0	0	870978
4	Belur	45570	175	151000	210	0	0	196955
5	Channarayapatna	40833	79463	74500	0	706	0	195502
6	Hassan	77925	3380	566698	3716	0	0	651719
7	Holenarsipura	58172	1279	2000	339	0	35500	97270
8	Sakaleshpur	45940	1153	0	1690	0	0	48783
	Overall	**407902**	**89529**	**1682217**	**10918**	**851**	**35500**	**2226917**

Materials and Methods

III. MATERIALS AND METHODS

The present study was carried out to characterize the indigenous chicken in four different agro-climatic zones of Hassan district and document the management practices followed in indigenous chicken farming.

Part - 1. Study under field circumstances.

3.1 Study area location, geography and climate

Karnataka state is located in the southwestern portion of India which is having a geographical area of 1,91,791 square kilometers with a population of 6,10,95,297 people, consisting of 3,09,65,685 male and 3,01,29,612 females. (Census report 2011). In Karnataka, rural regions accounted for around 69 per cent of the total population, compared to 73.9 per cent nationally. Karnataka has 38.5 per cent of its rural population engaged in agriculture, compared to 34.2 per cent nationally. Among the 34.2 per cent of cultivators, 2.9 per cent were agricultural labourers and 3.6 per cent worked in cattle, forestry, fisheries, plantations and related businesses (2001 census).

Present study was undertaken in Hassan district consisting of four four agro-climatic zones viz Central Dry Zone covering Arasikere taluk, Southern Dry Zone which is having Channarayapatna taluk, Southern Transition Zone which covers Alur, Arakalgud, Belur, Hassan and Holenarasipura taluks and Hilly zone which covers Sakaleshpura taluk. Cluster of two villages were selected randomly in each agro-climatic zones as suggested by the resident Veterinary Officers (Table 3.2)

The district's total geographical area is 6,62,602 hectares, of which 66.66 per cent is cultivable land and 24.47 per cent is uncultivable land. The district is located between 12^0 13' north latitude and 75^0 33' and 76^0 38' east longitude.

Table 3.1: Demographic and geographic feature of the study area

SI. No	Particulars	CDZ	SDZ	STZ	HZ	Pooled
1	Latitude and longitude	12^0 13’ and 13^0 33’ North Latitude and 75^0 33 and 76^0 38 East Longitude				
2	Geographical Area (km^2)	123452	103464	332797	102889	662602
3	Forest Land (ha)	15049	697	16860	26169	58775
4	Barren and uncultivable land (ha)	6330	5319	15945	2771	30365
5	Fallow land (ha)	8358	8948	35186	4459	56951
6	Cultivable waste land (ha)	220	870	11291	1761	14142
7	Permanent pasture (ha)	430	9275	11374	11864	32943
8	Net cultivable land (ha)	89663	77277	240764	55996	463700
9	Human Population	315339	279798	1052651	128633	1776421
10	Literacy Ratio (%)	78.96	75.64	73.53	79.55	76.07
11	Indigenous chicken Population	878265 (39.43%)	195502 (8.77%)	1104364 (49.59%)	48783 (2.19%)	2226914

Source: District drought proofing Plan, Hassan Disrict-2018

A structured interviewe Schedule (Annexure I) was prepared to collect information regarding farmers status, land holding pattern, source of income, livestock owned, purpose of rearing indigenous chicken, flock structure of indigenous chicken, provision for housing, hatching systems followed, egg production, mode of marketing eggs and indigenous chicken, consumer preference, demand for birds, mortality in chicks, feeding habits, vaccination status and morphological traits were recorded using the NBAGR proforma (Annexure – II). A sample of 10 households with minimum of 10 adult birds from each village was selected randomly for the survey, so that a minimum of 100 birds from each agro-climatic zone are covered. A total of 118 male birds and 282 female birds were examined for recording phenotypic traits on the spot during the survey period, with the format being utilized for documenting morphological features as provided in Annexure-II.

3.2 Farmers' profile, flock size, land holdings, livestock owned, purpose of rearing and flock size of indigenous chicken

Farmers' rearing at least ten native birds were interviewed to acquire the essential data. The data on land holdings on each chicken farmers were recorded in order to put them into four groups: more than 5 acres of land, 2.5 to 5 acres of land, less than 2.5 acres and land less labourers. Major livelihood activities such as agriculture, farm labour and animal husbandry activities, as well as the other livestocks owned, were documented. The information pertaining to purpose of rearing indigenous chicks, number of chicks housed below eight weeks of age, male and female birds aged between nine to twenty weeks and adults aged above twenty weeks were collected.

3.3 Housing and hatching system followed

Data on housing, location of chicken house, hatching preferences by farmers such as selection of eggs for incubation based on the size and colour of eggs, hatching season, materials used in hatching nest, frequency of hens coming out during hatching and hatching per centage were all documented.

3.4 Egg production profile and marketing methods

Farmers were interviewed about the number of eggs layed in one cycle, number of cycles in a year and total number of eggs in a year per hen and the data was collected. Consumer preference and demand such as during festivals, functions and seasons were noted. Modes of marketing such as direct sale to consumer, retail store or wholesale shop through middle men and selling in shandy were documented.

3.5 Feeding habits, chick mortality, vaccination and deworming status and issues in keeping indigenous birds

Farmers were questioned and and the data on mortality per cent of chicks aged 0 to 8 weeks, feeding practices such as scavenging, semi-intensive and intensive rearing, vaccination status such as whether completely vaccinated, not vaccinated or rarely vaccinated was collected. Farmers were also enquired about the issues with rearing indigenous chickens such as predators, diseases, feed availability and health care availability.

Table 3.2 Villages surveyed in four agro climatic zones in Hassan district

S. No	Agro climatic zone	Taluka	Villages selected
1	Central Dry Zone	Arasikere	Bageshpura Haranahalli
2	Southern Dry Zone	Channarayapatna	Gulasinda Doddaganni
3	Southern Transition Zone	Hassan	Chikkakadalur Melagodu
4	Hilly zone	Sakaleshpura	Jannapura Heggadde

Part-2 3.6 Indigenous chicken phenotypic characteristics

According to the NBAGR proforma, a total of 118 males and 282 females were considered for phenotypic character recording. Qualitative data collected were feather properties, plumage colour and pattern, skin colour, shank colour, ear lobe colour, comb type and colour and the presence or absence of wattle.

3.6.1 Feather characteristics

3.6.1.1 Feather morphology

The presence of structural differences in feathers such as normal, frizzled and silkiness, was recorded.

3.6.1.2 Feather distribution

The distribution of feathers on various body areas was examined and classified as naked neck, feathered shank and feet, beard and crest.

3.6.2 Plumage

3.6.2.1 Plumage colour

Black, white, red, blue, gold and brown were among the plumage colours documented. Birds having several colours were categorized as multi-colored.

3.6.2.2 Plumage pattern

The colour distribution of the plumage on various body areas was investigated and classified as solid, dull, stripped, patchy, spotted, barred and mottled.

3.6.2.3 Plumage pattern within feather

Each bird's feathers on the anterior section of the back area were carefully examined to document secondary plumage patterns. The patterns were documented based on the variance in colour distribution inside each feather, namely self-white, self-black, self-blue, self-red, barred, mottled and lacing.

3.6.3 Skin colour

The skin colour was recorded by examining the non-feathered region of the skin beneath the wings. The birds were classified into three groups based on their skin colour: white skinned, yellow skinned and black skinned.

3.6.5 Shank colour

Each bird's shank colour was documented and classified as white, yellow, black, green shank.

3.6.6 Ear lobe colour

The birds were classified based on the colour of their ear lobes, which might be white or red or black

3.6.7 Eye colour

The birds' eyes were inspected and categorised as brown, grey or yellow.

3.6.8 Comb

3.6.8.1 Comb colour

Each bird's comb colour was observed and classified as black or red.

3.6.8.2 Comb type

Each birds comb is examined and combs were classed as single, pea, rose, walnut, strawberry.

3.6.9 Wattles

The presence or absence of wattles was noted in all of the birds.

3.7 Morphometric characteristics

3.7.1 Body weight

Each bird's body weight was recorded using the hanging weighing scale.

3.7.2 Breast angle

The breast angle was measured to one degree precision with a breastometer or protractor. The measurement was taken at the centre of the breast area and the value was recorded.

3.7.3 Shank length

The distance between the hock joint and the tarso metatarsus was measured using digital vernier callipers to an accuracy of 0.1mm.

3.7.4 Keel length

The keel length was measured from the tip of the keel bone to the sternum joint utilising digital vernier callipers with 0.1 mm precision.

3.8 External egg quality traits

Twenty eggs were collected from each agro-climatic zone to examine external and internal egg quality features.

3.8.1 Shell colour

Eggs were visually examined to determine their colour and divided into brown and light brown.

3.8.2 Egg weight

Egg will be weighed by 100 g digital weighing scale with 0.01 g accuracy.

3.8.3 Shape index

The longest length and widest breadth of each egg were measured in millimetres (mm) with digital slide callipers to an accuracy of 0.1 mm. The shape index (SI) was calculated using the formula below.

$$\text{Shape index} = \frac{\text{Breadth(mm)}}{\text{length(mm)}} \times 100$$

3.8.4 Shell weight

After drying the empty shells in a hot air oven at 130 °C for five hours, the shell weight was recorded separately.

3.8.5 Shell thickness

A screw gauge was used to measure the average shell thickness at the broad end, narrow end and centre piece.

3.9 Internal egg qualities

Twenty fresh eggs were collected from each agro-climatic zone and tested for internal egg qualities such as albumen index, yolk index and Haugh unit score.

3.9. 1 Albumin weight

After extracting the yolk, the albumen weight was measured using a digital scale to an accuracy of 0.1gm.

3.9.2 Yolk weight

After removing the albumen, the weight of the yolk was measured using a digital scale to an accuracy of 0.1 gm.

3.9.3 Albumin index

The thick albumen's longest length and widest breadth were measured with digital slide calipers. Ames tripad micrometre was used to measure the height of the albumen at three different sites. The albumen index was calculated using the formula shown below.

$$\text{Albumen index} = \frac{\text{Av. height of albumen(mm)}}{\text{Av. width and length of albumen(mm)}}$$

3.9.4 Yolk index

The height of the yolk was measured using an Ames micrometer and the diameter with digital slide calipers. The following formula was used to calculate the Yolk index.

$$\text{Yolk index} = \frac{\text{height of yolk(mm)}}{\text{diameter of yolk(mm)}}$$

3.9.5 Haugh unit score

The Haugh unit score (HUS) was calculated using the formula below.

$$\text{HU} = 100\text{Log}\,(\text{H} + 7.57 - 1.7\,\text{w}^{0.37})$$

Where H denotes the albumen height in mm and W denotes the egg weight in grames.

3.10 Statistical analysis

The data acquired on various factors were evaluated using SPSS 20 statistical software in accordance with Snedecor and Cochran (1967). Univarient analysis was used to compare between means for contious variables and chi square test/ Fisher exact test was used to know the association between attributes. For comparision between groups post hoc duncun test was used.

Results

IV. RESULTS

In this chapter result of the present study are presented. The primary objective of this study was phenotypic characterization of indigenous chicken and management practices followed in different agro-climatic regions of Hassan district. As part of the field study, the results of the survey on farmer status, land holding patterns, source of income, livestock owned, flock structure, housing, hatching system, egg production, marketing, feeding practices, vaccination details and morphological characters (as per NBAGR proforma) of indigenous chicken in four agro-climatic zones of Hassan district were recorded. External and internal quality traits of eggs from different agro-climatic zones studied in the laboratory are presented in the tabular form.

4.1 Survey in the field

4.1.1 Socioeconomic profile of farmers rearing indigenous chicken

Survey results of 80 households (20 households in each Taluk) from four agro-climatic zones of Hassan district namely, Central dry zone (Arasikere Taluk), Southern dry zone (Channarayapatna Taluk), Central transition zone (Hassan Taluk) and Hilly zone (Sakaleshpura Taluk) on gender and caste of indigenous chicken owners were presented in table 4.1.1 and fig. 4.1.

Results of the present study based on gender caste of the indigenous chicken rearing owners were presented in table 4.1.1. Totally 58.75 per cent of women and 41.25 per cent of men were involved in rearing indigenous chicken. With respect to men Arasikere and Sakaleshpur region they were about 45 per cent followed by Hassan (40%) and Channarayapatna (35%). Higher female farmers were seen in

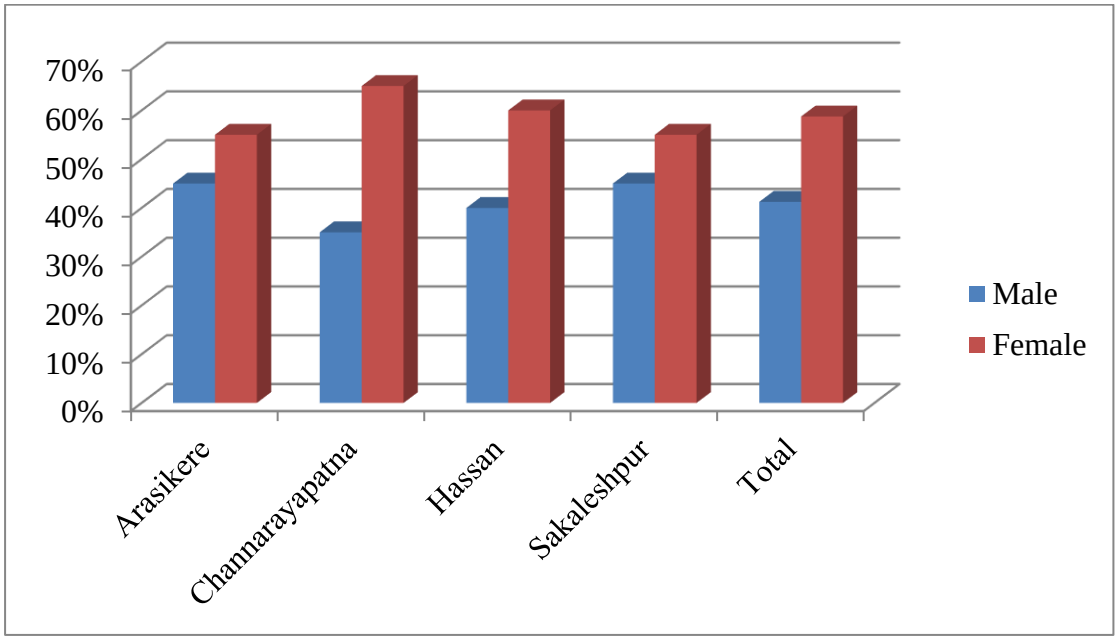
Channarayapatna (65%) and in Hassan taluk (60%), compared to Sakaleshpur and Arasikere taluk (55%).

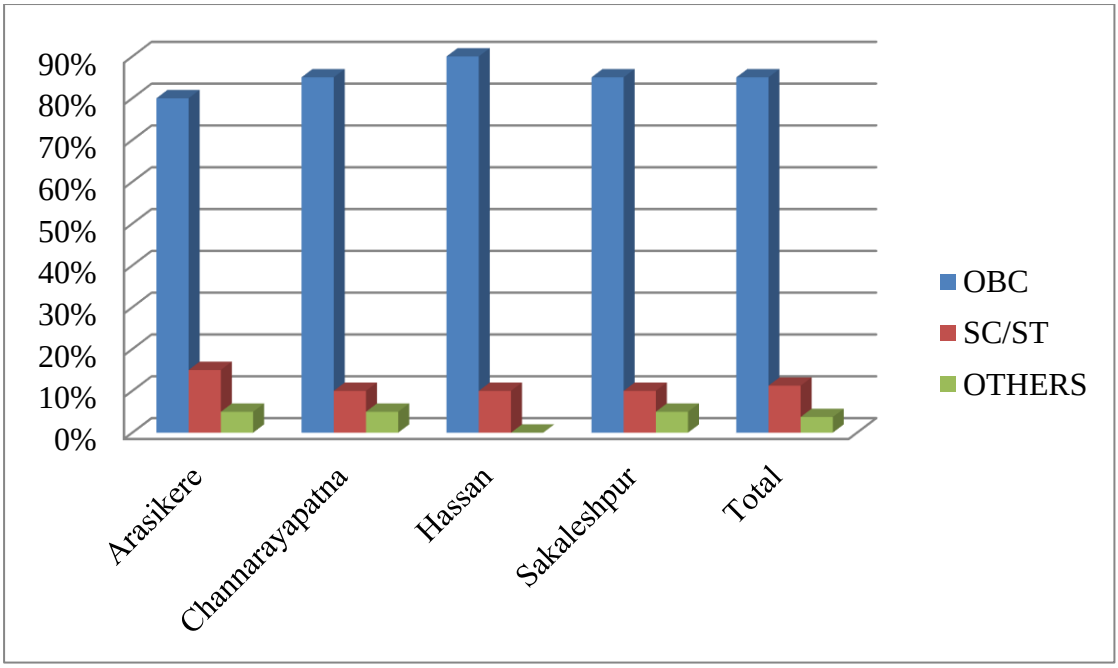
Caste of the farmer rearing indigenous chicken in four agro-climatic zone of Hassan was presented in table 4.1.1. In Hassan taluk 90 per cent of farmers belonged to OBC whereas, in Channarayapatna and Sakaleshpur they were about 85 per cent and 80 per cent in case of Arasikere. Highest SC/ST farmers rearing indigenous chicken was from Arasikere which is about 15 per cent and 10 per cent in remaining other three taluks. Other category people of abpot five per cent were rearing native chicken in Arasikere, Channarayapatna and Sakaleshpur talukas. In Hassan taluk none of the other category people were rearing indigenous chicken. Totally 68 farmers of OBC, nine farmers of SC/ST and three farmers of other category constituting 85 per cent, 11.25 per cent and 3.75 per cent respectively were rearing indigenous chicken. However, there is no significant difference observed between different regions.

Table 4.1.1 Table showing Gender and caste of farmers rearing indigenous chicken in different agro-climatic regions of Hassan (%)

Region	**Gender**				**Caste**					
	Male		Female		OBC		SC/ST		Others	
	N	%	N	%	N	%	N	%	N	%
Arasikere	9	45	11	55	16	80	3	15	1	5
Channarayapatna	7	35	13	65	17	85	2	10	1	5
Hassan	8	40	12	60	18	90	2	10	0	0
Sakaleshpura	9	45	11	55	17	85	2	10	1	5
Total	33	41.25	47	58.75	68	85	9	11.25	3	3.75
Chi square test P value	0.199				0.986					

Figure 4.1: Gender and caste of farmers rearing indigenous chicken in different agro-climatic regions of Hassan





4.1.2 Land holding pattern

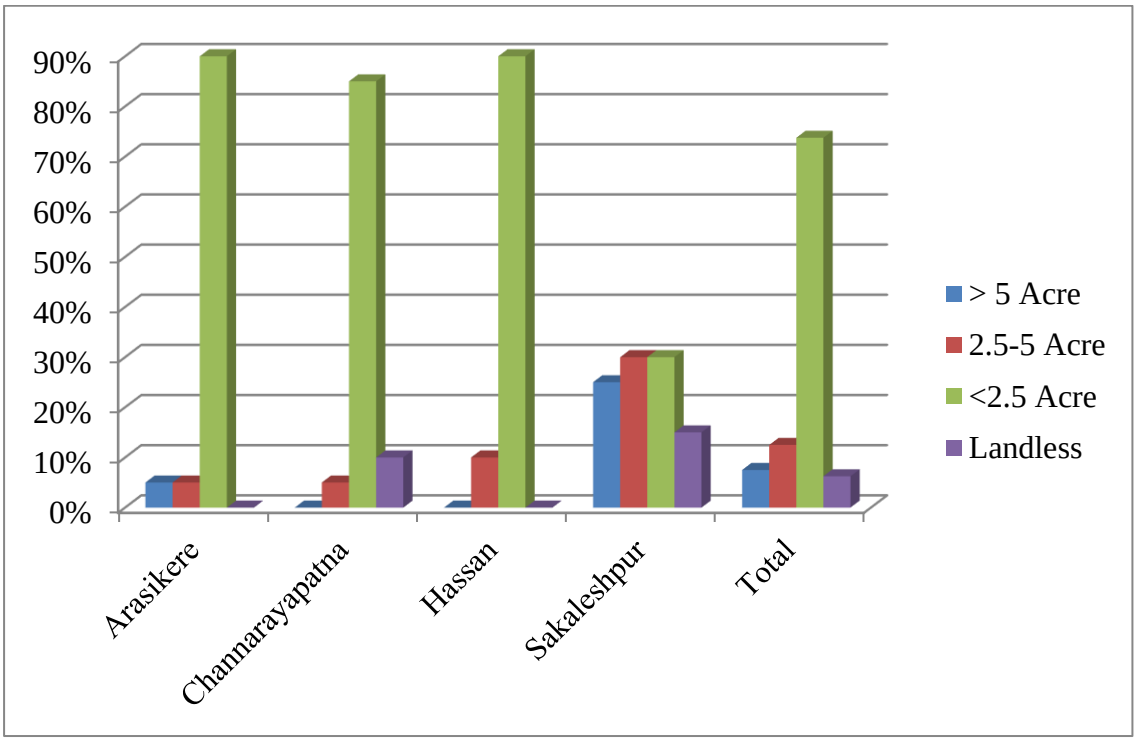
The results on the land holding pattern of selected farmers were presented in Table 4.1.2. The farmers were classified as large farmer (>5 acres), medium farmer (2.5-5 acres), small farmer (< 2.5 acres) and landless farmers. In Hassan and Channarayapatna none of the large farmers were rearing indigenous chicken whereas, five per cent and 25 per cent in Arasikere and Sakaleshpur were rearing indigenous chicken. Among different agro-climatic regions, 30 per cent and 10 per cent of medium farmers were actively involved in indigenous chicken rearing from Sakaleshpur and Hassan taluk, respectively. Further, we observed 90 per cent of small farmers from Arasikere and Hassan were involved in indigenous chicken production. However, only 30 per cent of small farmers in Sakaleshpur were involved in indigenous chicken production.

In the group of landless categories, 10 per cent from Channarayapatna and 15 per cent from Sakaleshpur were rearing indigenous chicken. However, there is no landless farmers were observed in indigenous chicken production from Arasikere and Hassan taluk. Overall, 73.75 per cent of small farmers, 12.5 per cent of medium farmers, 7.5 per cent of large farmers and 6.25 per cent of landless farmers were involved in indigenous chicken production among different agro-climatic regions of Hassan district. The land holding capacity of farmers between different regions showed a significant difference ($P<0.01$).

Table: 4.1.2 Land holding pattern of farmers rearing indigenous chicken (%)

Region	Land holding pattern								
	>5 Acres		2.5-5 Acres		< 2.5 Acres		Landless		P value
	N	%	N	%	N	%	N	%	
Arasikere	1	5	1	5	18	90	0	0	<0.001
Channarayapatna	0	0	1	5	17	85	2	10	
Hassan	0	0	2	10	18	90	0	0	
Sakaleshpura	5	25	6	30	6	30	3	15	
Total	6	7.5	10	12.5	59	73.75	5	6.25	

Figure: 4.2. Land holding pattern of farmers rearing indigenous chicken



4.1.3 Livelihood and purpose of rearing

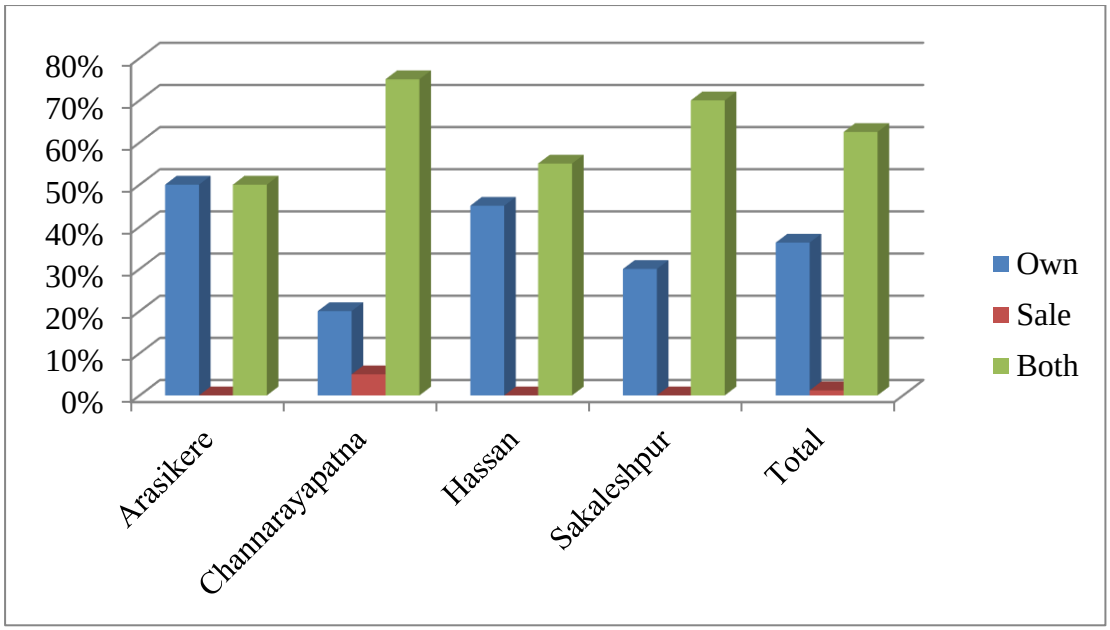
Livelihood activities and purpose of rearing indigenous chicken in four taluks of different agro-climatic zones of Hassan district were listed in table 4.1.3 and depicted in fig. 4.3. Farmers were classified based on their livelihood as agriculture, animal husbandry & agriculture and agriculture labor. A significant difference was observed between the agro-climatic zones and their livelihood. In Sakaleshpur, 40 per cent of farmers were rear indigenous chickens along with agriculture, followed by Hassan (15%), Channarayapatna (15%) and Arasikere (10%) taluks. Chicken rearing farmers in Arasikere (90%) were involved in both agriculture and animal husbandry, followed by Hassan (80%), Channarayapatna (70%), and Sakaleshpur (40%) taluks. Sakaleshpur (20%) taluk has the most agri-labor rearing indigenous chickens, followed by Channarayapatna (15%) and Hassan taluks (5%). The results of overall livelihood revealed that 70 per cent, 20 per cent, and 10 per cent farmers were involved in Agriculture & Animal husbandry, Agriculture and Agri-labour, respectively.

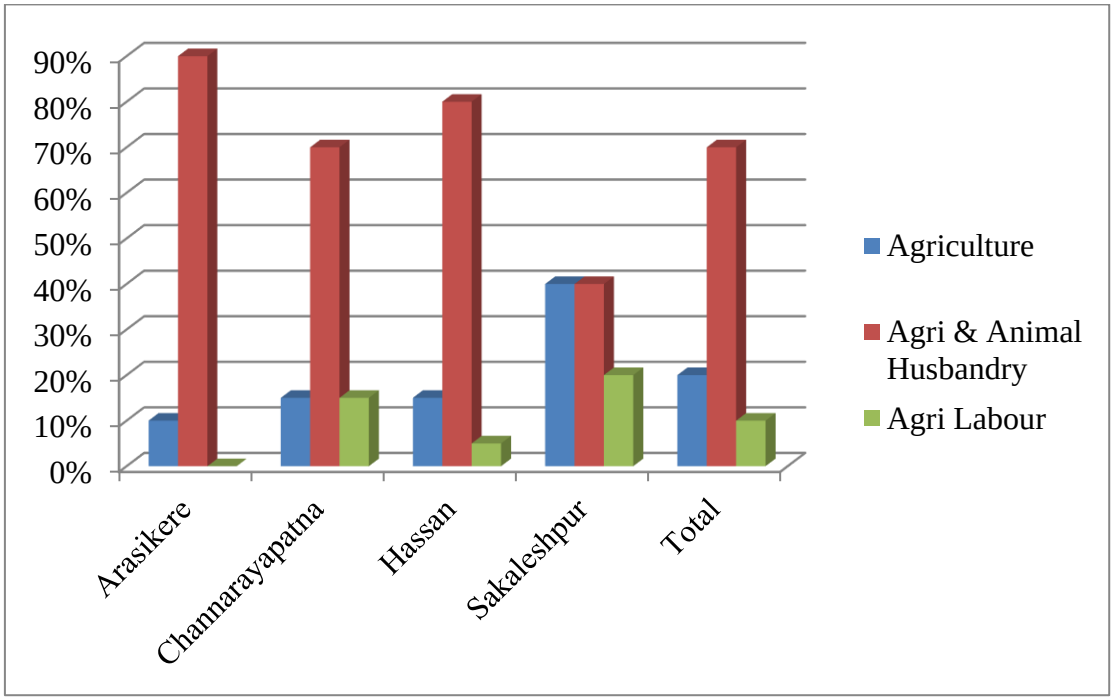
Farmers of Arasikere (50%), Channarayapatna (20%), Hassan (45%) and Sakaleshpur (30%) taluk were utilised the indigenous chicken meat and egg for their consumption. The majority of farmers in the Channarayapatna taluk (75%) use indigenous chicken meat and eggs for both own consumption and marketing, followed by Sakaleshpur (70%), Hassan (55%) and Arasikere (50%). Overall, in selected taluks of Hassan district observed more farmers (62.5%) were rearing indigenous chicken for both own consumption & marketing purpose. Whereas, 36.25 per cent of farmers were utilized indigenous chicken for their own consumption.

Table 4.1.3 Livelihood and purpose of rearing indigenous chicken

Region	**Livelihood**						**Purpose**					
	Agriculture		Agriculture and Animal husbandry		Agri-labour		Own		Sale		Both	
	N	%	N	%	N	%	N	%	N	%	N	%
Arasikere	2	10	18	90	0	0	10	50	0	0	10	50
Channarayapatna	3	15	14	70	3	15	4	20	1	5	15	75
Hassan	3	15	16	80	1	5	9	45	0	0	11	55
Sakaleshpur	8	40	8	40	4	20	6	30	0	0	14	70
Total	16	20	56	70	8	10	29	36.25	1	1.25	50	62.5
Chi square test P value	0.022						0.226					

Figure: 4.3 Livelihood and purpose of rearing indigenous chicken





4.1.4 Average flock size and Structure of indigenous chicken

In the present study information collected from selected farmers of four agro-climatic regions were presented in table 4.1.4. Indigenous chicken details were collected from 20 farmers of Arasikere (484 birds), Channarayapatna (524 birds), Hassan (370 birds) and Sakaleshpur (475 birds). Average flock size of various regions was 24.2 (Arasikere), 26.2 (Channarayapatna), 18.5 (Hassan) and 23.75 (Sakaleshpur) and overall average was 23.16. Flock size range was varied from 10 to 59 birds among different regions.

The percentage of chicks among various regions was 32.83 per cent (Arasikere), 27.86 per cent (Channarayapatna), 28.65 per cent (Hassan) and 25.47 per cent (Sakaleshpur). Adult male and female birds were 15.9 per cent and 30.56 per cent in Arasikere, 11.26 per cent and 27.29 per cent in channarayapatna, 12.7 per cent and 32.97 per cent in Hassan and 17.47 per cent and 25.68 per cent in Sakaleshpur taluk. Results of the overall flock structure observed were 28.7 per cent (chicks), 11.94 per cent (grower male), 16.27 per cent (grower female), 14.41 per cent (adult male) and 28.96 per cent (adult female) respectively. However, there is no significant difference observed between the different regions for flock structure and size ($P>0.05$).

Table 4.1.4 Flock structure of indigenous chicken

Regions	No. of farmers	Number of birds	Flock size	Chicks		Grower Male		Grower Female		Adult Male		Adult Female	
	N	N	Mean	N	%	N	%	N	%	N	%	N	%
Arasikere	20	484	24.2	7.95	32.8	1.8	7.44	3.2	13.22	3.85	15.9	7.4	30.56
Channarayapatna	20	524	26.2	7.3	27.86	3.65	13.93	5.15	19.66	2.95	11.26	7.15	27.29
Hassan	20	370	18.5	5.3	28.65	2	10.81	2.75	14.86	2.35	12.7	6.1	32.97
Sakaleshpura	20	475	23.75	6.05	25.47	3.45	14.53	4	16.84	4.15	17.47	6.1	25.68
SEM	-	-	-	1.034		0.58		0.677		0.531		0.729	
Total Mean	-	-	23.16	6.65±0.51 (28.7%)		2.76±0.29 (11.94%)		3.76±0.34 (16.27%)		3.33±0.27 (14.41%)		6.69±0.36 (28.96%)	
Chi square p value	-	-	0.11	0.268		0.07		0.73		0.73		0.452	

4.1.5 Chicken rearing with other livestock

Farmers rearing indigenous chicken along with livestock and different housing system were presented in table 4.1.5. Farmers were classified based on the diversity of livestock rearing capacity as poultry with large ruminants, poultry with small ruminants, poultry with large ruminants & small ruminants and only poultry keepers. In Arasikere 20 per cent farmer's reared poultry along with large ruminantns, 10 per cent with small ruminants, 65 per cent with both large and small ruminants and 5 per cent were rearing only poultry. In Channarayapatna taluk 35 per cent with large ruminants, 5 per cent with small ruminants, 60 per cent with both large & small ruminants and only poultry rearing farmers were not found. Results of the Hassan region revealed that the 45 per cent of farmers reared indigenous poultry with large ruminants, 10 per cent with small ruminants, 35 per cent with both large and small ruminants and 10 per cent only reared indigenous chicken. In Sakaleshpur taluk 20 per cent, 6.25 per cent, 35 per cent and 45 per cent farmers were rearing indigenous chicken with large ruminants, small ruminants, large and small ruminants and chicken alone. Overall, Farmers rearing indigenous chicken along with livestock in Hassan district were, 30 per cent (large ruminants), 6.25 per cent (small ruminants), 48.75 per cent (both large and small ruminatns), and 15 per cent (poultry alone). Results showed that, there is no significant difference between the regions.

The results indicated that 47.5 per cent of farmers kept chickens along with other livestock, 26.25 per cent kept chickens in their courtyard and 26.25 per cent house chickens separately. There was a significant difference between the regions with respect to housing. In Sakaleshpur taluk 65 per cent of the farmers provide separate housing for their birds.

Table 4.1.5 Table showing details of farmer rearing indigenous chicken with other livestock and housing of indigenous chicken

Region	Farmer rearing chicken with other livestock								Housing					
	With large ruminants		With small ruminants		With both large and small ruminants		Only poultry keepers		Livestock house		Owner courtyard		Separate housing	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Arasikere	4	20	2	10	13	65	1	5	11	55	6	30	3	15
Channarayapatna	7	35	1	5	12	60	0	0	11	55	6	30	3	15
Hassan	9	45	2	10	7	35	2	10	11	55	7	35	2	10
Sakaleshpur	4	20	5	6.25	7	35	9	45	5	25	2	10	13	65
Total	24	30	5	6.25	39	48.75	12	15	38	47.5	21	26.25	21	26.25
Chi square test P value	0.115								0.001					

4.1.6 Details of hatching practices and egg production

Data on selection of egg and bedding material used for hatching purpose is presented in table 4.1.6. Interestingly, 85 per cent of farmers from Arasikere, 90 per cent in Hassan, 80 per cent in Sakaleshpur and 65 per cent in Channarayapatna were selected the eggs based on the colour and size. Overall, in Hassan district 62.50 per cent of farmers selected the eggs based on colour and size. It was found that there is no significant difference between different agro-climatic regions and egg selection based on colour and size.

Our collected data from Arasikere zone showed that 50 per cent of farmers were used grass, 35 per cent of farmers used grass with ash and 15 per cent of farmers used grass with sand. Similarly, in Channarayapatna 10 per cent of farmers' used grass, 55 per cent used grass with ash and 35 per cent farmers used grass with sand as a bedding material. In Hassan region 15 per cent of farmers' used grass, 55 per cent used grass with ash and 30 per cent farmers used grass with sand as bedding material for hatching indigenous chicken eggs. Whereas, Sakaleshpur farmers were used only grass as a bedding material. Overall, in Arasikere, Channarayapatna, Hassan and Sakaleshpur taluks farmers used grass (43.75%), grass with ash (36.25%) and grass with sand (20%), respectively as bedding material to hatch indigenous eggs. It was found that there is significant difference observed between different agro-climatic regions for bedding materials ($P<0.05$).

Table 4.1.6 Selection of eggs and bedding materials used for hatching.

Region	Egg selection for hatching based on colour and size				Materials used for hatching					
	Yes		No		Grass		Grass+Ash		Grass+Sand	
	N	%	N	%	N	%	N	%	N	%
Arasikere	3	15	17	85	10	50	7	35	3	15
Channarayapatna	7	35	16	65	2	10	11	55	7	35
Hassan	2	10	18	90	3	15	11	55	6	30
Sakaleshpur	4	20	16	80	20	100	0	0	0	0
Total	30	37.50	50	62.50	35	43.75	29	36.25	16	20
Chi square test P value	0.235				<0.001					

4.1.7 Frequency of hen outside during hatching

Frequency of hen coming outside and feeding during incubation period is presented in table 4.1.7 Eighty per cent of broody hen came outside the hatching area once in 2 days or more and 55 per cent of farmers provided feed during incubation of indigenous chicken eggs in Arasikere region. In Channarayapatna taluk indigenous chicken came outside (85%) once in two days or more and 60 per cent of farmers provided feed during incubation of eggs. Seventy per cent of hens came outside once in 2 days or more and 40 per cent of farmers provided feed during natural incubation to the broody hen in Hassan region. Results of Sakaleshpur region revealed that 95 per cent of broody hen came outside once in 2 days or more and 55 per cent of

indigenous birds were offered feed by farmers. Overall, 82.5 per cent of farmers observed that broody hen came outside during hatching. Further, 52.5 per cent of farmers offered feed during incubating indigenous chicken eggs to the broody mother and remaining 47.5 per cent were not offered feed. In Hassan district observed no significant difference between agro-climatic regions for hen outside and feeding during hatching (P>0.05).

Table 4.1.7 Frequency of Hen coming outside from brooding place and feeding during incubation.

Region	Hen outside during hatching				Feed during Incubation			
	Once in a day		Once in 2 days or more		Yes		No	
	N	%	N	%	N	%	N	%
Arasikere	4	20	16	80	11	55	9	45
Channarayapatna	3	15	17	85	12	60	8	40
Hassan	6	30	14	70	8	40	12	60
Sakaleshpur	1	5	19	95	11	55	9	45
Total	14	17.5	66	82.5	42	52.5	38	47.5
Chi square test P value	0.212				0.614			

4.1.8 Egg production profile of indigenous chicken in Hassan district

The farmers of Hassan district in different agro-climatic zone were interviewed regarding parameters like number of cycles per year, eggs kept for hatching, hatching per centage, clutch size and eggs per annum. Data were presented in table 4.1.8. Highest average number of cycles per year was observed in Hassan

taluk (3.4) followed by Arasikere (3.35), Channarayapatna (3.15) and Sakaleshpur taluks (3.1). The average number of cycles per year in different regions was 3.25±0.57 and found no significant difference (P>0.18) among the different agro-climatic zones.

Data on number of eggs placed for hatching was collected from farmers of four agro-climatic zones and results were presented in table 4.1.8 and significant difference (P<0.05) in number of eggs kept for hatching was observed by Duncun multiple range post hoc test. Channarayapatna farmers (14) placed more number of eggs followed by Arasikere (13.7). In Sakaleshpur region average number of eggs placed was 12.65 and 12.45 in Hassan. Overall, total mean number of eggs placed was 13.21±0.38 were kept for hatching.

Hatching per centage of indigenous chicken was collected from farmers (table 4.1.8) and results revealed that hatchability was more in Channarayapatna taluk (83.19%) which was significantly higher compared to other regions viz., Arasikere (78.57%), Hassan (77.86%) and Sakaleshpur taluk (76.83%). Total mean hatching per centage was 79.12±0.81. Between selected regions and hatchability per centage were significantly differed by Duncun multiple range post hoc test (P<0.05).

Clutch size is the number of eggs laid continuously by the bird on consecutive days and results are presented n table 4.1.8. Farmers from different were regions enquired and collected data showed that the mean clutch size was highest in Channarayapatna (16.05±0.43) followed by Hassan (16±0.43), Arasikere (15.8±0.43) and Sakaleshpur taluk (15.25±0.43). Average clutch size in Hassan district was 15.78±0.18 days with no significant difference between regions (P>0.05).

Total number of eggs laid by single hen in a year from different regions of Hassan district was presented in table 4.1.8. An average egg per year as per the farmers' survey ranged from 44 in Sakaleshpur taluk, 47.25 in Hassan taluk, 47.5 in Arasikere and 48.5 in Channarayapatna taluk. An average of 46.81±0.98 eggs were laid by each hen per annum. Stastiscal analysis by Duncun multiple range post hoc showed Arasikere Channarayapatna and Hassan are significanatly differed from Sakaleshpur for variable number of eggs laid per year (Table 4.1.8).

Table 4.1.8 No. of cycles, clutch size, egg production in indigenous chicken

Region	No of cycles per year	No. of eggs kept for hatching	Hatching per centage	Clutch size	Eggs per year
Arasikere	3.35	13.7^{bc}	78.57^{b}	15.8	47.5^{ab}
Channarayapatna	3.15	14^{c}	83.19^{a}	16.05	48.5^{a}
Hassan	3.4	12.45^{a}	77.86^{b}	16	47.25^{ab}
Sakaleshpur	3.1	12.65^{ab}	76.83^{b}	15.25	44^{b}
Total Mean	3.25±0.57	13.2±0.38	79.117±0.81	15.78±0.18	46.81±0.98
SEM	0.114	0.382	1.613	0.426	1.257
Chi square test P value	0.180	0.01	0.034	0.228	0.086

4.1.9 Marketing age of indigenous chicken in Hassan district

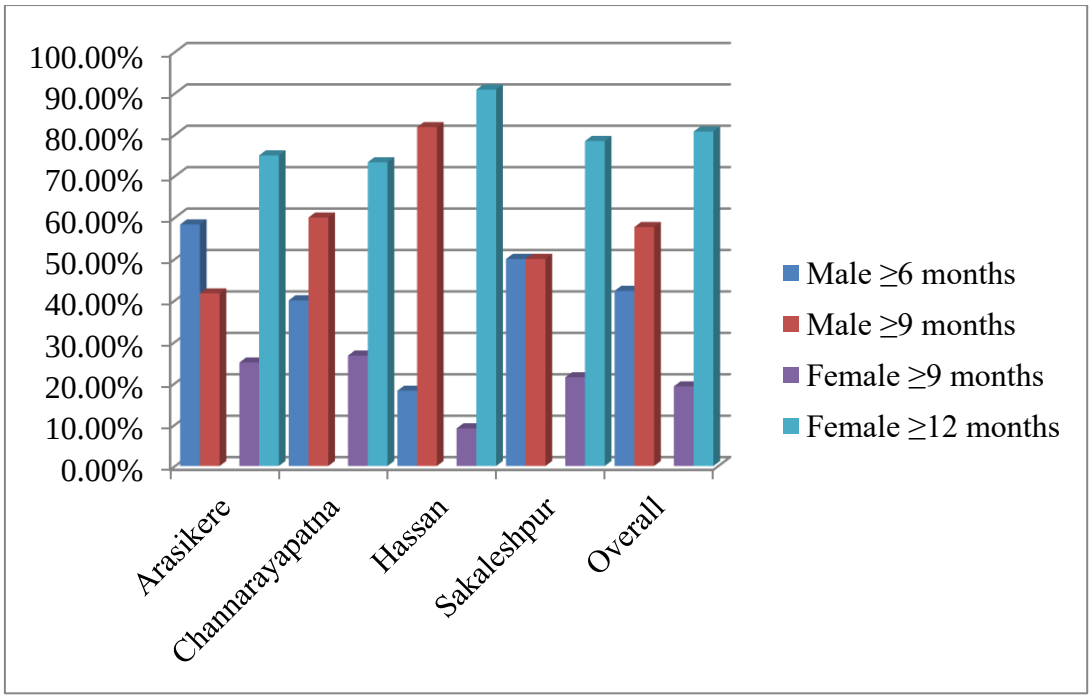
Results of marketing age of male and female indigenous chicken were presented in table 4.1.9 and depicted in fig. 4.4. In Arasikere taluk 58.33 per cent of farmers marketed the males at the age of more than six months. In case of females 25 per cent were marketed at the age of more than 9 months and 75 per cent were marketed at age of more than 12 months. Sixty per cent and 40 per cent farmers sold

males at the age of more than nine months and more than 6 months, respectively. In case of female 73.34 per cent and 26.66 per cent farmers sold at the age of more than 12 month and more than nine months, respectively in the Channarayapatna taluk. Farmers of Hassan taluk sold males at the age of more than nine months (81.82%) and more than 6 months (18.18%), whereas in females 90.9 per cent and 9.1 per cent were sold at the age of more than 12 months and nine months, respectively. Results of the Sakaleshpur taluk revealed that 50 per cent of males either more than six months or nine months but 78.48 per cent females were sold at the age of more than 12 months and 21.42 per cent at more than nine months. Overall results revealed that 57.69 per cent of males and 19.23 per cent of females sold at age of more than nine months and 42.3 per cent males in more than six months and 80.76 per cent females in more than 12 months. It was observed that there is no significant difference between selected regions and birds marketing age (P>0.05).

Table 4.1.9 Marketing age of male and female birds

Region	Males				Female			
	≥6 months		≥9 months		≥9 months		≥12months	
	N	%	N	%	N	%	N	%
Arasikere	7	58.33	5	41.67	3	25	9	75
Channarayapatna	6	40	9	60	4	26.66	11	73.34
Hassan	2	18.18	9	81.82	1	9.1	10	90.9
Sakaleshpur	7	50	7	50	3	21.42	11	78.48
Overall	22	42.3	30	57.69	10	19.23	42	80.76
Chi square test P value	0.412				0.719			

Figure: 4.4 Marketing age of male and female birds



4.1.10 Consumer preference and demand

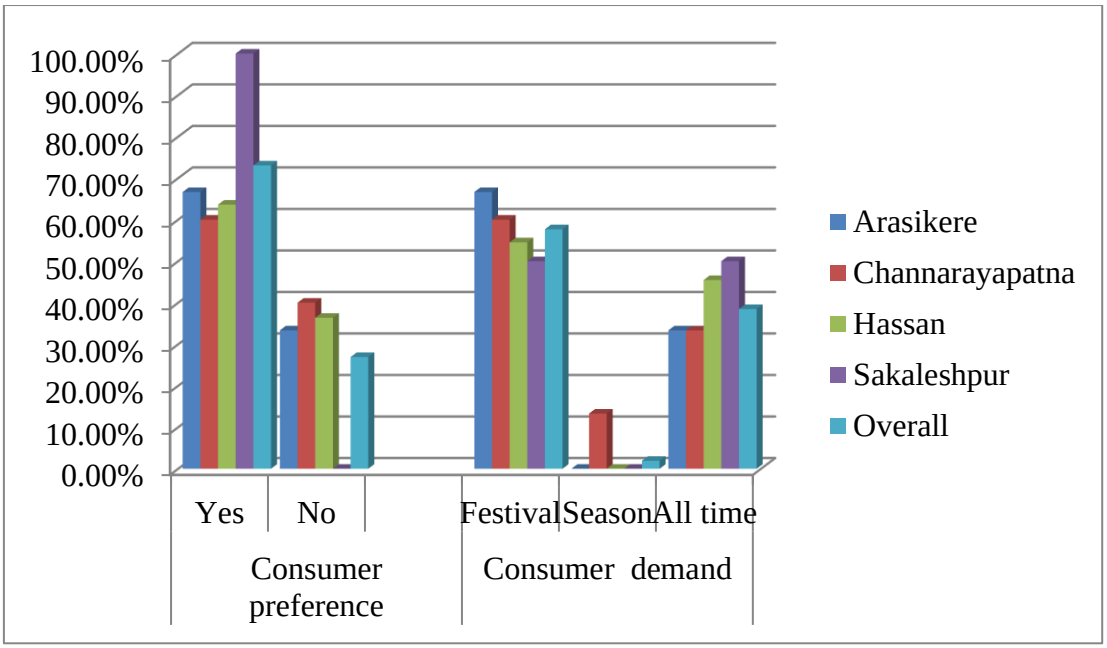
Interviewed results of the consumer preference for indigenous chicken plumage colours like multiple colour versus plain colour in different agro-climatic zones of Hassan district is presented in table 4.1.10. The consumer preference was high for multiple-coloured birds compared to plain plumage colour. Preferrence of multiful color birds over plain plumage colour among different regions were Arasikere (66.66%), Channarayapatna (60%), Hassan (63.63%) and Sakaleshpur (100%). The overall Consumer preference per centage is about 73.07 and the remaining consumer did not give any preference on bids plumage colour. It is found that there is a no significant difference between the regions for consumer preference on birds' plumage colour ($P>0.05$).

Indigenous chicken demand during different periods like festivals, different seasons and through out the year is presented in table 4.1.10. Further, in Arasikere taluk 66.66 per cent and 33.34 per cent consumer preferred during festival and all time, respectively. Whereas, in Channarayapatna 60 per cent, 13.33 per cent and 33.34 per cent preference was observed during festival, season and all times, respectively. In Hassan taluk, consumer preferred per centage was 54.54 per cent and 45.46 per cent in festivals and all time where as none preferred during season. Overall, 57.69 per cent, 1.92 per cent and 38.46 per cent consumer demanded during festivals, season and all time, respectively. Surprisingly, we found a significant difference between the various regions and demands (P>0.01).

Table 4.1.10 Consumer preference and demand

Region	**Consumer preference based on bird plumage colour**				**Consumer demand during different periods**					
	Yes		**No**		**Festivals**		**Season**		**All times**	
	N	%	N	%	N	%	N	%	N	%
Arasikere	8	66.66	4	33.34	8	66.66	0	0	4	33.34
Channarayapatna	9	60	6	40	9	60	2	13.33	4	33.34
Hassan	7	63.63	4	36.37	6	54.54	0	0	5	45.46
Sakaleshpur	14	100	0	0	7	50	0	0	7	50
Over all	38	73.07	14	26.92	30	57.69	2	1.92	20	38.46
Chi square test P value	0.031				0.006					

Figure: 4.5 Consumer preference and demand



4.1.11 Mode of marketing indigenous chicken

Data collected on mode of marketing like shandy, wholeale/retail shop and direct sale to consumer is presented in table 4.1.11. In Arasikere taluk, 25 per cent, 16.66 per cent and 58.34 per cent indigenous chicken marketed in shandy, wholesale/retail shop and sold to consumer, respectively. Interestingly, results of Channarayapattna revealed that 33.34 per cent and 66.66 per cent of farmers marketed in wholesale shop and shandy, respectively. In Hassan taluk, 45.45 per cent, 27.27 per cent and 27.28 per cent of indigenous chicken marketed at shandy, wholesale/retail shop and to consumer directly, respectively. Indigenous chicken from sakalshpur sold to wholesale/retail shop (35.71%) and 64.29 per cent directly to consumer, whereas none of the farmers marketed in shandy. Overall, results revealed that 36.53 per cent of indigenous chicken were marketed directly to consumer, 28.84 per cent to wholesale/retail shop and remaining 34.16 per cent marketed in shandy. From table

4.1.11 it is observed that there is a significant difference in mode of marketing between the regions (P<0.001).

Table 4.1.11 Mode of marketing indigenous chicken in different agro-climatic regions of Hassan district

Region	Marketing in shandy		Sold in wholesale/retail shop		Direct sale to consumer	
	N	%	N	%	N	%
Arasikere	3	25	2	16.66	7	58.34
Channarayapatna	10	66.66	5	33.34	0	0
Hassan	5	45.45	3	27.27	3	27.28
Sakaleshpur	0	0	5	35.71	9	64.29
Over all	18	34.61	15	28.84	19	36.53
Chi square test P value	<0.001					

4.1.11 Ethno veterinary practice and mortality in chicks

Farmers apply traditional knowledge to cure local chicken ailments. Farmers' most commonly utilised resources are onion blended with buttermilk, garlic, chiles, green vegetables, and paracetomol pills. Results of the ethno veterinary medicines used and mortality in chicks were presented in table 4.1.12. In region of Arasikere (60%), Channarayapatna (85%), Hassan (35%) and Sakaleshpur (30%) were did not used any local medicines. Overall, 52.5 per cent of farmers from Hassan district did not practice any local medicines. Whereas, 47.5% of farmers from Hassan district were followed the ethno veterinary medicines. It is found that no significant differences among agro-climatic regions (P>0.01).

Chick mortality per centage is presented in table 4.1.12. Chick mortality among different region of Hassan was Arasikere (45.25±1.98), Channarayapatna (38.5±2.32), Hassan (42.5±3.15) and Sakaleshpur (44.75±1.68), respectively. Overall mean mortality per centage in chicks was 42.68±1.5 and found no significant difference (P>0.05).

Table 4.1.12 Ethno veterinary medicines used for backyard chicken rearing and mortality in chicks

Region	**Ethno-veterinary medicines used**				**Mortality % in chicks (0-12 weeks)**
	Yes		No		
	N	%	N	%	
Arasikere	8	40	12	60	45.25±1.98
Channarayapatna	3	15	17	85	38.5±2.32
Hassan	13	65	7	35	42.5±3.15
Sakaleshpura	14	70	6	30	44.75±1.68
Total	38	47.5	42	52.5	42.68±1.5
Chi square test P value	0.001				0.404

4.1.13 Feeding practices, vaccination, deworming and major constraints of back yard chicken rearing.

Results of feeding practices followed by indigenous chicken rearing farmers are presented in table 4.1.13 and depicted in fig 4.6. Where as, 95 per cent of farmers from Hassan and 75 per cent from Sakaleshpur were permitted their birds for scavenging. Overall results revealed that 87.5 per cent and 12.5 per cent indigenous chicken were fed on scavenging and semi-intensive system respectively. There was no

significant difference in feeding habits between regions, according to the data ($P<0.05$).

The results of vaccination and deworming status of backyard chicken was presented in table 4.1.13 and depicted in fig. 4.6. None of the farmer from Arasikere neither dewormed nor vaccinated their birds. Further, 95 per cent of farmers from Channarayapatna, 90 per cent from Hassan and 80 per cent from Sakaleshpur, were not vaccinated and dewormed their indigenous chicken. Overall mean results revealed that 91.25 per cent of indigenous birds were not vaccinated and dewormed. Futher, no statistically significant difference was observed between regions for vaccination and deworming details ($P>0.05$).

Farmer's data on major constraints for backyard for indigenous chicken rearing were collected and presented in table 4.1.13 and depicted in fig. 4.6. Our results showed that 65 per cent of farmers from Arasikere, 80 per cent from Channarayapatna, 75 per cent from Hassan and 90 per cent from Sakaleshpur opined those major constraints was predator attack. Interestingly, infectious diseases were account for major constraints in Arasikere (35%), Channarayapatna (20%), Hassan (25%) and Sakaleshpur (10%). The mean of all agro-climatic zones revealed that 77.5 per cent predator attack followed by 22.5 per cent infectious diseases were responsible for major constraints of indigenous birds. It was found no significant differences across the regions for constraints ($P>0.05$).

Table 4.1.13 Feeding practices, vaccination, deworming and major constraints for backyard chicken rearing

Region	Feeding practices				Vaccination & deworming				Major Constraints for backyard chicken rearing			
	Scavenging		Semi-intensive		Yes		No		Predator Attack		Infectious diseases	
	N	%	N	%	N	%	N	%	N	%	N	%
Arasikere	18	90	2	10	0	0	20	100	13	65	7	35
Channarayapatna	18	90	2	10	1	5	19	95	16	80	4	20
Hassan	19	95	1	5	2	10	18	90	15	75	5	25
Sakaleshpura	15	75	5	25	4	20	16	80	18	90	2	10
Total	70	87.5	10	12.5	7	8.75	73	91.25	62	77.5	18	22.5
Chi square test P value	0.37				0.198				0.61			

Figure 4.6 Feeding practices, vaccination, deworming and major constraints for Backyard chicken rearing

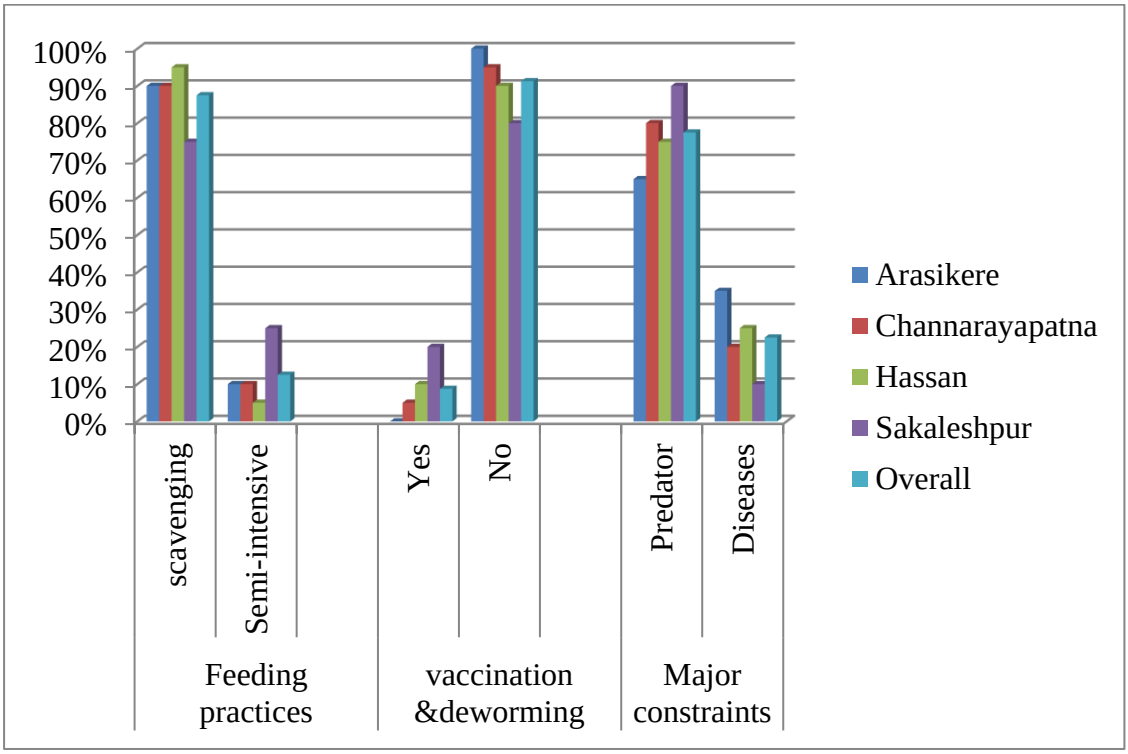


Plate No.1 Housing inside owner's courtyard and with other livestock

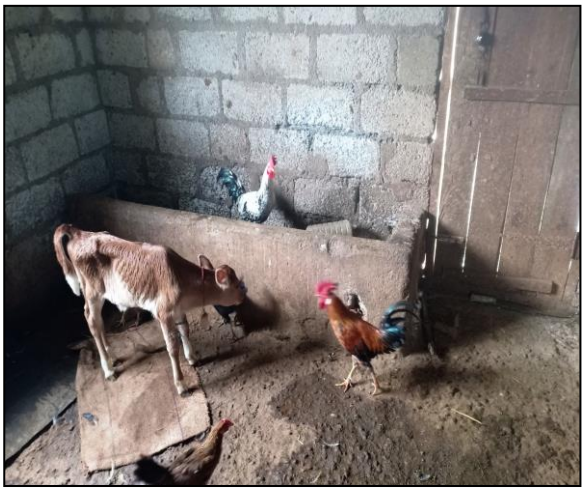


Plate No. 2 Housing with in Bamboo basket and locally available materials

Eggs kept for incubation

Chicks after hatching

Different types of housing

4.2. Phenotypic characterization

A total of 118 males and 282 females are considered in Hassan district for recording the physical characters as per National Bureau of Animal Genetics Resources (NBAGR) proforma and the results were presented in this chapter.

4.2.1 Feather morphology

A result of the present study on feather morphology is presented in table 4.2.1. It was revealed that normal feathers were observed 100 per cent in all four agro-climatic zones. However, no frizzel and silky feathers were observed in the different regions of Hassan district.

4.2.2 Feather distribution

Feather distribution was recorded in males and females in different regions of Hassan were presented in table 4.2.2 and 4.2.3, depicted in figure 4.7. Normal feather distribution was found 94.9 per cent in male indigenous birds and 97.87 per cent in female birds. Naked neck feather distribution was found 5.1 per cent in male birds and 2.13 percent in female indigenous birds. Statistical analysis revealed that there is no significant difference between the regions for feather distribution ($P>0.05$).

Normal feather distribution was prevalent more in male indigenous birds in all regions. Interestingly, naked neck was found only in Arasikere (6.25%) and Channarayapatna (13.33%) regions. Similarly, in female indigenous bird's normal feather distribution was prevalent more in all regions and naked neck was found in Arasikere (1.5%) and Channarayapatna (7.2%) regions.

Table 4.2.1 Feather morphology of indigenous chicken of Hassan district in different agro-climatic regions

Males feather morphology											**Female feather morphology**									
Categories	**Arasikere**		**Channaraya-patna**		**Hassan**		**Sakaleshpura**		**Total %**		**Arasikere**		**Channarayapatna**		**Hassan**		**Sakaleshpura**		**Total %**	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Normal	32	10	30	100	29	100	27	100	118	100	68	100	70	100	71	100	73	100	282	100
Chi square test P value	P>0.05										P>0.05									

*Fisher exact test

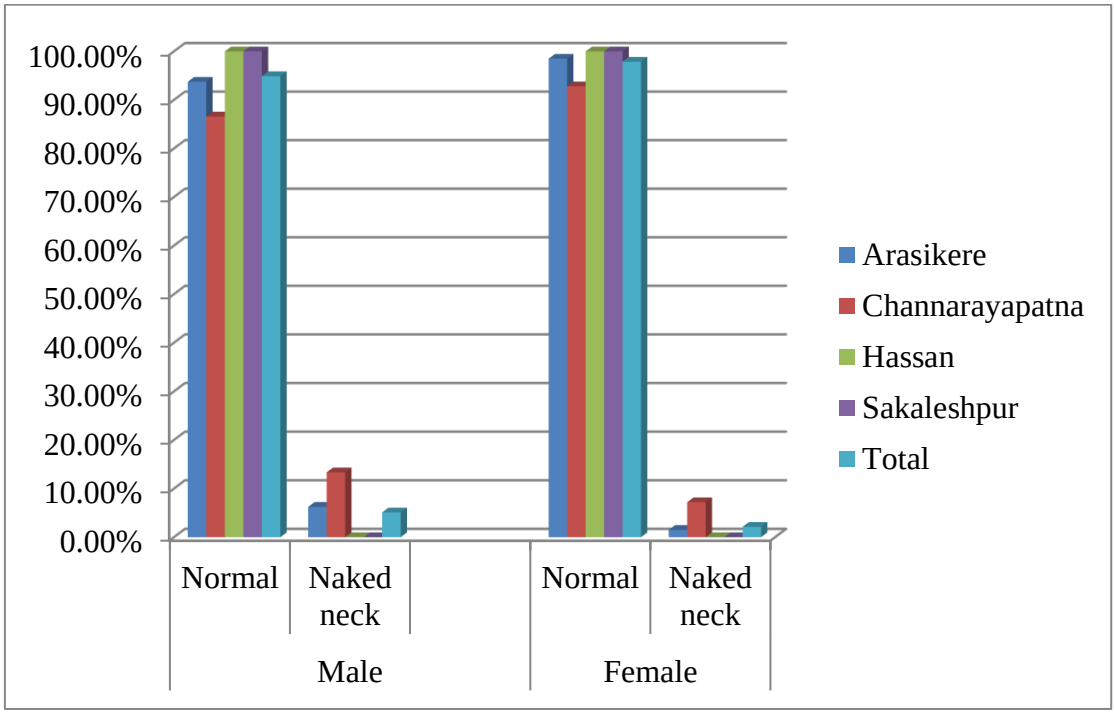
Table 4.2.2 Feather distribution of indigenous chicken in different agro-climatic regions of Hassan district (Males)

Males feather distribution											
Categories	**Arasikere**		**Channarayapatna**		**Hassan**		**Sakaleshpur**		**Total %**		**Chi square Value**
	N	%	N	%	N	%	N	%	N	%	
Normal	30	93.75	26	86.6	29	100	27	100	112	94.9	0.053
Naked neck	2	6.25	4	13.33	0	0	0	0	6	5.1	

Table 4.2.3 Feather distribution of indigenous chicken in different agro-climatic regions of Hassan district (Females)

Females feather distribution											
Categories	**Arasikere**		**Channarayapatna**		**Hassan**		**Sakaleshpura**		**Total %**		**Chi square Value**
	N	%	N	%	N	%	N	%	N	%	
Normal	67	98.5	65	92.8	71	100	73	100	276	97.87	0.05
Naked neck	1	1.5	5	7.2	0	0	0	0	6	2.13	

Figure: 4.7 Feather distribution of indigenous chicken in different agro-climatic regions of Hassan district



4.2.3 Plumage colour in males and females

Plumage colours recorded in male birds and female birds of different agro-climatic regions is presented in table 4.2.4 and 4.2.5 respectively. Data of seven plumage colour viz., white, black, red, brown, multi-colour and gold were observed during the study.

Results showed that more dominant plumage colours in male indigenous were red (28.81%), multi-colour (27.12%), brown (16.94%), white (13.55%) and black (11.86%). Least observed colour was gold (1.69%). In case of females black (30.85%), brown (27.30%), multi-colour (17.73%) and white (13.47%) were the most observed colours. Red (10.63%) was the least observed in female indigenous birds.

Collected data on plumage colour in both male and female birds revealed that there is no significant difference across the regions in Hassan district (P>0.05).

In male birds multi-colour plumage colour (37.5%) frequencies were more in Arasikere taluk followed by red (18.75%). White and brown colours (15.62%) were found in equal proportion and black colour (12.5%) is the least observed. The plumage colour observed in Channarayapatna taluk was red (40 %), multi-colored (33.34 %), brown (10 %), white (10 %) and black (6.6 %). Red plumage colour (27.58%) was highest in Hassan taluk followed by brown (24.13%), multi-colour (24.13%), white (13.79%), black (10.3%) and gold colour plumage (3.4%). Male birds in Sakaleshpur taluk had more red plumage colour (29.62 %). Followed by brown (25.92 %) and multi-color (25.92 %) plumage are in equal proportion followed by black (18.51%), white colour (14.81%) and gold (3.7%).

In case of female bird's black (29.41%) was the most common plumage colour in Arasikere taluk, followed by brown and multi-color (20.58%) in same proportions, white (16.17%) and red (13.23%). In Channarayapatna taluk female birds with black plumage colour (32.85%) and brown colour (30%) were more common followed by white (17.51%), multi-colour (12.85%) and red plumage (8.5%). Least common plumage colours observed in Hassan taluk were red (9.85%) and white (15.49%). Most common plumage colours observed in Hassan were brown (22.53%), multi-colored (21.12%) and black (30.98%). In case of Sakaleshpur taluk brown (35.61%) and black (30.13%) were the most common plumage colours observed followed by multi-color (16.43%), white (6.84%) and red (10.95%).

Table 4.2.4 Plumage colour of indigenous chicken Males in different agro-climatic regions of Hassan district

Categories	Arasikere		Channaraya -Patna		Hassan		Sakalespura		Total %		Chi square value
	N	%	N	%	N	%	N	%	N	%	
White	5	15.62	3	10	4	13.79	4	14.81	16	13.55	0.631*
Black	4	12.5	2	6.6	3	10.3	5	18.51	14	11.86	
Red	6	18.75	12	40	8	27.58	8	29.62	34	28.81	
Brown	5	15.62	3	10	7	24.13	5	25.92	20	16.94	
Multi-colour	12	37.5	10	33.34	6	24.13	4	25.92	32	27.12	
Gold	0	0	0	0	1	3.4	1	3.7	2	1.69	

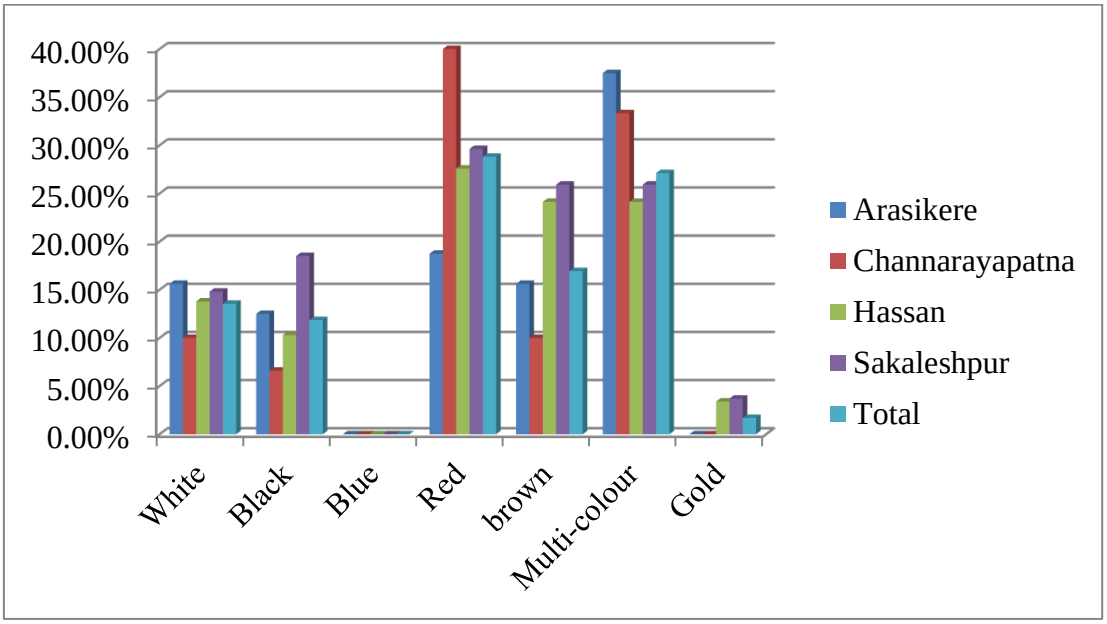
- Fishers Exact test

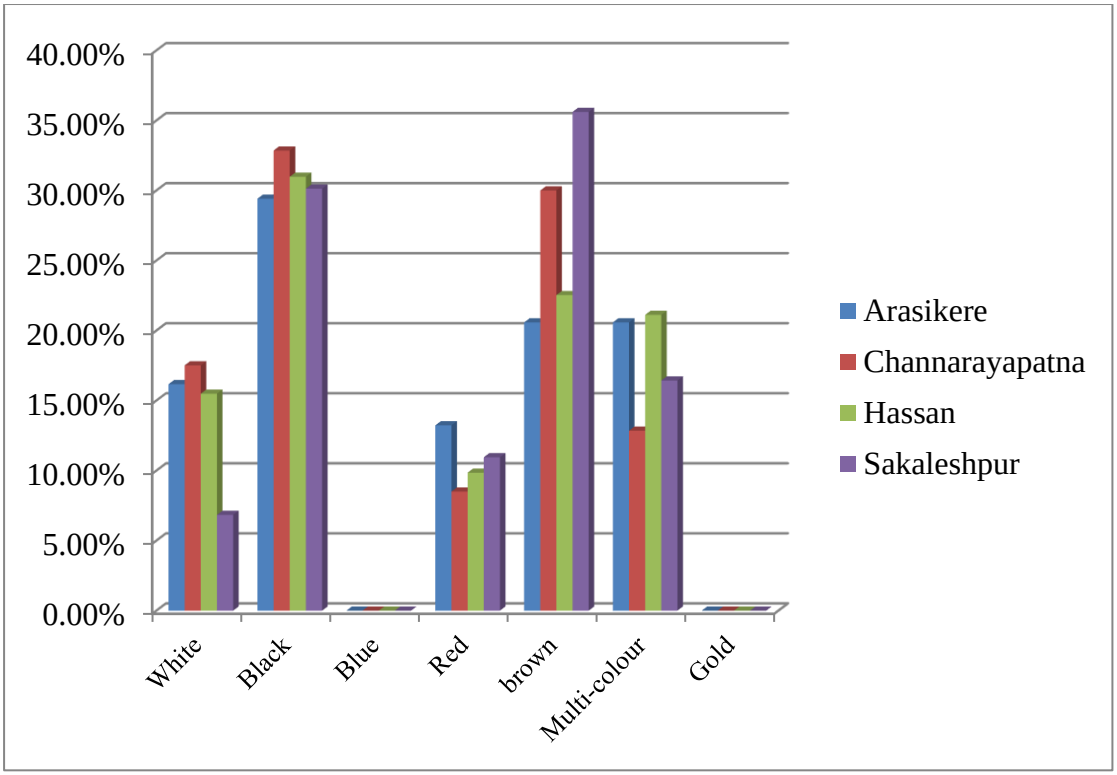
Table 4.2.5 Plumage colour of indigenous chicken in different agro-climatic regions of Hassan district (Females)

Categories	Arasikere		Channaraya -Patna		Hassan		Sakalespura		Total %		Chi square value
	N	%	N	%	N	%	N	%	N	%	
White	11	16.17	11	17.51	11	15.49	5	6.84	38	13.47	0.637*
Black	20	29.41	23	32.85	22	30.98	22	30.13	87	30.85	
Red	9	13.23	6	8.5	7	9.85	8	10.95	30	10.63	
Brown	14	20.58	21	30	16	22.53	26	35.61	77	27.30	
Multi-colour	14	20.58	9	12.85	15	21.12	12	16.43	50	17.73	

*Fisher's Exact test

Figure 4.8 Plumage colour of indigenous chicken Males and females in different agro-climatic regions of Hassan district





4.2.4 Primary and secondary plumage pattern in male and female birds

Primary plumage pattern in chicken was classified as solid, dull, stripped, patchy, spotted, barred, mottled and results were presented in table 4.2.6.

Total percent of male indigenous birds have more solid pattern (58.47%) followed by dull (14.4%) and barred (11.86%). Other patterns observed were patchy (6.78%), stripped (3.38%), mottled (3.38%) and spotted (1.69%).

In case of female birds most common pattern was solid (36.87%), dull (36.88%) and barred (11.2%). Other patterns observed were stripped (6.02%), mottled (5.67%), patchy (3.19%) and spotted (0.35%). Solid pattern was the most common primary plumage pattern observed in both male and female indigenous birds. Statistical analysis on primary plumage patterns were revelaed that there is a significant difference across the regions of Hassan district ($P>0.05$).

In Arasikere taluk most common pattern observed in male indigenous birds was solid (53.12%), dull (15.62%), patchy (12.5%) and barred (12.5%). Least observed pattern was stripped (3.12%) and mottled (3.12%). In case of Channarayapatna taluk solid (63.33%), dull (16.66%) and patchy (13.33%) were the common pattern observed. Spotted (6.66%) was the least observed pattern. In Hassan taluk most prevalent pattern was solid (55.17%), dull (13.79%), barred (13.79%) and stripped (10.34%). Least observed common pattern was mottled (6.89%). In Sakaleshpur taluk common patterns observed were solid (62.96%), barred (22.22%) and dull (11.11%). Mottled pattern (3.7%) was the least observed in male indigenous birds.

Further, female indigenous birds exhibited solid (44.18%), barred (20.58%) and dull (20.59%) pattern in Arasikere taluk. Stripped (4.41%), mottled (8.82%) and patchy (1.47%) were the least exhibited pattern. In case of Channarayapatna taluk most common primary plumage pattern observed was solid (55.57%) and dull (24.29%). Other patterns observed were barred (8.57%), stripped (4.29%), mottled (4.29%) patchy (1.42%) and spotted (1.42%). In Hassan taluk dull (40.84%) and solid (28.17%) were the most common pattern observed. Least observed pattern was stripped (8.45%), barred (8.45%) patchy (7.04%) and mottled (7.04%). In case of Sakaleshpur region dull (60.27%) followed by solid (20.54%) were the common pattern observed.

Table 4.2.6 Primary plumage pattern of indigenous chicken in different agro-climatic regions of Hassan district (Males)

Male											
Categories	**Arasikere**		**Channaraya -patna**		**Hassan**		**Sakaleshpur**		**Total %**		**Chi square value**
	N	%	N	%	N	%	N	%	N	%	
Solid	17	53.12	19	63.33	16	55.17	17	62.96	69	58.47	0.046
Dull	5	15.62	5	16.66	4	13.79	3	11.11	17	14.4	
Stripped	1	3.12	0	0	3	10.34	0	0	4	3.38	
Patchy	4	12.5	4	13.33	0	0	0	0	8	6.78	
Spotted	0	0	2	6.66	0	0	0	0	2	1.69	
Barred	4	12.5	0	0	4	13.79	6	22.22	14	11.86	
Mottled	1	3.12	0	0	2	6.89	1	3.7	4	3.38	

Female											
Categories	**Arasikere**		**Channaraya -patna**		**Hassan**		**Sakaleshpur**		**Total %**		**Chi square value**
	N	%	N	%	N	%	N	%	N	%	
Solid	30	44.18	39	55.57	20	28.17	15	20.54	104	36.87	0.046
Dull	14	20.59	17	24.29	29	40.84	44	60.27	104	36.88	
Stripped	3	4.41	3	4.29	6	8.45	5	6.84	17	6.02	
Patchy	1	1.47	1	1.42	5	7.04	2	2.73	9	3.19	
Spotted	0	0	1	1.42	0	0	0	0	1	0.35	
Barred	14	20.58	6	8.57	6	8.45	5	6.84	31	11.2	
Mottled	6	8.82	3	4.29	5	7.04	2	2.73	16	5.67	

4.2.5 Secondary plumage pattern in Male and Female birds

As per NBAGR, secondary plumage pattern was classified as self black, self white, self red, barred, lasing and mottled. The results obtained were presented in table 4.2.7.

Observation was made on 118 male birds in different regions indicates most common secondary plumage pattern were self- black (34.74%), self-white (42.37%) and self-red (16.94%). Other patterns observed were barred (3.38%), mottled (1.69%) and lasing (0.84%).

Further, 282 female birds were examined for secondary plumage pattern. Self-white (41.48%), self-black (41.84%), lasing (12.32%) and mottle (12.32%) were most common patterns observed. Other less common pattern was self-red (6.73%) and barred (6.73%). Observed data on secondary plumage pattern showed a statistically non significant between the region for both male and female birds ($P>0.05$).

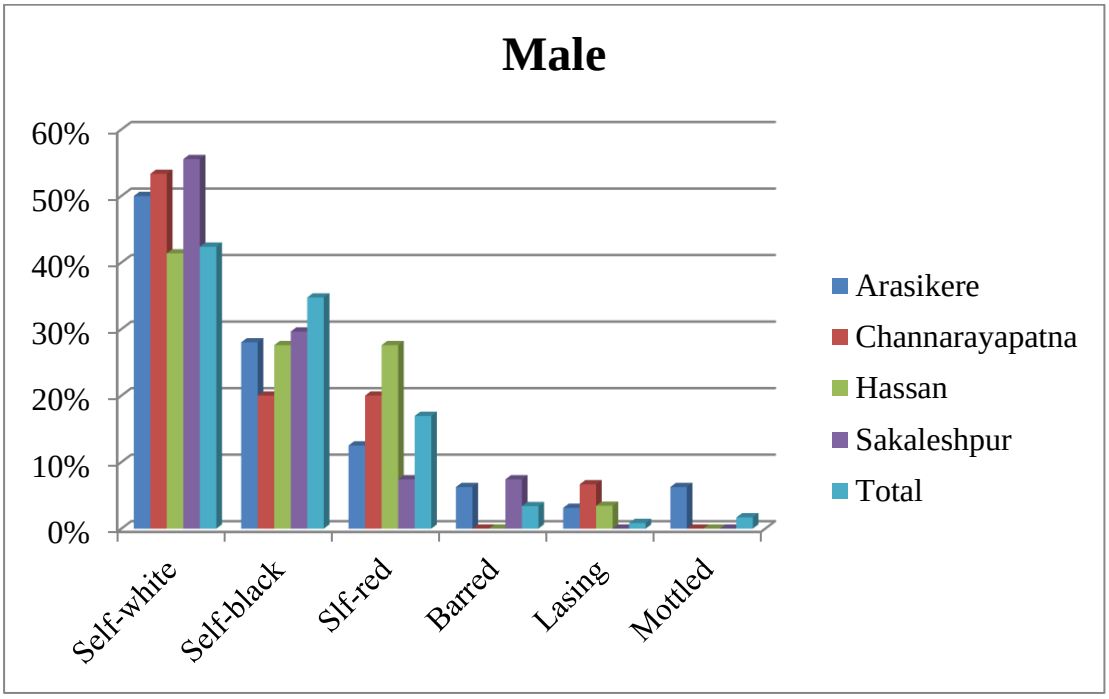
In male indigenous birds most common secondary plumage pattern observed in Arasikere taluk was self- white (50%) followed by self- black (28%). Other pattern observed were self red (12.5%), barred (6.25%), mottled (6.25%) and lasing (3.12%). In Channarayapatna taluk most common pattern observed was self white (53.33%) and self black (20%) pattern. Other two patterns seen were self- red (20%) and lasing (6.66%). In Hassan taluk self- black (27.58%) and self- red (27.58%) were seen in equal percentage. Most common secondary pattern was self white (41.37%) and less common pattern was lasing (3.44%). Most commont pattern observed in Sakaleshpur region was self white (55.55%) followed by self black (29.62%), self red (7.4%) and barred (7.4%).

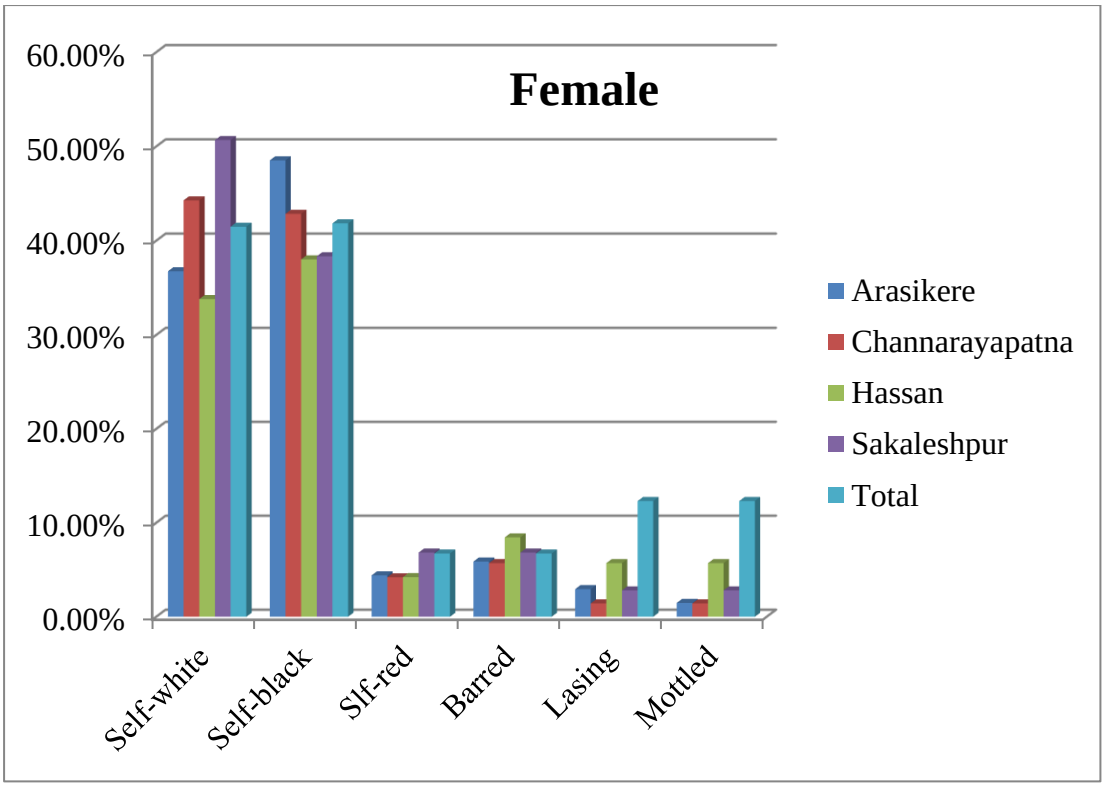
Further, female birds in Arasikere taluk have more self-black (48.52%) pattern followed by self- white (36.76%). Other patterns were barred (5.88%), self red (4.41%), lasing (2.94%) and mottled (1.47%). In Channarayapatna taluk self- white (44.28%) and self- black (42.85%) pattern were most common secondary plumage pattern observed. Lasing and mottled (1.42%) were less common pattern. Most common pattern observed in Hassan taluk was self- black (38.02%) and self-white (33.8%). Self- white pattern (50.68%) was most frequent in Sakaleshpur taluk followed by self black (38.35%). Self red (6.84%), barred (6.84%), lasing (2.81%) and mottled (1.4%) were the other secondary pattern seen in Sakaleshpur taluk.

Table 4.2.7 Secondary plumage pattern of indigenous chicken males and females in different agro-climatic regions of Hassan district

Male											
Categories	**Arasikere**		**Channaraya -patna**		**Hassan**		**Sakaleshpur**		**Total %**		**Chi square P value**
	N	%	N	%	N	%	N	%	N	%	
Self-white	16	50	16	53.33	12	41.37	15	55.55	50	42.37	0.402
Self-black	7	28	6	20	8	27.58	8	29.62	41	34.74	
Self-red	4	12.5	6	20	8	27.58	2	7.4	20	16.94	
Barred	2	6.25	0	0	0	0	2	7.4	4	3.38	
Lasing	1	3.12	2	6.66	1	3.44	0	0	1	0.84	
Mottled	2	6.25	0	0	0	0	0	0	2	1.69	
Female											
Categories	**Arasikere**		**Channaraya -Patna**		**Hassan**		**Sakalespura**		**Total %**		**Chi square P value**
	N	%	N	%	N	%	N	%	N	%	
Self-white	25	36.76	31	44.28	24	33.8	37	50.68	117	41.48	0.209
Self-black	33	48.52	30	42.85	27	38.02	28	38.35	118	41.84	
Self-red	3	4.41	3	4.2	3	4.22	5	6.84	19	6.73	
Barred	4	5.88	4	5.71	6	8.45	5	6.84	19	6.73	
Lasing	2	2.94	1	1.42	4	5.71	2	2.81	9	12.32	
Mottled	1	1.47	1	1.42	6	8.45	1	1.4	9	12.32	

Figure: 4.9 Secondary plumage pattern of indigenous chicken males and females in different agro-climatic regions of Hassan district





4.2.6 Qualitative characteristics of indigenous chicken

Sex wise qualitative character of indigenous chicken like skin colour, shank colour, ear lobe colour, comb colour, comb type, eye colour and wattles were observed and results were presented in table 4.2.8 and 4.2.9.

4.2.6.1 Skin colour

In male indigenous birds, the white skin colour was 93.1 percent in Hassan, followed by 92.59 per cent in Sakaleshpur, 78.12 per cent in Arasikere, and 73.3 per cent in Channarayapatna. Whereas, yellow skin colour was in 26.66 per cent in Channarayapatna, 21.8 per cent in Arasikere, 7.4 per cent in Sakaleshpur and 6.89 per cent in Hassan taluk. The information on skin colour in male indigenous birds is presented in table 4.2.8.

Similarly in female indigenous birds, white skinned were 91.42 per cent in Channarayapatna taluk followed by 84.93 per cent in Sakaleshpur, 82.35 per cent in Arasikere and 71.83 per cent in Hassan taluks. However statistically non significant difference in skin colour among various agro-climatic regions of Hassan district. The information on skin colour in female indigenous birds is presented in table 4.2.9.

4.2.6.2 Shank colour

The various colours of shank observed in indigenous male birds are presented in table 4.2.8. In Arasikere taluk only yellow colour shank in 78.12 per cent and white shank in 21.87 per cent of indigenous male birds were observed. In Channrayapatna and Hassan taluks only yellow colour shank birds were observed. In Sakaleshpur taluk yellow coloured shank in 81.48 per cent and white coloured shank in 18.51 per

cent of the indigenous birds were observed. A significant difference in shank colour of male birds between regions was observed.

But in case of female indigenous birds all four coloured shank birds were observed which is presented in table 4.2.9. In Arasikere Taluk, the colour of shank observed were 17.64 per cent, 61.76 per cent and 20.58 per cent of white, yellow and black coloured shank respectively were seen. In Channarayapatna 11.42 per cent, 61.42 per cent, 20 per cent and 7.14 per cent of white, yellow, black and green shank respectively were observed. In Hassan taluk, 19.12 per cent, 64.71 per cent and 20.59 per cent of white, yellow and black coloured shank respectively were observed. In Sakaleshpur taluk, 16.44 per cent, 73.97 per cent and 9.61 per cent of white, yellow and black coloured shank respectively were observed. Significant association between Shank colour and regions was observed.

4.2.6.3 Ear lobe colour

The examination of the ear lobes in Indigenous birds revealed Red, White, or a combination of Red and White as its different colour. Overall in Hassan district, 85.59 per cent of male birds had red earlobes and 14.4 per cent male birds have red & white mixture ear lobe.

In Arasikere taluk, red ear lobe was seen in 68.75 per cent male indigenous birds and rest had red and with ear lobed (Table 4.2.8). In Channarayapatna, 83.33 per cent indigenous birds had red ear lobe and the rest were red and white colour ear lobed. In Hassan, 93.10 per cent indigenous birds had red ear lobe and the rest were red and white colour ear lobed. However, only red ear lobed indigenous birds were

observed in Sakaleshpur taluk. Further, a significant association between regions and ear lobe colour of male indigenous birds was observed ($P<0.05$).

The colour of ear lobes observed in female indigenous birds of Hassan district was red (50.35%), red and white (43.26 %) and white (6.38 %). Red & White mixture ear lobe (52.94%) was more prevalent in Arasikere taluk followed by red ear lobe (30.88%) and white ear lobe (16.17%). Similarly, in Sakaleshpur taluk red & white mixture ear lobe (54.79%) was predominant followed by red (41.12%) and white (4.11%) ear lobes. Where as, red ear lobe (61.43%) was more common in Channarayapatna taluk followed by red & white (35.71%) colour mixture and white (2.86 %) ear lobe colour. In Hassan taluk 67.61 per cent of indigenous birds had red ear lobe, 29.58 per cent had red & white mixture and remaining 2.82 per cent white colour ear lobe. Further, a significant association of ear lobe colour of indigenous birds and regions was observed. Results of ear lobe colour in male and female birds were presented in table 4.2.8 and 4.2.9, repectively.

4.2.6.3 Comb colour

According to NBAGR proforma comb colour was categorised as black and red. In Table 4.2.8 and 4.2.9 separate sex wise comb colour is presented. All indigenous chicken irrespective of sex and region had red comb. Based on the data collected, it is concluded that there is no statistically significant variation in comb colour between the regions in Hassan district ($P>0.05$).

4.2.6.4 Comb type

Comb type like single comb, pea comb and rose comb was categorized and presented sexwise in the table 4.2.8 and 4.2.9 The most common comb type recorded

in Arasikere taluk was single comb (93.75%) and the rest pea comb (6.25%) in indigenous birds. Similar results were observed in Channarayapatna taluk where single comb type (93.33%) was predominant followed by pea comb (6.67%). In Hassan taluk, along with single comb (86.2 per cent), pea comb (6.89 %) and rose comb (6.89 %) was also noticed. In Sakaleshpur taluk only single comb type was observed. Overall, in Hassan district, comb type observed in male indigenous chicken were; single comb (93.22 %), followed by pea comb (5.08%) and rose comb (1.69%). Further, the difference in comb types of male indigenous birds between regions was not significant (P>0.05).

Results of comb type of in female birds from Arasikere taluk pea comb type (55.88%) was most prevalent followed by single comb (38.23%) and least observed was rose comb (5.88%). Single comb type (57.14%) was observed most in Channarayapatna taluk, next most common type is pea comb (41.42%) and least observed was rose comb (1.42%) in this region. Similar results were observed in Hassan taluk with single comb (52.11%), pea comb (46.48%) and rose comb (1.4%). Both single comb (49.31%) and pea comb (50.69%) was observed commonly in Sakaleshpur taluk. whereas rose comb was not observed in this region. Different comb types observed in selected taluks of Hassan district were single combs (49.29%), pea combs (48.58%) and rose combs (2.12%) respectively. There is no significant difference in comb type between females of various regions in Hassan district (P>0.05).

4.2.6.5 Eye colour

The colour of the eyes like Grey, black and Brown was examined in 118 male birds from various regions and is shown in table 4.2.8 and depicted in fig. 4.10. It is

observed that in male indigenous chicken brown eye colour (78.12%) was the most prevalent in Arasikere followed by grey colour (21.87%). In Channarayapatna taluk, similar results were observed with brown colour eyes (76.66 %) and grey colour eyes (23.33%). Grey colour eye was observed in 34.48 per cent and 29.62 per cent, brown colour eye was observed in 65.52 per cent and 70.37 per cent birds in Hassan and Sakaleshpur taluks respectively. Black colour eyes were not seen in Hassan district. Among all regions, the most common eye colour recorded was brown (69.50 %), followed by grey (30.50%). Analysis revealed that there is no significant difference in colour of eye in male birds among the regions (P>0.05).

The colour of the eyes of 282 female birds was examined and presented in table 4.2.9. In Arasikere taluk, the colours Brown (48.53%), Grey (45.58%) and black colour (5.88%) eye was observed. In Channarayapatna taluk, brown eyes (51.42%) were the most common, followed by grey (35.71%) and black colour eyes (12.85%). Similarly in Hassan taluk, 50 per cent of the birds had brown colour eyes, 40.85% were grey and 9.86 per cent were black. Brown-eyed (63.01%) birds were the most common in Sakaleshpur taluk, with grey (31.5%) being the second most common colour, followed by black (5.78%). Overall, in different agro-climatic regions eye colour observed in indigenous birds were Brown (53.19 %), grey (38.3 %) and black (8.51 %) in Hassan district. According to data obtained from various regions, there is no significant difference in eye colour of female birds (P>0.05).

4.2.6.6 Wattles

Data collected on presence or absence of wattles was investigated and presented in table 4.2.8 and 4.2.9. It was observed that all male birds in the Hassan

district have wattles (100%). As a result, observations on wattles revealed no statistically significant differences among regions (P>0.05).

Adult female birds from Hassan district were analyzed for the presence or lack of wattles. Birds with wattles are found in 54.71 per cent in Arasikere taluk, 61.42 per cent in Channarayapatna taluk, 61.97 per cent in Hassan taluk and 54.79 per cent in Sakaleshpur taluk. According to the data obtained overall in Hassan district 58.16 per cent had wattles and 41.84 per cent of female indigenous chicken did not have wattles. It indicates that the presence or absence of wattles in female's birds has no statistical significance difference (P>0.05).

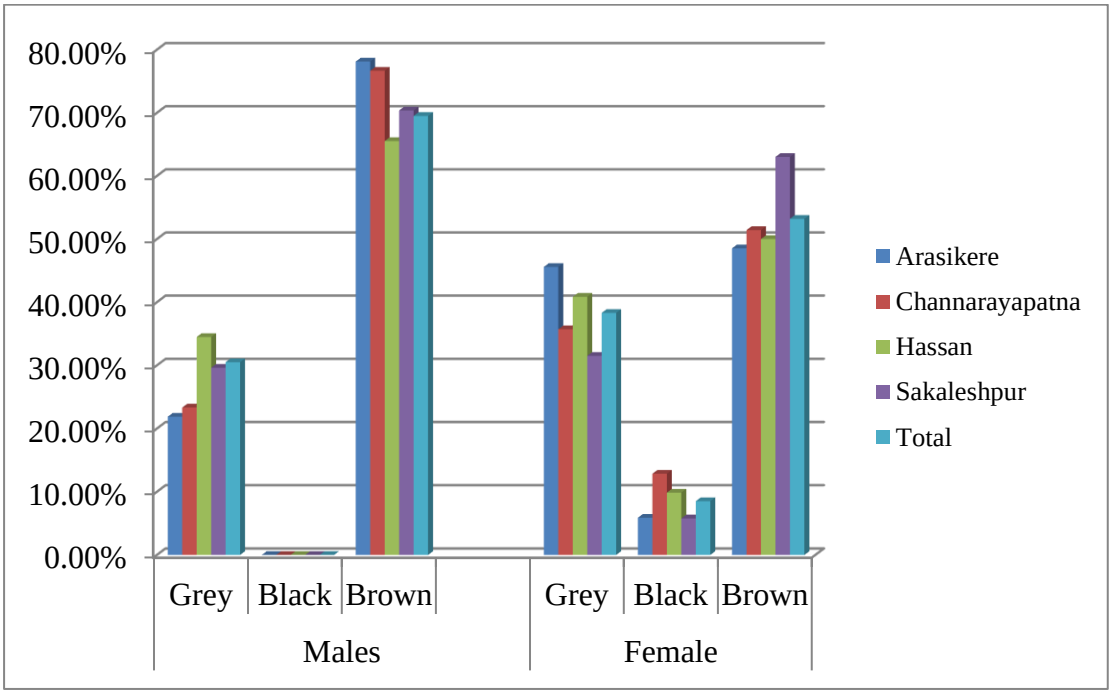
Table 4.2.8 Distribution of qualitative characteristics of indigenous chicken in different agro-climatic regions of Hassan district (Males)

Categories	Type	Arasikere		Channaraya-Patna		Hassan		Sakaleshpur		Total %		Chi-square P value
		N	%	N	%	N	%	N	%	N	%	
Skin colour	White	25	78.12	22	73.33	27	93.1	25	92.59	99	83.91	0.093
	Yellow	7	21.8	8	26.66	2	6.89	2	7.4	19	16.1	
Shank colour	White	7	21.87	0	0	0	0	5	18.51	12	10.16	0.001
	Yellow	25	78.12	30	100	28	100	22	81.48	106	89.83	
Ear lobe colour	Red	22	68.75	25	83.33	27	93.10	27	100	101	85.59	0.002
	Red & White	10	31.25	5	16.66	2	6.89	0	0	17	14.4	
Comb colour	Red	32	100	30	100	29	100	27	100	118	100	0.475
Comb type	Single	30	93.75	28	93.33	25	86.2	27	100	110	93.22	0.303
	Pea	2	6.25	2	6.67	2	6.89	0	0	6	5.08	
	Rose	0	0	0	0	2	6.89	0	0	2	1.69	
Eye colour	Grey	7	21.87	7	23.33	10	34.48	8	29.62	39	30.50	0.293
	Black	0	0	0	0	0	0	0	0	0	0	
	Brown	25	78.12	23	76.66	19	65.52	19	70.37	79	69.50	
Wattles	Present	32	100	30	100	29	100	27	100	118	100	P>0.05

Table 4.2.9 Distribution of qualitative characteristics of indigenous chicken in different agro-climatic regions of Hassan district (Females)

Categories	Type	Arasikere		Channaraya-Patna		Hassan		Sakaleshpur		Total %		Chi-square P value
		N	%	N	%	N	%	N	%	N	%	
Skin colour	White	56	82.35	64	91.42	51	71.83	62	84.93	233	82.62	0.144
	Yellow	12	17.64	6	8.57	20	28.16	11	15.06	49	17.38	
Shank colour	White	12	17.64	8	11.42	13	19.12	12	16.44	45	15.96	<0.001
	Yellow	42	61.76	43	61.42	44	64.71	54	73.97	183	64.89	
	Black	14	20.58	14	20	14	20.59	7	9.61	49	17.36	
	Green	0	0	5	7.14	0	0	0	0	5	1.77	
Ear lobe colour	Red	21	30.88	43	61.43	48	67.61	30	41.12	142	50.35	<0.001
	White	11	16.17	2	2.86	2	2.82	3	4.11	18	6.38	
	Red & White	36	52.94	25	35.71	21	29.58	40	54.79	122	43.26	
Comb colour	Red	68	100	70	100	71	100	73	100	282	100	>0.05
Comb type	Single	26	38.23	40	57.14	37	52.11	36	49.31	139	49.29	0.265
	Pea	38	55.88	29	41.42	33	46.48	37	50.69	137	48.58	
	Rose	4	5.88	1	1.42	1	1.4	0	0	6	2.12	
Eye colour	Grey	31	45.58	25	35.71	29	40.85	23	31.5	108	38.3	0.328
	Black	4	5.88	9	12.85	7	9.86	4	5.78	24	8.51	
	Brown	33	48.53	36	51.42	35	50	46	63.01	150	53.19	
Wattles	Present	37	54.71	43	61.42	44	61.97	40	54.79	164	58.16	0.698
	Absent	31	45.58	27	38.57	27	38.02	33	45.21	118	41.84	

Figure: 4.10 showing results of eye colour in indigenous chicken of different agro-climatic regions in Hassan district



4.3 Body weight (gms), Breast angle (degree), keel bone length (mm) and shank length (mm) of adult indigenous chicken in different agro-climatic regions of Hassan district.

4.3.1 Body weight

Results of average body weight, Breast angle, keel bone length and shank length of male indigenous chicken is presented in table 4.3.1 and presented graphically in fig. 4.11. A total of 118 adult male birds from various regions were measured. Mean body weight of Arasikere was 1.813 kg, Channarayapatna 1.66 kg, Hassan 1.648 kg, and Sakaleshpur 1.79 kg. Overall average body weight of male adult birds from study area was 1.73±0.05 kg. Statistically there are no significant differences (P>0.05) in adult male body weight between Hassan district regions.

Mean adult body weight of 282 female birds from various regions was 1.36 kg in Arasikere, 1.27 kg in Channarayapatna, 1.27 kg in Hassan, and 1.33 kg in Sakaleshpur. A statistical analysis of the data indicates that there is no significant difference in adult female body weight between regions (P>0.05).

4.3.2 Breast Angle

The breast angle of adult male and female birds from various regions was measured using a breastometer and the findings are shown in table 4.3.1. Breast angle of Arasikere, Channarayapatna, Hassan and Sakaleshpur talukas was 70.59^0, 73.07^0, 67.63^0, and 69.59^0 respectively. Overall average breast angle was 70.31 ± 0.51^0 of Hassan district. On statistical analysis by Duncun multiple range post hoc tests showed Channarayapatna region was statistically significant from other regions of Hassan district for breast angle in both male and female birds.

Table 4.3.2 shows that the breast angle of female birds in Arasikere and Channarayapatna (72.66^o) taluks were similar. Whereas in Hassan (67.88^0) and Sakaleshpur (67.99^o) taluks were slightly lower. Mean breast angle of female birds in Hassan district was 69.62 ± 0.39^0. The results show that there is a significant difference in the breast angle of female birds across regions.

4.3.3 Keel bone length

The keel bone length of adult male and female birds was measured using a digital Vernier calliper, statistically non significant (P>0.05) keel bone length was recorded in adult male indigenous chicken. Measurement of 121.05, 118.78, 118.35, 119.78 mm was observed in Arasikere, Channarayapatna, Hassan and Sakaleshpur

region respectively and the mean keel bone length of male chicken was 119.49±0.88 (Table 4.3.1).

Mean keel bone length of adult female birds from various places was measured and found Arasikere region was significant difference (P<0.05) from other regions by duncun multiple range post hoc test. Arasikere had the longest keel bone length of 116.5mm, followed by Sakaleshpur 114.11mm, Hassan 113.65mm, and Channarayapatna had the shortest 111.59mm length. Mean keel bone length of female indigenous chicken was 113.97±0.5 mm (Table 4.3.2).

4.3.4 Shank length

The length of the shank was measured in both male and female birds using a digital Vernier calliper. The mean shank length of male birds from different regions was 97.89mm in Arasiker, 96.5mm in Channarayapatna, 95.18mm in Hassan, and 95.85 mm in Sakaleshpur. Overall average shank length in male birds was 96.35±0.89. Table 4.3.1 reveals that there is no significant variation in shank length across regions (P>0.05) but on analysis by Duncun multiple range post hoc test revealed Arasikere region was significantly differed from other regions for shank length.

Statistically significant shank length was recorded in indigenous female chicken. Arasikere had the longest mean shank length of adult female birds was 89.92mm, followed by Sakaleshpur 85.14mm, Hassan 84.25mm, and Channarayapatna taluk had the shortest 82.64mm. The average shank length of selected female birds from various regions is 85.49±0.49mm.

Table 4.3.1 showing Body weight (kg), Breast angle (degree), keel bone length (mm) and shank length (mm) of adult male birds.

Categories	Males						P value
	Arasikere	Channaraya-Patna	Hassan	Sakaleshpur	SEM	Overall Mean	
Body weight	1.813	1.66	1.648	1.79	0.1	1.73±0.05	0.526
Breast angle	70.59^{ab}	73.07^{b}	67.63^{a}	69.95^{a}	1.03	70.31±0.51	0.02
Keel bone Length	121.05	118.78	118.35	119.78	1.758	119.49±0.88	0.722
Shank length	97.89	96.5	95.18	95.85	1.783	96.35±0.89	0.759

Table 4.3.2 Body weight (kg), Breast angle (degree), keel bone length (mm) and shank length (mm) of adult female birds.

Categories	Females						P value
	Arasikere	Channaraya-patna	Hassan	Sakaleshpur	SEM	Total %	
Body weight	1.36	1.27	1.27	1.33	0.033	1.308±0.017	0.157
Breast angle	$70.04\pm^{a}$	72.66^{b}	67.88^{a}	67.99^{a}	0.768	69.62±0.39	0
Keel bone Length	116.5^{b}	111.59^{a}	113.65^{ab}	114.11^{ab}	1.013	113.97±0.52	0.01
Shank length	89.92^{b}	82.64^{a}	84.25^{a}	85.14^{a}	0.962	85.49±0.49	<0.001

Figure: 4.11 Showing body weight of male and female indigenous chicken from four agro-climatic regions of Hassan district

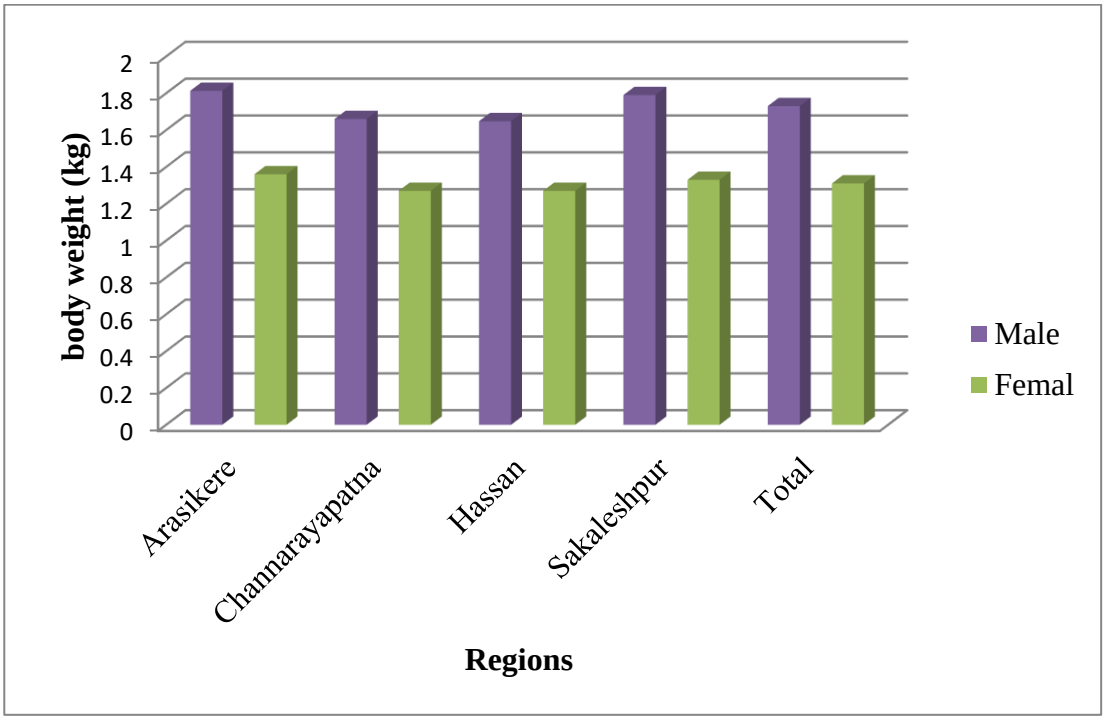


Figure 4.12 Showing breast angle of indigenous chicken in four agro-climatic regions

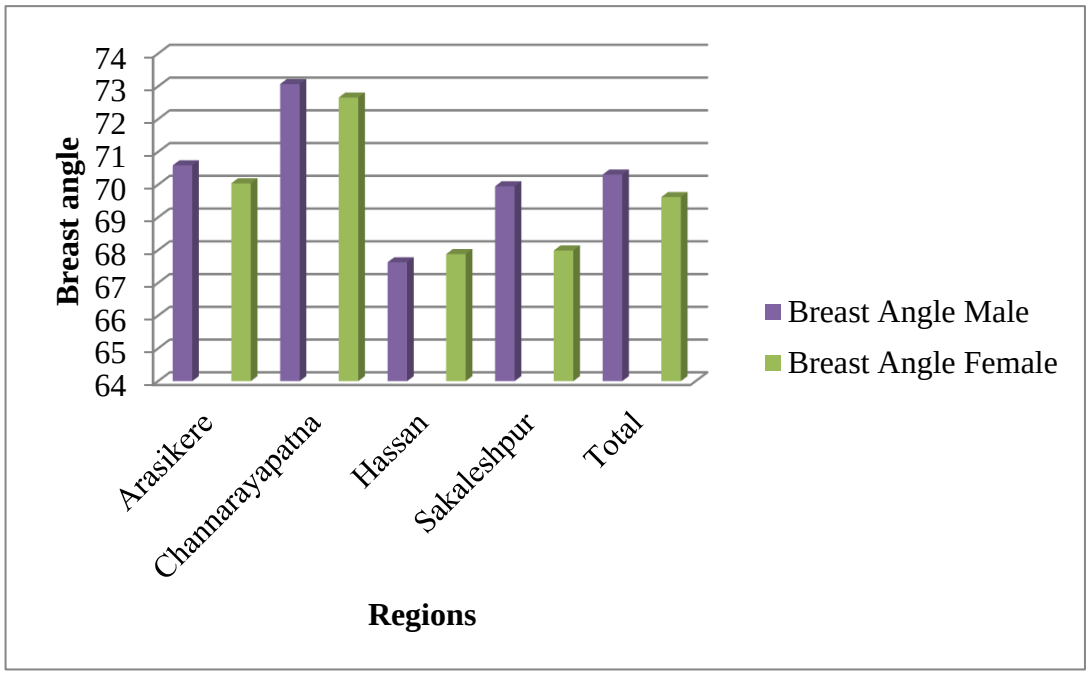


Figure 4.13 Showing Keel bone length of indigenous chicken from four agro-climatic regions of Hassan district

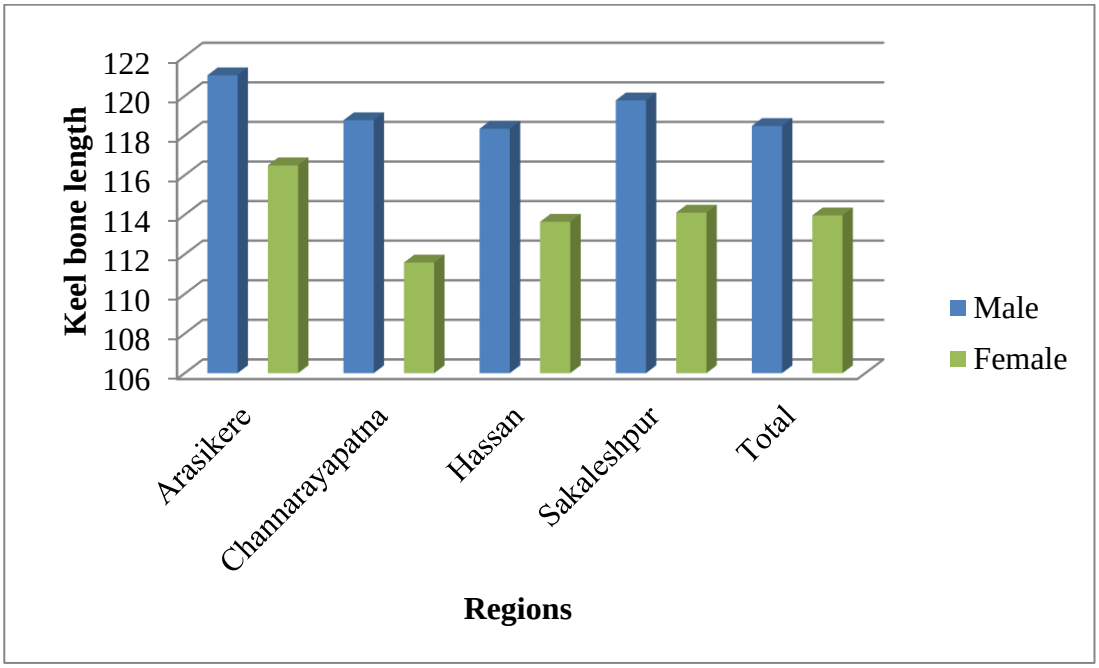
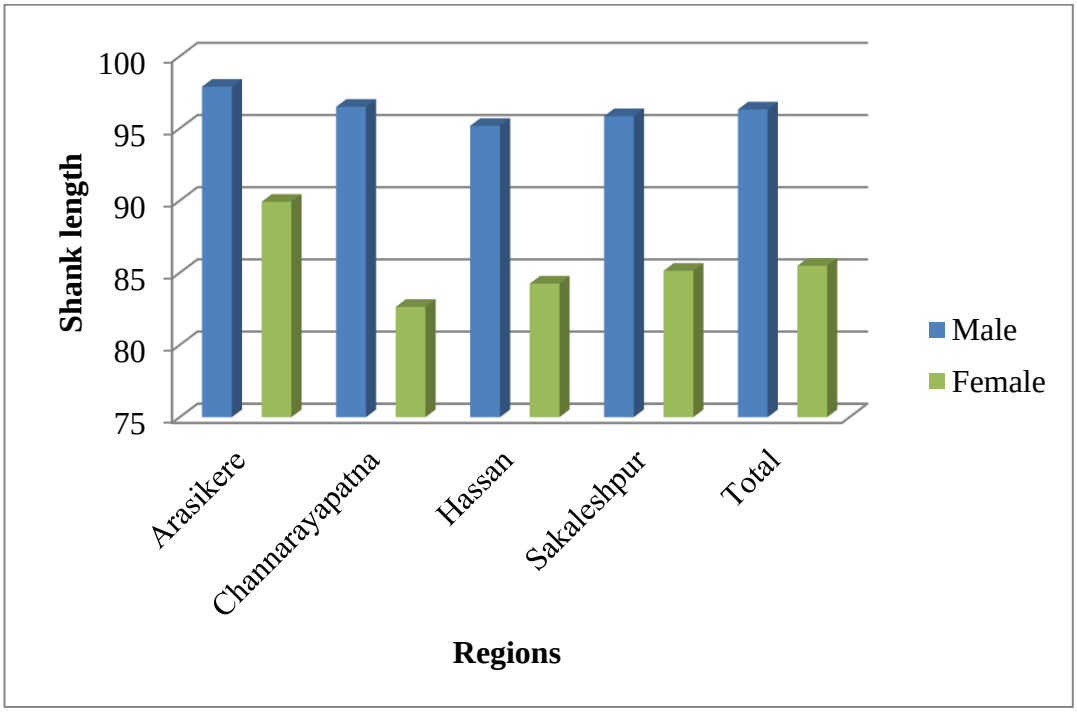


Figure: 4.14 showing Shank length of indigenous chicken from four agro-climatic regions of Hassan district



4.4 Egg quality traits of indigenous chicken from four agro-climatic conditions of Hassan district

Results of the egg quality in terms of egg colour (Brown, Cream, Dark brown) egg weight, shell thickness, shell weight, shape index and HUS data was taken and presented in table 4.4.1.

4.4.1 Shell colour

Eggs selected from different regions were classified based on the colour as brown, creamy and dark brown. Eggs collected from Arasikere taluk consists more of brown colour (50%) followed by cream colour (45%) and dark brown (5%). Brown colour (60%) eggs were higher in Channarayapatna taluk followed by creamy (35%) and dark brown colour (5%). Cream colour (50%) eggs were observed most in Hassan taluk followed by brown (45%) and dark brown colour (5%) is least observed colour. shell colour of eggs observed in Sakaleshpur taluka were brown (50%) creamy (40%) and dark brown (10%) respectively. Overall pooling all the regions indicates brown colour eggs (51.25%) most in all the regions followed by cream colour eggs (42.5%) and dark brown (6.25%). Based present study it indicates no significant difference ($P>0.05$) in shell colour of eggs between the regions.

4.4.2 Egg weight

Mean egg weight from different agro-climatic regions was weighed using precision weighing balance and presented in table 4.4.1. Statistically significant difference ($P<0.05$) in egg weight was observed among the various agro-climatic zones. Mean egg weight was 42.44g, 40.69g, 39.30g and 41.53g in Arasikere,

Channarayapatna, Hassan, Sakaleshpur taluks respectively. Mean egg weight of Hassan district was 40.99±0.51.

4.4.3 Egg shell thickness and weight

Piece of egg shell was taken and measured using screw gauge. Results are presented in table 4.4.1 and found statistically difference in egg shell was observed among the group ($P<0.05$). The shell thickness of eggs collected from different regions of Hassan district were Hassan (0.34mm), Arasikere (0.33mm), Channarayapatna (0.33mm) and least shell thickness found in Sakaleshpur (0.29mm). The average thickness of an egg shell from Hassan district was 0.32±0.01.

The egg shell piece of each egg was dried in a hot air oven and the weight was recorded using a digital weighing scale. Egg shell weight 4.06g which was highest in Arasikere taluk followed by 4.01g in Channarayapatna, 3.96g in Hassan and 3.97g in Sakaleshpur taluks The average egg shell weight in Hassan district found recorded was 3.99±0.04 (Table 4.4.1). Data analysis on egg shell weight reveals no significant difference between regions for egg shell weight ($P>0.05$).

4.4.4 Shape index and Haugh unit

The ratio of the egg's breadth to its length is known as the shape index and the data were presented in tabular form 4.4.1. The average shape index of eggs from different regions of Hassan district was 77.65±0.042. Arasikere had the highest shape index (80.72) which is statistically higher than all other regions then followed by Hassan (77.16), Sakaleshpur (76.62), while Channarayapatna taluk had the lowest (76.08) shape index. The shape index between regions statistically shows a significant difference ($P<0.05$).

4.4.5 Haugh unit

The average Haugh unit score of eggs collected from various Hassan district regions was 67.46±1.03. Indigenous chicken eggs of Hassan (71.98) and Sakaleshpur (71.31) taluks had higher HU Which is statistically difference from other two regions then followed by Arasikere (63.53) and Channarayapatna (63.01) ahd similar results. Statistical analysis indicates there is no significant difference Haugh unit between the regions.

4.4.6 Albumin index

The internal qualities of native chicken egg like Albumin weight, yolk weight, Albumin index and yolk index were collected and presented in table 4.4.2.

Albumin index was expressed as the ratio of average thick albumin height to average breadth and length of albumin. The albumin indexes found in various regions are as follows: 0.046 in Hassan, 0.045 in Channarayapatna, 0.044 in Sakaleshpur, and in Arasikere it was 0.043. The mean albumin index measured in Hassan district was 0.045±0.01. The results in table 4.4.2 show that there is no significant difference in albumin index of eggs collected from different regions ($P>0.05$).

4.4.7 Yolk index

The yolk index is the ratio of the height of the yolk to its diameter. In eggs collected from various regions of Hassan district's mean yolk index was 0.37±0.01. . The mean yolk index in Channarayapatna and Hassan taluks was 0.37 which is similar. Sakaleshpur taluk with 0.39 was having the highest and Arasikere taluk with

0.36 having the lowest albumin index. It is found that there was no significant difference in yolk index between regions (P>0.05).

4.1.8 Albumin weight and yolk weight

Albumin was separated from egg and measured in digital scale and presented in table 4.4.2. Mean albumin weight of eggs collected from different regions of Hassan district was 22.08±0.44g. Albumin weight was found higher in Arasikere (22.84g) and Channarayapatna taluks (22.68g), followed by Sakaleshpur (21.85g) and lowest in Hassan taluk (20.93g). As per the statistical analysis it is found that there is no significance difference for albumin weight of eggs between regions (P>0.05).

The mean weight of an egg yolk measured in the Hassan district was 13.06±0.24g. Significantly higher (P<0.05) weights were observed in Sakaleshpur (14.11g) and Channarayapatna (14.52g) compared to other groups. Yolk weight of 12.39g in Arasikere and 11.23g in Hassan was recorded which is statistically different among the group.

Table 4.4.1 External Egg quality traits from indigenous chicken from different agro-climatic conditions of Hassan district

Region	Egg colour (%)			Egg Weight	Shell Thickness	Shell Weight	Shape index	Haugh unit
	Brown (41)	Cream (34)	Dark brown (5)					
Arasikere	50	45	5	42.44^{a}	0.33^{a}	4.06	80.72^{a}	63.53^{b}
Channarayapatna	60	35	5	40.69^{ab}	0.33^{a}	4.01	76.08^{b}	63.01^{b}
Hassan	45	50	5	39.30^{b}	0.34^{a}	3.96	77.16^{b}	71.98^{a}
Sakaleshpur	50	40	10	41.53^{ab}	0.29^{b}	3.97	76.62^{b}	71.31^{a}
SEM				1.02	0.011	0.084	0.832	2.051
Total	51.25	42.5	6.25	40.99±0.51	0.32±0.01	3.99±0.04	77.65±.042	67.46±1.03
P value	0.797			0.171	0.019	0.854	0.001	0.002

Table 4.4.2 Internal Egg quality traits from indigenous chicken from different agro-climatic conditions of Hassan district

Region	Albumin index	Yolk index	Albumin Weight (g)	Yolk Weight (g)
Arasikere	0.043	0.36	22.84	12.39[a]
Channarayapatna	0.045	0.37	22.68	14.52[b]
Hassan	0.046	0.37	20.93	11.23[a]
Sakaleshpur	0.044	0.39	21.85	14.11[b]
SEM	0.001	0.009	0.88	0.47
Total	0.045±.001	0.370±0.01	22.08±0.44	13.06±0.24
P value	0.233	0.297	0.401	<0.001

Figure 4.15 Showing Egg shell colour from four agro-climatic conditions of Hassan district

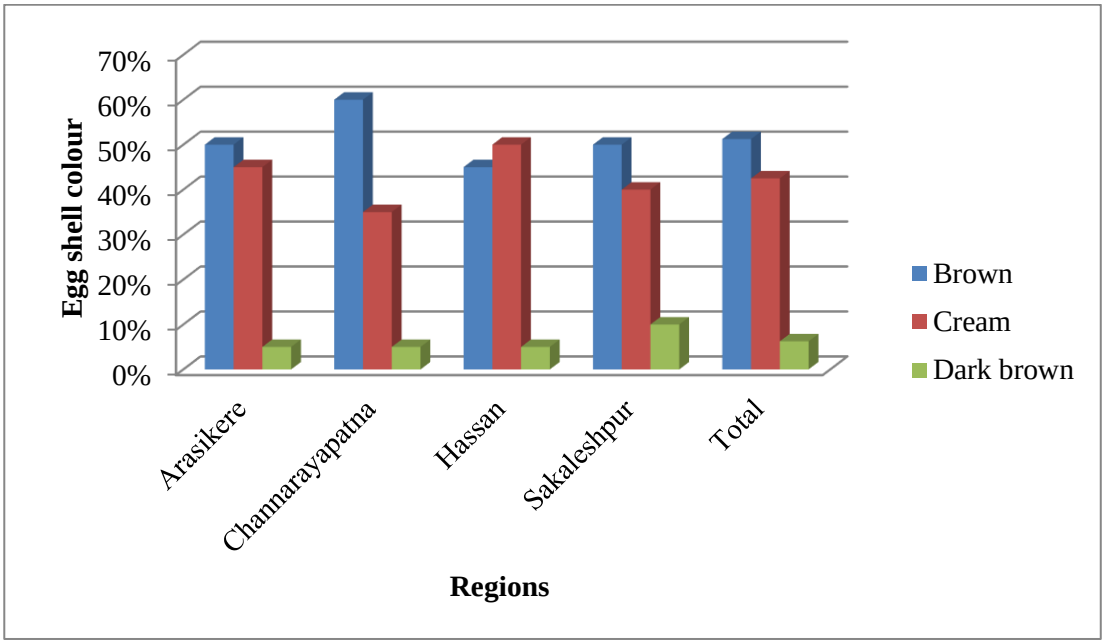


Figure 4.16 Showing Egg weight (g), Shape index, Haugh unit of eggs collected from four agro-climatic regions of Hassan district

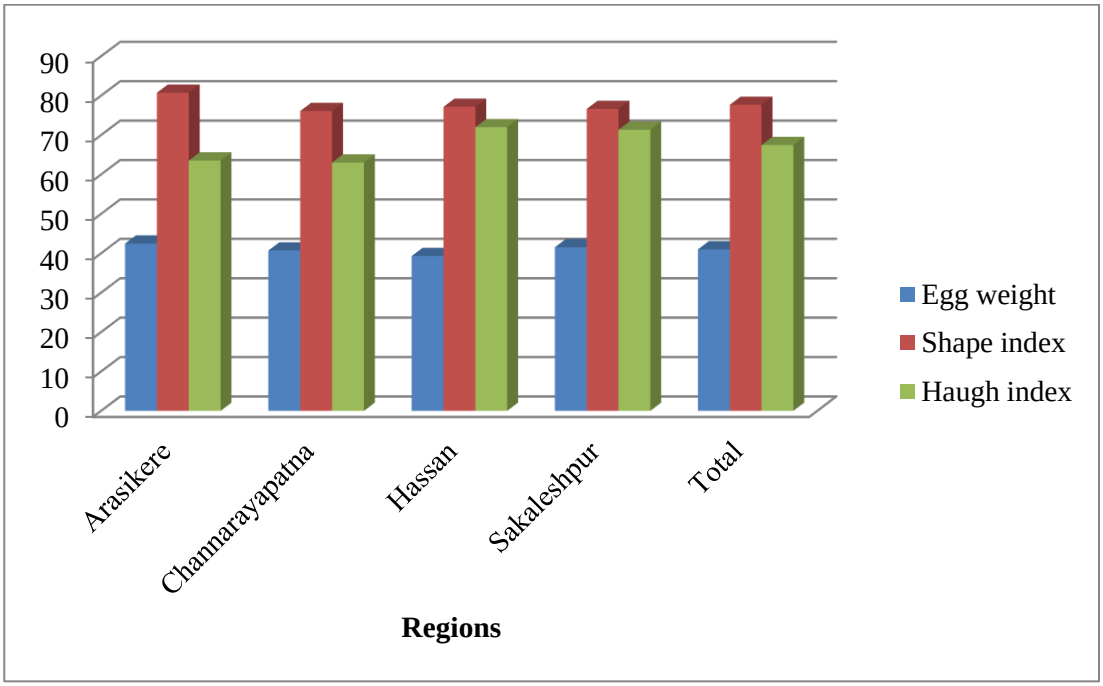


Figure: 4.17 Showing egg shell thickness and dry shell weight of eggs collected from four agro-climatic regions of Hassan district

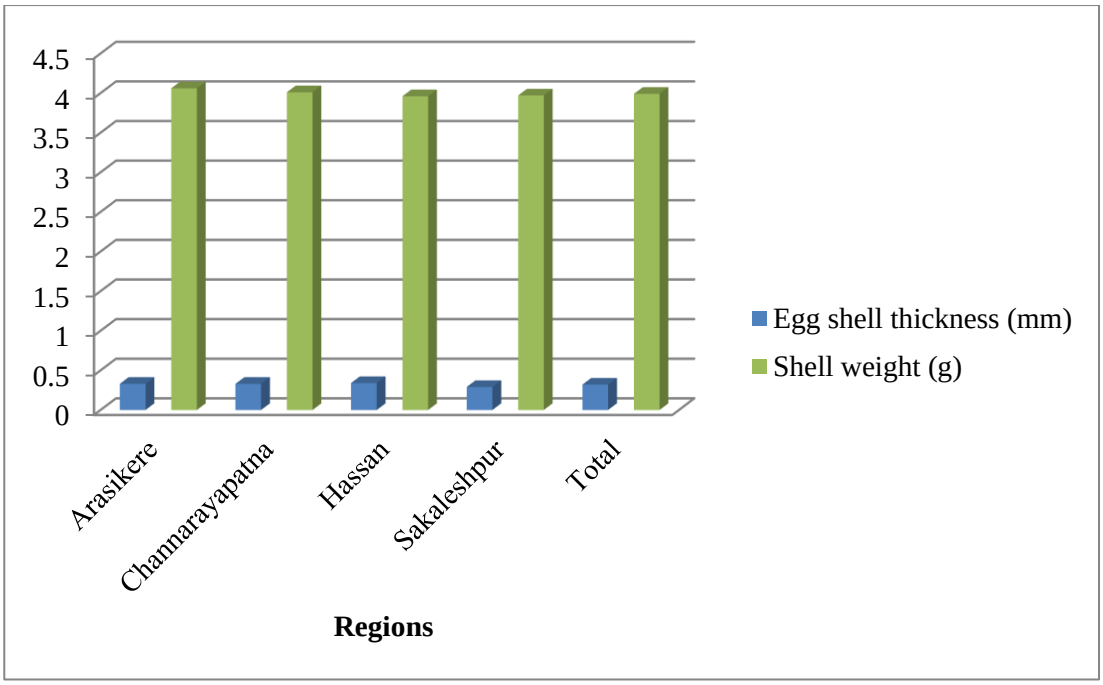


Figure: 4.18 Showing Albumin and Yolk weight of eggs collected from four agro-climatic regions of Hassan district

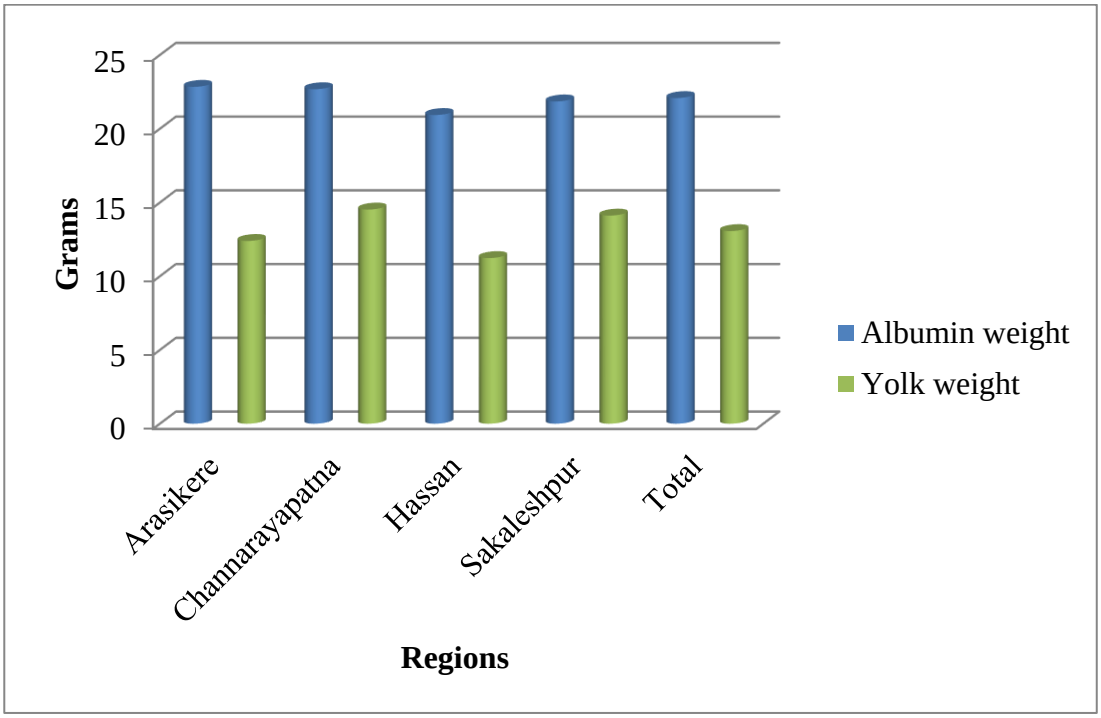


Plate No. 3 Feather Distribution

Normal

Naked neck

White colour plumage

Brown colour plumage

Black colour plumage

Red colour plumage

Plate No. 4 Different types of plumage pattern

Stripped

Spotted

Lasing

Barred

Mottled

Patchy

Plate No 5 Shank colour and comb type

Yellow

Green

White

Black

Single comb

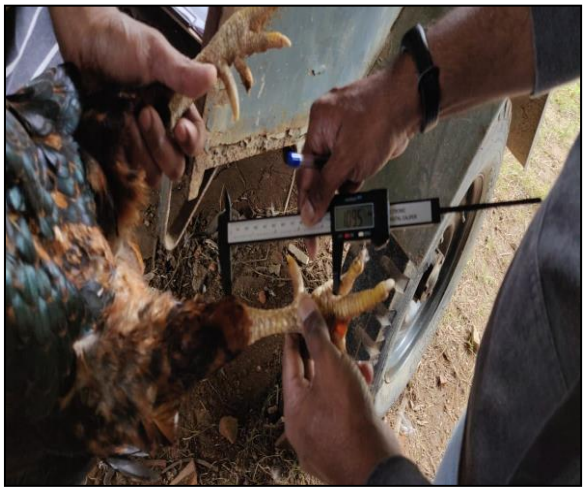
Rose comb

Plate No-6 Eye colour, body measurement, yolk height and ear lobe colour

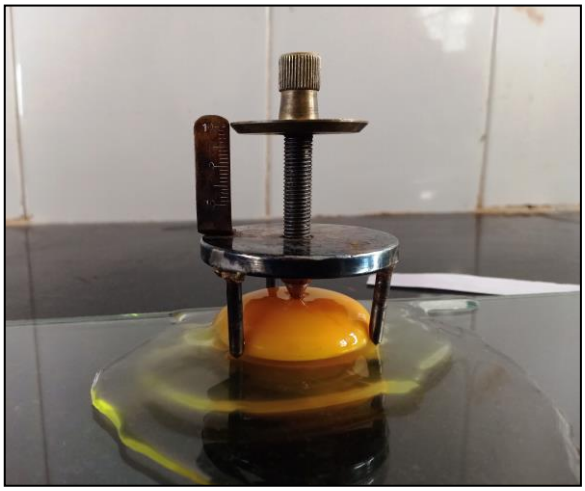
Brown colour eye with pea comb

Grey colour eye

Breast angle measurement



Shank lenth measurment



Yolk height measurement

Red and white ear lobe

Discussion

V. DISCUSSION

5.1 Socio - economic status of farmers

5.1.1 Gender and cast of owners

In the current study, it was noticed that women (58.75 %) participation in indigenous chicken rearing in all the regions of Hassan district was more than men (41.25%) (Table 4.1.1). Backyard chicken rearing being an activity with less physical exertion, relatively easy and a subsidiary activity along with the daily household chores with good liquidity could be the reasons for more women involvement. The results are in accordance with the Islam *et al*. (2021) who reported that 83 per cent of women were involved in Assam, Kumar *et al*. (2013) in Kannur and Kozhikode districts of Kerala who observed 89.06 per cent involvement of women and Adebayo *et al*. (2013) in Nigeria wherein 59.13% of women were engaged in poultry. In contrary to the present study Sourav (2013) reported in Murshidabad district of West Bengal, where 48.1 per cent of women involvement in chicken rearing was observed which was lower than men.

The results on caste of indigenous chicken owners depicts that majority of respondents in Hassan district belonged to OBC (85%) followed by SC/ST (11.25%) and other castes (3.75%). OBC category being the dominant caste in Hassan district and majority of them being involved in farming could be the reason for such results. Similar results have been observed by Sourav (2013) in Murshidabad district of West Bengal where 84.4% of OBC category farmers were involved in indigenous chicken rearing. On contrary, Mandal *et al*. (2013) have reported that majority of respondents involved in chicken rearing belonged to General Caste (57.5%) followed by Schedule

caste (21.67%), Schedule tribe (12.5%) and OBC (8.33%) in Bareilly district of Uttar Pradesh. Dumrya *et al*. (2015) too have reported that majority of village poultry owners in Sundarban region of West Bengal belonged to general caste (46%) followed by scheduled caste (24%), other backward castes (22%) and scheduled tribe (8%).

5.1.2 Land holding pattern

The overall land holding details of poultry owners from different regions of Hassan district indicates that majority of them (73.75%) belonged to less than 2.5 acres category. Only 12.5 per cent of them had land between 2.5 to 5 acres and meager number (7.5%) were owning land above five acres. This clearly depicts that backyard poultry rearing is a very good subsidiary activity for the small and marginal farmers. Interestingly very meager number of landless labourers was involved in chicken rearing. Their compulsion to move out of the farm premises for longer duration of the day in search of labour and inability to take of the chicken could be the reason for their poor participation in the activity. The present results are similar with that of Mandal *et al*. (2006) in Bareilly district of Uttar Pradesh (<1 hectare 47.92%, 1-2 hectare 20 %). However, he reported that 27.08 per cent of the respondents were landless owners. Likewise, Dumrya *et al*. (2015) have reported that majority of the chicken owners (54.2%) owned land up to one acre, followed by landless (34.4%) and more than one acre land (11.4%) holding in Sundarban region of West Bengal. We can observe that as in Bareilly here too landless labourers were involved in chicken rearing. Similar results have been reported from the below two studies from other two divisions of Karnataka. Rajakumar, (2013) has reported from Bangalore division that majority belonged to less than 2 acres (40.95%) followed by 2 to 5 acres (29.28%),

land less labourers (20.55%) and more than 5 acre (9.22%). Gopinath (2013) has reported from Mysore division that the majority of farmers were owning 2 to 5 acres of land (32.11 %), followed by more than 5 acres of land (25.16 %), less than 2 acres (20.05 %) and landless labourers (22.66 %). He also reported that there was a significant difference in land holding between the districts in Mysore division.

5.1.3 Livelihood and purpose of rearing

Agriculture and animal husbandry was opted by highest number (70 %) followed by agriculture only (20%) and agriculture labour alone (10%). Agriculture and livestock rearing being complementary to each other could be the reason for such an option. Occupation opted for livelihood among the indigenous chicken rearing farmers in Hassan district varied significantly ($P<0.05$) between the regions. Except for Sakaleshpur region in other regions agriculture and animal husbandry was predominant. More of estate farming and relatively high incidence of predation in Sakaleshpur region could the reason for such results. Similar results have been reported by Islam *et al*. (2021) wherein 39.50% farmers of different agro-climatic zones of Assam opted agriculture and animal husbandry followed by Agriculture (36.50%) and Agriculture labour (19.50%). However, Mandal *et al*. (2006) reported that farmers in Bareilly district chose labour (52.92%) followed by agriculture (22.50%), animal husbandry (14.58%), business (7.08%) and service (2.92%). However, in contrast to these studies Sharma (2018) has reported that in Jammu district respondent poultry farmer’s most preferred occupation was agriculture (32.50%) followed by labour (30%), service (15.10%), business (13%) and animal husbandry (10%).

Purpose of rearing indigenous chicken was for both own consumption and marketing the excess chicken (62.5%) in Hassan district. This trend was most observed in Channarayapatna region (75%) followed by Sakaleshpur (70%), Hassan (55%) and Arasikere (50%). Data on purpose of rearing indigenous chicken in different agro-climatic regions of Hassan district revealed no significant association between the regions (P>0.05). Meat consumption being predominant in Hassan region and the fact that backyard poultry is a very good source of supplementary income to the farmers could the reasons for the observed results.

The present findings similar to that of Sudhir Naik (2021) who reported that 65.49% farmers in Bidar and 66.31% in farmers Koppal district of Karnataka were rearing indigenous chicken for both own consumption and marketing. On the contrary, Veeranagowda (2020) reported that only 45.83 per cent farmers in Bijapur, 49 per cent in Belgaum and 45 per cent in Dharawad reared indigenous chicken for both consumption and marketing purpose. However, Gopinath (2013) has reported that majority of the farmers (54.94%) reared indigenous chicken for own consumption in Mysore division of Karnataka.

5.1.4 Average flock size and structure of indigenous chicken.

Average flock size of various regions was 24.2 (Arasikere), 26.2 (Channarayapatna), 18.5 (Hassan) and 23.75 (Sakaleshpur) and overall average was 23.16. However, no significant difference was observed between the different regions for size (P>0.05). According to Veerannagowda (2020) the average flock size of indigenous chicken was 15.35±0.16 in Dharawad district, 23.61±0.16 in Bijapur and 30.28±0.18 in Belgaum with overall mean 23.07 which is in accordance with present study. The findings were similar to observations of Rajakumar (2013), who reported

that flock sizes in Bangalore division ranged from 16.17±0.15 to 22.83±0.12. Contrarily, the average flock size in the Mysore division of Karnataka ranged from 17.19±0.28 to 19.67±0.18 (Gopinath, 2013) and just 4.69 as reported by Mandal *et al*. (2006) in Bareilly district of Uttar Pradesh. The flock sizes of poultry breeds such as, Kalasthi (13.6), Desi (15.85), Danki (16.7) and Daothigir (23) varied (Vij *et al*., 2005 and Vij *et al.,* 2006b).

With respect to the overall average flock structure there were 6.65±0.51 chicks, 2.76±0.29 grower males, 3.760±.34 grower females, 3.33±0.27 adult males and 6.69±0.36 adult female. Similar observations have been made by Gopinath (2013) who reported 6.97 chicks, 3.64 grower males, 3.5 grower females, 3.47 adult males and 2.98 adult females in Mysuru division of Karnataka.

5.1.5 Chicken rearing with other livestock

Most of the farmers (48.75%) reared chickens with small and large ruminants compared to others. Further, 30 per cent of farmers reared large ruminants with indigenous chicken. Only meager number (6.25%) of farmers reared poultry with small ruminants. Chicken rearing being a supplementary activity to the farmers could be the reason for them rear chicken along with other livestock.

The current study is consistent with that of Sharma *et al*. (2018), who reported that 35.83 per cent of respondents in Kashmir reared poultry along with cattle. According to Kumar *et al*. (2013) in Kannur and Kozhikode districts of Kerala, other animal husbandry activities along with native chicken farming include cattle rearing (23.4%), both cattle and goat rearing (17.2%), and goat rearing (12.5%). Surprisingly,

43.8 per cent of households had no other animal husbandry activity besides backyard chicken keeping.

5.1.6 Poultry housing

The results indicated that 47.5 per cent of farmers kept chickens along with other livestock, 26.25 per cent kept chickens in their courtyard and 26.25 per cent house chickens separately. Normally, farmers create wooden platforms in the sheds for perching. This requires no extra space exclusively for the chicken. This could be reason for majority to rear chicken along with other livestock.

There was a significant difference between the regions with respect to housing. In Sakalespur taluk 65 per cent of the farmers provide separate housing for their birds. Relatively high predator menace in the dispersed dwellings surrounded with vegetation could be the reason.

Similarly, separate housing was not provided by farmers in Belgaum division (70.50%) (Veerennagowda, 2020); Bangalore division (83.33 %) (Rajakumar, 2013) and Mysore division (78.27%) (Gopinath, 2013) of Karnataka. Interestingly, Islam *et al*. (2021) reported that in different agro-climatic zones of Assam majority of farmers (63%) provided housing within their dwellings. According to Tantia *et al*. (2005b), Vij *et al*. (2005b), and Kumar and Kumar (2007), only open housing is used in native chicken production.

5.1.7 Hatching practices and egg production

In Hassan district, 37.50 per cent of farmers selected the eggs based on their size and colour. Majority of them (62.5%) do not practice egg selection before

hatching. Chi square analysis revealed that there is no association between regions for egg selection before natural incubation for hatching purpose. Lack of awareness in this regard could be the reason, indicating the need for extension in this regard.

The present study is in accordance with Islam *et al*. (2021) who reported that majority of the poultry farmers in Assam do not practice selection of eggs before incubation.

In Hassan district farmers were using bedding material available with them like dry grass (43.75%), dry grass along with ash (36.25%) and dry grass with sand (20%) to naturally incubate eggs for hatching. Significant difference between regions was observed with respect to use of bedding material. In Sakaleshpura all the respondent farmers (100%) used only grass as bedding material. This could be the traditional practice in the region.

The current findings are in accordance with Mcanish *et al*. (2004), reported that grass was the commonly used bedding material in Zimbabwe. Likewise, paddy straw bedding was used as bedding material in indigenous Miri birds as reported by Vijh *et al*. (2005a) and wood shavings or paddy straw was used in Bangladesh (Das *et al*., 2008). However, Kumar *et al* (2013) reported that majority of the farmers (51.6%) in Kannur and Kozhikode districts of Kerala used sand as the bedding material.

5.1.8 Frequency of hen outside during natural hatching.

Majority of the farmers in Hassan district (82.5%) opined that hen moved outside during incubation once in two days and 17.5 per cent said that once in a day. Results indicated that there was no association between agro-climatic regions of Hassan with respect to hen moving outside during incubation.

Similarly, it was observed that majority of the farmers (52.5%) in Hassan district keep cereals and water to broody hen to avoid the loss of body condition. Chi square analysis of data showed there is no association for the feeding during the hatching between the regions. Literature was not available to compare the present study results.

5.1.9 Egg production profile of indigenous chicken of Hassan district.

5.1.9.1 Number of cycles per year

The average number of egg producing cycles per year in indigenous chicken was 3.25±0.57. Highest average cycles were observed in Hassan taluk (3.4) followed by Arasikere (3.35), Channarayapatna (3.15) and least in Sakaleshpur (3.1). Results showed that there is no significant association between variable numbers of egg producing cycles with agro-climatic regions in Hassan district. Current study is in accordance with Vij *et al*. (2007), where he reported number of cycles ranged from 3.7 to 4 with mean of three cycles per year in Tellichery breed of chicken. Similarly, number of cycles per year in Daothigir breed ranged from 3.0 to 3.5 (Vij *et al*., 2006b). According to Gopinath (2013), average cycles per year in Mysore division were 2.8 to 2.97. On contrary to present study Veerannagowda (2020) reported 2.22±0.02 in Dharwad, 2.60±0.02 in Bijapur district and 2.65±0.02 in Belgaum districts. Similarly, Sudhir Naik (2021) reported 1.99±0.03 and 2.35±0.03 in Gulbarga district, which was lower than the present study observation.

5.1.9.2 Number of eggs placed for hatching.

Average number of eggs placed for natural incubation in the present study recorded was 13.2±0.38. Highest eggs placed for hatching was observed in

Channarayapatna (14 eggs) followed by Arasikere (13.7 eggs), Sakaleshpur (12.65 eggs) and Hassan (12.45 eggs). Statistical analysis revealed that there is a significant association between the numbers of eggs placed for hatching in different agro-climatic regions of Hassan district. Results of the present study was similar to as per Iqbal and Pampori (2008), they reported that 12-14 eggs were kept for hatching in Kashmiri indigenous chicken. Islam *et al*. (2021) in a survey in four agro-climatic regions of Assam also showed that the number of eggs set per broody hen or duck ranged from 13.06±0.26 to 13.77±0.25 with an overall mean value of 13.59±0.23. On contrast to this Kumar *et al* (2013) reported that the average number of eggs set under a broody hen was 10.4 in Kannur and Kozhikode districts of Kerala, which was just below the results of the present study.

5.1.9.3 Hatching percentage

Statistical analysis revealed that there is a significant association of hatching percentage between the regions ($P<0.05$). Highest hatching percentage was recorded in Channarayapatna region (83.19%) followed by Arasikere (78.57%), Hassan (77.86%) and Sakaleshpur (76.83%) regions. The average percentage of hatching pooled from all regions was 79.12±0.806. Current study is in accordance with Gawande *et al*. (2007) who reported hatchability rate on total egg set ranged from 81.39±0.78 per cent in Nagaon district of Assam, which is almost equal to our study. Kalita *et al*. (2011) reported 81 to 100 per cent hatchability in six districts of Assam. On contrary to this Mandal *et al*. (2013) reported 60-65 per cent of hatching in indigenous chicken of Bareilly districts, Uttar Pradesh. Similarly, Kumar *et al*. (2016) reported 71.22 per cent of hatchability in indigenous chicken of northern midland agro-climatic zones of Kerala.

5.1.9.4 Clutch size

Average clutch size of current study in different regions was 15.78±0.18 eggs. Clutch size was highest in Channarayapatna with 16.05 eggs followed by Hassan (16), Arasikere (15.8) and 15.25 in Sakaleshpur. Present study results showed that there is no significant association between regions for clutch size. Iqbal and Pampori (2008) reported similar results in indigenous chicken of Kashmir (12-15). Present results are in agreement with study by Gopinath (2013) in Mysore (15.29±0.13), Mandya (14.92±0.13) and Chamarajnagar (16.00±0.00). According to Rajakumar (2013) in Bangalore division, clutch size of 17.48±0.06 in Chikkaballapur, 17.97±0.05 in Bangalore rural and 16.16±0.10 in Ramanagar district was observed. Similar results were recorded by Veeranngowda (2020) in Bijapur district (15.40±0.10) but little higher clutch size was recorded in Dharwad (18.65±0.17) and Belgaum (17.11±0.09) district. Sudhir Naik (2021) observation was in accordance with present study in Bidar (15.72±0.06), but he documented significantly lower clutch size in Gulbarga (14.70±0.06) and Koppal (14.20±0.007) districts.

5.1.9.5 Eggs per year

Average eggs per year as per the present study in Hassan district was 46.81±0.976. Highest average eggs 48.5 per year was observed in Channarayapatna region followed by Arasikere (47.5), Hassan (47.25) and lowest was observed in Sakaleshpur region (44 eggs). Chi square analysis showed that there is no significant difference between the Arasikere, Channarayapatna and Hassan regions. However, a significant difference observed between Sakaleshpur and Channarayapatna regions for eggs produced in a year.

Present study was in accordance with Gopinath (2013) in Chamarajnagar, he reported 46.79±0.65 eggs per year from indigenous chicken. He also reported 44.63± 0.62 eggs per year in Mysore district, 41.58±0.61 in Mandya district. Sudhir Naik (2021) reported similar results in Gulbarga district (45.29±0.13) followed by Bidar (44.85±0.11) and Koppal district (44.39±0.11). On contrast to present study Rajakumar (2013) reported highest eggs per year in Bangalore rural (54.27±0.59) followed by Chikkaballapur (52.21±0.61) and Ramanagar (48.07± 0.61) district. Veeranngowda (2020) reported quite lower eggs per year from indigenous chicken of Dharwad (37.78± 0.31) followed by Bijapur (39.80± 0.42) and reported highest eggs per year in Belgaum district which was 48.27±0.48. This clearly indicates agro-climatic zones may have influence on egg production per year.

5.1.10 Marketing age of indigenous chicken in Hassan district

Majority of the farmers (57.69%) sold male birds at the age of more than nine months, while 42.3 per cent of them sold at more than six months of age. Similarly, majority of the farmers (80.76%) sold female birds at more than 12 months of age. There is no association between the regions for marketing age of male and female birds ($P>0.05$). Since a smaller number of male birds are required for breeding and they also attain marketable weight faster than females, they are sold at earlier age than females.

Present results are in accordance with Verrannagowda (2020), who reported average marketing age of male birds was 9.04±0.06 and female birds was 11.14±0.05 months. Rajakumar (2013) results are agreement with present results as he reported average marketing age of male and female birds was 9.10±0.05 and 12.48±0.04 months, respectively. Similarly, according to Gopinath (2013) average age of

marketing the male birds was 6.91±0.06 and female birds was 11.64±0.12, He also reported that there is a significant difference in marketing age of indigenous chicken between the districts in Mysore division. According to Islam *et al*. (2021) most culling age of both male and female was six to seven months followed by one- or two-year age. On the contrary to these Kumar *et al*. (2013) reported culling age of female birds in Kerala was three years.

5.1.11 Consumer preference and demand

Consumer preference based on bird plumage colour was observed in present study. Overall, in Hassan district 73.07 per cent of consumer prefer indigenous chicken having multiple plumage colours over the plain plumage. Interestingly, in Sakaleshpur taluk all consumers prefer indigenous chicken-based plumage colour followed by Arasikere (66.66%), Hassan (63.63%) and Channarayapatna (60%). Chi square analysis showed that there is a significant association between the regions in Hassan district for consumer preference on indigenous chicken. Similarly, Bet *et al.* (2011) observed that consumers prefer coloured birds than only black colour birds in Kenya. According to Muhikambele (2019), more than 50 per cent consumers prefer mixed plumage colour followed by brown colour and black colour was less preferred in Tanzania.

Study on demand by consumers for indigenous chicken was showed more during the festival season (57.69%) followed by all the time (38.46%). Least demand for indigenous chicken during different seasons was observed. Chi square analysis of data showed there is an association between the regions for consumer demand during different periods. Demand during festivals was more in Arasikere taluk (66.66%), followed by Channarayapatna (60%), Hassan (54.54%) and Sakaleshpur (50%).

Present study was in accordance with Islam *et al*. (2021), who reported that demand for indigenous chicken increased during festival seasons and fetched higher prices.

5.1.12 Mode of marketing indigenous chicken

Marketing methods followed by farmers in different regions Hassan district comprising of all four agro-climatic zones revealed that 36.53 per cent of farmers sold indigenous chicken directly to consumers, 34.61 per cent of birds were sold at shandy and 28.84 per cent birds to wholesale or retail shop. Results of present study showed that there is an association between the regions for marketing methods of indigenous chicken $P<0.05$). Region wise results showed that, more farmers sold birds directly to consumers in Sakaleshpur (64.29%) and Arasikere (58.34%). However, farmers from Channarayapatna (66.66%) and Hassan (45.45%) directly marketed their indigenous birds in shandy. On contrary, Sakaleshpur (35.71%) and Channarayapatna (33.34%) farmers preferred to sell in wholesale or retail shop.

According to kumar *et al*. (2013) farmers (52.33%) sold chicken to consumers and 47.67 per cent sold birds at local market which is in accordance with present study. On contrary to present study Mandal *et al*. (2013) reported that majority of farmers sold birds at home (94.41%), followed by consumer doorstep (59.26%), village shop keepers (55.09%), middlemen (4.17%) and village market (3.70%) in Bareilly district of Uttar Pradesh. According to Islam *et al*. (2021) in Assam farmers sold 10-15 per cent of birds directly to consumer. He also reported that existing marketing channel in Assam for indigenous birds was from producer to local vendor who would again sell the birds directly to consumer or retailer or another trader.

5.1.13 Ethno veterinary practice and mortality in chicks

The present study found that 52.5 per cent of indigenous chicken rearers in Hassan district used ethno-veterinary medicine when their flocks become ill. Chi square analysis showed that there is a significant association between the regions for ethno veterinary medicines usage ($P<0.05$). Among the regions 70 per cent of farmers from Sakaleshpur used the ethno veterinary medicines followed by 65 per cent in Hassan, 40 per cent in Arasikere and just 15 per cent in Channarayapatna region. Commonly used materials were garlic, onion, green chillies and butter milk. Present study was in accordance with Vinothraj *et al*. (2019) he reported majority of farmers in Erode district of Tamilnadu were using ethno-veterinary medicines like pepper, onion and cumin to treat the birds. According to Gueye (1999) 35 per cent poultry keepers in Nigeria, 58 per cent in Tanzania, 59 per cent in Gambia, 79 per cent in Botswana and 59 per cent in Mozambique use ethno-veterinary medicines in African continent. Thakur *et al*. (2013) studied in Chamba districts of Himachal Pradesh on management practices adopted by indigenous chicken rearing farmers and reported that 84.90 per cent of farmers use garlic and onion as an ethno-veterinary medicine to treat diseases in birds. According to Kumar *et al*. (2013) 31.3 per cent of farmers use indigenous knowledge to treat birds followed by 20.3 per cent use allopathic, 15.6 per cent use combination of both and 32.8 per cent have not used any medicines.

In the current study overall mortality in chicks between 0-8 weeks of age was 42.68±1.5 in Hassan district. Chick mortality was highest in Arasikere taluk (45.25±1.98) followed by 44.75±1.68 per cent in Sakaleshpur, 42.5±3.15 in Hassan and 38.5±2.32 in Channarayapatna taluk. Statistical analysis showed that there is no association between the regions for mortality in chicks. On contrary to present study

Vij *et al*. (2005) reported 20-30 per cent mortality in Danki breed upto eight weeks of age. According to Vijh *et al* (2005a) reported 11 per cent mortality in Miri breed up to four weeks of age. Halima *et al*. (2007) reported 7.4 to 33.5 per cent mortality in Ethiopian native chicks from day old to four weeks of age. Study by the Kumar *et al*. (2016) on mortality pattern in northern highland agro-climatic zones of Kerala revealed that 28.63 per cent mortality in chicks under field conditions.

5.1.14 Feeding practices, vaccination, deworming and major constraints for backyard chicken rearing

Scavenging type of feeding (87.5%) was the major chicken feeding practice followed in Hassan district. Highest of 95 per cent farmers in Hassan taluk, 90 per cent farmers each in Arasikere and Channarayapatna talukas and 75 per cent farmers in Sakaleshpur taluk practices scavenging feeding of indigenous chicken. Semi-intensive rearing practice was highest in Sakaleshpur taluk followed by Arasikere, Channarayapatna and Hassan. Data analysis showed there is no association between the regions for feeding practices in Hassan district.

The results in accordance with Mandal *et al*. (2006) who reported that all farmers in Bareilly district followed the scavenging system of feeding. Further, Pankaj *et al*. (2013) who studied the management practices of indigenous chicken in tribal villages of Jorhat district, Assam also reported that all farmers followed semi-intensive system of rearing.

Vaccination and deworming details collected from indigenous chicken rearing farmers showed that only 8.75 per cent of farmers follow regular vaccination and deworming. Among the regions 20 per cent farmers in Sakaleshpur follow vaccination

followed by 10 per cent in Hassan and five per cent in Channarayapatna taluk. None of the farmers from Arasikere vaccinated their flocks against infectious diseases. Statistical analysis showed that there is no significant association (P>0.05) between the regions for vaccination and deworming. Compared to present study Gopinath (2013) and Rajkumar (2013) reported that 39 per cent and 36 per cent of farmers in Mysore and Bangalore division followed vaccination practices. On contrary to present study Veeranagowda (2020) reported 54 per cent vaccination of indigenous chicken in Belgaum division.

In the present study 77.5 per cent farmers revealed that major constraints for rearing indigenous chicken in Hassan district was predator attack. The remaining 22.5 per cent farmers opined that major constraint was infectious diseases. Predator attack was the major constraints in Sakaleshpur taluk (90%), followed by Channarayapatna (80%), Hassan (75%) and Arasikere (65%). For 35 per cent of farmer's infectious disease was the major constraint in Arasikere followed by 25 per cent in Hassan, 20 per cent in Channarayapatna and 10 per cent in Sakaleshpur taluk. Statistical analysis showed that there is no association between the regions for variable major constraints in indigenous chicken rearing (P>0.05).

Present study was in contrary with mandal *et al*. (2006) reported that infectious diseases was the major constraints followed by predator attack. The present findings were in accordance with the Sharma *et al.* (2018), they reported that 90 per cent of respondents opined that predator are the major constraints for indigenous chicken production in Jammu district of Jammu and Kashmir state. According to Sumanta *et al*. (2015) in Sundarban region of west Bengal incidence of diseases are the major constraint for indigenous chicken production followed by predator attack.

Thakur *et al*. (2013) reported that major constraints for rearing indigenous chicken in Chamba district of Himachal Pradesh was predator (83.01%) followed by diseases (17.89%). These findings are similar to present study on constraints for rearing indigenous chicken.

5.2 Phenotypic characterization

5.2.1 Feather morphology

The present study revealed that all indigenous chicken birds in Hassan district had normal feathers. These findings are in accordance with Rajkumar (2013) and Gopinath (2013), where they reported 100 per cent of normal feathers in indigenous chicken of Bangalore and Mysore division of Karnataka. Findings of Verranagowda (2020) reported 5.55 per cent frizzled feathers both in male and female birds. Negusie Dana *et al*. (2010) found normal (81.4%) and silky feathered (18.6%) feathers in Ethiopian native birds.

5.2.2 Feather distribution

Results of the present study revealed that 94.9 per cent of male birds showed normal feather distribution and 5.1 per cent of male birds showed naked neck feather distribution. Analysis indicated that there is no association between the regions for feather distribution of male birds ($P>0.05$). Naked neck feather distribution was identified only in Arasikere (6.25%) and Channarayapatna (13.33%) regions. In both male and female birds featherd shank and feet, beard and crest type of feather distribution was not observed in four agro-climatic zones.

Normal feather distribution was 97.87 per cent in female birds and and 2.13 per cent birds showed naked neck in Hassan district. Naked neck feather distribution was observed in Arasikere (1.5%) and Channarayapatna (7.2%) regions. Analysis revealed that there is no association for feather distribution between the regions (P>0.05).

Findings of present study was agreed with Rajkumar (2013) in Bangalore division, where he reported 96.63 and 96.88 per cent normal feathers, 2.33 and 1.83 per cent naked neck feather distribution in male and female birds, respectively. Further, he reported 1.03 per cent and 1.28 per cent of feathered shank in male and female birds of Bangalore division which is not seen in Hassan district. According to Gopinath (2013) normal and naked neck feathers in both male and female were 95.03 per cent and 4.95 per cent respectively. On contrary to present study Verrenagowda (2020) reported 77.40 per cent normal and 22.58 per cent naked neck feather distribution in male birds. In female birds he reported 81.66 per cent normal and 18.33 per cent of naked neck feather distribution in Belgaum district of Karnataka.

5.2.3 Plumage colour in males and females

White, black, red, brown, multi-colour and gold colour plumage was observed in male and female birds. Red colour was observed in 28.81 per cent of males and 10.63 per cent female birds. Other colours observed were brown 16.94 per cent in male birds and 27.30 per cent in female birds. A Multi colour plumage was observed in 27.11 per cent of males and 17.73 per cent of females. However, white colour plumage was observed with proportion of 13.55 and 13.47 per cent in males and females, respectively. Chi square analysis revealed that plumage colour between the regions shows no significant association (P>0.05).

Gopinath (2013) reported white (9.97%), black (15.07%), blue (0.85%), red (20.34%), brown (18.04%), gold (7.24%), and mixed colour (28.44%) plumages in Mysore indigenous birds. Rajakumar (2013) reported brown (31.24%), black (23.92%), multicolor (21.25%), red (15.81%), white (3.85%), and blue (2.9%) plumage colour in males of Bangalore division of Karnataka. Female birds he reported that brown (31.73%), black (24.20 %), and multicolor (21.36%), red (13.28%), blue (5.61%), and white (3.81%) plumage colour. On contrary to present study Verranagowda (2020) reported brown (30.37%) as dominant plumage colour followed by black (27.41%), red (18.52%), multi-colour (15.93%), white (4.81%) and blue (2.96%) in male birds. Major colour observed by him in female birds were brown (28.15%), black (26.30%), red (20%), multi-colour (19.82%), white (3.70%) and blue (2.04%). According to Sudhir Naik (2021) major colour observed in male indigenous chicken of Gulbarga division was multi-colour (40.8%) followed by red (20.2%) and similarly dominant colour observed in females was brown (37.17%) followed by black (24.93%).

In present study blue colour plumage pattern was not observed in both male and females. Varied plumage pattern observed in indigenous chicken may be because of no preferential selection of birds for breeding based on plumage colour.

5.2.4 Primary plumage pattern observed in male and female birds

Statistical analysis showed that there is a significant association between the regions for primary plumage pattern in male birds of Hassan district ($P<0.05$). Dominant primary plumage pattern observed in male birds of Hassan district was solid (58.47%) followed by dull (14.4%), barred (11.86%), patchy (6.78%), stripped and mottled (3.38%). Whereas stripped, patchy and spotted plumage pattern was not

seen in Sakaleshpur region. Stripped plumage pattern was seen only in Arasikere and Hassan region, patchy plumage pattern was seen only in Arasikere and Channarayapatna region. Spotted plumage pattern was observed only in Channarayapatna region.

Analysis of data indicates there is a association between the regions for primary plumage pattern of female birds ($P<0.05$). Solid (36.87%) and dull (36.88%) primary plumage pattern were observed in equal proportion in female birds followed by barred (11.2%), stripped (6.02%), mottled (5.67%), patchy (3.19%) and least was spotted (0.35%). However, in female birds spotted plumage pattern was observed only in Channarayapatna region.

Few studies on Karnataka's indigenous chicken have been conducted by different authors in different regions. Gopinath (2013) reported that the overall per centage of plumage pattern recorded in combined sex under field study of Mysore division was solid (45.78%), dull (8.96%), stripped (18.46%), patchy (19.18%), spotted (2.39%), barred (3.00%), and mottled (2.17%). Rajkumar (2013) found that 35.18 per cent of male indigenous birds in the Bangalore division under field study were solid colour, 22.77 per cent were dull, 3.45 per cent were stripped, 7.02 per cent were patchy, 7.57 per cent were spotted, 3.07 per cent were barred and 22.86 per cent were mottled. The plumage patterns observed in female indigenous birds were solid (35.82%), dull (23.43%), mottled (18.49%), spotted (7.62%), patchy (5.05%), stripped (4.91%), and barred (4.67%). The findings are in accordance with present study for solid pattern in male and female birds. According to Veeranagowda (2020), study on male's primary plumage patterns were classified as solid (34.44%), dull (24.8%), stripped (3.33%), patchy (5.18%), spotted (6.66%), barred (8.52%), and

mottled (17.04%). Females were solid (32.40%), dull (23.89%), stripped (5%), patchy (3.33%), spotted (6.67%), barred (12.22%), and mottled (16.48%) in Belgaum division. According to Sudhir Naik (2021) the highest percentage of primary plumage pattern recorded in male birds was solid (41.37%), while the lowest percentage recorded was stripped (0.003%). Female birds had the highest percentage of dull primary plumage pattern (41.88 %) and the lowest percentage of stripped primary plumage pattern (0.24%) in Gulbarga division.

5.2.5 Secondary plumage pattern in male and female

In the present study dominant plumage pattern observed in four agro climatic zones male indigenous chicken birds of Hassan district were 42.37 per cent self-white, followed by 34.74 per cent self-black, 16.94 per cent self-red, 3.38 per cent barred,1.69 per cent mottled and 0.84 per cent lasing. Barred plumage pattern was completely absent in Channarayapatna, Hassan regions similarly lasing pattern was not seen in Sakaleshpur. Whereas, mottled pattern was seen only in Arasikere region. Statistical analysis of data showed there is no significant association for secondary plumage pattern in male indigenous chicken between the regions ($P>0.05$).

Most dominant secondary plumage pattern in female indigenous chicken was self- white and self–black each (41.84%). Other pattern observed was lasing and mottled each of 12.32 per cent, self red and barred each of 6.73 per cent. Statistical analysis revealed that there is no association between the regions for secondary plumage pattern in female indigenous birds ($P<0.05$).

Present results are in accordance with Veeranagowda (2020) in Belgaum division, where he reported self red (36.66%) and self-black (25.56%) are the

dominant pattern observed in male birds. Other pattern observed by the author was self-white (4.81%), self-blue (2.22%), barred (4.81%) and mottled (25.92%). But in female birds he reported most dominant pattern was self red (37.41%) and mottled (23.33%). Findings of Rajakumar (2013) found secondary plumage pattern in male birds of the Bangalore division of Karnataka was self-red (37.90%), mottled (30.01%), self-black (23.4%), self-white (3.85%), self-blue (2.90%), barred (2.67%), and in case of females self-white (3.81%), self-black (20.46%), self-blue (5.61%), self-red (29.65%) and mottled (23.16%). Gopinath (2013) reported self-white (12.83%), self-black (19.69%), self-blue (1.87%), self-red (37.57%), barred (3.34%), mottled (4.27%), and lasing (20.38%) in pooled sex in indigenous chicken of the Mysore division of Karnataka. Self red and self-black are the dominant colours noticed by him in Mysore division. Higher frequencies of red and black pattern within the feather were also reported by Bhuiyan *et al*. (2005), Vij *et al*. (2005), Tantia *et al*. (2006a), and Vij *et al*. (2006a). Male and female indigenous chicken have diversified secondary plumage pattern varied from zone to zone.

5.2.6 Qualitative characteristics of indigenous chicken

5.2.6.1 Skin colour

White skin colour was most prevailing in both male (83.91%) and female indigenous chicken (82.62%) of Hassan district. However, 16.10 per cent yellow colour skin was observed in male and 17.38 per cent in female birds. Chi square analysis revealed that there is no association for skin colour in male and female birds between the regions ($P>0.05$).

The present results are on contrary to Veeranagowda (2020) study, reported that the colour of the skin in males was yellow (95.18%) and white (4.81%) and in case of females it was yellow (95.73%) and white (4.25%). Rajakumar (2013) reported that in Bangalore division male indigenous birds, yellow colour predominated with 97.58 per cent and 2.41 per cent white colour, whereas in females, yellow (97.62%) predominated in field conditions and white colour was 2.38 per cent. Gopinath (2013) reported yellow (90.04%) and white (9.95%) in pooled sex of indigenous chicken from Karnataka's Mysore division. Sudhir Naik (2021) concluded that male indigenous birds had 76.99 per cent yellow skin and 23.01 per cent white skin, while female indigenous chicken had 83.54 per cent yellow skin and 16.46 per cent white skin. Carotenoids and melanins, which are primarily responsible for yellow and black colours, skin and shank pigmentation.

As documented by Vijh *et al*. (2005a), Vij *et al*. (2006a) and Kumar and Kumar (2007) the Ghagus breed of chicken has white skin, while other indigenous chickens have white or yellow skin (NBAGR. 2011). This is in accordance with the present study. Other skin colours, such as grey or pink, have been reported in other indigenous chickens, either alone or in combination with white and yellow (Vij *et al*.2005; Vijh *et al*.2005b; Tantia *et al*.2006a; Vijh *et al*.2006; Vij *et al*.2006b). In different breeds of chicken in different locations, Chaterjee and Yadav (2008) reported pinkish white or yellow white skin, while Ravikumar (2011) reported black colour skin.

5.2.6.2 Shank colour

Yellow colour (89.83%) shank was observed more in male indigenous chicken of Hassan followed by white colour shank (10.16%). However white colour shank

was not observed in Channarayapatna and Hassan regions. Whereas in female indigenous chicken yellow colour (64.89%) shank predominate followed by black (17.36%), white colour (15.96%) and green colour (1.77%) shank. However, green colour shank was observed only in Channarayapatna region. Chi square analysis revealed that there is an association between the regions for colour of shank in both male and female birds ($P<0.05$).

Present findings are in agreement with Sudhir Naik (2021) in Gulbarga division where he reported Yellow (77.30%), black (9.20%), white (11.35%), and green (2.15%) were the most common colours in male indigenous birds. Yellow shank (78.93%), white shank (8.47%), black shank (10.65%), and green shank (1.65%) were the most common shank colours in females. Similar observation was done by Veeranagowda (2020), Yellow colour shank was the most common color among males (87.77%), followed by white (3.70%), black (6.29%), and green (2.22%). In case of female Yellow (89.62 %), white (2.21 %), black (6.29 %) and green (1.84 per cent) were the most observed shank colours. Rajakumar (2013) found that males had yellow (93.17%), black (3.17%), white (2.85%), and green (0.4%) colour shank, while females had yellow (92.99%), black (4.14%), white (1.75%), and green (1.10%) colour shank. In the indigenous chicken of the Mysore division of Karnataka, Gopinath (2013) reported that yellow (77.97%), white (7.13%), black (10.89%), and green (3.98%) colour shank in pooled sex. The majority of the birds had yellow-colored shanks, according to Vij *et al*. (2005), Vijh *et al*. (2005b), and Kumar and Kumar (2007).

5.2.6.3 Ear lobe colour

In the present study most prevalent ear lobe colour observed in male indigenous chicken of Hassan district was red (85.59%) followed by mixture of white and red (14.4%). Interestingly, red and white mixture ear lobe colour was not observed in Sakaleshpur region. Similarly, in females most common ear lobe colour observed was red (50.35%), red and white (43.26%) and white (6.38%). Red and white colour was dominant in Arasikere (52.94%) and Sakaleshpur (54.79%) region while red colour was dominant in Channarayapatna (61.43%) and Hassan (67.61%) region.

The current study's findings are almost similar with those of Veeranagowda (2020), reported that the colour of the ear lobe was found red (99.25 %) and white (0.74 %) in males and on contrarily he reported 100 per cent red colour ear lobe in females of Belgaum division of Karnataka. Similarly, Sudhir Naik (2021) recorded 100 per cent red ear lobe observed in all the three districts of Gulbarga division. Rajakumar (2013) observed 100 per cent red ear lobes in males and 99.75 per cent red and 0.25 per cent white in females in the indigenous chicken of Bangalore division. According to Gopinath (2013), the ear lobe colour was 100 per cent red in both males and females of Mysore division. Few authors reported other ear lobe colours, such as Msoffe *et al*. (2001) reported as red and white, Bhuiyan *et al*. (2005) reported as red and white, Tantia *et al*. (2005a) reported as white, Vij *et al*. (2006a) reported as brown or white or grey, Vij *et al*. (2007) reported as white and brown, Iqbal and Pampori (2008) reported as white and red, Kumar (2009) reported as white, red and yellow ear lobe.

5.2.6.4 Comb colour

In the present study it is found that all male and female indigenous chicken from different regions of Hassan district had red colour comb, indicates there is no association between the region for comb colour (P>0.05).

Present study was in agreement with Veeranagowda (2020) study, he reported that all the indigenous birds of Belgaum division had red-coloured combs. Also, Rajakumar (2013) and Gopinath (2013) both reported 100 per cent red combs in indigenous chicken from Karnataka's Bangalore and Mysore divisions, respectively. Except for the Kadaknath breed which has a purple comb (Mohapatra and Panda,1981), almost all Indian breeds have red combs (Vijh *et al*.2005a; Tantia *et al*.2005a; Tantia *et al*.2005b; Tantia *et al*.2006a; Vij *et al*.2006a).

5.2.6.5 Comb type

Among the comb type's single comb (93.22%) was most prevalent in male indigenous chicken of Hassan district followed by pea comb (5.08%) and rose comb (1.69%). However, rose comb in cocks was observed only in Hassan region.

In case of females most common comb type observed was single comb (49.29%) followed by pea comb (48.58%) and rose comb (2.12%). Interestingly, rose comb hen was observed only in Arasikere and Hassan regions. Statistical analysis of data revealed that there is no significant association between the regions for comb type both in male and female indigenous birds (P>0.05).

The finding of present study was in agreement with Veeranagowda (2020), who observed that male birds had single combs (73.33%), pea combs (22.21%) and

rose combs (4.44%). Females had 73.51 per cent single comb, 22.03 per cent pea comb and rose comb 4.44 per cent. Similarly, Rajakumar (2013) reported that in the Bangalore division of Karnataka, males had single comb (45.17%), pea comb (52.15%) and rose comb (2.67%), while females had single comb (47.29%), pea comb (49.07%) and rose comb (3.64%). As per observations of Gopinath (2013), who reported, indigenous chicken in the Mysore division of Karnataka were predominantly single comb (97.61%) and pea comb (2.37 %). Sudhir Naik (2021) reported 97.88 per cent and 93.48 per cent of single comb, 0.30 per cent and 0.72 per cent rose comb and 1.2 per cent and 5.8 per cent in male and female birds, respectively in Gulbarga division. The current study's findings are consistent with the breed descriptor of chicken (NBAGR, 2011), which states that Ghagus birds have predominantly single comb. According to the other literature available, indigenous chicken populations possessed predominantly single comb, as well as pea and rose comb (Vij *et al*.2005; Tantia *et al*.2005a; Vijh *et al*.2005b).

5.2.6.6 Eye colour

In the current findings most predominant eye colour observed in male birds of Hassan district was brown (69.50%) and grey (30.50%). Black colour eye was not observed in this study. Whereas in female indigenous chicken of Hassan district eye colour observed was brown (53.19%) followed by grey (38.3%) and black (8.51%). Chi square analysis of data revealed that there is no association between the regions for eye colour of the indigenous chicken both in male and female ($P>0.05$).

Eye colour of female birds were in accordance with study of Veeranagowda (2020), he reported 53.7 per cent brown 37.38 perent grey and 8.88 per cent black. But in males he reported black colour eye (6.66%) which is absent in present study.

According to Rajkumar (2013), the eye colour of indigenous chickens in the Bangalore division of Karnataka was brown (46.26%), grey (44.76%) and black in males (14.71%). Females had brown (53.04%), grey (39.62%) and black (7.34%). Contrary to present study Gopinath (2013) observed brown (91.26%) and grey (8.72%) in pooled sex in indigenous chicken from Karnataka's Mysore division. According to breed descriptor (NBAGR, 2011) the Ghagus breed had red eye colour. The other eye colours reported in the literature are varied shades of brown, black and grey (Vij *et al*.2005; Vijh *et al*.2005a; Kumar and Kumar, 2007).

5.2.6.7 Wattles

All the male indigenous chicken birds have wattles as per the observation of the present study in different regions of Hassan district. Whereas in female birds only 58.16 per cent of birds have wattles and remaining 41.84 per cent birds across all the regions don’t have wattles. Statistical analysis of data revealed that there is no association for presence or absence of wattles between the regions (P>0.05).

According to Gopinath (2013), wattles were present in 93.42 per cent of indigenous chicken in Mysore division of Karnataka and absent in 6.57 per cent of indigenous chicken in pooled sex. Contrary to present findings Veeranagowda (2020) reported that, wattles were present in 38.51 per cent of the birds and rest 61.47 per cent did not have wattles. Whereas in case of female’s wattles were present in 43.51 per cent of birds and absent in 56.47 per cent in Belgaum division of Karnataka. Conversely to present findings Rajakumar (2013) reported 47.84 per cent of male birds have wattles and absent in 52.15 per cent birds of Bangalore division. But in case of female birds 50.93 per cent have wattles and 49.07 per cent birds don’t have,

which is similar to present findings. Sudhir Naik (2021) reported that 95.40 per cent in males and 90.07 per cent in female birds had wattles in Gulbarga division.

The Ghagus breed had smaller red wattles, according to the breed descriptor (NBAGR, 2011). Wattles in Nicobari birds were pink (Vijh *et al.*2006), whereas wattles are absent in Danki breeds (Vij *et al*. 2005). Variations in phenotypic traits are expected because the study was conducted in different genotypes from different environmental conditions, requiring them to have a lot of variations in order to adapt to changing environmental conditions and also meet their physiological activities.

5.3 Body weight (kg), Breast angle (degree), keel bone length (mm) and shank length (mm) of adult indigenous chicken in different agro-climatic regions of Hassan district.

5.3.1 Body weight (kg)

Mean body weight of adult male birds from different regions in the present study was 1.73±0.05 kg. Highest body weight was recorded in Arasikere region (1.813 kg) followed by Sakaleshpur region (1.79 kg). Body weight of male birds in Hassan (1.648 kg) and Channarayapatna (1.66 kg) was below the mean value of district. However, on statistical analysis of data revealed that there is no association between the regions and adult male body weight.

Mean body weight of female birds from different regions was 1.308±0.017 kg. Mean body weight of female birds was highest in Arasikere (1.36 kg) and Sakaleshpur (1.33 kg) whereas mean body weight of both Channarayapatna and Hassan (1.27 kg) was lower than mean body weight of female birds from all the

regions (1.308±0.017 kg). Chi square data analysis revealed that there is no significant association between the regions for female body weight.

Present study was in accordance with Banerjee (2012) he reported that average body weight of male native chicken was 1.76±0.132 kg. But he reported 1.080±0.112 kg body weight in female birds, which is lower than present study. Similarly, Aseefa and Melesse (2018) reported body weight of 1.68±0.2 kg in male and 1.42±0.2 kg in female birds in south western Ethiopia. Gawande *et al*. 2007 reported body weight of male indigenous chicken in different regions of Assam was1349.49±24.33 g and female body weight was 1041.66±18.95 g in tribal areas. According to Thakur *et al*. (2013) average body weight of male birds was 1.7 kg and female birds were 1.65 kg in Chamba district of Himachal Pradesh. According to Yadav *et al*. 2017 average body weight of male in Ghagus breed chicken was 2.16±0.25 and female was 1.43±0.81 kg. Saravanan *et al*. (2020) reported body weight of male birds range from 0.78 kg to 1.03 kg and female was 0.61 to 0.95 kg in Kolli hilly areas of TamilNadu.

5.4.1 Breast angle

Mean breast angle observed in male indigenous birds of Hassan district was 70.31 ± 0.51^0. Average breast angle was highest in Channarayapatna (73.07^0) region followed by Arasikere (70.59^0), Sakaleshpur (69.95^0) and Hassan (67.63^0). Analysis of data revealed that there is a association for breast angle between the regions for male birds ($P<0.05$). In case of females mean breast angle in Hassan district was 69.62±0.39 and highest was observed in Channarayapatna (72.66^0) region and lowest was in Hassan (67.88^0) region. Chi square data analysis revealed that there is an association between the regions for breast angle in female birds ($P<0.05$).

Present study was in accordance with Chatterji *et al*. (2007), he reported 70.5 ± 8.01^0 breast angle in pooled sex of Kadaknath breed. Similarly, Rajakumar (2013) reported breast angle of 73.87 ± 0.58^0 in pooled sex of indigenous chicken from Chikkaballapur district of Bangalore division. But in contrary to present study, he reported higher breast angle in Ramanagar (84.04 ± 049^0) and Bangalore rural district (77.10 ± 0.47^0). According to Gopinath (2013) breast angle was 84.38^0 in Mandya, 85.21^0 in Chamarajnagar male indigenous birds of Mysore division. He also reported 84.19^0 in Mandya district and 82.47^0 in Chamarajnagar district female indigenous birds. Veeranagowda (2020) reported breast angle of pooled sex indigenous chicken in Belgaum division was 78.54^0 in Bijapur, 80.96^0 in Belgaum and 80.53^0 in Dharwad district, which is higher than our findings in Hassan district. Singh and Pathak (2016) studied the breast angle in Kadaknath and Aseel breeds and reported 70.45^0 and 81.65^0 respectively.

5.4.3 Keel bone length

Average keel bone length in present study was 119.49±0.88 mm in male indigenous chicken and 113.57±0.52 mm in female birds. Among the male's highest keel bone length was measured in Arasikere (121.05 mm) and lowest was in Hassan region (118.35 mm). Between the regions in female bird's highest keel bone length was observed in Arasikere (116.5 mm) and lowest was in Channarayapatna (111.59 mm). Statistical analysis of data indicated that there is no association ($P>0.05$) between the regions for keel bone length in male birds but significant association was observed in female birds between the regions ($P<0.05$).

Findings of present study is in accordance with Rajakumar (2013) study in Ramanagar district, he reported 122.61±0.69 mm keel bone length in male birds and

108.45±2.29 mm in female birds. Haunshi *et al*. (2010) measured the keel bone length in Miri breed which was 103.41 mm and 88.79 mm in females, it is lower than the present findings. According to Gopinath (2013) mean keel bone length of male at 20th week of age was 75.58 mm in Mandya, 78.50 mm in Mysore and 83.06 mm in Chamarajnagar districts of Mysore division. Similarly in female he reported 68.46 mm in Mandya, 66.14 mm in Mysore and 68.65 mm in Chamarajnagar. According to Veerenagowda (2020) average keel bone length was 114.04 mm in Dharawad district and 123.75 mm in Bijapur District male indigenous birds. He also reported 111.90 mm in Bijapur and 102.58 mm in Belgaum district female birds, which is higher than present study.

5.4.4 Shank length

Overall mean shank length measured in male birds of Hassan district was 96.35±0.89 mm and in female 85.49±0.49 mm. Statistical analysis of data revealed that there is no association ($P>0.05$) between the region for shank length in male indigenous birds but significant association was observed between the regions for female shank length ($P<0.05$). Average shank length was highest in Arasikere region (97.89 mm) and lowest in Hassan region (95.18 mm) for male birds. In case of female bird's shank length was highest in Arasikere (89.92 mm) and lowest in Channarayapatna region (82.64 mm).

Gopinath (2013) reported similar to present findings in Chamarajnagar district, he reported 92.61 mm in males and 75.76 mm in female birds at 20th week of age. According to Rajakumar (2013) average shank length in male indigenous birds was 86.06 mm in Ramanagar district and 97.56 mm in Bangalore rural district. Similarly, average shank length in female indigenous birds was 69.02 mm in Ramanagar district

and 77.20 mm in Bangalore rural district. Veeranagowda studied the shank length in Belgaum division and he reported that 88.37 mm in Dharawad district and 89.29 mm in Bijapur district for combined sex, which is in agreement with present findings in Hassan district. According to Faruque (2010) shank length of male indigenous birds of Bangladesh was 96.3 mm and female birds was 92 mm, these results are in accordance with present findings. Similarly, Haunshi *et al*. (2010) reported 84.56 mm shank length in male birds but lower shank length in female birds (66.82 mm). Padhi *et al*. (2012) reported higher shank length in both male (115.95 mm) and female birds (111.64 mm) in Ghagus breed of chicken at 20^{th} week.

5.5 External Egg quality traits of indigenous chicken from different agro-climatic zones of Hassan districts.

5.5.1 Shell colour

In the present study 51.25 per cent brown colour egg shell was observed followed by 42.5 per cent cream colour and 6.25 per cent dark brown colour egg. Interestingly, dark brown colour eggs were observed more in Sakaleshpur region and equal percentage was observed in remaining regions. On statistical analysis of data revealed that there is no association between the regions for shell colour of eggs in Hassan district ($P>0.05$).

In accordance to present study Veernagowda (2020) reported in Belgaum division that 55.92 per cent eggs were brown colour but he also reported 35.18 per cent light brown and 8.89 per cent cream-coloured eggs, which is in contrary to present study. Rajakumar (2013) reported that the majority of the eggs from indigenous chicken of Bangalore division of Karnataka were light brown (44.46%),

followed by brown (38.65%) and cream-coloured eggs (16.90%). According to Gopinath (2013), the majority of eggs from Mysore division of Karnataka's indigenous chicken showed cream colour (50.33%), brown (26.32%), and light brown (23.33%), which is in converse to present study. Sudhir Naik (2021) reported that percentage of cream, light brown and brown colored eggs recorded was 14.99, 38.64 and 46.37%, respectively. Vij *et al*. (2005) reported dark brown, white and creamy white shell colours in Danki breed. Vijh *et al*. (2005a) in Miri, Tantia *et al*. (2005b) in Gagus, Parmar *et al*. (2006) in Kadaknath, Vij *et al*. (2007) in Tellicherry and Kalitha *et al*. (2011) in indigenous chicken of Assam reported different colours. The shell colour is a qualitative trait unique to the breed and colour variations mainly due to non descriptive type.

5.5.2 Egg weight

Average egg weight of indigenous chicken in Hassan district was 40.99±0.51 g. Egg weight was heavier in Arasikere (42.44 g) followed by Sakaleshpur (41.53 g), Channarayapatna (40.69 g) and Hassan (39.30 g). Statistical analysis showed that there is no significant difference between Channarayapatna, Hassan and Sakaleshpur region but significantly heavier egg weight was recorded in Arasikere region ($P>0.05$).

In accordance with present study Rajakumar (2013) reported that egg weight ranged from 39.83±0.43 gm in Ramanagar district to 43.79±0.70 gm in Bangalore rural district, with an overall mean egg weight of 41.45±0.56 gm in the indigenous chicken of Bangalore division of Karnataka. On contrary to present study Veeranagowda (2020) reported higher egg weight in Dharwad (45.59±0.70 g), Belgaum (46.88±0.49) and Bijapur (47.28±0.68). According to Gopinath (2013), egg

weight ranged from 38.90±1.84 gm in Chamarajnagar district to 40.10±0.544 gm in Mandya district, with an overall mean of 39.46±0.86 gm in the indigenous chicken of Mysore division of Karnataka, which is almost similar to present findings. Sudhir Naik (2021) reported that average egg weight recorded was 38.83±1.37 g in Gulbarga division. The findings are comparable to those of Fayeye *et al*. (2005) in Fulani breed of chicken (40.73 gm), Tantia *et al*. (2005b) in Ghagus breed of chicken (40.25±2.39 gm), and Kalitha *et al*. (2009) in indigenous Assam chicken (38.69±0.69 gm). Tantia *et al*. (2006a) reported lower egg weights in the Ankaleshwar breed of chicken (35.09±0.14 gm). Singh *et al*. (2009) reported higher egg weights in Uttarakhand's local hill fowl (52.03±0.90 gm) and Yadav *et al*. (2009) in native fowl of Uttar Pradesh (52.95±0.59 g).

5.5.3 Shell thickness (mm)

Egg shell thickness was found to be lowest in Sakaleshpur regions (0.29 mm) and highest in Hassan region (0.34 mm) followed by Arasikere and Channarayapatna with thickness of 0.33 mm each. Statistically significant difference was observed between the regions for egg shell thickness ($P<0.05$).

The current findings are in agreement with those of Veeranagowda (2020), who reported a mean egg shell thickness of 0.32 mm in indigenous chickens from Belgaum, Dharwad and Bijapur districts. Rajakumar (2013), on the other hand, reported higher values in indigenous chicken of Bangalore division of Karnataka, with shell thickness ranging from 0.39±0.01 mm in Chikkaballapur district to 0.42±0.01 mm in Ramanagar district. Gopinath (2013) reported similar values in indigenous chicken of Karnataka's Mysore division, stating that the shell thickness ranged from 0.334±0.003 mm in Mandya district to 0.357±0.011 mm in Chamarajanagar district,

with no significant differences observed between the districts. Whereas Vijh *et al*. (2005a) in Miri, Tantia *et al*. (2005a) in Kashmir Favorella, Parmar *et al*. (2006) in Kadaknath, and Tantia *et al*. (2006a) in Ankaleshwar all reported lower values than present study ranging from 0.25 to 0.30 mm.

5.5.4 Shell weight (g)

In present study mean shell weight of eggs collected from different regions of Hassan district was 3.99±0.004 g and found there was no significant association between the regions (P>0.05). Egg shell weight was more in Arasikere (4.06 g) followed by Channarayapatna (4.01 g), Sakaleshpur (3.97 g) and Hassan (3.96 g).

The current study's findings were consistent with those of Vij *et al* (2007), who reported an egg shell weight of 3.95±0.15 g in the Bursa breed. In contrast to the current results, Gopinath (2013) recorded higher shell weights of 4.90±0.23 (Chamarajnagar), 5.30±0.17 (Mysore) and 5.25±0.20 (Mandya) in indigenous chicken of Mysore division. Iqbal and Pampari (2008) reported 4.63 g in Kashmiri, Vij *et al* (2016) reported shell weight of 5.04 g in Kaunayen, Vij *et al* (2005) reported 5.73 g shell weight in Danki breed and Vijh *et al* (2006) in Nicobari breed reported 5.84 g shell weight, which was higher than present study.

5.5.5 Shape Index

Mean shape index of eggs collected from different regions was 77.65±0.042 and on statistical analysis found there is a significantly higher Shape index was observed in Arasikere compared to other regions of Hassan district. Arasikere had the highest shape index of 80.72, followed by Hassan (77.16), Sakaleshpur (76.62) and Channarayapatna region had the lowest 76.08 shape index.

Results of the present study was in accordance with Verranagowda (2020), he reported 74.58±1.45 in Belgaum, 75.35±0.28 in Bijapur and 76.28±0.83 in Dharwad district with overall mean value of 75.40±0.55. The findings of this study agree with Rajakumar (2013), who found that the shape index of indigenous chickens in the Bangalore division of Karnataka ranged from 73.69±1.53 in Chikkaballapur district to 76.45±0.82 in Ramanagar district, with no significant differences between the districts. Sudhir Naik (2021) reported lower shape index (71.34±1.23) in eggs from Gulbarga division than present study. Gopinath (2013) also found that the shape index of indigenous chicken in Karnataka's Mysore division ranged from 73.59±1.79 in Mysore to 75.36±1.35 in Chamarajanagar. The above findings are also comparable to those of Parmar *et al*. (2006) in the Kadaknath chicken breed which is having the shape index of 73.93.

5.5.6 Haugh unit

Significantly (P>0.05) higher Haugh unit was noticed in Hassan and Sakaleshpur regions compared to Arasikere and Channarayapatna. Haugh unit were lower in Arasikere and Channarayapatna but remained non significant among the regions in Hassan district.

The present findings are in agreement with Gopinath (2013), he reported in indigenous chicken of Mysore division of Karnataka the HUS value ranged from 67.50±1.40 to 70.40±0.76. In contrary to present findings Veeranagowda (2020) reported higher Haugh unit in indigenous chicken eggs from Bijapur (77.70±0.88), Belgaum (78.20±0.92) and Dharawad (79.30±0.40 districts respectively. According to Rajakumar (2013) Haugh unit score of Ramanagar was 77.30±1.52, Chikkaballapur was 76.70±1.06 and Bangalore rural was 75.60±0.60, which is higher than present

study. According to Sudhir Naik (2021) haugh unit of indigenous chicken from Gulbarga division was 68.89±1.24, which is slightly higher than the present study.

5.6. Internal egg quality traits of indigenous eggs from different regions of Hassan district.

5.6.1 Albumin Index

The mean albumin index of eggs collected from different regions of Hassan district was 0.045±0.001 and on Statistical analysis of data showed there is no significant association (P<0.05) between the regions for albumin index of eggs. Albumin index value was more in Hassan (0.046) followed by Channarayapatna (0.045), Sakaleshpur (0.044) and Arasikere (0.043).

Gopinath (2013) found similar results in indigenous chicken from Karnataka's Mysore division, stating that the albumen index ranged from 0.034±0.003 in Chamarajnagar to 0.046±0.002 in Mandya, with significant differences between the districts. In Bijapur, Belgaum, and Dharawad districts, respectively, the higher albumen index recorded by Veerenagowda (2020) was 0.06±0.00, 0.07±0.00, and 0.07±0.00. The eggs from Belgaum and Dharawad districts differ from the eggs from Bijapur district by a significant (P0.05) margin. Results are slightly higher than the present study also. Rajakumar (2013) found that the albumen index of indigenous chickens in the Bangalore division of Karnataka was 0.077±0.003, 0.068±0.003, and 0.066±0.002 for Ramanagar, Chikkaballapur and Bangalore Rural districts, respectively. The current study results also converse to the findings of Singh *et al*. (2009) in Uttarakhand's local hill fowl and Yadav *et al*. (2009) in Uttar Pradesh's

native fowl, which recorded 0.08±0.03 and 0.08±0.002, respectively. Tantia *et al*. (2006a) in the Ankaleshwar breed of chicken a value of 0.08±0.006 was also reported.

5.6.2 Yolk index

Mean yolk index value of overall the regions in Hassan district was 0.37±0.01. Statistical analysis of data on yolk index revealed that there no significant difference between the regions for yolk index of indigenous chicken eggs (P>0.05). Yolk index was found lower in Arasikere (0.36) and highest in Sakaleshpur region (0.39).

Present results are in accordance with finding of Sudhir Naik (2021), who reported 0.381±0.0045 yolk index in indigenous chicken eggs from Gulbaraga division. Veeranagowda (2020) reported lower values in Bijapur (0.34) and similar values in Belgaum (0.36) and Dharawad (0.38) district. The results of the present study are in agreement with that of Rajakumar (2013) who reported that indigenous chicken eggs from Bangalore division of Karnataka showed yolk index value of 0.39±0.003, 0.38±0.015 in Bangalore rural and Chikkaballapur district. In the indigenous chicken from Mysore division of Karnataka, Gopinath (2013) found that the yolk index ranged from 0.283±0.004 in Mandya district to 0.339±0.006 in Chamarajnagar district, which is lower than the current study. The findings are also consistent with those of Singh *et al*. (2009) in Uttarakhand's local hill fowl and Yadav *et al*. (2009) in Uttar Pradesh's native fowl. Tantia *et al*. (2005a) in Kashmir, Vijh *et al*. (2005a) in Miri Favorolla, Vijh *et al*. (2005b) in Kalasthi, Tantia *et al*. (2005b) in Ghagus, Vij *et al*. (2006a) in Punjab Brown and Tantia *et al*. (2006a) in Anakaleshwar found that the yolk index value ranged from 0.35±0.02 to 0.47±0.036.

5.6.3 Albumin and yolk weight

Mean albumin weight of eggs from indigenous chicken in different regions of Hassan district was 22.08±0.44 g. Statistical analysis of data revealed that there is no significant difference between the regions for albumin weight (P>0.05). The weight of albumin was more in Arasikere (22.84 g) followed by Channarayapatna (22.68 g), Sakaleshpur (21.85 g) and Hassan (20.93 g).

The mean weight of yolk from different regions of Hassan district was 13.06±0.24 g and a significant difference between the regions (P<0.05) was observed. Channarayapatna had the highest yolk weight (14.52 g), followed by Sakaleshpur (14.11 g) and found significantly no difference between them. Similarly, between Arasikere (12.39 g) and Hassan (11.23 g) no significant difference was observed.

Sumashree *et al*. (2019) reported albumin weight of 24.46 g and yolk weight of 13.95 g in indigenous chicken egg from Raichur poultry farm, which is similar to present study of Hassan district. Niranjan *et al*. (2008) found that the albumin weight of eggs from Aseel and Kadaknath was 28.97±0.59 g and 26.29±0.49 g, respectively and the yolk weight was 16.32±0.24 and 12.49±0.09 g, which is higher than the current findings. Saiful Islam and Ripon kumar (2010) reported that albumin weight of indigenous chicken in Bangladesh that 18.92±1.66 and yolk weight 14.65±3.48. Present findings are similar to Markos *et al* (2017), reported albumin weight of 22.2 g, 21 g and 19.3 g respectively in local chicken of highland, midland and lowland areas of Ethiopia. Similarly, they also reported 16.5 g, 15.6 g and 13.1 g yolk weight in those regions.

Summary

VI. SUMMARY

The present study was conducted with the objective of assessing the phenotypic characteristics of indigenous chicken (as per NBAGR proforma) present in different agro-climatic regions of Hassan district viz Central dry zone involves Arasikere taluk, Southern dry zone which is having Channarayapatna taluk, Southern transition zone which covers Alur, Arakalagudu, Belur, Hassan and Holenarasipura taluks. Data was collected as per NBAGR proforma. Study also includes the survey with structured questionnaire in selected villages from four agro-climatic regions of Hassan district to record the management practices followed. A total of 118 male and 282 female adult indigenous chicken was utilized to record the phenotypic characteristics and 80 farmers were interviewed with structured questionnaire for survey study.

Among the surveyed villages in the entire region female participation for indigenous chicken rearing was more in Channarayapatna taluk (65%) followed by Hassan (60%), Arasikere and Sakaleshpur (55%). Majority of indigenous chicken rearing farmers belong to other backward caste (85%) in Hassan district followed by 11.25 per cent SC/ST and 3.75 per cent other caste farmers. Land holding pattern revealed 73.25 per cent of farmers are having less than two acre of land who are rearing most indigenous chicken in Hassan district. Others are 12.5 per cent having 2.5 to 5 acre of land and 7.5 per cent had more than 5 acres of land. Major livelihood activities observed was Agriculture with Animal husbandry (70%) followed by agriculture (20%) and agriculture labour (10%), On statistical analysis showed significant difference between the regions. Foremost purpose of rearing indigenous chicken was for own consumption and for sale (62.5%), observed no significant

difference between the regions. Average flock size of indigenous chicken was 23 from the selected farmers in four agro-climatic regions and adult female birds (28.96%) and chicks (28.7%) are most in flocks. In Hassan district it was observed that only poultry rearing farmers are more in Sakaleshpur region (45%) and in remaining regions farmers rear indigenous chicken along with other livestock (85%). It is observed that 47.5 per cent farmers provide housing for indigenous chicken along with other livestock, 26.25 per cent keep birds in the courtyard of their house and 26.25 per cent provide separate housing. Regarding hatching practices in Hassan district only 37.5 per cent of farmers choose eggs based on colour and size before natural incubation. Farmers also use different bedding material like dry grass along with ash (36.25%), dry grass along with sand (20%) and remaining 43.75 per cent use only grass as a bedding material for natural incubation. 82.5 per cent farmers revealed that hen prefer to go outside for voiding faeces once in two days and 17.5 per cent opined once in a day. It is also observed that overall, 52.5 per cent farmers made available food and water for broody hen during natural incubation and found no significant difference across the regions. From survey it was revealed that overall average number of eggs kept for natural incubation 13.2±0.382 and hatching per centage of 79.12±0.81.

The average number of egg-laying cycles per year for indigenous chickens from various Hassan district regions was 3.25±0.57, clutch size was 15.78±0.18 and eggs per annum was 46.81±0.98. Marketing age of male birds was above nine months according to 57.69 per cent farmers and above six months from remaining 42.3 per cent of farmers. For female birds it was observed that 80.76 per cent sold after 12 months of age and 19.23 per cent sold afte nine months. It is also observed that 73.07 per cent farmers said that consumers consider physical characteristics like plumage

colour, shank length and weight of birds before buying the indigenous chicken. 57.69 per cent farmers observed more demand for indigenous chicken during the festival seasons and 38.46 per cent respond that demand for indigenous chicken is throughout the year and only 1.92 per cent considered demand vary with seasons. Marketing channels used by farmers for indigenous chicken were 34.61 per cent direct sale birds in shandy, 28.84 sale in wholesale or retail shop and 36.53 per cent directly sold to consumers. Overall chick mortality of 42.68 per cent was recorded in Hassan district. Farmers are using ethno-veterinary medicines like onion, garlic, green chilies and buttermilk to treat the ailing birds, it was observed that 47.5 per cent farmers from all the regions in Hassan district use ethno-veterinary medicines. 91.25 per cent of farmers did not vaccinate and deworm their flocks in different agro-climatic regions. Feeding practices followed in Hassan district was 87.5 per cent scavenging and remaining 12.5 per cent follow semi-intensive system of rearing. From the survey it was observed that for the 77.5 per cent farmers' revealed predator attack was the major constraint to indigenous chicken and rest 22.5 per cent diseases to birds.

Study showed normal feather morphology of all male and female birds in Hassan district, no frizzled and silky feather morphology could be observed. Male birds of 94.9 per cent and 97.87 per cent female birds had normal feather distribution. Remaining 5.1 per cent male and 2.13 female birds had naked neck feather distribution. Naked neck was observed only in Arasikere and Channarayapatna regions. Among the plumage coloures red plumage (28.81%) and multi-colour (27.12%) was more prevalent in male birds followed by brown (16.94%), white (13.55%), black (11.86%) and gold (1.69%) plumage colour. In female bird's black (30.85%) and brown colour (27.30%) was most prevalent followed by multi-colour (17.73%), white (13.47%) and red (10.63%) plumage colour. statistically no

significant difference was observed between the regions for plumage colour. Solid primary plumage pattern (58.47%) was most dominant in male birds and dull plumage (36.88%) pattern was dominant in female birds least pattern was spotted in both male (1.69%) and female (0.35%) birds. From the data analyses for plumage pattern showed a significant difference between the regions for both male and female birds ($P<0.05$). Among the secondary plumage pattern self white pattern (42.37%) was most common in male birds, but in case of female birds both self white (41.48%) and self black (41.84%) pattern was most prevalent in different agro-climatic regions of Hassan district. On statistical analysis of data showed there is no significant difference between the regions for either of sex indigenous chicken ($P>0.05$)

Most predominant skin colour was white in all four agro-climatic regions for male (83.91%) and female birds (82.62%), other skin colour observed was 16.1 per cent and 17.38 per cent yellow in male and female birds respectively. Per centage of different coloured shank observed in male indigenous birds in different agro-climatic regions were 10.16 per cent white shank and 89.83 per cent yellow coloured shank. In case of females 15.96 per cent white coloured shank, 64.89 per cent yellow shank, 17.36 per cent black shank and 1.77 per cent green shank of which green coloured shank was observed only in Channarayapatna region. It is found significant association ($P<0.05$) between the regions for shank colour in both males and females. Most prevalent ear lobe colour observed in male birds was red (85.59%) and in case of females 50.35 per cent red ear lobe and 43.26 per cent red & white mixture earlobe colour could be observed. 6.38 per cent white colour earlobe was observed only in female birds. statistical analysis of data revealed that there is a significant association ($P<0.05$) between the regions for earlobe colour. the only colour of comb observed was red in both male and female birds in all regions of Hassan district. Single comb

type (93.22%) pattern was the more dominant comb type observed in male birds and other comb type observed was 5.08 per cent pea comb and 1.69 per cent rose comb. In case of female birds both single (49.29%) and pea comb type (48.58%) was most common comb type observed, only 2.12 per cent rose comb type was observed. On analysis of data statistically showed no significant association (P>0.05) between the regions for comb type in male and female birds. Most common eye colour observed in male birds was brown (69.50%) followed by grey colour eye (30.50%). In case of females also brown colour (53.19%) was the most common followed by grey (38.3%) and black coloured eye (8.51%). No significant association (P>0.05) between the regions for eye colour in both male and female birds was observed. Wattles were present in all the regions of male birds but in case of female birds only 58.16 per cent birds had wattles with no significant association between the regions (P>0.05).

Twenty eggs from each agro-climatic region were collected for examination of external and internal qualities of indigenous bird's egg. Most common colour of egg shell was brown (51.25%) and cream (42.5%) and least was dark brown (6.25%). It was found no significant association between the regions for egg colour (P>0.05). Weight of egg was measured in digital weighing scale; highest egg weight was observed in Arasikere region (42.44 g) and least was in Hassan region (39.30 g). Average egg weight from all the regions was 40.99 g with no significant difference between the regions (P>0.05). Average shell thickness was 0.32±.001 mm with highest being observed in Hassan region and lowest in Sakaleshpur region. Average Shell weight from all the regions was 3.99±0.04 g and highest shell weight being observed in Arasikere (4.06 g) and lowest in Hassan region (3.96 g). Statistically significant difference was observed for shell thickness but non significant difference for shell weight was observed between the regions. Shape index was found highest in

Arasikere region (80.72), least in Channarayapatna region (76.08) and observed significant difference between the regions ($P<0.05$). Haugh unit of eggs was found non significant between the Arasikere (63.53) and Channarayapatna regions. Similarly shape index was found non significant between the Hassan (77.16) and Sakaleshpur regions (76.62) but found significant between among various regions in Hassan district ($P<0.05$).

For collected eggs from different regions Albumin index and yolk index was found significantly no difference between the regions. Mean albumin index was 0.045±.001 and was recorded highest in Hassan region (0.046) and lowest in Arasikere region (0.043). Mean yolk index found was 0.37±0.01, highest being found in Sakaleshpur region (0.39) and lowest in Arasikere region (0.36). Weight of albumin was measured in digital weighing scale and highest albumin weight was found in Arasikere region (22.84 g) and least in Hassan region (20.93 g). Mean albumin weight of eggs from different regions was 22.08±0.44 g and statistically found non significant between the regions. Mean yolk weight of eggs was 13.06±0.24 g and found significant difference between the regions. Yolk weight was found non significant between Arasikere (12.39 g) and Hassan (11.23 g) regions similarly and it was non significant between Channarayapatna (14.52 g) and Sakaleshpur regions (14.11 g).

Conclusion

- From the present study it can be concluded that indigenous chicken has varying phenotypic characters like different plumage colour, plumage pattern, skin colour, shank colour, eye colour, body weight and egg traits showed a genetic variation within the indigenous chicken of selected villages and it can be exploited through improved better management practices and breeding strategies.
- Study indicates an agro-climatic condition have no effect on phenotypic characters of birds but showed variation in management practices and marketing methods employed by farmers.
- Mortality in chicks was observed more in all agro-climatic divisions and measures should be taken through proper training of farmers and providing better veterinary services.
- Predator attack and diseases are the major constraints for farmers rearing indigenous chicken and it can be controlled by providing proper housing, better management practices and vaccination against infectious diseases.
- Only 37.5 per cent farmers choose the eggs before natural incubation, selection of eggs and providing feed and water during natural incubation will not affect the body condition of broody hen and improve the hatching per centage.
- In the present study only eight villages from four taluks of Hassan district were selected in Hassan district, further study is needed to know more about the phenotypic characters and management practices in other taluks also.
- Molecular characterization and genetic similarity or variation with other recognized indigenous chicken breeds of India need to be done through further investigation and efforts must be taken to conserve the germplasm.

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Abstract

VIII. ABSTRACT

Indigenous chicken (IC) plays an important role in rural household economics, nutritional security, women empowerment and socio-cultural aspects of farmers in developing countries. The present study was undertaken to characterize IC present in different agro-climatic region of Hassan district and to document their management practices. The agro-climatic zones consist of Central dry zone, Southern dry zone, Central transitional zone and Hilly zone. Physical characters of IC were recorded in 118 male and 282 female birds from the above regions and 20 farmers from each agro-climatic zone were interviewed through structured questionnaire schedule to collect data on management practices. More women (58.75%) were involved in rearing IC than men and average flock size was 23.16. Further 73.75% farmers holding <2.5 acre of land were rearing more IC and 70% of farmers were having other animal husbandry activities. Purpose of rearing indigenous chicken was for both own consumption and sale (62.5%) and 47.5% kept chicken with other livestock or in owner courtyard (26.25%). Only 8.75 per cent farmers vaccinate their flock and major constraits of rearing IC was predator attack (77.5%). In the phenotypic characters all male and female birds had normal feather morphology and only 5.1% in males and 2.13% in female IC had naked neck feather distribution. With respect to plumage colour among males 28.81% red, 27.12% multi-colour and in female 30.85% black and 27.30% brown were the major colours observed. Solid (58.47%) type plumage pattern was dominant in males and whereas in females solid (36.87%) and dull (36.88%) were predominated. White skin colour was most common in both male (83.91%) and female birds (82.62%). Among the ear lobe red colour (85.59%) observed in male IC whereas in female red (50.35%) and red and white colour (43.26%) was observed. Colour of comb was 100% red in male and female IC and single comb was dominant in male (93.22%) whereas in female both single comb (49.29%) and pea comb (48.58%) was common. Brown colour eye (69.50%) observed more in male, 53.19% brown and 38.3% grey eye was seen in female IC. Study indicated IC in Hassan district had varied phenotypic characters and farmers from different agro-climatic zones followed their own kind of management practices.

Annexure

ANNEXURE- I

QUESTIONNAIRE

1. Basic information about the indigenous chicken rearing farmers

a) Name of the farmer & Mobile No:…….

b) Community (circle, GEN, OBC, SC/ST, OTHERS) ……

c) Land holding:

Landless	0-2.5 acre	2.5-5 acre	≥ 5 acres

d) Gender of the interviewee and person engaged in chicken rearing

Male	Female

e) Major livelihood activities:

Agriculture	Agriculture labour	Animal husbandry activity	Other

f) Purpose of rearing indigenous chicken

Own use	Sale of eggs and meat	Both

g) Number of livestock

Cross breed cattle	Local cattle	Buffalo	Sheep	Goat	pig

2. Current flock size and structure

Number of chicks (0-8 weeks)	Growing Male	Growing Female	Adult Male	Adult Female	Total

3. Housing

3.1 Quality of poultry housing

a. Size of the house and number of birds……

b. Is enough ventilation in the poultry house available? Yes …. No ….

c. Is there protection from snakes, cats and other predators? Yes …. No

3.2 location of chicken house

a. Chicken house is separate
b. Chicken inside the owner house
c. Chicken house in owner's courtyard
d. Poultry house with other livestock
e. Other

4. Hatching system

4.1 selections of eggs:

a. whether size of egg is considered for hatching **big or small**
b. Colour of egg is considered for hatching **yes or no**

4.2 Care of hatching eggs

Material used in hatching basket grass……sand……. others…….

4.3 Care of the sitting hens and eggs

(a) Feeding Type of cereal …….

(b) Water Source Open well…… Borewell……. Others …….

(c) Frequency of coming out (from brooding place) Once a day……Once in two days…… Others (Specify)……

4.4 Hatching per centage

Number of eggs kept for hatching
Number of chicks borned

4.5 Egg production

Number of cycles per year
Number eggs produced in one clutch
Number of eggs per year

5. Marketing age

Male	>6 months	>9 months	Female	>9 months	>12 months

6. Mode of marketing

Direct sale to consumer
To retail or wholesale shop
Selling in shandy

7. Ethno-veterinary medicines used for treating ailing birs

a) Yes……. b) No…….

8. Consumer preference based on plumage colour

Multi-colour
Plain colour

9. Demand

Festival
Functions
Season

10. Mortality in chicks

Mortality from 0-8 weeks
Mortality from 8 weeks and above

11. Feeding practices followed

Scavenging
Semi-intensive
Intensive

11.1 Extra feed provided: cereals, concentrates, household wastes. Others…….

12. Vaccination details

Vaccinated
Not vaccinated
Vaccinated occasionally

13. Deworming details

Dewormed regularly
Dewormed occasionally
Not dewormed

14. Problems in keeping Desi birds.

Problem	Tick	Rank (1,2,3,4,5)
Predators		
Diseases		
Feed availability		

ANNEXURE-II

NBAGR FORMAT FOR NEW STRAIN/VARIETY REGISTRATION

1.	Feather Characteristics	Males					Females				
a.	**Feather Morphology**										
	Normal										
	Naked neck										
	Silky										
	Others (specify)										
b.	**Feather distribution**										
	Normal										
	Naked neck										
	Feathered shank and feet										
	Beard										
	Crest										
	Others (specify)										
c.	**Feather growth rate**										
	Fast										
	Slow										
2.	**Colour**										
a.	**Plumage colour**										
	White										
	Black										
	Blue										
	Red										
	Brown										
	Gold										
	Others (specify)										
b.	**Plumage pattern**										
	Solid										
	Dull										
	Stripped										
	Patchy										
	Spotted										
	Barred										
	Mottled										
	Others (specify)										
c.	**Secondary pattern**										
	Self-white										
	Self-black										
	Self-blue										

	Self-red										
	Barred										
	Lasing										
	Mottled										
d.	**Skin colour**										
	White										
	Yellow										
	Blue										
	Black										
	Others (specify)										
e.	**Shank colour**										
	White										
	Yellow										
	Black										
	Blue										
	Green										
	Others (specify)										
F	**Ear lobe colour**										
	White										
	Red										
	Black										
	White & red										
	Others(specify)										
g.	**Comb colour and its intensity**										
	Black										
	Red										
	Others (specify)										
	Comb type and size (large, medium, small)										
3	**Comb type and size (large, medium, small)**										
	Single										
	Pea										
	Rose										
	Walnut/cushion/strawberry										
	Duplex/v shaped/double										
4	**Eye colour**										
	Grey										
	Black										
	Brown										
	Others										
5	**Wattles**										
	Present										
	Absent										
6	**Other specific visible traits**										
	Body length(cm)										
	Height(cm)										
	Body weight (gms)										
	Breast angle (degree)										
	Keel bone length (mm)										
	Shank length (mm)										