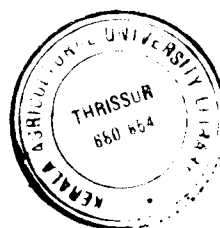


**PERFORMANCE OF CROSSES OF INDIGENOUS
NAKED NECK WITH WHITE LEGHORN
AND NEW HAMPSHIRE**

171717

**By
JOMY JOHN**



THESIS

**Submitted in partial fulfilment of the
requirement for the degree of**

Master of Veterinary Science

**Faculty of Veterinary and Animal Sciences
Kerala Agricultural University**

**Department of Poultry Science
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY, THRISSUR - 680651
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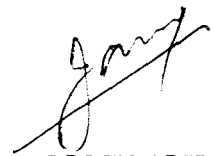
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DECLARATION

I hereby declare that the thesis entitled **“PERFORMANCE OF CROSSES OF INDIGENOUS NAKED NECK WITH WHITE LEGHORN AND NEW HAMPSHIRE”** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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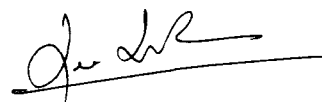
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JOMY JOHN

CERTIFICATE

Certified that the thesis, entitled “**PERFORMANCE OF CROSSES OF INDIGENOUS NAKED NECK WITH WHITE LEGHORN AND NEW HAMPSHIRE**” is a record of research work done independently by Jomy John, under my guidance and supervision and that it has not previously formed the basis of the award of any degree, fellowship or associateship to him.



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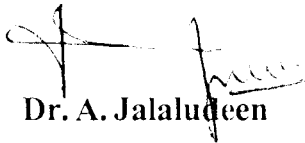


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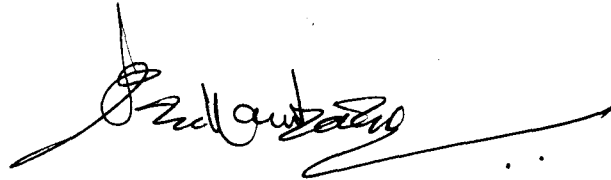
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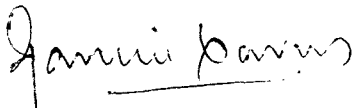
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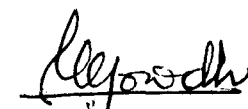
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Jomy John

*Dedicated to
My beloved grand parents*

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Introduction

INTRODUCTION

Poultry sector in India emerged from a mere backyard activity into a major promising industry, during the last two decades. Poultry provides quality human food such as eggs and meat and organic manure to agricultural crops. It also serves as a means of employment to a large number of people. The intensive system of rearing poultry contributes 70 per cent of total egg and meat in the country. The indigenous Desi fowls under rural sector which lag behind their exotic counterparts also contribute greatly to the Gross Domestic Product.

The backyard segment of poultry industry has a direct bearing on the egg production and income of weaker sections of the society, especially women. Modern large scale units contributed to the bulk of poultry meat and eggs produced in developed countries. In developing countries the backyard poultry deserves priority and encouragement by virtue of its low cost of production. Despite the fact that India ranked fifth in world's egg production in 1998, the per capita availability of eggs in the country is among the lowest in the world.

In Kerala, backyard rearing is still the most popular system of egg production. The chicken population of the state comprised of 52.61 percent, Desi stock and 47.39 per cent, improved varieties. According to 1996 livestock census of Kerala, the poultry population in the state was 26.95 million, which included 25.65 million chicken, 1.19 million ducks and 0.11 million of other poultry. (Anon, 1998)

The production in industrial type of poultry enterprise in the country has attained standards comparable to those elsewhere in the world. The focus should naturally shift towards enhancing non industrial productivity of birds reared in the backyard system. The major impediments in achieving this goal are the high mortality rate and adverse environmental conditions in rural homesteads.

Improvement in productivity of indigenous Desi birds that are acclimatized to the rural environment is an obvious choice under the present circumstances. This may be achieved by upgrading Desi stock with exotic breeds of chickens to produce a crossbred that is acclimatized, more viable and better in productivity. The breeding strategies for upgradation of Desi birds should also aim at retaining the desirable traits of native breeds and varieties. This highlights the need of pursuing the twin objectives of improving productivity and retaining desirable traits of indigenous birds, in tandem.

It has been experimentally proved that Naked Neck chickens have better laying rate, persistency, egg weight, shell strength and lowered mortality compared to 'normal neck' counter parts (Merat, 1986). The 'naked neck' gene is well distributed in poultry populations around the world. The 'naked neck' allele (Na) is dominant over 'normal neck' allele (na). (Hutt, 1949.) The Naked Neck birds are capable of combating thermal stress effectively. This remarkable feature of Naked Neck birds are attributed to the plumage reducing character of the 'naked neck' gene, facilitating the body heat loss. The indigenous Naked Neck birds have a variety of plumage colours and hence crossbreeding these birds with exotic high producing breeds of

chicken is likely to yield an offspring with better production potential, improved viability and coloured plumage pattern. Chickens having a spectrum of plumage colours are generally preferred by farmers of Kerala. Therefore crossbred chicken with a variety of plumage colours are likely to be more acceptable to rural poultry production.

University poultry farm, Mannuthy is maintaining lines of New Hampshire, White Leghorn and Naked Neck birds. White Leghorn, belonging to Mediterranean class of chicken, has excellent layer traits and has smaller body size that require less feed for maintenance. Hence a crossbred of Naked Neck Desi and White Leghorn is expected to yield a crossbred with improved productivity as well as tolerant to rural conditions. New Hampshire, dual purpose breed of chicken belonging to American class, has a chestnut coloured plumage. A cross between Naked Neck birds and New Hampshire is expected to yield progenies with higher body weight and attractive plumage patterns.

Therefore a study was planned to develop crosses of Naked Neck birds with White Leghorn and New Hampshire, utilizing the lines maintained in university poultry farm. The study envisages to evaluate and compare the various egg production traits in Naked Neck x White Leghorn and Naked Neck x New Hampshire crossbreds maintained under deep litter system of rearing.

Review Of Literature

REVIEW OF LITERATURE

Meteorological profile at Mannuthy region

Somanathan (1980) compiled data on meteorological profile of Mannuthy (latitude 10°32' N, longitude 76°16' E, altitude 22.25m above MSL) based on observations made during a period of five years. The highest mean daily maximum temperature was recorded during April (34.55°C) and the lowest during July (28.15°C). The mean minimum temperature recorded was the lowest during July (23.28°C) and the highest during May (25.27°C). The daily average relative humidity percentage varied from 75.68 to 86.52 during May to July.

In the above study, the rainy season in Mannuthy region was from May to November, of which June to August was cold and wet and May and September to November was warm and wet. Dry Season in Mannuthy was from December to April, of which December to January was warm and dry and February to April was hot and dry. The climate of Mannuthy was classified as hot and moist.

Mueller (1961) evaluated the effect of constant and fluctuating environmental temperature on biological performance of laying pullets and recorded depression in feed intake, egg weight, shell quality and egg production with increased mortality, in birds kept at 32°C.

McDowell (1972) reported that in warm humid areas where air temperature was 21°C and above, and when relative humidity was over 60 per cent, livestock production was affected.

North and Bell (1990) observed that feed consumption in laying hens was reduced by 50 per cent when house temperature was increased from 21 to 38°C.

Body weight

Body weights of different breeds and crosses reported by various authors are presented in Table 1.

Smetnev *et al.*(1955) recorded an average body weight of 2750g in males and 2020g in females of Moscow breed group of fowls, developed by crossing Yurlov fowls with Brown Leghorns and New Hampshires and mating the progeny *inter se*.

Tretjjakov (1955) reported that Zagorsk breed group of hens formed by crossing Yurlov, Russian White, New Hampshire and Rhode Island Red breeds weighed on an average 3000g at 1½ years of age.

Giavarini (1956) reported that Golden Romagna weighed 1200g and New Hampshire weighed 2600g at one year of age, while Golden Romagna x New Hampshire weighed 2000g at the same age.

Karapetjan and Gukasjan (1956) recorded an adult body weight of 3000-3200g in males and 2000-2100g in females of Erevan fowls, formed by grading up of local Armenian fowl with Rhode Island Red.

Van Albada (1956) recorded an average body weight of 1117g in White Leghorn and 1580g in North Holland Blues at 14 weeks of age. At the same age, White Leghorn x North Holland Blue and North Holland Blue x White Leghorn weighed 1418 and 1429g, respectively.

Czarnovski (1957) reported that Sussex x Greenleg crossbreds attained body weight of 1600-2000g in 6 months, while a lower body weight of 1300 - 1600g was recorded in pure bred Greenlegs at the same age.

Meregalli (1957) reported that adult males and females of Arno, an indigenous breed of Italy weighed 3000 and 2200g, with a growth rate similar to New Hampshire, while F₁ Arno x New Hampshire crosses were superior to both parent breeds.

Volkov *et al.*(1957) have described formation of a new breed group of fowl, the Kuchin Anniversary, in which Plymouth Rock, New Hampshire, Rhode Island Red, Australorp, White Leghorn and Livnys were utilised. The average body weight in males and females of the breed group were recorded as 3800 and 3000g respectively.

Eskilt *et al.* (1959) recorded mean body weight of 1760 and 2250g in adult Jaer x White Leghorn and White Leghorn x Plymouth Rock birds, respectively.

Kulangeiv (1965) recorded a body weight of 1885 and 1535g respectively in males and females of Russian White fowls at ten months of age. Zeravshan and Samarkhand breed groups were formed by crossing local Uzbek hens with Russian White females and mating the resulting female progeny with either New Hampshire or Australorp males. The males and females of Zeravshan breed group weighed 2885 and 1920g while those of Samarkhand breed group weighed 2877 and 1963g at 10 months of age.

Erdei (1969) described that Bontida Ermine fowl was 67.5 per cent Rhode Island Red and 37.5 per cent Sussex and the males averaged 2520 and 3800g while females averaged 2160 and 2600g respectively at 6 and 12 months of age.

Kumar *et al.* (1971b) reported that Aseel x Rhode Island Red weighed 1007g at 12 weeks of age and was heavier than other crosses of indigenous breeds and exotic breeds, which averaged 803.32 ± 37.64 g. The different crossbreeds involved reciprocal crosses of indigenous breeds of Naked Neck, Aseel and Black Bengal and exotic breeds of White Leghorn, Rhode Island Red and White Cornish.

Sharma *et al.* (1971) reported that Rhode Island Red birds weighed on an average 713g and Desi birds weighed 573g at 12 weeks of age, while the progenies of the cross between them averaged 667 and 665g at the same age.

Chhabra and Sapra (1973) recorded a mean body weight of 709g in Aseel birds at 12 weeks of age.

Al-Rawi and Amer (1974) reported that three way crosses of New Hampshire and Iraqi birds weighed 1897.8 and 1881.2g at sexual maturity, while three way crosses of White Leghorn and Iraqi averaged 1629.5 and 1645.1g at the same age. Three way crosses of Iraqi, New Hampshire and White Leghorn, at sexual maturity weighed 1714 and 1562.9g.

Huq *et al.*(1976) recorded higher body weight at sexual maturity in White Cornish x Desi (2814g), than White Leghorn x Desi and New Hampshire x Desi which averaged 998 and 1700g respectively.

Mahmoud *et al.*(1976) recorded a body weight of 2700 and 2000g in male and females respectively of Golden Montazah at 12 months of age.

Jain *et al.*(1977) reported that the body weight at 12 weeks of age in the crosses of Desi and Rhode Island Red were higher than that of the crosses of Desi and White Leghorn. The cross progenies of Rhode Island Red x Desi averaged 769g and its reciprocal averaged 738g, while a cross between White Leghorn and Desi weighed 687g and its reciprocal averaged 706g at 12 weeks of age.

Jain and Sharma (1977) reported a mean body weight of 1608 and 1244g in males and females of Desi x Rhode Island at 5 months of age, 2017 and 1400g in White Leghorn x Rhode Island Red while Desi x White Leghorn averaged 1665 and 1205g at the same age.

Karapetjan *et al.*(1978) recorded a mean body weight 1625g in Eravan x White Leghorn birds at 5 months of age.

Al-Soudi and Al-Jebouri (1979) reported that pure bred Iraqi birds weighed 1611g at one year of age, while progenies of cross between Iraqi and exotic breeds of White Leghorn and New Hampshire weighed 1610g at the same age. White Leghorn and New Hampshire weighed on average 1687 and 2286g at the same age.

Saeki and Inoue (1980) reported that White Leghorn x Red Jungle Fowl hybrids weighed 1347g at 163 days of age, while Red Jungle Fowl x White Leghorn hybrids weighed 1259g at 182 days of age.

Al-Rawi and Varela-Alvarez (1981) reported a higher body weight for White Leghorn X native Iraqi chicken at sexual maturity, than either of its parent breeds.

Radhakrishnan (1981) recorded an average body weight of 886 and 1382g in 'F' strain White Leghorn respectively at 20 and 40 weeks of age.

Howlinder and Ahmed (1984) recorded a body weight of 954g in Australorp x New Hampshire and 1006g in Aseel x Australorp at 12 weeks of age.

Sah *et al.* (1984) reported that males and females of Desi x White Leghorn weighed 777 and 750g at 20 weeks of age and was heavier than males and females of White Leghorn x Desi which weighed 725 and 668g at the same age. It was also heavier than pure bred Desi males and females, which averaged 716 and 562g at the same age.

Jain and Chowdhry (1985) recorded a body weight of 1163 ± 16.5 and 1223 ± 12.8 g for White Leghorn x Desi and Desi x White Leghorn birds respectively at 5 months of age.

Omeje and Nwosu (1986) reported that progenies of the cross between Gold Link and Local Nigerian weighed 1041 and 1046g at 20 weeks of age. Three way crosses involving the two breeds averaged 1123 and 955g at the same age.

Thomas and Rao (1988) recorded mean body weight of 1205g in Kadaknath males at 20 weeks of age.

Geo (1992) reported that body weight of ILM-90, strain cross White Leghorn, ranged from 882.94 to 886.90g at 20 weeks of age, while it ranged from 1400.80 to 1426.12g at 44 weeks of age.

Jayanthy (1992) reported body weight in Desi X New Rock and Desi X Austra White crosses as 1299 and 1007g at 20 weeks of age and 1974 and 1445g at 40 weeks of age respectively.

Beena (1995) reported that 'F' strain White Leghorn weighed on an average 944.85 and 1346.67g respectively at 20 and 40 weeks of age.

Dutta (1996) reported that purebred White Leghorn birds were 158.3g heavier than purebred Miri birds, and 97.8g heavier than crossbreds of Miri x White Leghorn birds.

Jayasree (2000) recorded mean body weight in New Hampshire and Naked Neck pullets as 1675.1 and 1682.3g at 20 weeks of age and 2635.45 and 2703.65g at 40 weeks of age, respectively.

TABLE-1 BODY WEIGHTS OF DIFFERENT BREEDS AND CROSSES REPORTED BY VARIOUS AUTHORS

AUTHORS 1	YEAR 2	COUNTRY 3	BREED - BREED CROSS 4	AGE 5	BODYWEIGHT(g) 6
Smetnev et al.	1955	U.S.S.R	Moscow	180 d	2750 M 2020 F
Tretjakov	1955	U.S.S.R	Zagorsk	1 ½ year	3000
Giavarini	1956		Golden Romagna New Hampshire (NH) Golden Romagna x NH	1 year " "	1200 2600 2000
Karapetjan and Gukasjan	1956		Erevan	Adult	3000-3200M 2000-2100F
Van Albada	1956		White Leghorn (WL) North Holl and Blues(NHB) WLH x NHB NHB x WL	14 weeks " " "	1117 1580 1418 1429
Czarnowski	1957	U.S.S.R	Sussex x Greenleg	6 months	1600-2000
Meregalli	1957	Italy	Arno	Adult	3000 M 2200 F
Volkov et al.	1957		Kuchin Anniversary	Adult	3800 M 3000 F
Eskilt et al.	1959		Jaer x WL WL x Plymouth Rock	"	1760 2250
Kulangiev	1965	U.S.S.R	Zeravshan Samarkhand Russian White	10 months " "	2885 M 1920 F 2877 M 1963 F 1885 M 1535 F
Erdei	1969		Isontida Ermine	6 months 12 months	2520 M 2160 F 3800 M 2600 F
Kumar et al.	1971 b	India	Aseel X RIR	12 weeks	1007
Sharma et al.	1971	India	RIR Desi RIR x Desi Desi x RIR	" " " "	713 573 667 665
Chhabra and Sapra	1973	India	Aseel	12 weeks	709
Al - Rawi and Amer	1974	Iraq	NH x (Iraqi x NH) NH x (NH x Iraqi)	At Sexual maturity "	1897.8 1881.2

contd.

			WL x (Iraqi x WL)	..	1629.5
			WL x (WL x Iraqi)	..	1645.1
			Iraqi x (NH x WL)	..	1714.0
			Iraqi x (WL x NH)	..	1562.9
Huq <i>et al.</i>	1976	Bangladesh	WL x Desi	213 days	998
			NH x Desi	240 days	1700
			White Cornish x Desi	274 days	2814
Mahmoud <i>et al.</i>	1976	Egypt	Golden Montazah	12 months	2700 M 2000 F
Jain <i>et al.</i>	1977	India	WL x Desi	12 weeks	687
			Desi x WL	..	706
			RIR x Desi	..	769
			Desi x RIR	..	738
Jain and Sharma	1977	India	Desi x RIR	5 months	1608 M 1244 F
			WL x RIR	..	2017 M 1400 F
			Desi x WL	..	1665 M 1205 F
Karapetjan <i>et al.</i>	1978	Armenia	Yerevan x WL	..	1625
Al-Soudi and Al-Jebouri	1979	Iraq	Iraqi	1 year	1611
			Iraqi cross	..	1610
			WL	..	1687
			NH	..	2286
Saeki and Inoue	1980	Japan	WL	159 days	1762
			Red Jungle Fowl	298 days	887
			WL x Red Jungle Fowl	163 days	1347
			Red Jungle Fowl x WL	182 days	1259
Radhakrishnan	1981	India	F strain White Leghorn	20 weeks 40 weeks	886 1382
Howlider and Ahmed	1984	Bangladesh	Australorp x NH	12 weeks	954
			Aseel x Australorp	..	1006
Sah <i>et al.</i>	1984	India	Desi	20 weeks	716 M 562 F
			Desi x WL	..	777 M 750 F
			WL x Desi	..	725 M 668 F
Jain and Chowdhry	1985	India	WL	5 months	1306
			RIR	..	1511
			Desi	..	1306
			WL x Desi	..	1163
			Desi x WL	..	1223
			RIR x Desi	..	1234
			Desi x RIR	..	1303
			RIR x WL	..	1441
			WLx RIR	..	1465
			RIR x (WL x Desi)	..	1249
			RIR x (Desi x WL)	..	1363
			WL x (RIR x Desi)	..	1126
			WL x (Desi x RIR)	..	1222
			Desi x (RIR x WL)	..	1274
			Desi x (WL x RIR)	..	1267

Omeje and Nwosu	1986	Nigeria	Gold link (GL)		
			Local Nigerian (LN)	20 weeks	1041
			N x GL	..	1046
			GL x (GL x LN)	..	1123
			N x (LN x GL)	..	955
Thomas and Rao	1988	India	Kadaknath	..	1205 M
Geo	1992	India	I.M - 90 (WL strain cross)	20 weeks	882.94 - 886.9
				44 weeks	1400.8- 1426.12
Jayanthy	1992	India	Desi x New Rock	20 weeks	1299
			Desi x Austra White	..	1007
			Desi x New Rock	40 weeks	1974
			Desi x Austra White	..	1445
Beena	1995	India	F strain White Leghorn	20 weeks	944.85
				40 weeks	1346.67
Dutta	1996	India	WL	..	1177
			Miri	..	1019
			Miri x WL	..	1080
Jayasree	2000	India	Naked Neck	20 weeks	1682
			New Hampshire	..	1675
			Naked Neck	40 weeks	2703
			New Hampshire	..	2635

Age at sexual maturity.

The age at sexual maturity (ASM) based on age at first egg and age at 50 per cent production in different breeds and crosses including the desi stocks reported by various authors are presented in Table 2.

Chapel (1951) reported that native Puerto Rican birds attained sexual maturity at 195 days of age, while White Leghorn attained sexual maturity at 192 days of age.

Meregalli (1957) reported mean age at sexual maturity in Arno birds of Italy as 162 days.

Marquez and Agcanas (1958) recorded age at sexual maturity of 225 days in New Hampshire and 206 days in White Leghorn. The age at sexual maturity in Native Banaba fowl was recorded as 236 days, while Native Banaba x New Hampshire matured earlier at 213 days of age.

Eskilt *et al.* (1959) recorded mean age at sexual maturity in Legbar x Jaer as 153 days, while it was 183 days in Brown Leghorn x Plymouth Rock.

Acharya and Kumar (1971) reported an earlier age at first egg for Rhode Island Red x Desi (201.8 days) followed by Desi pure breeds (204.3 days) and Rhode Island Reds (217.6 days).

Al-Rawi and Amer (1974) reported that progenies of three way crosses of New Hampshire and Iraqi attained sexual maturity at 130.8 and 141.6 days of age, while progenies of three way crosses of White Leghorn and Iraqi matured at 150.7 and 147.8 days of age. Progenies of three way crosses of Iraqi, White Leghorn and New Hampshire matured at 151 and 145.2 days of age.

Huq *et al.* (1976) stated that White Leghorn x Desi crosses attained 20 per cent production at 213 days of age followed by New Hampshire x Desi and White Cornish x Desi which took 240 and 274 days respectively to attain same level of production.

Mahmoud *et al.* (1976) reported that Golden Montazah, a cross bred involving Dokki-1 and Rhode Island Red, matured at 163 days of age.

Kamar *et al.* (1978) recorded mean age at sexual maturity as 249 days in Fayoumi x Rhode Island Red, while White Baladi x Rhode Island Red matured much later at 307 days of age.

Abdel Khader and El-Hossari (1979) reported that Fayoumi matured at 210.5 days of age, much earlier than Rhode Island Red birds which matured in 241.7 days.

Kumar and Acharya (1980) recorded mean age at sexual maturity in Desi birds as 208.76 days.

Saeki and Inoue (1980) recorded an earlier sexual maturity in White Leghorn (158.9 days) than Red Jungle Fowl (298.3 days) and the age at sexual maturity in reciprocal crosses of White Leghorn and Red Jungle Fowl was in between that of either of the parent breeds.

Islam *et al.* (1981) reported that fourth generation grades of Desi x White Leghorn matured at 210 days of age, while that of Desi x New Hampshire matured at 236 days of age. Fifth generation grades of Desi x White Leghorn matured earlier at 195 days, while that of Desi x New Hampshire matured at 220 days of age.

Radhakrishnan (1981) reported the mean age at first egg in 'F' strain White Leghorn as 157.8 days, while the age at 50 per cent production was recorded as 182.6 days.

Rao (1983) reported that slow feathering strain of White Leghorn, produced by back crossing F_1 progeny of slow feathering Kadaknath males and rapid feathering White Leghorn females matured earlier, at an age of 186.6 days compared to F_1 progeny of Kadaknath and White Leghorn (197.7 days), while Kadaknath bird matured at 187.1 days of age.

Singh (1983) recorded the mean age at first egg in 'F' strain White Leghorn as 176 days.

Nair and Bhattacharya (1984) recorded the mean age at first egg as 147.6 days in White Leghorn x Australorp birds.

Sah *et al.* (1985) recorded the age at sexual maturity of Desi, White Leghorn x Desi, Desi x White Leghorn and White Leghorn as 203.22, 184.17, 171.06 and 165.9 days, respectively showing intermediary values for cross breeds.

Dey *et al.* (1986) reported the age at first egg in a population of White Leghorn birds selected for egg number, as 157.19 ± 0.75 days, while in a random bred population of White Leghorn, it was 171.43 ± 3.98 days.

Omeje and Nwosu (1986) reported mean age at first egg in progenies of the cross between Gold Link and Local Nigerian as 163.7 and 161 days.

Thomas and Rao (1988) recorded mean age at first egg in Kadaknath birds as 189.2 days.

Geo (1992) reported that age at 50 per cent production in strain cross White Leghorn (ILM-90) ranged from 183.4 to 187.4 days under different floor densities.

Jayanthy (1992) reported the age at 50 per cent production in Desi x New Rock and Desi x Austra White crossbreds as 184 and 189 days respectively.

Dutta (1996) recorded an age at sexual maturity of 177 ± 1.25 days in White Leghorn x Miri crossbreds and 164 ± 1.62 days for purebred Miri birds. The age at sexual maturity was 163 ± 1.28 days in White Leghorn.

Leo (1999) reported that sexual maturity was attained in 194 days by New Rock birds, while Austra White attained sexual maturity at 184 days of age.

Jayasree (2000) reported that New Hampshire and indigenous Naked Neck birds laid their first egg at the same age of 161 days. New Hampshire attained 50 per cent production at 175.5 days of age, while Naked Neck attained the same level of production in 176.55 days.

Earlier sexual maturity is noticed in crosses of native breeds with exotic breeds, compared to their native parent breeds.

TABLE-2 AGE AT SEXUAL MATURITY IN DIFFERENT BREEDS AND CROSSES REPORTED BY VARIOUS AUTHORS

AUTHORS	YEAR	COUNTRY	BREED, BREED CROSS	A S M (DAYS)
Chapel	1951	Puerto Rico	Native Puerto Rican	195.0
			W L	192.0
Meregalli	1957	Italy	Arno	162.0
Marquez and Agcanas	1958	Philippines	NH	225.0
			W L	206.0
			Native Banaba x NH	213.0
			Native Banaba	236.0
Eskilt <i>et al.</i>	1959		Legbar x Jaer	153.0
			Brown Leghorn x Plymouth Rock	183.0
Acharya and Kumar	1971	India	RIR x Desi	201.8
			Desi x Desi	204.3
			RIR x RIR	217.6
Al Rawi and Amer	1974	Iraq	NH x (Iraqi x NH)	130.8
			NH x (NH x Iraqi)	141.6
			W L x (Iraqi x W L)	150.7
			W L x (W L x Iraqi)	147.8
			Iraqi x (NH x W L)	151.0
			Iraqi x (W L x NH)	145.2
Huq <i>et al.</i>	1976	Bangladesh	W L x Desi	213.0
			NH x Desi	240.0
			Cornish x Desi	274.0
Mahmoud <i>et al.</i>	1976	Egypt	Golden Montazah	163.8
Kamar <i>et al.</i>	1978	Egypt	Fayoumi x RIR	249.0
			White Baladi x RIR	307.0
Abdel Khader and Al - Hossari	1979	Egypt	Fayoumi	210.5
			RIR	241.7
Kumar and Acharya	1980	India	Desi	208.76
Saeki and Inoue	1980	Japan	White Leghorn	158.9
			Red jungle fowl	298.3
			W L x Red jungle fowl	163.4
			Red jungle fowl x W L	182.2
Islam <i>et al.</i>	1981	Bangladesh	4 th generation grades	
			Desi x W L	210.0
			Desi x NH	236.0
			Desi x White Cornish	274.0
			5 th generation grades	
			Desi x W L	195.0
Desi x NH	220.0			
Desi x White Cornish	225.0			

contd.

Radhakrishnan	1981	India	White strain White Leghorn	AFE 157.8 50% production 182.6
Rao	1983	India	Kadaknath Kadaknath x WL F ₁ Kadaknath x WL	187.1 186.6 197.7
Singh	1983	India	White strain White Leghorn	AFE 176
Nair and Bhattacharya	1984	India	White x Australorp	AFE 147.6 50% production 175.0
Sah <i>et al.</i>	1985	India	Desi White White x Desi Desi x White	203.22 165.9 184.27 171.06
Dey <i>et al.</i>	1986	India	White (population selected for egg number) White (random bred population)	157.19 171.43
Omeje and Nwosu	1986	Nigeria	Gold Link (GL) x Local Nigerian (LN) LN x GL GL x (GL x LN) LN x (LN x GL)	163.7 161.0 168.3 158.2
Thomas and Rao	1988	India	Kadaknath	189.2
Geo	1992	India	H-4-90 (Strain cross WL)	183.4- 187.4
Jayanthy	1992	India	Desi x New Rock Desi x Austra White	184 189
Dutta	1996	India	White Miri White x Miri	AFE 163 ,, 164 ,, 177
Leo	1999	India	New Rock Australwhite	194.0 184.0
Jayasree	2000	India	Naked Neck New Hampshire Naked Neck New Hampshire	AFE 161 ,, 161 50% production 176.55 ,, 175.5

Egg production

Egg production in various breeds and breed crosses, Desi birds and their crosses reported by different authors are presented in Table 3.

Macdonald *et al.* (1950) recorded an average annual production of 113.6 eggs for White Leghorn x Desi crosses by good feeding, housing and management while it was only 29 eggs when kept under primitive conditions.

Barkakti (1951) reported a higher egg number of 130 eggs for crosses between Miri and White Leghorn birds.

Chapel (1951) reported an average production of 33.7 eggs in White Leghorn x Native Puerto Rican birds and 39.9 eggs in New Hampshire x Native Puerto Rican birds, for a period of 120 days of production.

Anon (1954) recorded an average monthly production of 13 eggs in back cross progeny of F_2 generation of Chinese Kampong birds to Buff Leghorn sires as well as in F_1 generation Buff Leghorn x Chinese Kampong crosses.

Smetnev *et al.* (1955) recorded an average annual production of 182 eggs in Moscow breed group of fowl, which was evolved by crossing Yurlov fowl with Brown Leghorn and New Hampshire and again mating their progeny *inter se*.

Giavarini (1956) recorded an average annual production of 140 eggs for Golden Romagna x New Hampshire crosses, during first year of production.

Nagy *et al.* (1956) reported a production of 60-80 eggs upto one year of age in Bankiva x White Leghorn birds.

Kaem (1957) reported an average yearly production of 200 eggs in Red Moscow breed group of fowl; evolved from Rhode Island Red, Faverolle and Orlov Russian breeds of fowl.

Kodinec (1957) recorded an average annual production of 140- 180 eggs in Naked Neck fowl.

Meregalli (1957) reported that Arno fowl produced an average of 124.4 eggs in their first year of lay, while F_1 Arno x New Hampshire was superior in egg production than their parent breeds.

Volkov *et al.* (1957) reported that Kuchin Anniversary, a breed group of fowl developed by crossing Plymouth Rocks, New Hampshires, Rhode Island Reds, Australorps, Leghorns and Livinys, had an average annual production of 112-127 eggs.

Jull (1958) reported an average annual production of 173.95 eggs in Fayoumi x White Leghorn crosses during first year, while their reciprocal crosses also produced 172.2 eggs.

Desai and Halbrook (1962) reported that White Leghorn x Baladi crosses produced 132 eggs in 10 months, while purebred White Leghorn produced 148 eggs during the same period.

Kawahara (1961) reported heterosis for hen-housed, hen-day and survivor egg production in crosses between White Leghorn and Nagoya birds. The cross between White Leghorn x Nagoya birds produced more eggs than the reciprocal cross.

Sabalina (1964) reported that cross breeds of Faverolle x White Leghorn were intermediate in egg production to that of purebreds during the first laying season, and was highest during second laying season.

Petrov (1967) recorded an egg production of 92.3 for a period of six months for crossbreds of Black Shumens and White Leghorn and 78.4 in cross breeds of Black Shumens and New Hampshire birds.

Selvarajah and Khoo (1969) reported an average hen day egg production of 49.5 per cent in Ayam Boka Johor x New Hampshire crosses in 360 days.

Acharya and Kumar (1971) reported a higher hen day per cent of 33.31 in Desi x Rhode Island Red followed by 28.78 in Rhode Island Red x Desi, while it was 27.47 in Rhode Island Red and 22.8 in Desi, for a period of 3 months.

Kumar *et al.* (1971) recorded an average hen day egg production of 29.11 ± 1.50 for Rhode Island Red x Desi crosses, and 36.50 ± 1.50 for Desi x Rhode Island Red crosses for a period of 10 weeks from 6 months of age.

Aggarwal and Sapra (1972) reported average hen-day production of 26.44 eggs in Desi and 22.19 eggs in Naked Neck birds.

Al-Rawi and Amer (1974) recorded highest 90-day's egg production of 46.3 in White Leghorn x (Iraqi x White Leghorn) cross breeds among various three way crosses involving White Leghorn, New Hampshire and Iraqi birds.

Karapetjan (1974) reported that Erevan fowl; progeny of the cross between female lines of local Armenian fowl and male lines of Rhode Island Red, Australorp and New Hampshire, had an annual production of 167 eggs.

Arad *et al.* (1975) reported that total egg output of 44.2g/hen day in Leghorn x Bedouin crossbreds, was 44 percent higher than in laying Sinai Bedouin fowl.

Al-Soudi and Al-Jebouri (1979) reported hen-day production of Native Iraqi fowl as 39.6 eggs, while in progenies of cross between Native Iraqi and exotic birds of White Leghorn and New Hampshire, it was 42.2 eggs for a period of one year.

Al-Rawi and Varela-Alvarez (1981) recorded an annual production of 180 eggs in New Hampshire x Iraqi crosses and 139 eggs in Iraqi x White Leghorn cross.

Islam *et al.* (1981) reported that in fourth generation White Leghorn, New Hampshire and White Cornish grades of desi fowl, annual production averaged 116, 135 and 114 eggs respectively.

Merat *et al.* (1983) recorded an average egg production of 79.8 in Fayoumi and 113.3 in Fayoumi x Rhode Island Red, up to 42 weeks of age.

Rao (1983) recorded a production of 48.4 eggs at 300 days of age for Kadaknath X White Leghorn cross.

Singh (1983) reported that 'F' strain White Leghorn produced on an average 84 eggs up to 40 weeks of age.

Nair and Bhattacharya (1984) recorded an average production of 195 eggs in White Leghorn x Australorp, for a period of one year.

Sah *et al.* (1985) reported a hen-day egg production of 19.11, 26.82, 32.09 and 41.83 per cent for a period up to 240 days of age in Desi, White Leghorn x Desi, Desi x White Leghorn and White Leghorn birds, respectively.

Kalita *et al.* (1986) reported that White Leghorn (M-line) birds produced on an average 106.18 eggs for the period from 21-40 weeks of age.

Omeje and Nwosu (1986) recorded a 100-day average egg production of 51.65 for F2 generation of Local Nigerian x Gold Link crosses and 51.38 for Local Nigerian x (Local Nigerian x Gold Link) crosses.

Thomas and Rao (1988) recorded an average 300-day production of 49.79 eggs in Kadaknath birds.

Jayanthi (1992) reported a hen housed production of 37.61 eggs and 34.4 eggs in Desi x New Rock and Desi x Austra White crosses. The respective hen day egg numbers were recorded as 47.61 and 47.81 for the crosses.

Dutta (1996) reported mean hen-day egg production of 49 per cent for White Leghorn x Miri crosses and was found to be superior to Miri by 6.13 per cent and inferior to White Leghorn by 7.85 per cent.

Leo (1999) reported hen-day per cent of 47.69 in New Rock and 49.97 in Austra White birds upto 40 weeks of age.

Jayasree (2000) reported a hen-housed production of 66.41 eggs in New Hampshire and 72.13 eggs in Naked Neck, from 25 to 40 weeks of age.

TABLE-3 EGG PRODUCTION IN DIFFERENT BREEDS AND CROSSES REPORTED BY VARIOUS AUTHORS

AUTHORS	YEAR	COUNTRY	BREED / BREED CROSS	PRODUCTION PERIOD / CRITERIA OF MEASUREMENT Production up to	EGG NUMBER
Mac Donald <i>et al.</i>	1950	India	WL x Desi	1 year	113.6
Barkakti	1951	India	Miri x WL	"	130.0
Chapel	1951	Peurto Rico	WL x Native Puerto Rican NH x Native Puerto Rican	120 day's production "	33.7 39.9
Anon.	1954	Malaysia	Buff Leghorn x Chinese Kampong	1 month's production	13.0
Smetnev <i>et al.</i>	1955	U.S.S.R	Moscow	1 year	182 eggs
Giavarini	1956		Golden Romagna x NH	"	140 eggs
Nagy <i>et al.</i>	1956		Bankiva x WL	1 year	60-80eggs
Kaem	1957	U.S.S.R	Red Moscow	"	200.00
Kodinec	1957	Yugoslavia	Naked Neck	"	140-180
Meregalli	1957	Italy	Arno	"	124.40
Volkov <i>et al.</i>	1957	U.S.S.R	Kuchin Anniversary	"	112-127
Jull	1958	Egypt	Fayoumi x WL	"	173.95
Desai and Halbrook	1962	Sudan	WL x Baladi WL	10 month's production "	132 148
Petrov	1967		Black Shumen x WL Black Shumen x NH	6 month's production "	92.3 78.4
Selvarajah and Khoo	1969		Ayam Boka Johor x NH	360 day's HDP	49.5
Acharya and Kumar	1971	India	RIR Desi Desi x RIR RIR x Desi	HDP for 3 months " " "	27.47 22.80 33.31 28.78
Kumar <i>et al.</i>	1971	India	Desi RIR	Mean HD 70 d "	19.18 47.60
Aggarwal and Sapra	1972	India	RIR x Desi Desi x RIR Desi Naked Neck Black Bengal Aseel	" " HDP " " "	29.11 36.50 26.44 22.19 19.53 17.12
Al-Rawi and Amer	1974	Iraq	NH x (Iraqi x NH) NH x (NH x Iraqi) WL x (Iraqi x WL)	90 days production " "	36.1 39.5 46.3

			WL x (WL x Iraqi)	„	45.0
			Iraqi x (NH x WL)	„	42.0
			Iraqi x (WL x NH)	„	40.6
Karapetjan	1974	Armenia	Erevan	1 year average	167.0
Arad <i>et al.</i>	1975		Leghorn x Bedouin	egg output / hen day	44.2g
Al – Soudi and Al – Jebouri	1979	Iraq	Native Iraqi	HDP Up to 1 year	39.60
			Iraqi Cross	„	42.2
			W L	„	44.8
			NH	„	33.1
Al – Rawi and Varela – Alvarez	1981	Iraq	NH x Iraqi	1 year	180.0
			Iraqi x WL	„	139.0
Islam <i>et al.</i>	1981		4 th generation WL x Desi	„	116
			NH x Desi	„	135
			White Cornish x Desi	„	114
Merat <i>et al.</i>	1983	France	Fayoumi	up to 42 weeks	79.8
			Fayoumi x RIR	„	113.3
Rao	1983	India	Kadaknath x WL	upto 300 days	48.4
Singh	1983	India	'F' strain White Leghorn	upto 40 weeks	84
Nair and Bhattacharya	1984	India	W L x Australorp	1 year	195.0
Sah <i>et al.</i>	1985	India	Desi	HDP upto 240 days	19.11
			WL x Desi	„	26.82
			Desi x WL	„	32.09
			WL	„	41.83
Kalita <i>et al.</i>	1986	India	W L (M-line)	21 to 40 weeks	106.18
Omeje and Nwosu	1986	Nigeria	Local Nigerian (LN) x Gold link (GL)	100 day's average	51.65
			LNx(LNxGL)	„	51.38
Thomas and Rao	1988	India	Kadaknath	300 days	49.79
Jayanthy	1992	India	Desi x New Rock	40 weeks HHP	37.61
			Desi x Austra White	„	34.4
			Desi x New Rock	40 weeks HDP	47.61
			Desi x Austra White	„	47.81
Dutta	1996	India	WL x Miri	HDP 44 weeks	49.0
Leo	1999	India	New Rock	40 weeks – HDP%	47.69
			Austra white	„	49.97
Jayasree	2000	India	Naked Neck	HHP 40 weeks	72.13
			New Hampshire	„	66.41

Egg weight

The average egg weight of different breeds and breed crosses including native breeds reported by various authors are presented in Table 4.

Barkakti (1951) reported an egg weight $\frac{1}{2}$ - $\frac{3}{4}$ Oz more in cross bred between Miri fowls and White Leghorns than that of the purebred Miri fowl.

Chapel (1951) recorded an average egg weight of 42.25g in Native Puerto Rican fowl, while it was 45.75 and 47.5g respectively in progenies of White Leghorn x Native Puerto Rican and New Hampshire x Native Puerto Rican at 120 days of production.

Nagy *et al.* (1956) recorded an egg weight of 42-47g for crosses between Bankivas and White Leghorns.

Kodinec (1957) reported an egg weight of 58.7g in Naked Neck fowl at one year of age.

Kolobov (1958) recorded an average egg weight of 60-62g for Russian White fowl; originated from crossing White Leghorn and Native Russian fowls.

Petrov (1967) recorded an average egg weight of 60.1g for crosses between Black Shumens and New Hampshires.

Kumar *et al.* (1971a) recorded egg weights of 54.29, 47.04, 51.06 and 51.02g respectively for Rhode Island Red, Desi, Desi x Rhode Island Red and Rhode Island Red x Desi birds.

Kumar *et al.* (1971c) reported average egg weights of 48.47 ± 0.37 for Rhode Island Red x Desi crosses and 47.96 ± 0.40 g for Desi x Rhode Island Red crosses for a period of 10 weeks from 6 months of age.

Aggarwal and Sapra (1972) reported lower egg weight of 33.3g in Naked Neck birds compared to Desi, Black Bengal and Aseel birds.

Al-Rawi and Amer (1972) recorded an egg weight of 58.68g for New Hampshire x Iraqi cross breeds. Heterosis percentage for egg weight recorded was 10.48 in New Hampshire X Iraqi crossbreeds and 6.98 in Iraqi x New Hampshire and 5.39 in Iraqi x White Leghorn crosses.

Al-Rawi and Amer (1974) reported the egg weight in NH x (Iraqi x New Hampshire), NH x (NH x Iraqi), WL x (Iraqi x WL), WL x (WL x Iraqi) and Iraqi x (NH x WL) and Iraqi x (WL x NH) as 46.5, 45.4, 45.4, 46.2, 45.3 and 45.2 g, respectively.

Prasad *et al.* (1977) reported an average egg weight of 48.0g in White Rock x Local crossbreeds and 51.4g in Local x White Rock crosses.

Jain *et al.* (1978 b) recorded the egg weight in Desi birds as 40.45g and it was the lowest among Desi, White Leghorn, Rhode Island Red and their six two - way crosses and six three - way crosses.

Kamar *et al.* (1978) recorded an egg weight of 59.2g in Fayoumi X Rhode Island Red birds and 45.3 for Rhode Island Red x Fayoumi and 59.9g in White Baladi x Rhode Island Red crosses.

Abdel Khader and El-Hossari (1979) recorded an average weight of first egg in Fayoumi birds as 42.2g.

Sacki and Inoue (1980) reported an average egg weight of 46.37g in White Leghorn x Red Jungle fowl hybrids.

Al-Rawi and Varela - Alvarez (1981) recorded highest average egg weight for crosses between New Hampshire and Native Iraqi fowl with an average 8.9 per cent heterosis. White Leghorn x Iraqi crosses also showed hybrid vigour for egg weight.

Islam *et al.* (1981) recorded an egg weight of 57, 53 and 59g in fourth generation of indigenous chicken graded up with White Leghorn, New Hampshire and White Cornish breeds of fowl, respectively.

Radhakrishnan (1981) reported a mean egg weight of 53.2g in 'F' strain White Leghorn birds.

Mahapatra *et al.* (1982) reported an average egg weight of 40.08, 45.39, 40.64, 42.85, 46.52 and 48.32g in Kadaknath, Aseel Kager, Aseel Peela, Kadaknath x White Leghorn, Kadaknath x (Kadaknath x WL) and Kadaknath x New Hampshire birds, respectively.

Rao (1983) recorded an egg weight of 44.4g in Kadaknath x White Leghorn bird at 300 days of age.

Sah *et al.* (1985) recorded an average weight of first egg in Desi birds as 22.66g, while it was 35.57 and 31.36g in progenies of Desi x White Leghorn crosses and White Leghorn x Desi crosses respectively.

Omeje and Nwosu (1986) reported that the average egg weights in F₂ generation of reciprocal crosses in Local Nigerian fowl and Gold Link birds were 46.37 and 45.84g respectively. The egg weight of back cross progeny of reciprocal crosses to Gold Link and Local Nigerian birds were 50.59 and 43.65g respectively.

Fraga *et al.* (1987) reported heavier eggs, weighing 55.6 – 57.3g in naked neck White Leghorn birds than non naked neck White Leghorn birds.

Jalaludeen and Ramakrishnan (1989) reported that mean egg weight in strain cross White Leghorn ranged from 47.8 to 49.3g.

Salahuddin and Howlider (1991) recorded an average egg weight of 53.53g in Naked Neck fowl at 40 weeks of age.

Jayanthi (1992) reported that eggs of Desi x New Rock crosses were consistently heavier than that of Desi x Austra White crosses, at all ages of measurement. The initial egg weight of 36.67 ± 0.81 g in Desi x New Rock cross progressively increased to 46.74 ± 0.39 g at 37-40 weeks of age. Egg weight in Desi x Austra White cross increased from an initial value of 36.25 ± 0.67 g to a final egg weight of 44.88 ± 0.42 g at 37-40 weeks of age.

TABLE - 4 EGG WEIGHT OF DIFFERENT BREEDS AND CROSSES REPORTED BY VARIOUS AUTHORS

AUTHOR	YEAR	COUNTRY	BREED / BREED CROSS	AGE	EGG WEIGHT (g)
Chapel	1951	Puerto Rico	Native Puerto Rican	120 day's Production	42.25
			WL	"	48.25
			NH	"	52.25
			WL x Native Puerto Rican	"	45.75
			NH x Native Puerto Rican	"	47.5
Nagy <i>et al.</i>	1956		Bankiva x WL	Mean egg weight	42 - 47
Kodinec	1957	Puerto Rico	Naked Neck	1 year	58.7
Kolobov	1958		Russian White	1 year	60 - 62
Petrov	1967		Black Shumen x NH	"	60.1
Kumar <i>et al.</i>	1971 a	India	Desi x RIR	"	51.06
			RIR x Desi	"	51.02
			RIR	"	54.29
			Desi	"	47.04
Kumar <i>et al.</i>	1971 c	India	RIR x Desi	6 months	48.47
			Desi x RIR	"	47.96
Aggarwal and Sapra	1972	India	Desi	"	36.70
			Naked Neck	"	33.30
			Black Bengal	"	37.30
			Aseel	"	36.80
Al - Rawi and Amer	1972	Iraq	NH x Iraqi	"	58.68
Al - Rawi and Amer	1974	Iraq	NH x (Iraqi x NH)	-	46.5
			NH x (NH x Iraqi)	-	45.4
			WL x (Iraqi x WL)	-	45.4
			WL x (WL x Iraqi)	-	46.2
			Iraqi x (NH x WL)	-	45.3
			Iraqi x (WL x NH)	-	45.2
Prasad <i>et al.</i>	1977	India	White Rock x Local	-	48.0
			Local x White Rock	-	51.4
Jain <i>et al.</i>	1978 b	India	WL	400 days	58.74
			RIR	"	58.56
			Desi (D)	"	40.45
			WL x RIR	"	58.49
			WL x Desi	"	48.73
			RIR x WL	"	58.23
			RIR x Desi	"	47.78
			Desi x WL	"	49.24
			Desi x RIR	"	48.11
			(WL x Desi) x RIR	"	56.83
			(Desi x WL) x RIR	"	58.14
			(WL x RIR) x Desi	"	56.06
			(RIR x WL) x Desi	"	49.47
(RIR x Desi) x WL	"	55.62			
(Desi x RIR) x WL	"	53.16			
Kamar <i>et al.</i>	1978	Egypt	Fayoumi x RIR	-	59.2
			RIR x Fayoumi	-	45.3
			White Baladi x RIR	-	59.9

Abdel Khader and Al - Hossari	1979	Egypt	Fayoumi	Ist egg	42.20
			R I R	..	34.70
Saeeki and Inoue	1980	Japan	WL x Red jungle fowl	Average egg weight	46.37
Islam <i>et al.</i>	1981	Bangladesh	Indigenous chicken	..	57.0
			graded with WL	..	53.0
			NH	..	59.0
			White Cornish	..	59.0
Radhakrishnan	1981	India	'F' strain WL	..	53.2
Mahapatra <i>et al.</i>	1982	India	Kadaknath	..	40.08
			Aseel Kagar	..	45.39
			Aseel Peela	..	40.64
			Kadaknath x WL	..	42.85
			Kadaknath x (Kadaknath x WL)	..	46.52
			Kadaknath x NH	..	48.32
Rao <i>et al.</i>	1983	India	Kadaknath x W L	300 days	44.4
Sah <i>et al.</i>	1985	India	Desi	1 st egg	22.66
			Desi x WL	..	35.5
			W L x Desi	..	31.36
			W L	..	46.08
Omeje and Nwosu	1986	Nigeria	Local Nigerian (LN)	Average egg weight	
			x Gold Link (GL)	..	45.84
			GL x LN	..	46.37
			GL x (GL x LN)	..	50.59
			LN x (LN x GL)	..	43.65
Fraga <i>et al.</i>	1987		Naked Neck WL	..	55.6- 57.3
Jalaludeen and Ramakrishnan	1989	India	Strain Cross WL	..	47.8- 49.3
Salahuddin and Howlider	1991	Bangladesh	Starcross	40 weeks	54.73
			RIR	..	52.50
			Naked Neck	..	53.53
			Fayoumi	..	38.37
Jayanthi	1992	India	Desi x New Rock	..	46.74
			Desi x Austra White	..	44.88
Padhi <i>et al.</i>	1998	India	White Leghorn	..	62.86
			Naked Neck	..	56.31
			Brown Nicobari	..	46.70
Jayasree	2000	India	Naked Neck	Mean egg weight	53.36
			New Hampshire	..	50.44
			Naked Neck	40 weeks	55.85
			New Hampshire	..	52.82

Padhi *et al.* (1998) recorded an average egg weight of 62.86 ± 1.8 g in White Leghorn, 56.31 ± 1.51 g in Naked Neck and 46.70 ± 1.06 g in Brown Nicobari birds.

Jayasree (2000) recorded mean egg weight of 50.44g in New Hampshire, while a significantly higher egg weight of 53.36g was recorded in Naked Neck birds for the period from 25 to 40 weeks of age. At 40 weeks of age the New Hampshire and Naked Neck eggs weighed 52.82 and 55.85g respectively.

Feed consumption / Feed conversion ratio (FCR)

Observations by various workers on feed consumption and FCR of different breeds and breed crosses including native breeds are presented in Table 5.

Dev *et al.* (1971) recorded feed consumption per 100 eggs as 16.6kg in purebred White Leghorn, 16.56 kg in White Leghorn x Rhode Island Red and 16.9 kg in Rhode Island Red x White Leghorn pullets.

Kumar *et al.* (1971 b) reported the feed consumption per kilogram eggs in Desi, Rhode Island Red, Rhode Island Red x Desi, and Desi x Rhode Island Red as 20.01 ± 2.10 , 6.39 ± 0.20 , 11.20 ± 1.14 and 8.43 ± 0.46 kg respectively.

Aggarwal and Sapra (1972) reported that four Desi breeds viz. Nondescript Desi, Naked Neck, Black Bengal and Aseel consumed 128.93, 137.78, 104.43 and 135.73g feed per day respectively, with a corresponding FCR of 13.06, 29.32, 14.68 and 42.28. (kg feed per kg of egg produced).

Jain *et al.* (1978 b) recorded a lower FCR of 3.79 (feed per dozen eggs) in Desi birds, while two-way and three-way crosses involving the Desi birds and exotic breeds of White Leghorn and Rhode Island Red showed considerable improvement in this trait.

Karapetjan *et al.* (1978) recorded average feed efficiency (per 10 eggs) of 2.1 in Erevan x White Leghorn birds.

Al-Soudi and Al-Jebouri (1979) recorded daily mean feed consumption of 102g in Iraqi birds, while progenies of Iraqi and exotic breeds of White Leghorn and New Hampshire consumed on an average 107g per day.

Balachandran *et al.* (1979) reported mean daily feed consumption of 109g per bird in 'F' strain of White Leghorn under deep litter system of rearing.

Merat *et al.* (1983) reported that progenies of Fayoumi x Rhode Island Red cross had a better average FCR of 2.92 (per kg of eggs), compared to Fayoumi birds with significantly lower FCR of 4.12.

Jayanthy (1992) recorded daily mean feed consumption of 95.71 and 91.21g during initial period and 124.76 and 107.42g of during 37-40 weeks of age in Desi x New Rock and Desi x Austra White crosses respectively. The overall mean feed consumption was 106.61g in Desi x New Rock and 104.95g in Desi x Austra White from 20 to 40 weeks of age. The overall FCR during 21-40 weeks of age were 4.09 and 4.93 for Desi x New Rock and Desi x Austra White crosses respectively. In both the crosses, Naked Neck birds showed better FCR than Normal Neck birds.

Bhatti *et al.* (1997) reported a higher feed conversion ratio for Aseel x Rhode Island Red cross, compared to purebred Aseel and White Leghorn birds. It was also observed that there was no significant difference in feed consumption between Aseel x Rhode Island Red and Aseel x White Leghorn crosses.

Jayasree (2000) recorded an overall mean daily feed consumption of 123.06g in New Hampshire and 123.46g in Naked Neck for the period from 21 to 40 weeks of age. Mean feed conversion ratio per dozen eggs from 25 to 40 weeks of age in New Hampshire was 2.6, while it was 2.45 in Naked Neck birds. Differences in both the parameters between the two breeds was statistically non significant.

TABLE - 5 FEED CONSUMPTION / FEED CONVERSION RATIO OF DIFFERENT BREEDS AND CROSSES REPORTED BY VARIOUS AUTHORS

AUTHOR	YEAR	COUNTRY	BREED / BREED CROSS	CRITERIA OF MEASUREMENT	FEED CONSUMPTION / FEED CONVERSION RATIO
Dev <i>et al.</i>	1971	India	WL	feed consumption Per 100 eggs (Kg)	16.90
			WL X RIR	..	
			RIR X WL	..	
Kumar <i>et al.</i>	1971b	India	Desi	feed consumed Per kg eggs (kg)	20.01
			RIR	..	6.39
			RIR x Desi	..	11.20
			Desi x RIR	..	8.43
Aggarwall and Sapra	1972	India	Desi	..	13.06
			Naked Neck	..	29.32
			Black Bengal	..	14.68
			Ascel	..	42.28
Jain <i>et al.</i>	1978b	India	WL	feed/dozen eggs (kg)	2.74
			RIR	..	2.98
			Desi (DD)	..	3.79
			WR	..	2.60
			WD	..	3.27
			RW	..	2.48
			RD	..	2.80
			DW	..	3.14
			DR	..	2.89
			WD-R	..	2.78
			DW-R	..	3.03
			WR-D	..	3.51
			RW-D	..	3.14
			RD-W	..	2.72
DR-W	..	2.83			
Karpetjan <i>et al.</i>	1978	Armenia	Erevan x WL	Feed per 10 eggs (kg)	2.10
			Line cross	..	
			WL Line cross	..	2.50
Al Soudi and Al - Jebouri	1979	Iraqi	Iraqi	Feed /bird/day (g)	102.00
			Iraqi cross	..	107.00
			WL	..	112.00
			NH	..	125.00
Balachandran <i>et al.</i>	1979	India	'F' strain WL	..	109.00
Merat <i>et al.</i>	1983	Egypt	Fayoumi x RIR	Feed consumed Per kg eggs (kg)	2.92
			Fayoumi	..	4.12
Jayanthi	1992	India	Desi x New Rock	Feed / bird/ day (g)	106.61
			Desi x Austra White	..	104.95
			Desi x New Rock	FCR / dozen eggs	4.09
			Desi x Austra White	..	4.93
Jayasree	2000	India	Naked Neck	Feed/bird/day (g)	123.46
			New Hampshire	..	123.06
			Naked Neck	FCR / dozen eggs	2.45
			New Hampshire	..	2.6

Livability

The livability of certain native breeds and crosses as reported by different authors are listed out in Table 6.

Chapel (1951) reported that the pure native breeds were not apparently superior over standard breeds in respect of viability and resistance, but there was some indication of greater resistance among crossbred birds.

Desai and Halbrook (1962) reported that 52 per cent of White Leghorn birds and 65 per cent of White Leghorn x Baladi crosses survived up to an age of 10 months.

Sabalina (1964) recorded low mortality in Faverolle x White Leghorn crosses compared to purebred White Leghorn and Faverolle birds.

Acharya and Kumar (1971) recorded laying house mortality percentage in reciprocal crosses of Desi and Rhode Island Red lower than that of purebred Desi and Rhode Island Red birds during all seasons.

Al-Soudi and Sokkar (1974) found definite evidence that crosses have lower mortality than purebreds.

Huq *et al.* (1976) recorded an average livability of 87, 86 and 82 per cent in White Leghorn x Desi, New Hampshire x Desi and White Cornish x Desi birds respectively, up to 16 weeks of age.

Karapetjan *et al.* (1978) recorded better livability of 95 per cent in White Leghorn x Erevan, than 90 and 89 per cent respectively in Erevan and White Leghorn birds up to 90 days of age.

Al-Soudi and Al-Jebouri (1979) reported a mortality percentage of 0.7, 1.5, 1.5, 2.8 and 4.2 in Native Iraqi, crossbreds of Native Iraqi with White Leghorn and New Hampshire, purebred White Leghorn and New Hampshire birds respectively.

Howlider and Ahmed (1984) recorded mortality percentage of 14.28 in Australorp x New Hampshire and 19.04 per cent in Aseel x Australorp birds, up to 12 weeks of age.

Sah *et al.* (1984) recorded better livability in White Leghorn followed by Desi x White Leghorn, Desi and White Leghorn x Desi birds for a period up to 240 days of age.

Merat (1986) reported lower mortality in naked neck birds during growing as well as laying stage, than their normal neck counterparts.

Jayanthi (1992) recorded mortality percentage of 30.61 and 37.5 for Desi x New Rock and Desi x Austra White crosses for a period of 21-40 weeks of age.

Jayasree (2000) reported that the livability in New Hampshire birds for the period from 21 to 40 weeks of age was 91.66 per cent, while in Naked Neck birds it was 93.33 per cent; the difference being statistically non significant.

Broodiness.

Sacchi (1955) reported that broodiness was almost entirely absent in White Leghorn while it occurred in 20 per cent of New Hampshire birds.

Nagy *et al.* (1956) reported that broodiness lasted only for a few days in Bankiva x White Leghorn crosses.

Van Albada (1956) recorded a smaller incidence of broodiness in White Leghorn x North Holland Blue crosses than their reciprocal crosses.

Saeki and Inoue (1980) recorded the percentage of hens going broody as 0, 87.5, 11.10 and 63.0 in White Leghorn, Red Jungle Fowl, White Leghorn X Red Jungle Fowl, Red Jungle Fowl X White Leghorn hybrids respectively.

Jayanthi (1992) reported broodiness in Desi x New Rock and Desi x Austra White crosses and the period of broodiness was 25-30 days.

TABLE - 6 LIVABILITY IN DIFFERENT BREEDS AND CROSSES REPORTED BY VARIOUS AUTHORS

AUTHOR	YEAR	COUNTRY	BREED / BREED CROSSES	CRITERIA OF MEASUREMENT	VALUE (Per cent)	
Desai and Halbrook	1962	-	WL	Livability up to 10 months of age	52.00	
			WL x Baladi	"	65.00	
Acharya and Kumar	1971	India	RIR	Laying house mortality	27.10	20.0
			Desi	"	37.43	23.33
			Desi x RIR	"	22.33	13.33
			RIR x Desi	"	33.75	16.67
Huq <i>et al.</i>	1976	Bangladesh	WL x Desi	Livability up to 16 weeks	87.00	
			NH x Desi	"	86.00	
			WC x Desi	"	82.00	
Karapetjan <i>et al.</i>	1978	Armenia	W L x Erevan	Livability up to 90days	95.0	
			Erevan	"	90.0	
			W L	"	89.0	
Al - Soudi and Al - Jebouri	1979	Iraq	Native Iraqi	Mortality	0.7	
			Native Iraqi x WL	"	1.5	
			Native Iraqi x NH	"	1.5	
			WL	"	2.8	
			NH	"	4.2	
Howlider and Ahmed	1984	-	Australorp x NH	Mortality up to 12 weeks	14.28	
			Aseel x Australorp	"	19.04	
Sah <i>et al.</i>	1984	India	WL	Mortality up to 240 days	20.71	
			Desi	"	30.6	
			Desi x WL	"	23.9	
			WL x Desi	"	36.9	
Jayanthy	1992	India	Desi x New Rock	Mortality up to 4o weeks	30.60	
			Desi x Austra White	"	37.5	
Jayasree	2000	India	Naked Neck	Livability up to 40 weeks	93.33	
			New Hampshire	"	91.66	

Egg Quality

Egg quality includes a study of the quality of eggshell and quality of interior contents. Shell thickness is a measure of eggshell quality. Shape index, albumen index, yolk index and Haugh unit scores are other measures of egg quality. Egg quality data as reported by various authors are compiled in Table. 7.

Kumar *et al.* (1971a) reported that yolk index, yolk colour and Haugh unit score in reciprocal crosses of Desi x Rhode Island Red were intermediate to that of parent breeds. Shape Index in both reciprocal crosses was higher than that in pure Desi eggs, while in Rhode Island Red x Desi cross it was lower than in purebred Rhode Island Red eggs. Desi x Rhode Island Red cross had the same shape index as Rhode Island Red birds. Shell thickness was lower in Rhode Island birds than that of Desi birds and reciprocal crosses of Desi and Rhode Island Red. The shell thickness was the same in Desi, Rhode Island Red x Desi and Desi x Rhode Island Red.

Jain *et al.* (1978 a) recorded a higher proportion of yolk in Desi eggs than White Leghorn and Rhode Island Red eggs. The proportion of albumen in Rhode Island Red (63.75 per cent) was higher than in White Leghorn (60.72 per cent) and Desi (57.8 per cent) birds. Proportion of albumen decreased with increasing proportion of Desi blood in crossbreds. White Leghorn x Desi crosses had the thickest eggshell (0.015") and Rhode Island Red was the thinnest. Rhode Island Red had the highest Haugh unit score (81.80) and White Leghorn x (RIR x Desi), the lowest (62.36).

Kamar *et al.* (1978) reported that among crosses of Fayoumi, Rhode Island Red and White Baladi; maternal effects were significant for all traits studied, which included egg weight, albumen, yolk and shell weights and shell thickness. Crosses with Rhode Island Red dams exceeded both parent breeds in egg weight and weight of egg components.

Stino *et al.* (1978) observed that among crosses between Rhode Island Red, White Baladi and Fayoumi; Fayoumi x White Baladi crosses had the highest albumen percentage and the purebred Rhode Island Red had the highest shape index, Fayoumi x Rhode Island Red had the highest shell thickness, Rhode Island Red x Fayoumi had the highest yolk index and Haugh unit score. Heterosis

was apparent for yolk percentage, and dominant gene action was involved in albumen and shell percentages and egg shape index. It was concluded that a sex linked gene was involved in shell thickness and specific gravity and that Haugh unit and yolk colour was influenced by maternal effects.

Mahapatra *et al.* (1982) studied the egg quality traits in Kadaknath, Aseel Kagar, Aseel Peela, Kadaknath x White Leghorn, Kadaknath x (Kadaknath x White Leghorn) and Kadaknath x New Hampshire birds. Heaviest egg was recorded in Kadaknath x New Hampshire cross. Highest shape index value was observed in Kadaknath x White Leghorn crosses, while albumen index, Haugh unit score, yolk index and shell thickness were comparable for different crosses.

Fraga *et al.* (1987) reported that naked neck White Leghorn birds produced heavier eggs with larger yolks than non naked neck birds.

Salahuddin and Howlader (1991) studied egg quality traits in Rhode Island Red, White Leghorn, Naked Neck, Star cross and Fayoumi. Highest shape index was recorded in Rhode Island Red eggs (71.63), while the lowest was in Fayoumi (61.04). Yolk index was highest in Star cross (0.471) and the lowest was in Fayoumi (0.43). A Yolk index of 0.443 was recorded in Naked Neck eggs. Highest albumen index was recorded in White Leghorn and Star cross eggs (0.076), while the lowest was in Fayoumi eggs (0.067). Naked Neck eggs had an albumen index of 0.069. Highest Haugh unit score was recorded in White Leghorn (83.49), while the lowest was in Fayoumi (77.87). Naked Neck eggs had a Haugh unit score of 82.5. Shell thickness was highest in White Leghorn eggs (0.345mm) and the lowest was in Fayoumi (0.328mm). Shell thickness was 0.334 mm in Naked Neck eggs.

Jayanthy (1992) reported a shell thickness of 0.396 and 0.403 mm and Haugh unit score of 86 and 85 for Desi x New Rock and Desi x Austra White crosses respectively. Other egg quality traits viz., shape index, albumen index and yolk index also were comparable for both the crosses.

Padhi *et al.* (1998) measured various egg quality traits in White Nicobari, Brown Nicobari, Black Nicobari, Naked Neck and White Leghorn birds. White Leghorn eggs were significantly heavier than others (62.86 ± 1.88 g), while Brown Nicobari laid the smallest eggs (46.70 ± 1.06 g). Naked Neck recorded the highest value for shape index (75.36 ± 1.33), but had the lowest values of albumen index, Haugh unit score and shell thickness.

Jayasree (2000) studied egg quality traits in New Hampshire and Naked Neck eggs. Shape index was recorded as 1.34 and 1.32 respectively in New Hampshire and Naked Neck eggs. A significantly higher yolk index of 0.16 was recorded in New Hampshire than 0.14 in Naked Neck eggs. Haugh unit scores were comparable for both the breeds and were recorded as 87.16 and 80.58 respectively in New Hampshire and Naked Neck eggs. Shell thickness was 0.44mm in New Hampshire while significantly higher shell thickness of 0.48mm was recorded in Naked Neck eggs.

TABLE - 7 EGG QUALITY TRAITS IN VARIOUS BREEDS AND CROSSES REPORTED BY VARIOUS AUTHORS

AUTHORS	YEAR	COUNTRY	BREED/BREED CROSS	CRITEREON MEASURED	VALUE
Kumar <i>et al.</i>	1971	India	RIR	Shape index	74.7
			Desi	"	72.4
			RIR x Desi	"	74.3
			Desi x RIR	"	74.7
			RIR	Yolk index	48.7
			Desi	"	47.7
			RIR x Desi	"	48.3
			Desi x RIR	"	48.4
			RIR	Yolk colour	9.3
			Desi	"	11.2
			RIR x Desi	"	10.9
			Desi x RIR	"	10.5
			RIR	Haugh unit score	78
			Desi	"	75.9
			RIR x Desi	"	76.3
			Desi x RIR	"	77.7
			RIR	Shell thickness (inches)	0.011
			Desi	"	0.012
			RIR x Desi	"	0.012
			Desi x RIR	"	0.012
Salahuddin and Howlider	1991	Bangladesh	RIR	Shape index	71.63
			WL	"	70.28
			Naked Neck	"	70.81
			Starcross	"	69.50
			Fayoumi	"	61.04
			RIR	Yolk index	0.446
			WL	"	0.460
			Naked Neck	"	0.443
			Star cross	"	0.471
			Fayoumi	"	0.430
			RIR	Albumen index	0.068
			WL	"	0.076
			Naked Neck	"	0.069
			Starcross	"	0.076
			Fayoumi	"	0.067
			RIR	Haugh unit Score	82.55
			WL	"	83.49
			Naked Neck	"	82.50
			Starcross	"	83.12
			Fayoumi	"	77.87
RIR	Shell thickness (mm)	0.343			
WL	"	0.345			
Naked Neck	"	0.334			

Jayanthy	India	1992	Starcross	..	0.335
			Fayoumi	..	0.328
			Desi x New Rock	Shape index	75.38
			Desi x Austrawhite	..	76.47
			Desi x New Rock	Albumen index	0.113
			Desi x Austra White	..	0.103
			Desi x New Rock	Yolk Index	0.485
			Desi x Austrawhite	..	0.476
			Desi x New Rock	Shell thickness (mm)	0.396
			Desi x Austrawhite	..	0.403
Jayasree	India	2000	Desi x New Rock	Haugh unit score	86
			Desi x Austrawhite	..	85
			Naked Neck (NN)	Shape index	1.32
			New Hampshire (NH)	..	1.34
			NN	Albumen index	0.07
			NH	..	0.09
			NN	Yolk index	0.14
			NH	..	0.16
			NN	Haugh unit score	80.58
			NH	..	87.16
NN	Shell thickness (mm)	0.48			
NH	..	0.44			

Materials and Methods

MATERIALS AND METHODS

An experiment was conducted in Kerala Agricultural University Poultry Farm at Mannuthy, to evaluate and compare the production traits of progenies from Naked Neck X White Leghorn and Naked Neck X New Hampshire under deep litter system of rearing. The experimental chicks required for the study were hatched out by mating male lines of indigenous Naked Neck with White Leghorn and New Hampshire female lines maintained at University Poultry Farm, Mannuthy.

The objective of the present study was to compare the egg production traits of Naked Neck X White Leghorn and Naked Neck X New Hampshire crosses, from 20- 40 weeks of age, under deep litter system of rearing. The experimental chicks in the two groups were reared in separate pens on litter floor in a brooder cum rearing house under standard management conditions.

At 18th week of age, seventy-five (75) pullets each of Naked Neck x White Leghorn and Naked Neck x New Hampshire crosses were housed in identical pens on litter floor at the rate of 15 birds per pen in a well ventilated layer house with a floor space of 1800cm² per bird.

The experimental period ranged from 20 to 40 weeks of age and was divided into five periods, each of 28 days duration. The body weight was recorded individually at 20 and 40 weeks of age and the birds were reared during the period from July to December 1999. Experimental birds were fed standard layer mash as per BIS (1993), *ad libitum*. Shell grit was offered *ad libitum* in the pens. The ingredient composition of the feed is presented in Table 8. The proximate composition of the ration was estimated according to procedure described in AOAC (1990) and the per cent chemical composition of nutrients in the layer mash is presented in Table 9 .

Table 8 Per cent composition of layer mash

Sl. No.	Ingredient	Per cent
1	Yellow maize	45.00
2.	Ground nut cake	16.00
3.	Gingelly oil cake	5.00
4.	Dried unsalted fish	5.00
5.	Rice polish	23.00
6.	Shell grit	4.00
7.	Mineral mixture*	1.75
8.	Salt	0.25

Suppliment for 100 Kg feed : Vitamin premix 10 g. (Vitamin A 80,000 IU; Vitamin B₂ 20 mg; and Vitamin D₃ 5000 IU per gram)

* Mineral Mixture : Moisture (Max) 3%, Calcium 32%, Phosphorus 6%, Manganese 0.27 %, Iodine 0.01%, Zinc 0.26 %, Fluorine (Max) 0.03%, Iron 100 ppm, Copper 100 ppm.

Table 9 Per cent chemical composition of the nutrients in the layer mash

Sl. No	Nutrients	Per cent
1.	Dry matter	89.99
2.	Moisture	10.01
3.	Crude protein	18.53
4.	Crude fiber	4.91
5.	Ether extract	5.02
6.	Nitrogen free extract	47.83
7.	Total ash	13.70
8.	Acid insoluble ash	6.45
9.	Calcium	2.10
10.	Phosphorus	0.64

Metabolizable energy (calculated value) - 2675.0.Kcal/kg

The following traits were recorded during the course of the experiment.

1. Body weight:

Body weight of birds at 20 and 40 weeks of age was recorded individually to nearest 10g. (BW 20 and BW 40)

2. Age at sexual maturity: (ASM)

The age at first egg (days) and age at 50 per cent production (days) were recorded in each replicate and from these data, mean age at sexual maturity in Naked Neck X White Leghorn and Naked Neck X New Hampshire crosses were determined.

3. Egg production:

Egg production was recorded daily, during the course of the experiment, from 20 to 40 weeks of age. It was expressed as hen housed and hen day production, replicate wise and period wise for the two crosses.

They were calculated as follows.

$$\text{Hen housed number} = \frac{\text{Total number of eggs produced.}}{\text{Number of birds housed}}$$

$$\text{Hen housed per cent} = \frac{\text{Hen housed number} \times 100}{\text{Number of days}}$$

$$\text{Hen day number} = \frac{\text{Total number of eggs}}{\text{Average number of hens alive}}$$

$$\text{Hen day per cent} = \frac{\text{Hen day number} \times 100}{\text{Number of days}}$$

4. Egg weight:

All the eggs laid during last three days of each 28 - day period was weighed to the nearest 0.01g and the mean egg weight was arrived at, in the genetic groups Naked Neck X White Leghorn and Naked Neck x New Hampshire. The mean egg weight was calculated for each replicate and each of the mean value was also considered to be the mean egg weight for that particular week and period.

5. Feed consumption:

Feed was issued *ad libitum* from individual feed bins allotted to each replicate. The balance feed available in the feed bins and feeders at the end of each period was recorded. From this data, period - wise mean daily feed consumption per bird was worked out.

6. Feed conversion ratio: (FCR)

Feed conversion ratios were calculated in each period for each replicate as kilogram of feed consumed to produce dozen eggs.

7. Livability:

The period - wise per cent livability was recorded based on the number of birds alive during each period.

8. Broodiness:

The number of broody hens and duration of broodiness was recorded in each cross.

9. Plumage colour and egg shell colour:

Plumage colour and eggshell colour were recorded in Naked Neck X White Leghorn and Naked Neck X New Hampshire crosses, and compared between each other.

10. Egg quality:

Five eggs were collected at random from each replicate, during three consecutive days at the end of 32nd week of age, for conducting egg quality studies. The egg quality parameters determined were shape index, yolk index, and albumen index, Haugh unit scores and shell thickness. The height of albumen and yolk was measured using Ame's tripod stand micrometer, and width of yolk and albumen was measured using Vernier calipers. Shell thickness was measured using Ame's shell thickness measuring gauge to the nearest 0.01mm. Various indices were computed as given below.

$$\text{Shape index} = \frac{\text{Breadth}}{\text{Length}} \times 100$$

$$\text{Albumen index} = \frac{\text{Height of thick albumen}}{\text{Mean width of thick albumen}}$$

$$\text{Yolk index} = \frac{\text{Height of yolk}}{\text{Diameter of yolk}}$$

Economics:

The economics of egg production over feed cost was calculated taking into account the cost of feed ingredients prevailed at the local market.

The data were subjected to statistical analysis as per methods described by Snedecor and Cochran (1985). All the tests of difference between means were conducted at the 5% probability level.

RESULTS

Meteorological profile

The data pertaining to macroclimatic conditions at Mannuthy during the experimental period from February to July 1999 are presented in Table 10. The mean maximum temperature was highest during February – March (35.45°C) and lowest during June-July (29.5°C). The mean maximum temperature showed a decreasing trend from first period through fifth period. The mean minimum temperature which was 23.43°C during February-March, increased to 25.93°C during April-May, the third period of the experiment. In the final two periods, it followed a decreasing trend with mean minimum temperature of 22.9°C during June-July.

The mean per cent relative humidity recorded at 8 AM in the morning and at 2 PM in the afternoon showed an increasing trend throughout the course of the experiment. It increased from 78.75 to 94.0 per cent in the forenoon and 34.75 to 76.3 per cent in the afternoon with the lowest value during February-March and the highest in June-July.

Perusal of the wind velocity data presented in Table 10 indicated wide variations among different periods. It was the highest in the first period during February-March (5.33 kmph) and the lowest during June-July (2.60 kmph). In the second period, the wind velocity was only 2.65 kmph and again rose to 3.25 kmph in the third period. However, during fourth and fifth periods it was 2.9 and 2.6 kmph only.

Table 10 Period- wise meteorological data of Mannuthy region from February to July 1999.

Period	Month (age in weeks)	Temperature(°C)		Relative humidity (%)		Wind velocity (kmph)	Sunshine hours (Mean)	Total rainfall (mm)
		Max	Min	F.N	A.N			
I	Feb –Mar (21-24)	35.45	23.43	78.75	34.75	5.33	9.3	0.0
II	Mar-Apr (25-28)	34.95	24.9	89.75	54.5	2.65	8.03	26.2
III	Apr-May (29-32)	32.98	25.93	88.5	59.75	3.25	5.63	47.8
IV	May-June (33-36)	30.10	24.5	92.3	75.0	2.9	4.9	453.0
V	June-July (37-40)	29.50	22.9	94.0	76.3	2.6	5.2	442.0

The mean sunshine hours per day was maximum during February-March (9.3 h) and it was lower in the subsequent periods. The decrease in mean sunshine hours was observed till fourth period (May – June) which recorded 4.9 hours. The fifth period (June – July) received a mean of 5.2 hours of sunshine.

There was absolutely no rainfall in the first period covering February-March, while rainfall at the rate of 26.2 mm and 47.8 mm were recorded during second and third periods respectively which covered part of March, April and part of May. However during fourth and fifth periods, covering monsoon months of Kerala (May, June and July) the total rainfall recorded were 453.0 and 442.0 mm respectively.

Body weight

The data pertaining to mean body weight of NNWL and NNNH crossbred birds at 20 and 40 weeks of age are presented in Table 11, and figures 1 and 2. The mean body weight in different replicates of NNWL ranged from 1433.33 ± 35.07 to 1550.67 ± 33.7 g at 20 weeks of age. The overall mean body weight at 20 weeks of age was 1496.1 ± 15.75 g. The mean body weight in different replicates of NNNH varied from 1783.33 ± 39.58 to 1938.67 ± 59.36 g at 20 weeks of age with an overall mean body weight of 1855.6 ± 24.18 g. It was also observed that overall mean 20 week body weight of NNNH birds were 359.5g more than that of NNWL birds.

Table 11. Mean body weight (g) in Naked Neck x White Leghorn (NN WL) and Naked Neck x New Hampshire (NNNH).

Replicate	BW 20		BW 40	
Number	NNWL	NNNH	NNWL	NNNH
1.	1516.67± 33.33	1848.67±43.00	2133.33±60.49	2410.00±54.16
2.	1550.67±33.70	1890.67±69.50	1996.67±71.79	2523.33±62.65
3.	1471.33±32.19	1938.67±59.36	1933.33±46.72	2433.33±73.49
4.	1508.67±38.28	1783.33±39.58	1990.00±70.24	2343.33±73.49
5.	1433.33±35.07	1816.67±50.51	1964.29±33.33	2473.33±52.98
Overall Mean	1496.1±15.75 ^a	1855.6 ± 24.18 ^b	2004.1± 26.86 ^a	2436.7 ± 27.00 ^b

The overall mean values carrying different superscripts differed significantly.

Fig. 1 Body weight at 20 weeks of age in NNWL and NNNH

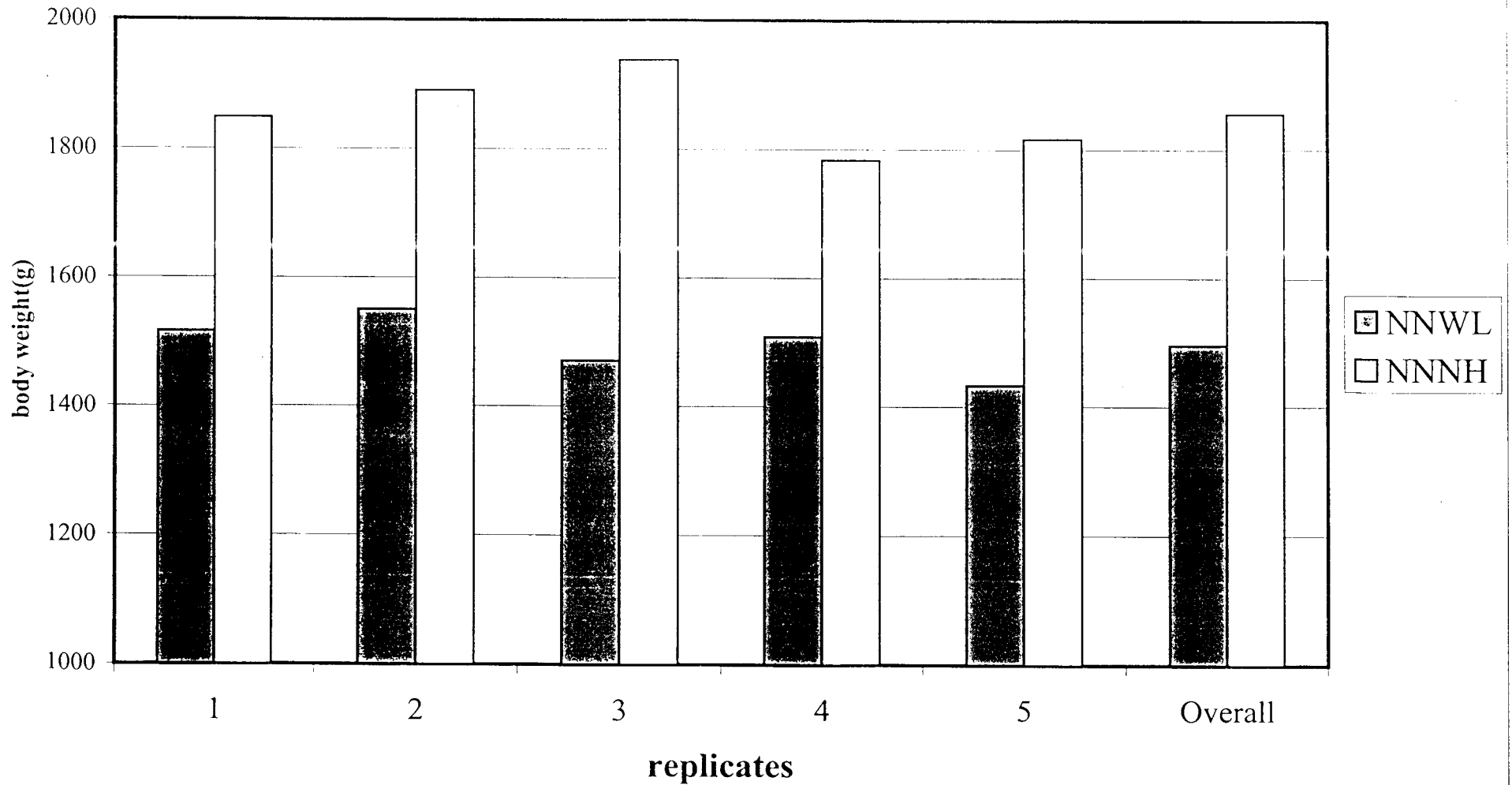
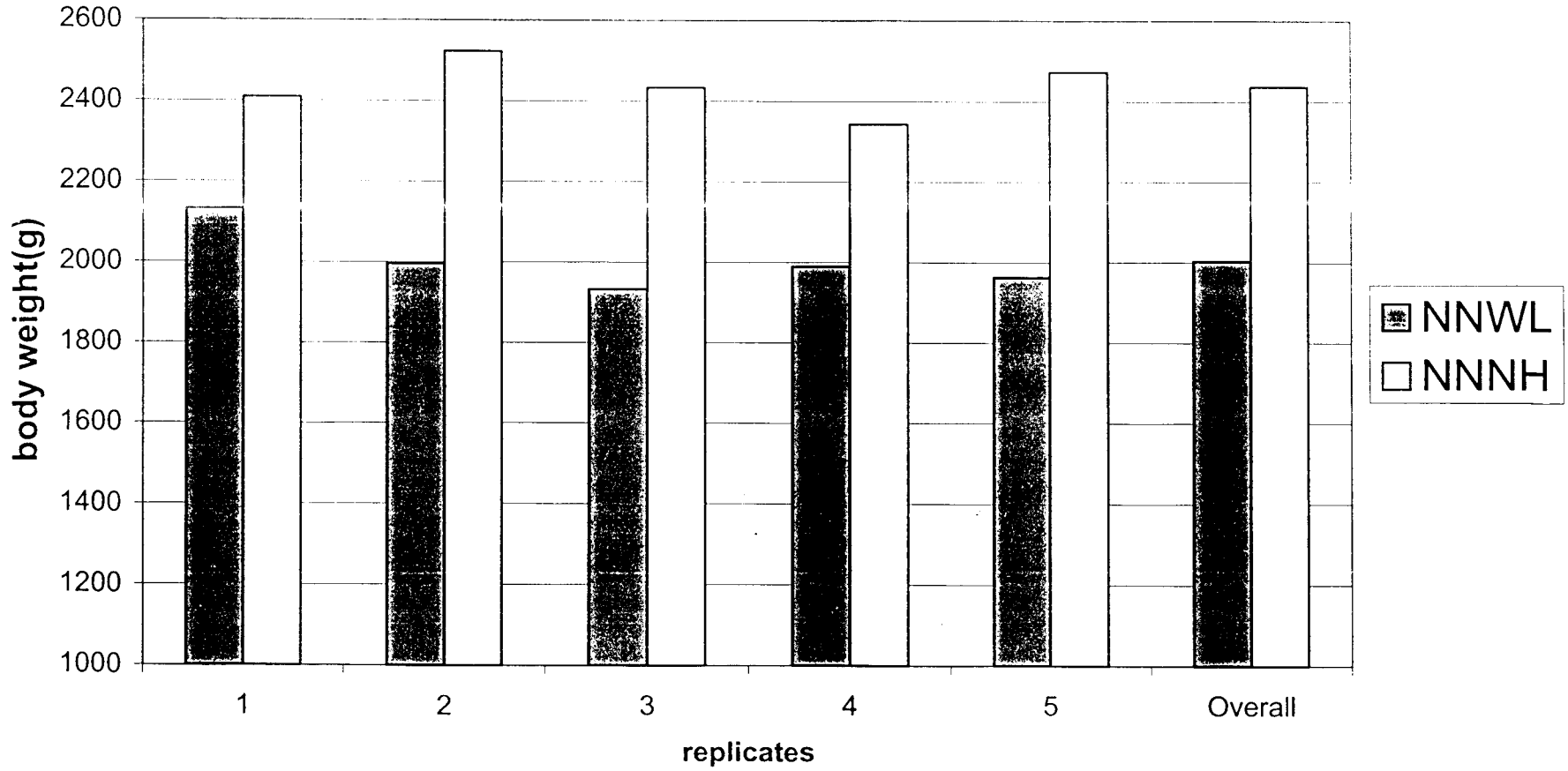


Fig. 2 Body weight at 40 weeks of age in NNWL and NNNH



The overall mean body weight in NNWL at 40 weeks of age was 2004.1 ± 26.86 g. The lowest mean body weight among different replicates of NNWL was recorded as 1990 ± 70.24 g (replicate 4) while highest mean body weight was recorded as 2133.33 ± 60.49 g. (replicate 1). In different replicates of NNNH, mean body weight at 40 weeks of age ranged from 2343.33 ± 73.49 (replicate 4) to 2523.33 ± 62.65 g (replicate 2) with an overall mean body weight of 2436.7 ± 27.00 g. NNNH birds were heavier by 432.6g than NNWL birds at 40 weeks of age, a trend similar to 20 weeks body weight. When the difference in body weight between NNWL and NNNH at 20 and 40 weeks of age was tested statistically, significant differences existed at both ages.

Age at sexual maturity

The age at sexual maturity in both the crosses, expressed as age at first egg in the flock, (AFE) and age at 50 per cent production are presented in Table 12. The age at first egg in the flock ranged from 147 to 154 days in NNWL while it ranged from 141 to 149 days in NNNH flock.

The first egg in NNWL was laid at 147 days of age, while NNNH birds laid their first egg six days earlier. The mean age at first egg in NNWL was 152 ± 1.3 days, while it was 146.8 ± 1.48 days in NNNH. The difference in mean age at first egg (AFE) between NNWL and NNNH was found to be statistically significant.

Table 12. Age at sexual maturity (days) in Naked Neck x White Leghorn (NNWL) and Naked Neck x New Hampshire (NNNH)

Replicate	Age at first egg (days)		Age at 50 percent production (days)	
	NNWL	NNNH	NNWL	NNNH
1.	147	141	158	163
2.	153	149	163	171
3.	152	149	158	165
4.	154	148	166	163
5.	154	147	167	161
Overall Mean	152±1.3 ^a	146.8±1.48 ^b	162.4±1.92 ^a	164.6±1.7 ^a

The Overall mean values carrying different superscripts within the trait differed significantly.

The age at 50 per cent production in NNWL cross ranged from 158 to 167 days among various replicates and the mean age at 50 per cent production was 162.4 ± 1.92 days. The earliest age at 50 per cent production among replicates of NNNH was 161 days. A maximum of 171 days was taken by one of the replicates of NNNH to attain 50 per cent production. The overall mean age at 50 per cent production in NNNH cross was 164.6 ± 1.7 days. When the data on age at 50 per cent production was subjected to statistical analysis, it was revealed that the days required to achieve 50 per cent production in both the crosses were statistically similar.

Egg Production

(a) Hen housed production

The week-wise mean hen housed egg number(HHN) and per cent (HHP) in NNWL and NNNH are presented in Table13 and figure 3.

The laying was commenced in the NNWL flock at 147 days of age . At 21 weeks of age, hen housed number was 0.04 eggs (0.57 per cent). It increased to 0.33 eggs (4.71 per cent) at 22 weeks of age and thereafter registered a marked increase in the two subsequent weeks with a HHN of 2.25 (32.14 per cent) and 3.85 eggs (55 per cent) at 23rd and 24th week of age respectively.

At 25th week of age, the HHN was 4.92 eggs (70.29 per cent). It again registered an increase at 26th week of age, during which period it produced 5.64 eggs (80.57 per cent). At 27th week of age hen housed production remained similar with a HHN of 5.63

Table 13. Week-wise mean hen housed egg number and per cent in Naked Neck x White Leghorn (NNWL) and Naked Neck x New Hampshire (NNNH) crosses from 21 to 40 weeks of age.

		NNWL		NNNH	
Period	Age in weeks	HHN	HHP	HHN	HHP
I	21	0.04	0.57	0.09	1.29
	22	0.33	4.71	0.59	8.42
	23	2.25	32.14	1.68	24.0
	24	3.85	55.0	3.77	53.86
II	25	4.92	70.29	4.68	66.86
	26	5.64	80.57	4.84	69.14
	27	5.63	80.42	5.31	75.86
	28	5.41	77.29	5.67	81.0
III	29	5.17	73.86	4.93	70.43
	30	5.04	72.0	5.07	72.43
	31	4.63	66.14	4.8	68.57
	32	4.64	66.29	4.8	68.57
IV	33	4.65	66.43	4.29	61.29
	34	4.69	67.0	3.93	56.14
	35	4.88	69.71	4.27	61.0
	36	4.95	70.71	4.95	70.71
V	37	5.05	72.14	5.25	75.0
	38	4.96	70.86	5.15	73.57
	39	4.80	68.57	5.21	74.43
	40	4.84	69.14	5.17	73.86

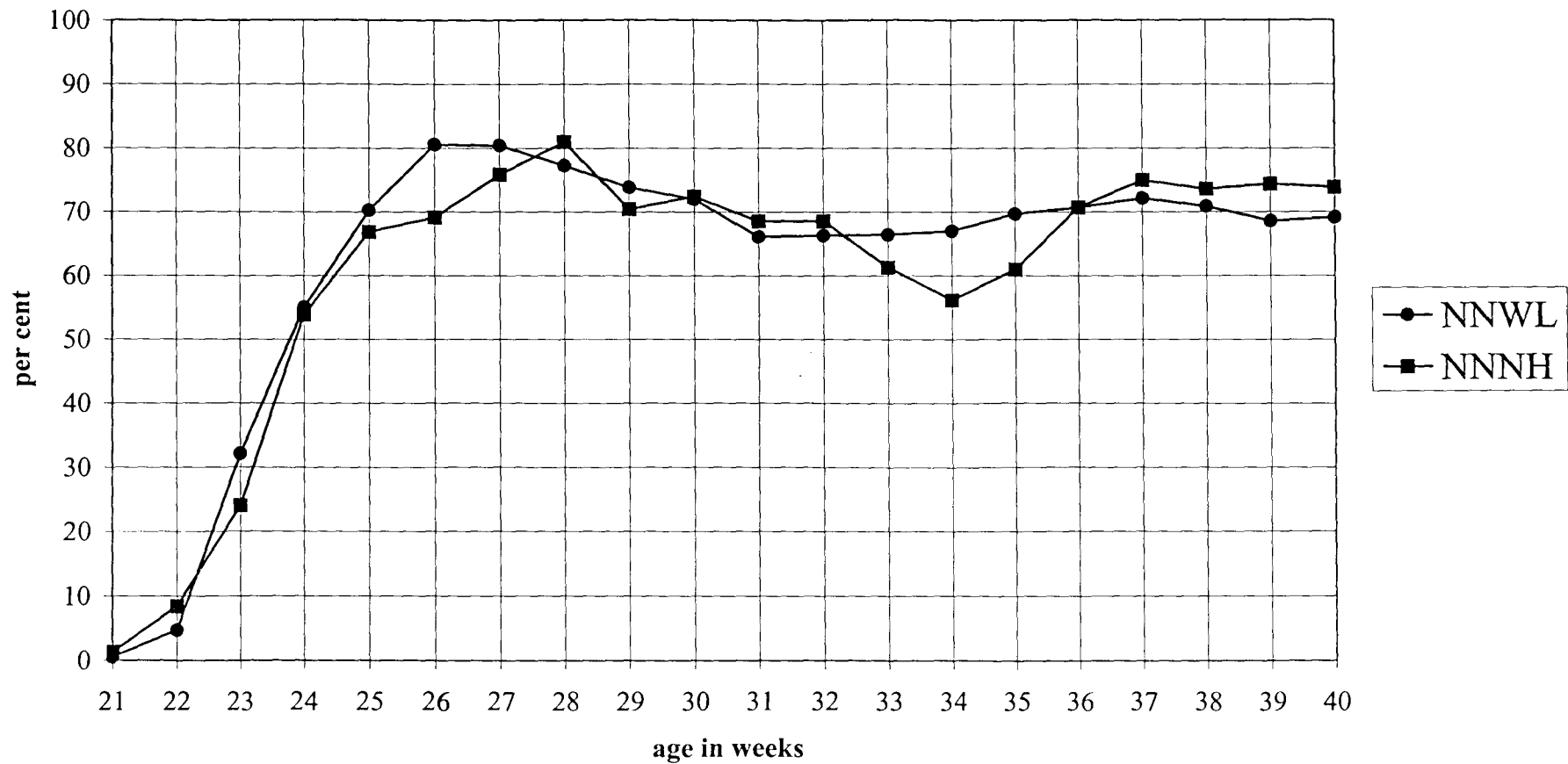
eggs (80.42 per cent). During the last week of the second period of the study, ie, at 28 weeks of age, a slight reduction in hen housed number to 5.41 eggs (77.29 per cent) was observed.

A HHN of 5.17 eggs (73.86 per cent) was recorded at 29 weeks of age (period III). A marginal reduction in hen housed production with a HHN of 5.04 eggs (72 per cent) was observed at 30 weeks of age. Hen housed number registered a further decrease during 31st week of age to 4.63 eggs (66.14 per cent). The production remained similar during 32nd week of age at 4.64 eggs (66.29 per cent).

At 33rd week of age, HHN was 4.65 eggs (66.43 per cent). It rose to 4.69 eggs (67 per cent) during the 34th week of age. It further increased to 4.88 eggs (69.71 per cent) during 35th week of age. During the last week of the fourth period of the study ie, at 36th week of age, hen housed number was 4.95 eggs (70.71 per cent)

The HHN was recorded as 5.05 eggs (72.14 per cent) during 37 weeks of age. A slight decrease in hen housed number with a production of 4.96 eggs (70.86 per cent) was registered at 38th week of age. At 39th week of age, egg number further decreased marginally to 4.80 eggs (68.57 per cent). At 40th week of age hen housed number was 4.84 eggs (69.14 per cent) in NNWL.

In NNNH the egg production commenced at 141 days of age. A hen housed number of 0.09 eggs (1.29 per cent) was recorded during 21st week of age. It increased to

Fig. 3 Weekly hen housed per cent egg production in NNWL and NNNH

0.59 eggs (8.42 per cent) at 22nd week of age. A steady increase in egg production was observed in the subsequent weeks. At 23 weeks of age, HHN was 1.68 eggs (24 per cent). During 24th week of age a still higher HHN of 3.77 eggs (53.86 per cent) was recorded.

At 25th week of age, a HHN of 4.68 eggs (66.86 per cent) was recorded. It increased to 4.84 eggs (69.14 per cent) during 26 weeks of age. At 27 weeks of age, it further increased to 5.31 eggs (75.86 per cent). The highest weekly hen day egg number of 5.67 eggs (81.0 per cent) was recorded at 28th week of age.

The HHN decreased to 4.93 eggs (70.43 per cent) during the 29th week of age. At 30 weeks of age, it made a slight increase with 5.07 eggs (72.43 per cent) but decreased to 4.8 eggs (68.57 per cent) during 31st and 32nd weeks of age.

At 33 weeks of age, the HHN was recorded as 4.29 eggs (61.29 per cent). It decreased to 3.93 eggs (56.14 per cent) at 34 weeks of age. A HHN of 4.27 eggs (61.0 per cent) was observed at 35 weeks of age. It further increased to 4.95 eggs (70.71 per cent) at 36 weeks of age.

The hen housed production registered an increase at 37 weeks of age to 5.25 eggs (75.0 per cent). At 38 weeks of age a slight decrease in HHN to 5.15 eggs (73.57 per cent) occurred. It again rose to 5.21 eggs (74.43 per cent) at 39 weeks of age. At the last week of the experiment, a HHN of 5.17 eggs (73.86 per cent) was recorded.

Period wise egg production

Period wise hen housed number and per cent in NNWL and NNNH crosses are presented in Table14 and fig. 4.

Hen housed number in NNWL during the first period of the experiment, from 21 to 24 weeks of age was recorded as 6.48 eggs (23.11 per cent). NNNH cross during the same period recorded a hen housed number of 6.13 eggs (21.9 per cent) The difference in hen housed number between NNWL and NNNH was not statistically significant.

During the second period of the experiment, from 25 to 28 weeks of age NNWL had a hen housed egg number of 21.60 eggs (77.14 per cent) as against 19.89 eggs (73.22 per cent) in NNNH birds. The difference was found to be statistically significant.

Hen housed number for the third period of experiment from 29 to 32 weeks of age in NNWL cross was recorded as 19.48 eggs (69.57 per cent). Though a higher hen housed number of 19.60 eggs (70.0 per cent) was recorded in NNNH cross for the same period, they were statistically similar.

During the fourth period of the study from 33 to 36 weeks of age, hen housed number in NNWL was recorded as 19.17 eggs (68.46 per cent). A significantly lower hen housed number of 17.44 eggs (62.3 per cent) was recorded in NNNH for the same period.

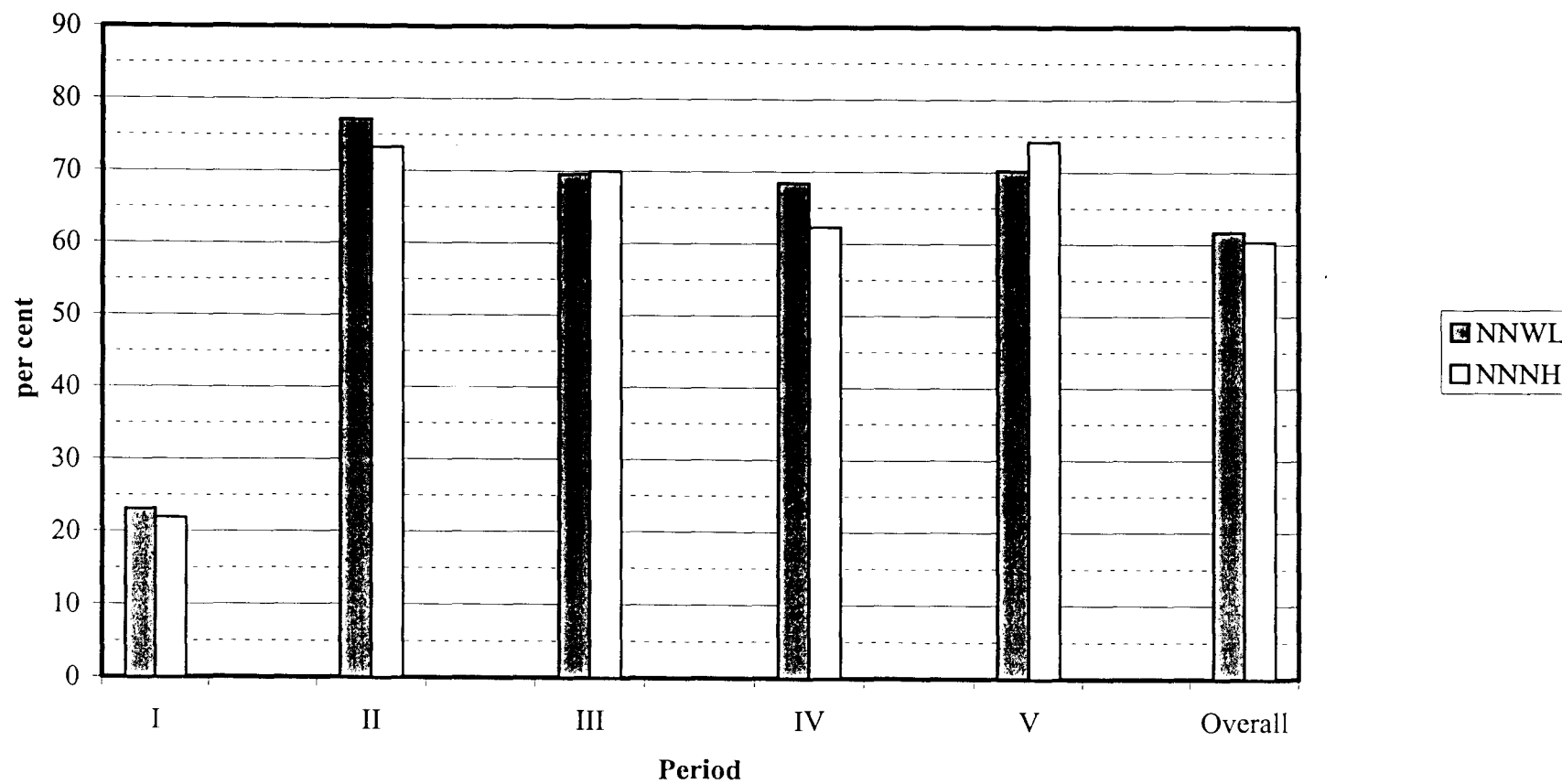
Table 14. Hen housed egg number and per cent in Naked Neck x White Leghorn (NNWL) and Naked Neck x New Hampshire (NNNH) crosses from 21 to 40 weeks of age.

Period	Age in weeks	NNWL		NNNH	
		HHN	HHP	HHN	HHP
I	21-24	6.48	23.11	6.13	21.9
II	25-28	21.61 ^a	77.14 ^a	19.89 ^b	73.22 ^b
III	29-32	19.48	69.57	19.60	70.0
IV	33-36	19.17 ^a	68.46 ^a	17.44 ^b	62.3 ^b
V	37-40	19.65	70.18	20.79	74.22
Overall	21-40	86.39	61.69	83.85	60.32

Mean values carrying different superscripts differed significantly

HHN - Hen housed number

HHP - Hen housed per cent

Fig 4. Period wise henhoused per cent in NNWL and NNNH

Hen housed number during the last period of experiment from 37 to 40 weeks of age was recorded as 19.65 eggs (70.18 per cent) in NNWL cross. However, in NNNH cross, the HHN was 20.79 eggs (74.22 per cent) during this period. The difference was statistically not significant.

In NNWL the highest hen housed percentage was 77.14, recorded during the second period of study from 25-28 weeks of age. While in NNNH, it was 74.22 recorded much later, during the last period of study from 37-40 weeks of age.

When the hen housed egg number for the whole experimental period of 21 to 40 weeks was considered it could be seen that the NNWL cross recorded 86.39 eggs (61.69 per cent). On the other hand a lower hen housed number of 83.85 eggs (60.32 per cent) was recorded in NNNH birds for the whole period. The hen-housed egg production data of the experimental birds for the whole period were subjected to statistical analysis to assess their performance and observed that hen housed production was not statistically different between the crosses tested.

Hen day production

Hen day number and per cent during 21 – 40 weeks of age is presented in Table 15. Hen day production was the same as hen housed production up to 39 weeks of age, since the livability was cent per cent in both the groups. One mortality was recorded in

Table 15. Hen day egg number and per cent in Naked Neck x White Leghorn (NNWL) and Naked Neck - New Hampshire (NNNH) crosses from 21 to 40 weeks of age.

Period	Age in weeks	NNWL		NNNH	
		HDN	HDP	HDN	HDP
I	21-24	6.48	23.11	6.13	21.90
II	25-28	21.60	77.14	19.89	73.22
III	29-32	19.48	69.57	19.60	70.00
IV	33-36	19.17	68.46	17.44	62.30
V	37-40	19.72	70.43	20.79	74.22
Overall	21-40	86.46	61.74	83.85	60.32

HDN - Hen day number

HDP - Hen day per cent

NNWL at 40 weeks. A hen day egg number of 4.91 eggs (70.14 per cent) was observed in NNWL at 40 weeks of age, against a hen housed egg number of 4.84. The difference in hen day production between the two crosses for the whole experimental period was also statistically non - significant.

Egg Weight

The mean egg weight (EW) in NNWL and NNNH for the different periods are presented in Table 16 and fig. 5.

The EW in NNWL was 44.19 ± 0.35 g at 24 weeks of age. In NNNH, the EW at the same age was 43.66 ± 0.42 g. However, the difference in EW between the two crosses were statistically non - significant.

The EW in NNWL increased to 46.85 ± 0.24 g during the second period of the study, at 28 weeks of age. At the same age, EW in NNNH was 46.77 ± 0.29 g. The difference in EW between the two crosses was statistically non - significant.

At 32 weeks of age, EW in NNWL cross was recorded as 48.92 ± 0.28 g. The EW in NNNH at the same age was 48.77 ± 0.31 g. The increase in egg weight for the crosses NNWL and NNNH was 2.07 and 2.0g respectively than the previous period. The

difference in EW between the two crosses was statistically non - significant during this period too.

At 36 weeks of age, the EW in NNWL increased to 51.28 ± 0.34 g. At the same age, the EW in NNNH also increased to 50.69 ± 0.28 g. The difference in EW between the two crosses were statistically non - significant.

The EW was recorded as 52.43 ± 0.30 g in NNWL at 40 weeks of age. The NNNH cross had an EW of 52.31 ± 0.25 g at the same age. Difference in EW between the two crosses at this age was also statistically non - significant.

The overall mean egg weight for the entire period of the experiment from 21 to 40 weeks of age was 48.73 ± 0.37 and 48.44 ± 0.38 g in NNWL and NNNH crosses respectively. The overall EW data also suggested that eggs laid by NNNH were lighter by 0.29g than NNWL eggs. The difference in overall EW for the entire period of the study, between the two crosses was statistically non - significant.

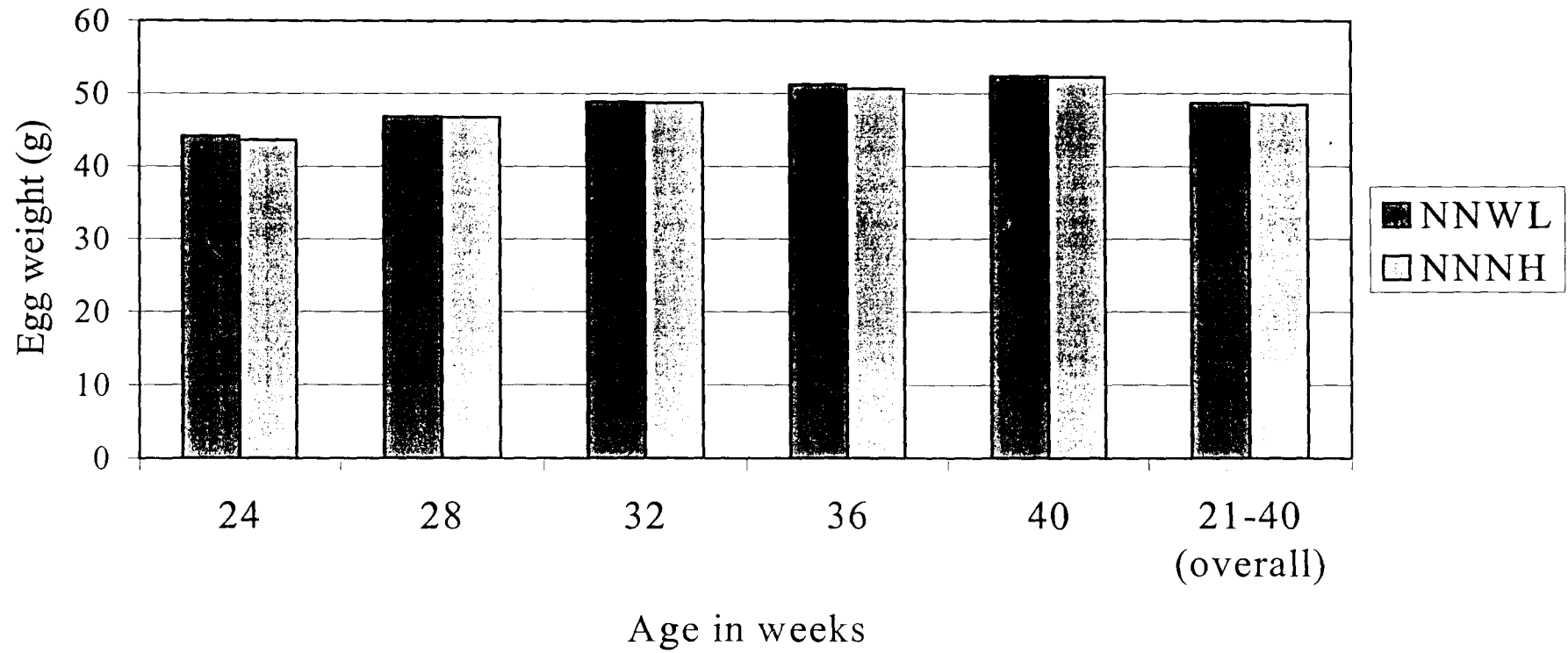
Feed Consumption

Mean daily feed consumption in NNWL and NNNH from 21-40 weeks of age are presented in Table 17 on per bird per day basis.

Table 16. Mean egg weight in Naked Neck x White Leghorn (NNWL) and Naked Neck x New Hampshire crosses (NNNH)

Period	Age in weeks	NNWL	NNNH
I	24	44.19±0.35	43.66±0.42
II	28	46.85±0.24	46.77±0.29
III	32	48.92±0.28	48.77±0.31
IV	36	51.28±0.34	50.69±0.28
V	40	52.43±0.30	52.31±0.25
Overall	21-40	48.73±0.37	48.44±0.38

Fig. 5 Mean egg weight in NNWL and NNNH



During the first period of the experiment from 21 to 24 weeks of age, NNWL birds consumed an average 104.23g feed. A similar feed consumption of 104.38 g was recorded in NNNH during the same period.

Feed consumption increased to 115.31g in NNWL during the second period of the study, from 25 to 28 weeks of age. In NNNH, it was 116.02g.

During the third period of the study from 29 to 32 weeks of age, the feed consumption in NNWL increased to 124.56g. Feed consumption was similar in NNNH cross (124.71g) during the same period of the study.

Feed consumption further increased in NNWL birds to 142.12g during the fourth period of the study from 33 to 36 weeks of age. Feed intake for the NNNH birds during this period was also same (142.11g).

During the fifth period of the experiment mean daily feed consumption decreased in both NNWL and NNNH. The feed consumption for the period from 37 to 40 weeks was 138.11 and 138.5g in NNWL and NNNH, respectively.

Mean daily feed consumption for the whole period of the study from 21 to 40 weeks of age was 124.83g in NNWL. A feed consumption of 125.14 g was recorded in NNNH birds for the same period indicating 0.31g more feed per bird per day than

Table 17. Mean daily feed consumption (g) in Naked Neck x White Leghorn (NNWL) and Naked Neck x New Hampshire (NNNH) crosses from 21 to 40 weeks of age.

Period	Age in weeks	NNWL	NNNH
I	21-24	104.23 ± 0.4	104.38 ± 0.23
II	25-28	115.31 ± 0.55	116.02 ± 0.28
III	29-32	124.56 ± 0.39	124.71 ± 0.47
IV	33-36	142.12 ± 0.51	142.11 ± 0.79
V	37-40	138.11 ± 0.24	138.5 ± 0.25
Overall	21-40	124.83 ± 2.88	125.14 ± 2.87

NNWL. The difference in feed consumption between NNWL and NNNH during all the five experimental periods as well as for the whole period was statistically non-significant.

Feed conversion ratio (FCR)

The mean feed conversion ratio in both the crosses for the different experimental periods and overall mean for the entire course of the experiment are presented in Table 18 and figure 6.

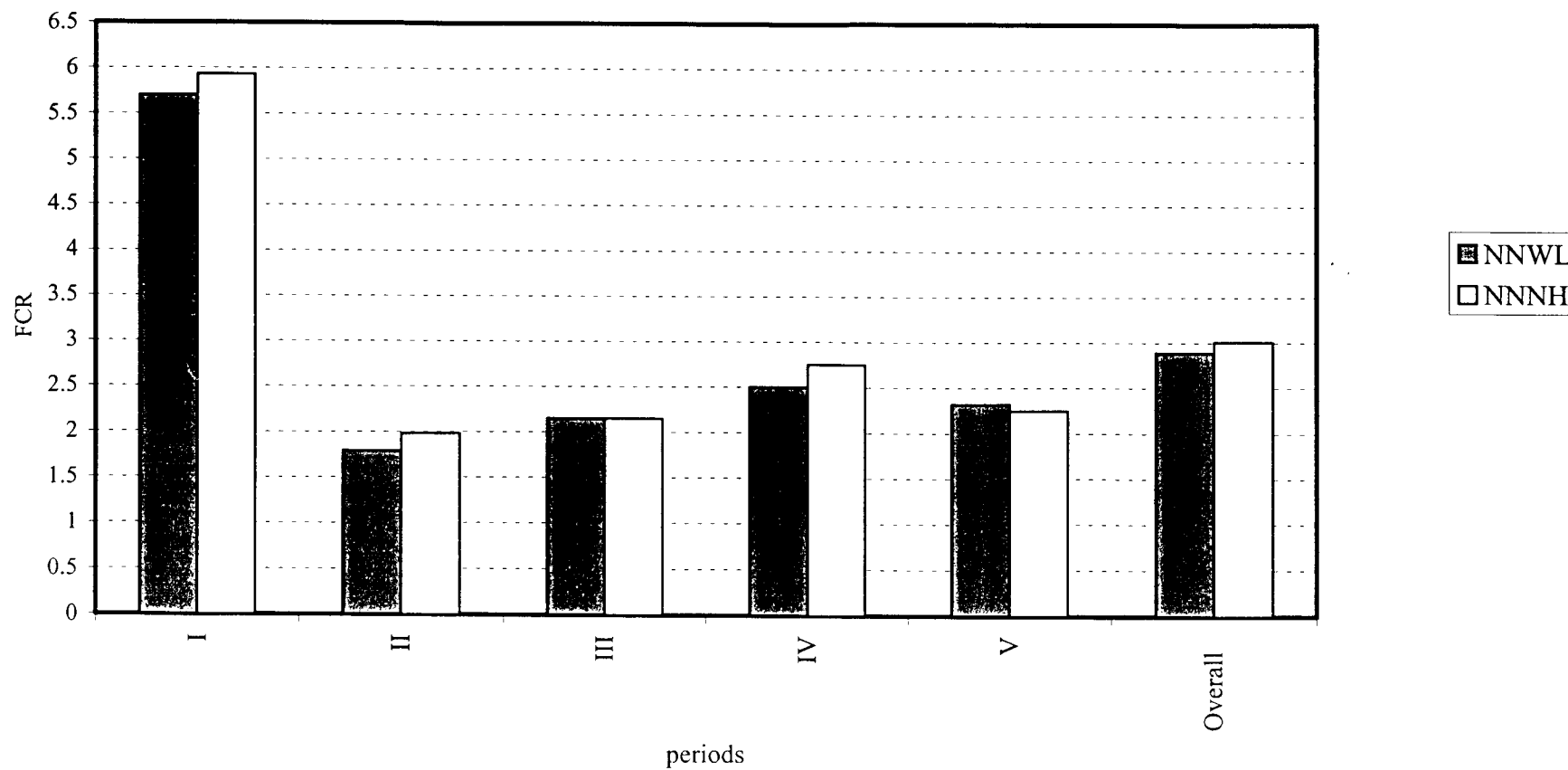
Feed conversion ratio for NNWL birds was 5.7 during the first period of experiment, from 21 to 24 weeks of age. In NNNH birds, FCR for the same period was 5.93. During second period from 25 to 28 weeks of age, the FCR in NNWL birds was 1.79, and it was 1.98 for the same period, in NNNH. FCR was the same for both NNWL and NNNH for the third period of study from 29 to 32 weeks of age (2.15). During the fourth period of the experiment from 33 to 36 weeks of age, NNWL birds had a FCR of 2.5, while it was 2.75 for NNNH. FCR marginally improved during the last period of the experiment from 37-40 weeks of age in both NNWL and NNNH. It was 2.32 in NNWL and 2.25 in NNNH.

Feed conversion ratio for the entire duration of the study from 21 to 40 weeks age was 2.89 for NNWL, while NNNH cross had a feed conversion ratio of 3.01. Statistical interpretation of the data on FCR revealed that this trait was not influenced by the crosses in any of the experimental periods as well as the period from 21 to 40 weeks of age.

Table 18. Feed conversion ratio (per dozen eggs) in Naked Neck x White Leghorn (NNWL) and Naked Neck x New Hampshire (NNNH) crosses from 21-40 weeks of age.

Period	Age in weeks	NNWL	NNNH
I	21-24	5.70 ±0.68	5.93±0.59
II	25-28	1.79±0.03	1.98±0.12
III	29-32	2.15±0.07	2.15±0.10
IV	33-36	2.50±0.07	2.75±0.09
V	37-40	2.32 ±0.06	2.25 ± 0.09
Overall	21-40	2.89±0.32	3.01±0.32

Fig. 6. Feed conversion ratio in NNWL and NNNH from 21 to 40 weeks of age



Livability

The per cent livability in NNWL and NNNH from 21 to 40 weeks of age is presented in Table 19 and graphically in fig.7. No mortality was recorded in NNNH during the entire period of the experiment thereby indicating cent per cent livability. A single mortality occurred in NNWL during 40th week of age and livability was 98.7 per cent for the experimental period.

Broodiness

Duration of broodiness (days) observed in both the crosses are presented in Table 20. Two birds were broody for nine days while in five birds period of broodiness ranged from 25 to 29 days. Prolonged broodiness for 50 days was exhibited by one of the birds while the largest duration in the cross was recorded as 63 days. Eight birds showed broodiness in NNNH. Duration of broodiness ranged from 22 to 30 in four birds. It ranged from 33 to 35 in two birds. One of the birds was broody for 49 days and the longest duration of broodiness in the cross was 69 days.

Plumage colour

The plumage colour in NNWL was off white in 72 birds. Only three birds showed brownish colouration on the wing feathers. In NNNH, 68 birds had the chestnut

Table 19. Per cent livability in Naked Neck x White Leghorn (NNWL) and Naked Neck x New Hampshire (NNNH) from 21 to 40 weeks of age

Period	Per cent Livability	
	NNWL	NNNH
1	100.0	100.0
2	100.0	100.0
3	100.0	100.0
4	100.0	100.0
5	98.7	100
Overall	98.7	100.0

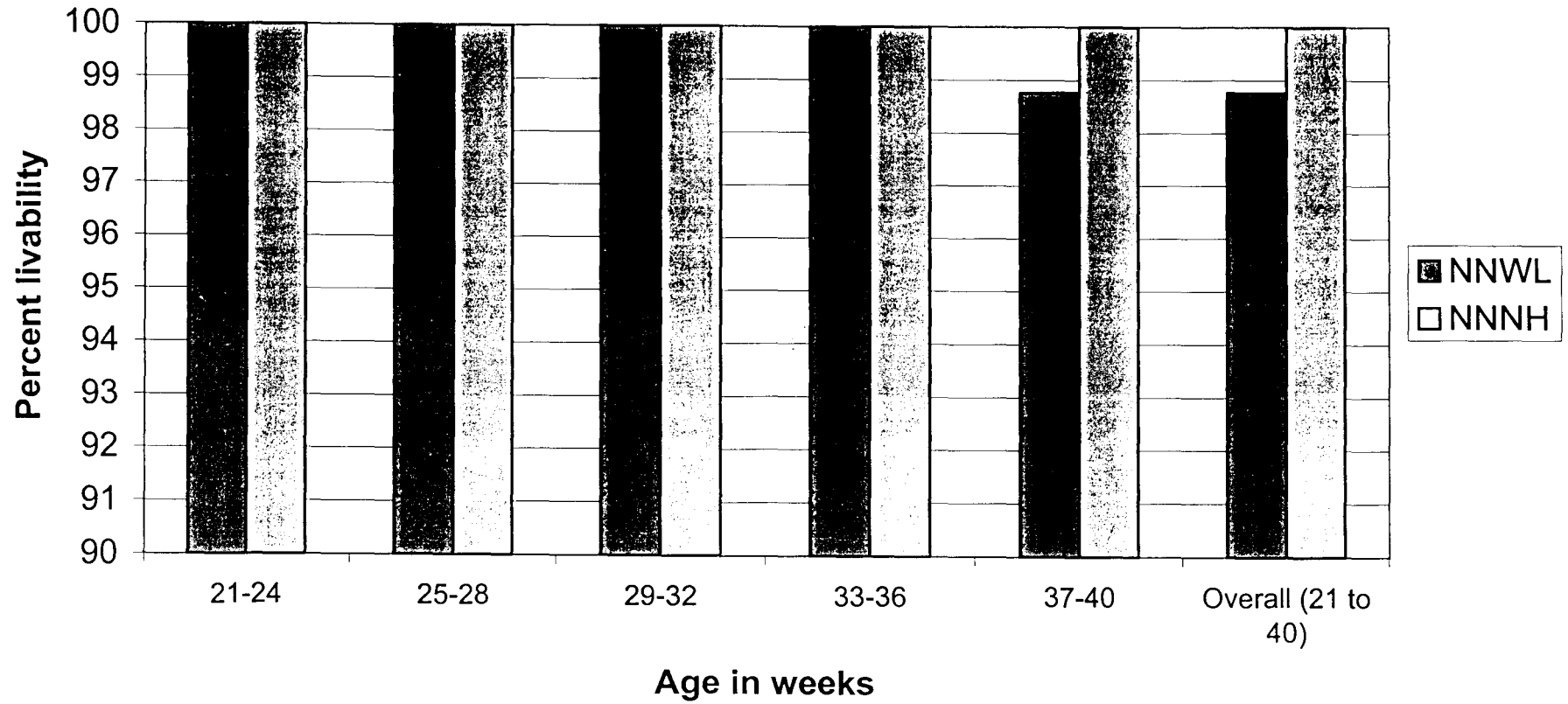
Fig. 7 Age wise livability in NNWL and NNNH

Table 20. Duration of broodiness recorded in Naked Neck x White Leghorn (NNWL) and Naked Neck x New Hampshire crosses from 21 to 40 weeks of age.

Sl. No	Replicate number	NNWL Duration			Replicate number	NNNH Duration		
		From	To	No of days		From	To	No of days
1	II	18/04/99	26/04/99	09	I	19/04/99	10/05/99	22
2	II	19/04/99	27/04/99	09	II	19/04/99	13/05/99	25
3	II	19/04/99	16/05/99	28	III	18/04/99	16/05/99	29
4	II	29/04/99	01/07/99	63	III	17/04/99	19/05/99	33
5.	III	18/04/99	13/05/99	26	III	23/04/99	01/07/99	69
6	IV	12/05/99	10/06/99	29	IV	19/04/99	18/05/99	30
7	IV	17/04/99	02/06/99	50	IV	18/04/99	22/05/99	35
8	V	23/04/99	18/05/99	26	IV	14/05/99	01/07/99	49
9	V	24/04/99	18/05/99	25				

coloured plumage resembling New Hampshire birds, while seven birds had multicoloured plumage resembling their Naked Neck sires.

Egg shell colour

The egg shell in NNWL was tinted while in NNNH it was brown or shades of brown.

Egg quality traits

The egg quality traits were measured at 32 weeks of age and the results are tabulated in Table 21.

The mean shape index recorded was 75.94 in NNWL. A higher shape index of 77.38 was recorded in NNNH. The difference in shape index between NNWL and NNNH was found to be statistically significant .

The mean albumen index was recorded as 0.089 in NNWL eggs. A higher albumen index of 0.099 was recorded in NNNH. The difference in albumen index between the two crosses was significant.

Table 21. Egg quality traits in Naked Neck x White Leghorn (NNWL) and Naked Neckx New Hampshire (NNNH) crosses at 32 weeks of age.

Period	Trait	NNWL	NNNH
I	Shape Index	75.94 \pm 0.44 ^a	77.38 \pm 0.49 ^b
II	Albumen Index	0.089 \pm 0.004 ^a	0.099 \pm 0.002 ^b
III	Yolk Index	0.442 \pm 0.004	0.447 \pm 0.003
IV	Shell Thickness	0.376 \pm 0.006	0.373 \pm 0.004
V	Haugh Unit	84.78 \pm 1.44	88.00 \pm 0.80

Mean values with different superscripts within the trait differed significantly.

A mean yolk index of 0.442 was observed in NNWL as compared to a mean yolk index of 0.447 in NNNH. The difference in mean yolk index was statistically non-significant.

The mean shell thickness in NNWL was recorded as 0.376 mm. NNNH eggs at the same age had a lower shell thickness of 0.373 mm. However, the difference in shell thickness between the two crosses was statistically non-significant.

The mean Haugh unit score in NNWL eggs was 84.78. A higher mean Haugh unit score of 88.00 was recorded in NNNH at the same age. The difference in Haugh unit score between the two crosses was also statistically non-significant.

Economics

The economics of egg production over feed cost for the period from 21 to 40 weeks of age in both the crosses are presented in Table 22.

The total feed intake in NNWL cross for the entire course of the experiment from 21 to 40 weeks of age was recorded as 1309.55 kg. During the period of experiment NNWL birds produced 6479 eggs. The cost of feed was Rs. 10 per kg. The cost of feed per egg produced was worked out as 202.12 paise.

Table 22. Economics of egg production over feed cost from 20 to 40 weeks of age in Naked Neck x White Leghorn (NNWL) and Naked Neck x New Hampshire (NNNH) crosses in deep litter.

Particulars	NNWL	NNNH
Feed intake (kg) 20-40 weeks	1309.55	1314.05
Total number of eggs produced 20-40 weeks	6479	6289
Feed consumed per egg (g)	202.12	208.94
Cost of feed (Rs/kg)	10.00	10.00
Cost of feed per egg (Paise)	202.12	208.94

The NNNH bird consumed 1314.05kg of feed during the entire course of experiment to produce 6289 eggs. The cost of feed per egg produced worked out to 208.94 paise.

Discussion

DISCUSSION

Meteorological Profile

The meteorological data of the experimental period presented in Table 10 revealed that hot and humid conditions prevailed at the initial phases of the experiment. However long sunshine hours has provided adequate light to the birds. The high temperature - humidity combination might have induced heat stress in the birds, more so in NNNH because they were comparatively heavier. The delay in attaining peak production may be attributed to the stress during first two periods. In the subsequent periods, though the temperature decreased, it was still in the panting stage in the last period. The humidity had gone up since the monsoon started in the fourth period and the sunshine hours also decreased. The weather combination also might have caused stress on the birds evidenced by non maintenance of peak and irregular levels of production.

Body Weight

20 week body weight

The 20 week body weight set out in Table 11 clearly showed that NNNH is a heavier cross compared to NNWL. The overall mean of 1855.60 ± 24.18 g is NNNH was 359.50g more than NNWL cross (1496.1 ± 15.75 g) and this difference was statistically significant. Although the male line used in the production of the crosses were the same, a lower body weight in NNWL cross might be due to lower body size in White Leghorn female line. The Naked Neck and New Hampshire lines utilized in this experiment was reported to have 20 week body weight of 1675.10 and 1682.3g,

respectively (Jayasree, 2000). The NNNH cross showed an increase of 176.9g than the mid parent value of parent lines which works out to 9.53 per cent of progeny mean. This may be attributed to heterosis. Similarly, the 'F' strain of white Leghorn utilized in this study was reported to have a 20 week body weight of $944.85 \pm 8.86g$ (Beena, 1995). The NNWL registered an increase of 186.17g than the mid parent value of parent lines, which works out to 12.44 per cent of progeny mean, which also may be indicative of heterosis for this trait.

The observations made in the present study in NNWL was higher than those reported by Jain and Sharma (1977) and Jain and Chowdhry (1985). The Desi line utilized by the latter weighed only 1306 g at 20 weeks while the line used in the present study showed a body weight of 1675.10g at the same age and this difference might have caused the difference in weight of the progeny. A higher 20 week body weight of 1625g in Eravan x White Leghorn by Karpatejan *et al.* (1978) might be due to strain differences. Since strain differences influence this trait to a large extent, worthwhile comparison cannot be attempted unless the birds are of the same strain.

40 Week body weight.

NNNH continued to be heavier at 40 weeks also, with a body weight of $2436.70 \pm 27.00g$ than NNWL which recorded a body weight of $2004.10 \pm 26.86g$ (Table 11). The gain in body weight was moderate in both the crosses. While NNWL gained 508g from 20 to 40 weeks, it was 581g in NNNH. This moderate increase in body weight indicated growth in body size rather than deposition of fat inside the

body. This aspect is desirable for a higher egg production and greater economy. Though the 40 week body weight in NNNH may be closer to the standard weight for heavy breeds, it is on the higher side for a medium type of bird. The NNWL may be categorized as a medium bird.

The 40 week body weight in 'F' strain of White Leghorn was reported as 1382g by Radhakrishnan (1981), while it was recorded as 1346.67 ± 12.19 g by Beena (1995). Jayasree (2000) has reported that the Naked Neck line weighed 2703.65g at 40 weeks of age. The 40 week body weight of 2004.10 ± 26.86 g for NNWL cross in the present study is close to the mid parent value of the parent lines. A similar observation was made by Dutta (1996) in Miri x white Leghorn cross which weighed on an average 1080g at 40 weeks of age, while their Miri and White Leghorn parent lines weighed 1019 and 1177g respectively at the same age.

The 40 week body weight of 2436.70 ± 27.00 g for NNNH cross recorded in the present study was higher than the body weight of 2000g in Golden Romagna x New Hampshire at one year of age (Giavarini, 1956) which may be due to strain differences. Jayanthy (1992) reported a 40 week body weight of 1974 g in a three way cross involving Desi x New - Rock, which is lower than the results of present study. However, Jayasree (2000) reported a higher body weight at 40 weeks of age for New Hampshire (2635g) and Naked Neck (2703g, which were the lines used in this experiment. The higher body weight might be due to cage system of rearing.

Age At Sexual Maturity (AFE)

The data on age at first egg set out in Table 12 revealed that NNWL cross started laying at 147th day, whereas NNNH cross started laying at 141st day of age. The overall mean AFE was significantly lower in NNNH than NNWL cross. Though NNWL had 50 per cent inheritance of White Leghorn from female side, the start of laying has been late. The NNNH though consisted of heavier breeds, has started laying at an earlier age. This might be due to expression of heterosis in the cross. Age at first egg need to be lowered further so that more eggs could be obtained from these crosses.

The data on age at 50 per cent production revealed that the initial advantage of NNNH cross in age at first egg was not maintained in this trait. The NNWL cross reached 50 per cent production 2.2 days earlier than NNNH cross, but the difference was not significant. Attaining 50 per cent production at an earlier age is an added advantage in layer birds since a better intensity of production could be achieved.

The mean age at 50 per cent production for NNWL observed in the present study was lower than that reported by Huq *et al.* (1976) in White Leghorn x Desi; Islam *et al.* (1981) in Desi x White Leghorn and Sah *et al.* (1985) in Desi x White Leghorn. This might be due to strain differences. Dutta (1996) also reported a higher age at first egg in White Leghorn x Miri cross of 177 days and 163 days in White Leghorn. This difference also might be due to the difference between the breeds.

Al – Rawi and Amer (1974) reported an ASM ranging from 131 to 151 days in crosses involving New Hampshire which is comparable to the results of this study. But Islam *et al.*(1981) reported a higher ASM of 220 days for cross involving Desi and New Hampshire. This may be due to the strain difference of the Desi and New Hampshire utilized. Age at 50 per cent production observed in NNNH was earlier than those reported by Jayasree (2000) in Naked Neck and New Hampshire, which were lines involved in this cross. This might be due to a higher 20 week body weight obtained in NNNH which is indicative of the better growth.

Egg production.

The weekly hen housed egg number and per cent in the two crosses under study, set out in Table 13 and in Figure 4, revealed that both the crosses came into lay at 21 weeks of age. The per cent egg production was comparable up to 25 weeks of age. Thereafter NNWL cross touched a peak of 80.57 per cent at 26th week of age. But, the NNNH cross could attain a peak of 81.0 per cent at 28th week only. The difference in female lines employed could have caused variations in age for attainment of peak production. The White Leghorn female line used was an egg type breed whereas the New Hampshire line used was a dual purpose breed.

The hen housed per cent from 27 to 32 weeks of age was also quite similar with the values fluctuating in both the crosses. There was a gradual decline in the egg number during this period. The summer season, with the temperature inside the house reaching up to 35^oC might have also contributed to this decline. The egg production

declined further in NNNH cross from 32 to 34 weeks of age, the difference reaching as much as 11 per cent . But, on the contrary the egg production was maintained in NNWL cross. It appeared that the summer stress was more detrimental to NNNH. But after the onset of monsoon, during later half of the fourth period, the egg production has increased in the NNNH cross, bridging the gap by 36th week of age. Thereafter, this cross had a marginal advantage over NNWL cross, till the end of the experiment (40 weeks).

The hen housed egg number from 21 to 40 weeks of age was recorded as 86.39 in NNWL, whereas it was 83.85 in NNNH. This represented hen housed per cent of 61.69 and 60.32 respectively. Though NNWL had an advantage of 2.54 eggs over NNNH, this difference was not significant statistically. (Table 14). A perusal of the HHN over the periods showed a significantly higher number in the second and fourth periods in NNWL, whereas it was similar in first, third and fifth periods. Hen housed percentage (HHP) values of 61.69 and 60.62 in NNWL and NNNH respectively were also statistically similar. Maximum production occurred in the second period with the production touching 77.14 and 73.22 per cent in NNWL and NNNH, respectively. The decline and the improvement in egg production was reflected in the period wise production also. It appeared that the NNNH which was heavier by 433g had lesser capability to cope up with summer. But eventually, since it was able to regain the egg production, the hen housed egg production did not vary significantly.

Since the livability was hundred per cent till 39th week of age, the hen day number and per cent was the same as that of hen housed egg number and per cent. The only difference occurred during the 40th week in NNWL cross. Therefore the trend and variations in HDN and HDP were same as that of HHN and HHP.

The Naked Neck and New Hampshire breeds, which were utilized in this study as parents, was reported to have an HHP of 72.13 and 66.41 respectively up to 40 weeks of age (Jayasree, 2000). Compared to the parent lines involved, the NNNH in the present study recorded 11.72 and 17.44 eggs more than Naked Neck and New Hampshire breeds, respectively. This may be explained as the expression of heterosis in this breed cross.

Dutta (1996) reported a HDP of 49.0 up to 44 weeks of age in White Leghorn x Miri crossbreds which was lower than HDP observed in NNWL (61.69). This might be due to the poor productivity of the Miri breed used in their study. The HHP observed in NNNH (60.32) in the present study was higher than those reported by Jayanthi (1992) in Desi x New Rock cross (37.61) and Desi x Austra white (34.4) and this might be due to the difference in the productivity of the breeds involved. The HDP in NNWL were also superior to those reported by Sah *et al.* (1985) in Desi x White Leghorn (32.09) and White Leghorn x Desi (26.8), Rao (1983) in Kadaknath x White Leghorn (48.4). The lower production in these reports might be due to the poor productivity of the breeds utilized for the cross.

Egg weight

The initial egg weight in NNWL and NNNH which was 44.19 and 43.66g at 24 weeks, increased to 52.43 and 52.31g respectively at 40 weeks of age (Table 16). The egg weights in different periods in the two crosses were very similar and the differences were not statistically significant. The overall mean egg weight of 48.73g in NNWL and 48.44g in NNNH was also statistically similar. Although the birds of NNNH cross were heavier, the same has not been reflected in its egg weight. The increase in egg number compared to parent lines might have resulted in a lower egg weight.

The egg weight at 40 weeks of age observed in this study in NNWL and NNNH was comparable with the report of Salahuddin and Howlader (1991) in Naked Neck (53.53g) and in Rhode Island Red (53.50g). But it was lower than the reports of Padhi *et al.* (1998) in Naked Neck (56.31g). This might be due to line differences. Compared to parental lines, the NNNH had a lower egg weight at 40 weeks of age indicating the absence of hybrid vigour.

Feed consumption

The mean daily feed consumption in NNWL and NNNH set out in Table 17 revealed very narrow variations for this trait. This was evident in the different periods as well as in the overall criteria. The average feed consumption from 21 to 40 weeks was 124.83 ± 2.88 g in NNWL and 125.14 ± 2.87 g in NNNH, respectively. The feed consumption showed an increase over the age from 21 to 36 weeks of age and

thereafter reduced slightly from 36 to 40 weeks of age. The increase in the feed consumption could be attributed to the increase in egg production as well as body weight. The rate of increase was also within normal limits. A point of consideration for this trait was the difference between the two crosses for their body weight. Although NNNH was heavier by 432.6g at 40 weeks of age, this was not reflected in the feed consumption. Therefore, it is presumed that much of the feed was utilized for production purposes and minimum quantity was utilized for bodyweight maintenance. The feed consumption data observed in the present study is in agreement with the observations made by Jayasree (2000) in indigenous Naked Neck and New Hampshire. Jayanthy (1992) recorded a lower daily feed consumption in Desi x New Rock ($106.61 \pm 4.17\text{g}$) and Desi x Austra White ($104.95 \pm 5.20\text{g}$) from 21 to 40 weeks of age. These differences might be due to difference in body weight of the lines involved

Feed conversion ratio (FCR)

The data on feed conversion ratio (Table 18) showed that it was high during the initial period when the birds started production, but it improved to more acceptable values from the second to the fifth period. The NNNH showed higher FCR values than the NNWL at the second and fourth periods of the experiment since the egg production in the corresponding periods was lower in former cross. The FCR value was the same in third period in both the groups. In the fifth period the mean values was lower in NNNH. The overall values of 2.89 and 3.01 for NNWL and NNNH respectively, was inflated due to the higher values in the first period, when the

egg production was initiated. The FCR values were in general acceptable and indicated that the crosses utilized the feed for production purposes and that the wastage was minimum. The detrimental effect of the summer season could be attributed to poor FCR in NNNH.

Results of the study was in agreement with reports of Merat *et al.* (1983) in crossbred chicken. The FCR observed in present study was better than that observed by Jayanthi (1992) in crossbred populations and this might be due to differences in egg production.

Livability

The data on livability (Table 19) has brought out the excellent performance of the crosses for this trait. During the first four periods, there was no mortality in both the crosses in spite of the fact that these periods correspond to the hot season of the year, when the temperature and humidity were high. The birds were also under the physiological stress of peak egg production during this period. Both the crosses could withstand these combined stresses effectively and there was only a slight reduction in egg number in NNNH cross. This ability of Naked Neck birds to cope up with summer stress was evident from the results of this study. A better livability in Naked Neck chicken has been documented by Merat (1986). The results of the present study is also supported by observation made by Desai and Halbrosk (1962), Sabalina (1964), Acharya and Kumar (1971) and Al-Soudi and Sokkar (1974) who reported

better livability in crosses of exotic and native breeds over their respective parent lines.

Broodiness

Broodiness of varying durations observed in both the crosses (Table 20) revealed that some of the birds were broody from 9 to 69 days. Although broodiness may be a trait which decreases egg production, it may be of utility in the context of backyard rearing. If the crosses are to be utilized for back yard rearing, this character may be put to use by the farmers to raise progeny. In the present study only nine birds in NNWL group (12 per cent) and eight birds in NNNH group (10.7 per cent) expressed broodiness. Therefore a drastic decline in egg production due to this trait was not noticed. This trait might have been inherited from Naked Neck male line, since the female line (White leghorn and New Hampshire) do not possess this character. The utility of these broody hens for hatching and rearing of chicks has to be verified under field conditions.

The expression of broodiness was reported by Jayanthi (1992) in Desi x New Rock and Desi x Austra white for periods ranging from 25 to 30 days. Nagy *et al.* (1956), Van Albada (1956) and Saeki and Inoue (1980) have also reported incidence of broodiness in crosses of White Leghorn with native breeds of chicken.

Plumage Colour And Shell Colour

The birds of the NNWL cross were off white whereas those of NNNH cross were multicoloured. This character is of significance if the birds are to be utilized for backyard rearing. Since the farmers prefer to raise coloured birds in the backyard, the NNNH cross has a definite advantage in this regard. But the NNWL cross also can be used in backyard, since they also have good production potential.

The egg shell colour in NNNH birds was brown or shades of brown which is again an advantage in the backyard conditions of rearing. The brown eggs from the household rearing fetches a premium price in the market. Since this a breed character, no special effort has to be taken to maintain the egg colour. The egg shell colour in the NNWL was tinted . This may be of some disadvantage under backyard rearing.

Egg quality

The egg quality of the NNWL and NNNH were also assessed in this study (Table 21). The NNNH had a higher shape index of 77.38, compared to 75.94 of NNWL. This observations revealed that eggs of the former cross were wider and it was closer to the ideal regular, ovoid shape. Similarly, albumen index was also better in NNNH indicating a better egg white quality, indicative of good egg quality. The yolk index and shell thickness were satisfactory and similar in both the crosses. The Haugh unit scores were also good. The results suggested that the eggs laid by NNWL and NNNH were of good quality.

The mean shape index in NNWL and NNNH cross recorded in the present study is in agreement with the observation made by Kumar *et al.* (1971a) in RIR x Desi crosses. Similar results were also obtained by Jayanthi (1992) in Desi x New Rock and Desi x Austra white. Lower values for shape index was recorded by Salahuddin and Howlider (1991) in White Leghorn and Naked Neck chicken and it might be due to strain difference. The mean albumen index and yolk index recorded in the present study is lower than the observations made by Jayanthi (1992) in crossbred chicken involving native and exotic breeds. The mean shell thickness observed in the present study was similar to the reports by Jain *et al.* (1978a), on shell thickness in various crossbreds. The Haugh unit score of NNWL and NNNH eggs recorded in the present study is higher than the observation made by Kumar *et al.* (1971a) and Jayanthi (1992) in various crosses involving Desi birds.

Economics

Economics of egg production set out in Table 22 revealed a higher cost of production per egg in NNNH cross than NNWL (208.94 vs 202.12). This variation has resulted from a higher feed intake coupled with a lower egg number in the NNNH group. Although the cost of feed per egg is on the higher side, it could be reduced considerably under backyard conditions.

Considering the production performances in NNWL and NNNH, it was observed that the mean values of egg number up to 40 weeks of age, egg weight, feed consumption and feed efficiency were similar in both the crosses. But the 20 week and 40 week body weight were higher in NNNH. Both the crosses expressed broodiness, high egg quality and excellent livability. The cost of feed per egg was lower in NNWL cross whereas the NNNH cross had multicoloured plumage and it laid brown shelled eggs. Although these two crosses were found to be very much comparable in production traits, the NNNH cross had the advantage in terms of body weight, plumage colour and egg shell colour. Therefore NNNH cross may be subjected to evaluation under the field conditions to ascertain it's utility as a bird for backyard rearing.

Summary

SUMMARY

An experiment was conducted at Kerala Agricultural University Poultry Farm, Mannuthy to evaluate and compare the production traits of Naked Neck x White Leghorn and Naked Neck x New Hampshire hens. Experimental chicks required for the study were hatched out by mating male of Naked Neck line with female of White Leghorn and New Hampshire respectively. The experimental chicks of the two crosses were reared in separate pens on litter floor under standard managerial conditions. At 18 weeks of age seventy five naked neck pullets each of Naked Neck x White Leghorn (NNWL) and Naked Neck x New Hampshire (NNNH) crosses were housed on litter floor in identical pens at the rate of 15 birds per pen and reared up to 40 weeks of age. The production performance of birds for five periods of 28 days each were recorded from February to July 1999. Data were subjected to statistical analysis and the following results were obtained.

1. The mean maximum temperature over the entire period of study from February to July 1999 was 32.27°C while the mean minimum temperature was 24.24°C. Mean per cent humidity was 90.22 during fore noon and 62.72 per cent during afternoon. The average value of sunshine hours was 6.38.
2. The mean body weight at 20 weeks of age was 1496.10 ± 15.75g in NNWL and 1855.60 ± 24.18g in NNNH and the body weight at 40 weeks of age was 2004.10 ± 26.86g NNWL and 2436.70 ± 27.00g in NNNH. Body weight of NNNH was significantly higher than that of NNWL both at 20 and 40 weeks of age.
3. The age at sexual maturity, recorded as mean age at first egg, was 152 days in NNWL and 146.8 days in NNNH and the difference between them was significant.
4. The week - wise mean hen housed production in NNWL reached a peak of 80.57 per cent at 26th week of age, while NNNH touched a peak of 81 per cent at 28th week of age.
5. The overall mean hen housed egg number upto 40 weeks of age was 86.39 in NNWL and 83.85 in NNNH and the difference was not statistically significant.

6. The overall mean egg weight was 48.73g in NNWL and 48.44g in NNNH and the difference between them was not statistically significant.
7. The overall mean daily feed consumption from 21 to 40 weeks of age was 124.83 g in NNWL and 125.14 g in NNNH, the difference being statistically non - significant.
8. The overall mean feed conversion ratio per dozen eggs was 2.89 for NNWL and 3.01 for NNNH and the difference in feed conversion ratio between the two crosses were statistically non - significant.
9. The livability was recorded as 98.7 per cent in NNWL for the period from 21-40 weeks of age while cent percent livability was recorded in NNNH.
10. Broodiness was shown by nine birds of NNWL cross for durations ranging from 9 to 63 days, while eight birds of NNNH cross exhibited broodiness for durations ranging from 22 to 69 days.
11. The plumage colour in NNWL was off white in 72 birds while three birds showed brownish colouration on wing feathers. NNNH birds had chestnut coloured plumage resembling New Hampshire birds while a small proportion of birds had multi coloured plumage resembling their Naked Neck sires.
12. Egg shell colour was tinted in NNWL while egg shell colour in NNNH was brown or shades of brown.
13. The mean shape index at 32 weeks of age was 75.94 in NNWL and 77.38 in NNNH and the difference between the crosses were statistically significant
14. The mean albumen index at 32 weeks of age was 0.089 in NNWL and 0.099 in NNNH, and the difference between them was found to be statistically significant.
15. The mean Yolk index at 32 weeks of age was 0.442 in NNWL and 0.447 in NNNH.
16. The mean shell thickness at 32 weeks of age was 0.376 mm in NNWL and 0.373 in NNNH.
17. The mean Haugh unit score at 32 weeks of age was 84.78 in NNWL and 88.00 in NNNH.

18. The cost of feed per egg was 202.12 paise for NNWL and 208.94 paise for NNNH for the entire course of the study.

From the above findings it is evident that NNNH had significantly higher body weight than NNWL both at 20 and 40 weeks of age. Significantly lower age at first egg was observed in NNNH. Both the crosses had statistically similar hen - housed production, hen - day production, egg weight, feed consumption and feed conversion ratio. The cost of feed consumed per egg produced was also comparable for both NNWL and NNNH. It may also be concluded that both NNWL and NNNH crosses are acclimatized to the environment due to the fact that peak production was reached during summer months. Most of the economic traits being statistically comparable between NNWL and NNNH, the significantly higher body weight, lower age at first egg, better shape index and albumen index along with coloured plumage pattern and brown shelled eggs of the NNNH birds are advantageous as it was much preferred by rural farmers of Kerala which gives it an edge over NNWL birds with off white plumage colour and tinted eggs. However the Naked Neck x New Hampshire cross may be subjected to further studies in larger flock size under field conditions.

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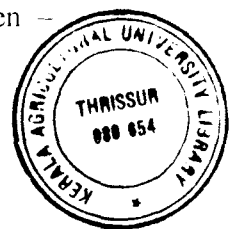
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**PERFORMANCE OF CROSSES OF INDIGENOUS
NAKED NECK WITH WHITE LEGHORN
AND NEW HAMPSHIRE**

**By
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ABSTRACT OF A THESIS

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ABSTRACT

An experiment was conducted at Kerala Agricultural University Poultry Farm, Mannuthy, to evaluate and compare the production traits of Naked Neck x White Leghorn (NNWL) and Naked Neck x New Hampshire (NNNH) crosses under deep litter system of rearing from 20 to 40 weeks age. Seventy five pullets of each cross were housed in identical pens of 15 birds each and production performance was evaluated for five 28- day periods from February to July 1999. Standard feeding and managerial practices were followed throughout the study.

The NNNH were heavier than NNWL at 20 weeks of age (1855.6 vs 1496.1g) and at 40 weeks of age (2436.7 and 2004.1g). The age at first egg of 146.8 ± 1.48 days in NNNH was significantly earlier than 152 ± 1.3 days in NNWL. The age at 50 per cent production was similar in NNWL (162.4 ± 1.92 days) and NNNH (164.6 ± 1.7 days). The week-wise mean hen housed production in NNWL reached a peak of 80.57 per cent at 26th week of age, while NNNH attained a peak of 81.0 per cent at 28th week of age. The overall mean hen housed number up to 40 weeks of age was 86.39 in NNWL and 83.85 in NNNH. Hen day production remained the same as hen housed production up to 39th week of age and the overall trend was similar.

The daily feed consumption from 21 to 40 weeks of age was 124.83g in NNWL and 125.14g in NNNH. The feed conversion ratio per dozen eggs was 2.89 for NNWL and 3.01 for NNNH. Broodiness was shown by nine birds in NNWL for durations ranging from 9 to 63 days while eight birds in NNNH were broody for durations ranging from 22 to 69 days. The mean egg weight from 21 -- 40 weeks was

48.73g in NNWL and 48.44 g in NNNH. The shell thickness was 0.376 mm in NNWL and 0.373 in NNNH. The Haugh unit score was 84.78 in NNWL and 88.00 in NNNH. The plumage Colour in NNWL was off white, but a few birds showed brownish colour on wing feathers. 90 per cent of the NNNH birds had chestnut coloured plumage resembling New Hampshire birds while the rest were multi coloured resembling indigenous Naked Neck birds. Egg shell was tinted in NNWL while NNNH eggs were brown or shades of brown. The livability was 98.7 percent in NNWL, while it was 100 per cent in NNNH. The cost of feed consumed per egg was 202.12 paise for NNWL and 208.94 paise for NNNH for the entire course of the study.

Both NNWL and NNNH cross had statistically comparable hen housed production, egg weight, feed consumption and feed conversion ratio. Both the crosses had excellent livability and good egg quality. However a significantly higher body weight both at 20 and 40 weeks of age, earlier average age at first egg, coloured plumage pattern, and brown shelled eggs in NNNH cross are much preferred by rural farmers. The results of the present study warrants further studies on Naked Neck x New Hampshire cross under field conditions.