EFFECT OF ALTERNATE DAY, SCRATCHED AND PHASE FEEDING ON THE PERFORMANCE OF EGG TYPE CHICKEN

by

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DEDICATED

to

POULTRY FARMERS

CERTIFICATE I

This is to certify that this thesis entitled, "Effect of alternate day, scratched and phase feeding on the performance of egg type chicken" submitted for the degree of Master of Vety. Science in the subject of Livestock Production Management (Poultry Science) of the Haryana Agricultural University, is a bonafide research work carried out by Shri Sachin Baruah under my supervision and that no part of this thesis has been submitted for any other degree.

The assistance and help received during the course of investivation have been fully acknowledged.

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CERTIFICATE II

This is to certify that the thesis entitled, "Effect of alternate day, scratched and phase feeding on the performance of egg type chicken" submitted by Shri Sachin Baruah to the Haryana Agricultural University in partial fulfilment of the requirements for the degree of Master of Vety. Science in the subject of Livestock Production and Management (Poultry Science) has been approved by the Student's Advisory Committee after an oral examination on the same, in collaboration with an External Examiner.

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C O N T E N T S

I. INTRODUCTION

The cost of poultry feed represents the largest single expenditure, accounting for over 60 percent of the total input of broiler and egg production. The price of the major feed ingredients like maize, groundnut cake and fish meal greatly fluctuates and creates a serious problem for poultry producers. To counter-balance this type of malady, the farmers are always in search of ways and means to reduce the cost of feed and restore profit margin. Sidhu and Rangi (1979) reported that the egg prices increased by 86 percent while the feed prices registered an increase of 213 percent during the last 14 years (ending 1973). It is important to evolve a feeding system which can reduce the cost of production and permit an economic performance of birds.

The use of unconventional agro-industrial wastes and by-products as poultry feed has attracted the attention of scientists since long time for economic feeding of birds. Sidhu and Nagpal (1965) prepared and evaluated a large number of economic poultry rations, using rice polish, maize grit, molasses, maize gluten meal and antibiotic wastes. The feed cost was reduced by 40 percent over standard rations as reported by Sidhu and Nagpal (1965). Rao et al. (1966) observed that rice polishing could be included in the growing ration at 40 percent level, enabling a considerable reduction in the cost of feeding.

Ad libitum feeding of birds is a common practice but it has been observed that birds tend to over eat in this feeding regime. In order to check this controlled feeding is practised by poultry farmers. The restricted feeding is one of the many methods of controlled feeding and is generally practised in growing pullets between 6 and 20 weeks age. Various methods like limited feeding time; low dietary protein/amino acid concentration, nutrients dilutor by replacing diet with low nutritional value such as whole oat, oat hull, saw dust etc.; restricting the quantity of feed offered; energy restriction; and elevation of environmental temperature.

There is substantial information available on restricted feeding during growing period. Schneider et al. (1955), Hollands and Gowe (1961, 1965); Fuller and Dunahoo (1962), and Strain et al. (1965) reported that quantitative feed restriction during the rearing period reduced body weight at point of production, delayed the sexual maturity, decreased laying house mortality, resulted in feed saving and better reproductive performance than the control group.

Twenty percent restriction of feed during growing period (6 to 20 weeks of age) has given most satisfactory result. (Reddy et al., 1974).

Scratched feeding is an old age method of rearing birds. In a broad sense it is also a restricted method of feeding with nutrient restriction.

Phase feeding of laying stock is another method of feeding birds for improving efficiency of egg production. During the early period (onset of lay Phase I) is the most critical in the productive life of pullets. At this stage high level of dietary nutrients are required for growth of body tissues and feathers as birds are still growing. After 8 to 10 weeks of onset of lay, the young pullets consume sufficient amount of energy and protein to permit them to produce eggs at the rate of 85-95 percent, to increase body weight, to combat stress and disease, and improve egg size. Reducing the protein content of ration with advancing age thereafter (Phase II and III) save some money. Scott et al. (1969) recommended that the dietary protein requirements were 18.0, 16.0 and 15.09 percent per day for Phase I, II and III, respectively.

The information on integrated approach of various feeding methods specially scratched and phased during growing and laying period is lacking. The present study was undertaken with the following objectives:

1. To reduce the feed cost for egg production through controlled feeding.

2. To evaluate the effect of controlled feeding (scratched and alternate day feeding) on the productive performance of growing birds.

3. To study the effect of phase feeding during laying period, on reproductive performance (sexual maturity, egg production, egg weight) of hens.

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2. REVIEW OF LITERATURE

General

The effect of restricted feeding on growing pullets upon their subsequent laying house performance varies depending upon the method, duration, age and severity of feed restriction. Over consumption of feed due to *ad libitum* feeding may cause obesity which in turn results in poor reproduction. Fuller et al. (1959) and MacIntyre and Gardiner (1964) noticed delayed sexual maturity, improvement in egg production and feed efficiency and a significant reduction in the number of small eggs laid by restricted birds.

Gowe *et al.* (1960) observed that feed restriction during growing period is a mild stress which stimulates greater development of the endocrine glands. During laying period this stress is removed and the birds achieve a higher rate of lay and greater resistance to environmental stress.

Michael and Hodges (1975) studied the histo-chemistry of the duodenum of the restricted and normal fed birds and showed some atrophy of the intestinal villi resulting in the increased mucosal enzyme activity and enhanced nutrient absorption in the gut.

Watson (1975) observed that the broiler breeding pullets subjected to feed restriction during the rearing period had larger, heavier oviduct, a faster rate of growth of ovarian follicles and greater speed of oviposition time throughout the year. He suggested that the change in the

size of ovary and oviduct of the restricted reared hens seems to be related to improved production.

About 5 percent saving in feed consumption of growing pullet has been reported by Yates and Schaible (1963) by skipping feeding once a week.

Bjornstad and Hvidsteir (1973) offered feed on every second day from 8 to 20 weeks of age and noted that the birds consumed 9-10 percent less feed than those fed ad libitum throughout the period.

Proudfoot and Lamoreux (1973) showed that "Skip-a-day" method of feed restriction resulted in increased egg size, reduced body weight and improvement in feed efficiency. No significant difference was observed between skip-a-day programme and ad libitum feeding with respect to sexual maturity, body weight gain, except considerable saving in feed consumption over the 8-40 weeks period on Strain Cross White Leghorn pullets as studied by Nair and Ramakrishna (1977).

'Scratch' feeding is one of the old methods of feeding birds. Some cereal grains were spread in the range for scratching by birds and their partial nutrient requirement was met by feeding on green grass and insects in the range. In a sense, this method of feeding was restriction of feed nutrient particularly protein and hence desirable effects were observed (Brake and Garlich, 1980).

Denton and Lillie (1959) fed White Leghorn pullets with 12 and 16 percent protein diets during rearing and laying periods. They observed that low protein grower diets resulted in decreased body weights of pullets. The feed consumption and egg production, however, remained unaffected in comparison to the feeding of 16 percent protein.

Bullock et al. (1963), Lillie and Denton (1966), Petersen et al. (1966), Smith (1967), Summers et al. (1969) and Blair et al. (1970) reported a reduction in body weight gain and feed consumption during rearing period due to protein restriction.

The sexual maturity was delayed in the protein restricted birds compared to full fed birds (Waldroup and Harms,1962, Palafox, 1965, Lillie and Denton, 1966-67, Peterson et al., 1966).

Malynicz (1977) reported the results of feeding the broiler starter or grower rations containing 10, 25, 35 and 50 percent rice bran and found that body weight gain and efficiency of feed conversion did not differ significantly. There was a considerable economic advantage in substituting rice bran for sorghum.

Sanz and Elias (1979) reported that 50 percent replacement of maize by rice polishing in chicken diet resulted in faster body weight gain and better feed efficiency of 2.54 as compared to 2.75 in maize exclusive maize fed group.

Maize replaced by rice polishing to the extent of 25, 50, 75 or 100 percent had no depressing effect on carcass

meat and viscera as compared to control fed 57.15 percent maize (Sauz and Elias, 1980).

Bruins (1958) reported the results of feeding grower diets containing 40 percent oat mill and control group were fed normal diets either ad libitum or restricted during the growing period. Intake of the low energy diet was found 35 percent higher than that of the normal diet and 85 percent greater than that of the birds restricted during the rearing period. Caloric reduction was 31 percent through quantitative food restriction but only 13 percent through the feeding of high fibre diets.

The broiler breeder pullets fed on diet containing more than 35 percent oat meal had a decreased body weight gain and increased age of sexual maturity (Issacks et al., 1960, Waldroup and Harms, 1962; Yates and Schaible, 1963, and Waldroup et al., 1966). Lillie and Denton (1966) diluted the grower rations by adding 25-30 percent oat hulls and found that the feed consumption increased significantly and the sexual maturity was not affected.

Sharma (1967) reported that addition of 15 percent saw-dust in layer ration increased feed consumption and showed poor economic returns.

Restricting the quantity of feed during growing phase of chicken reduce body weight gain and weight at sexual maturity, increases the rearing mortality and decreases the laying house mortality (Gowe et al., 1960).

Fuller and Dunahoo (1962) and Strain et al. (1965) observed that quantitative restriction of feed during the rearing period reduced body weight at point of lay, delayed sexual maturity and decreased laying house mortality.

Quantitative feed restriction during growing period improved egg production during pullet year and also subsequent years, feed efficiency and laying house viability were also improved (Gowe et al., 1960, Holland and Gowe, 1961, 65: and Strain et al., 1965).

The phase feeding in laying stock is a way of reducing feed cost by varying the energy and protein level at different stages of production. The protein and energy content is kept highest in the first phase of laying period (22 to 42 weeks) as there is necessity for adequate protein, amino acids, vitamins and minerals for maximum production, increase in egg size and normal growth to physiological maturity. During the subsequent two phases of reproductive life of hens egg production starts declining and thus demand for body growth decreases. Hence, the nutrient content of ration is also decreased.

Scott et al. (1969) reported the following approximate daily protein requirements by White Leghorn pullets during Phases I, II and III (Table 1).

Table 1

Approximate requirements of daily dietary protein by White Leghorn pullets during Phase I, II and III.

	Dietary protein needed per hen per day		
	Phase I (g)	Phase II (g)	Phase III (g)
Output of one egg	9.9	10.5	9.5*
Maintenance of body tissues	5.3	5.3	5.3
Growth of body tissues	2.1	0.0	0.0
Growth and maintenance of feathers.	0.7	0.2	0.2
Total dietary protein needed	18.0	16.0	15.0

* 85 percent production.

Smith (1967) tested diets containing 11, 15 and 19 percent protein during rearing and laying periods. The three protein levels did not result in differences in egg production: (74.9, 73.8 and 75.8 %) but egg weight and body weight were affected by increased protein.

Reid et al. (1951) found that 18 percent protein ration was superior to either 15 or 13 percent for egg production.

Miller et al. (1956) found that neither egg production nor body weight was affected by increasing the protein level from 12 to 21 percent. Similar information on the plane of nutrition in laying bird was reported by Thornton et al.(1957). They did not notice any effect on egg production, feed efficiency, or body weight by feeding 17, 15, 13 and 11 percent protein in strain cross White Leghorn.

Effect of controlled feeding

Duration of restriction period:

The feed for restriction is practised in growing birds at 5 to 6 weeks of age and continued till 21 to 25 weeks of age. Restriction upto 12 weeks has no significant effect on later performance. Restriction from 5-6 weeks to over 25 weeks affects production adversely (Vedhanayagam, 1979).

Gardiner and MacIntyre (1962) observed that earlier the age of feed restriction, the greater was the reduction in body weight and delay in sexual maturity.

Fuller and Dunahoo (1962) studied the performance of pullets restricted from 6 to 12, 6 to 18 and 6 to 24 weeks of ages. They observed that when feed restriction was stopped at or before 18 weeks of age, the birds were able to compensate and the effect of restriction on sexual maturity was little.

Effect of body weights and weight gains:

Milby and Sherwood (1956) observed that birds kept on restricted feeding during growing period were lighter at 20 or 21 weeks of age. Removal of feed restriction resulted in a rapid recovery in body weight and at 46 and 61 weeks of age the differences in body weights between restricted and full fed groups were not significant. Gowe et al. (1960) observed that feed restriction reduced the body weight of the pullets. Similar observations were reported by Walter and Aitken (1961), Hollands and Gowe (1961, 1965).

The degree of reduction in body weights depended upon the level and duration of restriction. Fuller and Dunahoo (1962), Gardiner and MacIntyre (1962), MacIntyre and Gardiner (1964) reported a direct relationship between duration and degree of restriction, and body weight at the end of feed restriction. They further reported that once the restricted groups were put on full feed they gained weight rapidly but never attained the body weight of the full fed group. At the end of the laying period all restricted groups were significantly lighter than the full fed group.

Strain et al. (1965) reported that 30 percent feed restriction in White Leghorn pullets from 5-21 weeks of age resulted in a decrease of 310 gm in weight at 21 weeks and at 365 days the differences was only 40 gms.

Fuller et al. (1970) observed that there was a difference of 422 gms at 24 weeks between restricted and full fed groups and at 365 day the difference was levelled off.

Iino et al. (1969) observed that feeding Plymouth Rock pullets on skip-a-day a week plan did not affect growth rate although feed intake was 9 percent more and body weight at 44 weeks was 6 percent less than on the control diet.

Voitle et al. (1974) reported that skip-a-day plan was most effective in controlling body weight in case of broiler breeds at 24 weeks of age. Sirbu et al. (1977) found that when birds deprived of feed for 1 day a week has satisfactory body weight gains.

No significant difference between alternate-day feeding programme and ad libitum feeding with respect to body weight gain on pullets was observed by Nair and Ramakrishna (1977).

Jackson (1970) reported a significant reduction in body weight gain in medium and light weight hybrids using high energy (2690 ME Kcal/kg) and ultra-high-energy (3550 ME Kcal/kg when feed was restricted.

Reddy et al. (1974) observed that feed restriction from 7-20 weeks of age retarded the growth of pullets during rearing period depending on the level of restriction, but feed restriction had no effect on body weight after 32 weeks of age.

Pym and Dillon (1974) reported a marked compensatory body weight gains in all the birds restricted during the rearing period. It appeared that increased feed consumption and better utilisation during full feeding period after feed restriction were largely responsible for compensation in body weight. Vaidya and Sathe (1974) also observed a similar phenomenon. When full feeding was given after 24 weeks of age, birds grew faster than control and by 36 weeks of age there were no differences in body weight between restricted and full fed groups.

Singh et al. (1975) observed a significant reduction in body weights in birds of restricted fed groups compared to full fed group.

Narahari et al. (1975) reported a significant reduction in body weight at time of housing among the pullets restricted

for 5 to 20 or 25 weeks of age. At 31 weeks of age all these groups attained body weights comparable with those of the controls. This uniformity was maintained till the end of experiment (55 weeks). Berg and Bearse (1961), Deaton and Quisenberry (1963) and Strain et al. (1965) reported significantly lighter body weights at the end of the laying cycle, following feed restriction during the sexual maturity.

Effect on sexual maturity:

The age at first egg and age at a specified level of production, usually at 50 percent production are widely adopted as measures of age at sexual maturity. The onset of sexual maturity produces a prominent effect on the physiological development processes and the development of feather, pigment in coloured birds like Barred Plymouth Rocks and Rhode Island Red. The age at sexual maturity is negatively correlated with total egg production and this trait differs in different breeds, varieties and strains. Although the early sexual maturity is a genetically controlled character, yet environmental influences like breeding, feeding, housing and mana gement play an important role in it expression. Restricted feeding delays the age at sexual maturity. However, the annual egg production is increased by attaining a higher peak level and slow rate of decline thereafter, the rate of delay is governed by the severity of feed restriction.

Schneider et al. (1955) noticed that sexual maturity was delayed by 2 to 4 weeks in the birds kept on a low protein ration by quantitative feed restriction during growing period.

Gowe et al. (1960) observed a 12 day delay in sexual maturity in White Leghorn birds by a feed restriction treatment for 8 to 21 weeks of age at 70 percent level of feeding.

Hollands and Gowe (1961) reported that full fed birds attained sexual maturity 16 days earlier than feed restricted birds when the levels and duration of feeding were 90 percent from 22 to 28 days, 80 percent from 29 to 35 days and 70 percent from 36 to 147 days.

Fuller and Dunahoo (1962) restricted the feed intake of White Leghorn pullets for the periods - none, 6-12, 6-18, 6-24, 12-24 weeks of age. During these periods feed was limited to the average intake at 6 weeks of age. The respective age at sexual maturity were 147, 145, 159, 179 and 181 days.

Strain et al. (1965) reported that feed restriction in Single Comb White Leghorn pullets from 22 to 146 days of age at 70 percent feeding retarded sexual maturity by 15 days.

Lillie et al. (1966) found a significant delay in maturity of White Leghorn fed 75 percent feed from 8 to 20 weeks.

In White Rock and White Cornish pullets maintained on medium and low energy feeds skipping feed every seventh day from 10-49 weeks resulted in 10 days delay in sexual maturity (Iino et al., 1969).

Reddy (1970) reported that feed restriction at 10 to 40 percent levels delayed sexual maturity in White Leghorn by 7 to 31 days.

Lee and Kim (1977) restricted the diets of broiler breeders to 20-35 percent of ad libitum level from 7-24 weeks of age and observed that sexual maturity was delayed by 1 to 2 weeks in restricted groups as compared to ad libitum fed groups.

Singh et al. (1975) restricted the feed of broiler pullets to 90, 80 and 70 percent of ad libitum intake during 14 to 25 weeks of age and observed that age of sexual maturity was delayed as the level of restriction was increased from ad libitum to 70 percent. Age at sexual maturity was lowest for the controls as compared to the restricted groups. Narahari et al. (1976) fed the egg type pullets ad libitum and 80 or 70 percent of ad libitum for varying period ranging from 5 weeks to 10, 15, 20 or 25 weeks of age. They observed that age at first egg, 50 percent and peak production stages were delayed in restricted groups by 1 to 32, 1 to 19 and 2 to 16 days, respedtively compared to controls. The delay in age at first egg was based on level and duration of restriction.

Sharma (1978) reported that restricted egg type pullets took longer time to attain sexual maturity. The delay was by 9 to 25 and 7 to 22 days at first egg and at 16 percent production, respectively due to restricted feeding. He further observed that the restricted pullets took lesser time to reach peak production in comparison to the control group. The pullets of control group took 51 days to reach peak production whereas the pullets of the 70 percent of ad libitum feed intake group took only 32 days.

Nair and Ramakrishna (1977) studied the effect of skip-a-day feeding on Strain Cross White Leghorn pullets from 8 to 40 weeks of age. They found no significant differences on sexual maturity between skip-a-day programme and ad libitum feeding.

Solun et al. (1978) restricted feeding of young replacement pullets from 85 to 160 days and observed that age at first laying was 160 to 183 days.

Gous (1978) studied the effect of feeding low Lysine and low protein diets from 8 to 20 weeks in chickens reported a delayed sexual maturity.

The average age at sexual maturity of hybrid Leghorn pullet was 160 to 167 days compared to 155 days for normal fed, when feed was restricted during 57 to 140 days of age.

Effect on feed intake and feed efficiency:

Milby and Sherwood (1956) observed that the feed consumption per bird to maturity, from maturity to end of laying and the feed required to produce a dozen of eggs, were 10.1, 41.4 and 2.45 kg in full fed group compared to 9.5, 40.0 and 2.27 kg, respectively in restricted groups.

MacIntyre and Aitken (1959) observed that the feed consumed upto the age of 2 percent egg production, 2 percent egg production to end of the laying period and to produce a dozen of eggs was 7.6, 42.8 and 2.3 kg in the full fed groups and 6.7, 41.9 and 2.31 kg, respectively in restricted groups.

Walter and Aitken (1961) found that the feed consumption of full fed group and restricted group upto the age of maturity from first egg to the end of the laying cycle and to produce a dozen of eggs was 6.0, 39.3 and 2.15 kg and 5.6, 39.0 and 2.08 kg, respectively.

Fuller and Dunahoo (1962) on the contrary observed that the feed consumption of a bird in the full fed group was less upto the age of maturity in comparison to the feed consumption of the bird in restricted group.

In White Leghorn, feed consumption from 145 to 500 days was slightly more in the restricted group but the difference was much less than the amount of feed saved during the growing period (Strain et al., 1965).

Lillie et al. (1966) reported that fibre dilution increased feed intake and feed restriction reduced feed intake significantly.

In White Cornish and White Rock birds skip-a-day every 7 days had no effect on feed intake (Iino et al., 1969).

Reddy et al. (1974) reported that the feed-restriction from 7 to 20 weeks of age resulted in a significant reduction in feed consumption without any significant difference in the efficiency of feed utilization. During laying period feed efficiency decreased in the restricted groups compared to the groups fed ad libitum in growing period.

Vaidya and Sathe (1974) found that the feeding of ad libitum diets, after 24 weeks of age to the restricted reared birds resulted in higher feed consumption than the control birds. However, the feed efficiency in the restricted fed groups was better than that of control.

Narahari et al. (1975) observed that the pullets reared on ad libitum and 80 and 70 percent of ad libitum feeding from 5 to 25 weeks of age consumed from first egg to 55 weeks of age 3.65, 3.08 and 3.29 kg of feed to produce one kg of eggs and 2.2, 1.95 and 2.06 kg feed for the production of one dozen of eggs, respectively. The performance efficiency index was found 30.5, 35.1 and 30.9 from 23 to 55 weeks of age in these group, respectively.

Singh et al. (1975) in broiler breeder stock found that the average feed efficiency ratios from 14 to 25 weeks of age in the groups fed 90, 80 and 70 percent of ad libitum were 6.19, 6.12, 5.65 and 5.56, respectively and during the laying period the feed consumption for the production of a dozen eggs was 3.30, 3.70, 3.00 and 2.80 kg, respectively for the aforesaid levels of feed intake. The average feed consumption in the laying period i.e. from 182 to 300 days of age in these groups was 11.62, 10.80, 11.22 and 10.38 kg, respectively.

Watson (1975) reported that feed consumption per bird during laying period was higher in case of restricted groups compared to the full fed groups. The average feed consumption per bird per day during 22 to 42 weeks was 162, 192, 190 and 188 grams, respectively for 100, 80, 70 and 60 percent restriction of ad libitum.

Nair and Ramakrishna (1977) observed that the feed consumption by pullets reared on ad libitum, one day feed deprivation in every seven days, 80 and 70 percent of ad libitum feeding from 8 weeks to point of lay were 17.30,

15.23, 14.44 and 13.22 kg feed with feed efficiency 2.32, 2.25 2.20 and 1.77 kg per dozen eggs.

Sharma (1978) observed that feed consumption of the pullets reared on restricted diets was similar to or lesser than the feed intake of the ad libitum fed groups during the laying period. The lesser feed consumption in the severely restricted groups was due to the smaller size of the restricted fed groups. The feed efficiency from 22 to 50 weeks of age was better in all the groups reared on restricted feeding when compared to full fed groups birds. It was concluded that the pullets on restricted feeding programme made better utilization of the feed.

Effect on egg production:

The early work of Kent (1937) as quoted by Carlson and Hoeizel (1946) indicated that restricted feeding during the rearing period increased the number of egg with a decrease in number of small eggs. However, Sherwood and Milby (1954) Singsen et al. (1954) and Milby and Sherwood (1956) could not observe any consistent effect on egg production as a result of feed restriction during growing period.

Schneider et al. (1955) observed that there was no difference in number of eggs laid between control and restricted groups, however a significant shift in egg production curve was noticed.

Fuller et al. (1959) found that restriction upto 12 or 18 weeks of age had no apparent effect on egg production but prolonged restriction upto 24 weeks of age resulted in increased egg production from 32 to 52 weeks of age - both on the hen housed and hen-day-basis.

Quisenberry *et al.* (1959) reported that caloric restriction of pullets during growing period had no consistent effect on rate of egg production.

The protein and energy (PE) ratio i.e. 16:946 diets of laying hens gave significantly higher feed/food protein conversion ratios than 17.2:936 and 18:1000 diets, respectively as reported by Quisenberry *et al.* (1967).

Gowe *et al.* (1960) concluded that restricting the feed intake of pullets during the growing period increased the intensity of egg production after the delay in sexual maturity was overcome.

Hollands and Gowe (1961) noticed that despite delay in sexual maturity the restricted fed group laid more eggs in the first production year. Following forced moult, the restricted birds came into production more quickly and laid at a higher rate throughout the second production year.

Berg and Bearse (1961), Walter and Aitken (1961) and Gardiner and MacIntyre (1962) had shown that pullets restricted during the rearing period had a higher peak rate of lay than those fully fed during the growing period. Bullock *et al.* (1963) observed 3.2 percent higher rate of lay for equal periods after 50 percent production with restricted reared pullets.

Strain *et al.* (1965) observed that the rate of egg production after initial delay in sexual maturity was significantly higher for the birds kept in restricted feeding during growing period than the full fed birds. They concluded

that the optimum level of feed restriction during the rearing period for better egg production was between 70 to 80 percent of ad libitum feeding.

No significant difference in egg production of the birds from 8 to 20 weeks of age in the groups fed ad libitum, 80, 75 and 70 percent of ad libitum was noted (Lillie and Denton, 1966).

Gowe et al. (1965) and Reddy (1970) observed that feed restriction of 20 to 30 percent feed resulted in higher rate of lay.

Vaidya and Sathe (1974) allowed the feed intake at the rate of 80 and 70 percent of ad libitum intake from 12 to 24 weeks and found that the average egg production of ad libitum 80, 70 percent of ad libitum fed groups was 60.0, 65.04 and 61.03 percent in 100 days of egg production.

Reddy et al. (1974) tried five dietary regimes viz. ad libitum, 90, 80, 70 and 60 percent of ad libitum during growing stage from 7 to 20 weeks of age. They observed that all restricted feeding regimes had similar effect on egg production, as control, except 60 percent of ad libitum fed birds in which the production was depressed. They concluded that moderate feed restriction in the range of 70-80 percent of full feeding, during growing is more beneficial than the ad libitum feeding programme.

Voitle et al. (1970) observed that skip-a-day programme with broiler breeder pullets delayed sexual maturity, increased total egg production and reduced the interval between 25 and 50 percent production.

Bjornstad and Hvidsteir (1973) fed birds every second day and found that birds ate 9.1 percent less feed and gave higher egg yield compared to the full fed control.

Voitle et al. (1974) observed that hens laid more eggs after skip-a-day feeding than any other rearing treatment.

Auckland and Wilson (1975) restricting the laying hens from 32 to 68 weeks of age allowing rehabilitation period of ad libitum feeding observed that the egg production of the restricted group was 66 to 70 percent against 74.3 percent of the control.

Singh et al. (1975) observed that the broiler pullets on 90, 80 and 70 percent of ad libitum feed intake laid on an average 50, 57 and 38 percent in comparison to the 66 percent production of the control group.

Sharma (1978) observed that the restricted pullets showed poor rate of egg production during the first experimental period (22 to 26 weeks) but in later part of experimental periods the restricted pullets showed higher rate of egg production and concluded that the lower level of feed intake during the growing period increased the efficiency of egg production.

Robinson et al. (1979) reported that pullets with intake restricted by 6 percent in the laying period laid about 25 more eggs to 90 weeks than those fed freely during laying.

Solun et al. (1978) observed the feeding of birds and showed that restricted feeding of replacement pullets has an improvement and positive effect on productivity. Ageev et al. (1979) reported that egg production decreased when feed was restricted at the beginning of the laying period and increased when feed was restricted after the peak of laying at 300 days.

Heywang et al. (1955) showed that 15 percent protein ration at a high energy level was comparable to 18 percent level for egg production in both hot and moderate climate. Lillie and Denton (1967) found that a 14 percent ration in layer was adequate for maximum egg production.

Effect on egg weight:

Sherwood and Milby (1954) reported that first egg of birds kept on restricted feeding were heavier than the first egg of the full fed birds but at any given calender date the eggs were substantially of the same size. Milby and Sherwood (1956) also reported similar results.

Proudfoot and Gowe (1967) reported a heavier average egg weight from birds on restricted diet in comparison to the egg of the birds reared on ad libitum feeding when estimates were made in a sample of eggs at one point during the laying period.

Lee et al. (1971) did not observe any significant difference in the average egg weight at the same chronoligical age in restricted fed pullets and those fed "adequate" diet ad libitum during rearing. When the results were weighted

for production, egg size was found larger in restricted groups. The pullets fed laying deficient diets during rearing laid significantly smaller eggs than those fully fed controls.

Gowe et al. (1960), Walter and Aitken (1961), Fuller and Dunahoo (1962) and Strain et al. (1965) observed a reduced percentage of small eggs at the beginning of the production cycle in the case of the restricted birds and the mature weight of the egg was similar to that of birds maintained on full feed during the rearing period. Sunde et al. (1954) and Schneider et al. (1955) reported significant increase in the egg weight of restricted birds.

Reddy et al. (1974) observed that the size and production of egg mass per pullet were higher in the restricted birds.

Fuller and Chaney (1974) reared White Leghorn pullets on restricted dietary energy (2/3 of voluntary intake) treatments during growing period and observed that pullets under restricted energy regimes laid more settable eggs, fewer small and double yolked eggs and more eggs in "extra large" and "large" market egg classification than control.

Vaidya and Sathe (1974), Singh et al. (1975) and Gous (1978) observed that there was no difference in egg weights of full and restricted groups.

Narahari et al. (1975) observed a significant difference of egg weights between treatments. They noticed that in

groups which were fed 70 percent of ad libitum feeding, the egg weight was significantly higher than the full fed group. Similarly the egg weights on Ist, 10th and 100th day of production in 70 percent level of ad libitum feeding from 5 to 25 weeks of age were found heavier than those of control group.

Watson (1975) observed that the restriction of feed during the rearing period resulted in an increased percent rate of lay of hatchable eggs as compared to fully fed controls. Similar results were obtained in the recent works of Miller et al. (1977); Iotsyus et al, (1977) and Yeh (1980).

Thornton et al. (1957) used different range of protein levels (17, 15, 13 and 11 percent) in laying ration. Egg weight was reduced in a highly significant manner at the 11 percent level. Incidence of small eggs was greatest at the 11 and 17 percent level and lowest at the 15 percent level.

Effect on fertility and hatchability of eggs:

Restricted feeding during the rearing period does not have any deleterious effect on the fertility and hatchability of the eggs (Sunde et al., 1954; Milby and Sherwood, 1956). It rather had a better effect on the production of more settable eggs, accompanied with better fertility and hatchability (Schneider et al., 1955).

Voitle et al. (1974) also observed results in support to earlier findings that restricted feeding during rearing period had no adverse effect on fertility and hatchability.

Khan et al. (1977) observed that short term quantitative feed restriction treatments should have no adverse effect

on fertility and hatchability of broiler breeds of chicken. They found percent fertility and hatchability (Total egg basis) in ad libitum feeding, alternate-day-feeding and 50 percent restriction in feed intake from 16 to 23 weeks of age was 84.9, 85.3 and 87.2 and 71.9, 72.8 and 71.8, respectively.

Nair and Ramakrishna (1977) reported that skip-a-day feeding programme from 8 to 40 weeks had no effect on fertility and hatchability and noted some variations among various treatments but these minor differences did not follow any definite trend.

Tzvetanov et al. (1978) reported quantitative feed restriction during growing period improved hatchability.

Cave (1978) did not observe any significant difference in fertility on hatchability over the entire 28 weeks laying period. He fed all mesh, wheat and Rye plus wheat ad libitum feeding from 6 to 20 weeks of age to broiler breeders. The percent fertility and hatchability were 92.2, 92.4, 92.6 and 90.6, ..., 89.2, 89.8, respectively.

Effect on mortality:

The mortality rate during the rearing period was slightly higher in feed restricted birds than in the full fed birds (Fuller and Chaney, 1974). As reported by Schneider et al. (1955), Hollands and Gowe (1961), Fuller and Dunahoo (1962), Strain et al. (1965) and Proudfoot and Gowe (1967), there was little effect on the laying house mortality. However, Gowe et al. (1960), Hollands and Gowe (1961) reported that

laying house mortality was reduced in feed restricted birds as compared to ad libitum fed birds.

Bruckner and Hill (1971) reported the occurance of coccidiosis and respiratory disease in pullets under going feed restriction. Hollands and Gowe (1961) observed that these two conditions accounted for 20 percent of the extra deaths in pullets reared on restricted feeding. Berg and Bearse (1961) reported that infection and mortality rate in restricted birds due to staphylococcal arthritis was higher than in full fed birds. Cannibalism had also been reported as a contributing factor to the high rate of rearing mortality in the restricted birds (Schneider et al., 1955, Issacks et al., 1960). The above workers further reported that the mortality during the laying period was lower in birds restricted during the rearing period than those on ad libitum feeding.

The mortality percentage during rearing period was slightly higher in birds fed with low protein diets during the starting and growing periods. But the laying house mortality was not affected (Bullock et al., 1963, Lillie and Denton, 1966, Smith, 1967, Wright et al., 1968, Summers et al., 1969, and Blair et al., 1970). Vaidya and Sathe (1974), Singh et al. (1975) and Narahari et al. (1975) reported the over all mortality of the birds reared on restricted feeding was similar to the mortality of the group reared on full feeding. Reddy et al. (1974) noted higher overall mortality in the group fed ad libitum in comparison to the groups reared on restricted feeding.

Paterson (1975) and Farrel et al. (1976) showed that low dietary energy concentrations and different protein and energy ratio had no effect on mortality.

Economics of restricted feeding:

Bruckner and Hill (1971), Issacks et al. (1960) and Walter and Aitken (1961) reported that restricted feeding of growing pullets resulted in economy in egg production.

Gowe et al. (1965) compared the data of 5 years in relation to restricted feeding of replacement pullets during the rearing period with full feeding. They found that there was reduction in total feed cost for the rearing and laying periods of 2 and 3 years. Egg income from the restricted groups was higher due to (a) increased egg production (b) higher percentage of large and medium size eggs, (c) increased livability in the laying house. The higher net income for restricted birds was due to higher income from eggs and lower total feed costs. They concluded that restricted feeding during the growing percent of egg type stocks was biologically and economically profitable.

Hollands and Gowe (1965) reported that the restricted birds during 22-147 days had an increased economic return of 44 percent per bird in the first year of production and 89 percent in the second year of production compared with full fed groups.

Vaidya and Sathe (1974) reported higher returns from pullets at the end of the study at 36 weeks of age when they

were grown at 80 and 70 percent level of ad libitum feeding from 12 to 24 weeks of age.

Reddy et al. (1974) and Narahari et al. (1975) also indicated a higher margin of profit in restricted fed birds than the full fed birds.

Nair and Ramakrishna (1977) observed that longer restricted group had shown better feed economy and higher monetary return than the control or shorter restricted groups. They concluded that there was an income of about Rs 1 to 6 over feed cost per surviving pullet depending upon the duration of restriction compared to full fed groups. These data are in agreement with the reports published by Issacks et al. (1960) and Vaidya et al. (1974) who also reported higher monetary returns from restricted groups.

Sharma (1978) reported that the higher economic returns in the 70 percent restricted groups from 6 to 24 weeks of age were due to consumption of less feed, low rate of mortality and higher rate of egg production as compared to birds reared on ad libitum feeding.

*

3. MATERIALS AND METHODS

Experimental birds:

Three hundred thirty one-day old sexed chicks (hatched on 29th February, 1980) of a commercial layer strain were purchased from M/S Poona Pearls, New Delhi. The chicks were vaccinated against Ranikhet and Marek's disease. The chicks were reared to 6 weeks age. They were fed starter ration (Table 4). The experiment was started at 6 weeks and lasted upto 50 weeks of age.

Experimental Design:

The study was conducted in two parts. In both cases completely randomised design was followed and has been presented in table 2.

Table 2

Experimental design

Part I(6-20 weeks)	Treatment									
	Full fed			Alternate day			Scratched			(Feeding method)
	R_1	R_2	R_3	R_1	R_2	R_3	R_1	R_2	R_3	(Replication)
	(30)	(30)	(30)	(30)	(30)	(30)	(30)	(30)	(30)	(Number of birds)
Part II (20-50 weeks)										
	T_1		T_2	T_3		T_4	T_5		T_6	(Treatment(Table 3)
	(33)		(33)	(33)		(33)	(33)		(33)	(Number of birds)

Part I : Two hundred seventy, six weeks old chicks were divided randomly into 9 groups of 30 birds (27 female, 3 males) each. Three groups, each of 30 birds (90 birds) were allowed to each of the following treatments. The first experiment lasted till 20 weeks of age.

1. Full feeding(control) according to N.R.C.Standard.
2. Alternate-day feeding of ration made according to N.R.C.Standard.
3. Scratched feeding (based on primarily rice polishing).

Part II: At 20 weeks of age 66 birds (out of a total of 90 birds)from each of the three treatments of Part I were randomly selected. Each of these groups were sub-divided into two sub-groups of 33 birds (30 females and 3 males) each and were subjected to treatments detailed in Table 3.

Table 3

Dietary Treatments

Treatment Code	Part I	Part II
T_1	Control	Control
T_2		Phase
T_3	Alternate-day feeding	Control
T_4		Phase
T_5	Scratched feeding	Control
T_6		Phase

The duration of the second part of experiment was 20 to 50 weeks of age. This period was divided into three phases.

Phase I, 20 to 30 weeks, where birds were fed both for growth and production and Phase II 30 to 40 weeks, and Phase III 40 to 50 weeks, fed for production.

Housing and Management:

Normal housing and management practices were followed during the course of the study.

Lighting:

Light period was reduced from 24 hours to natural day length at 30 days of age and remained at natural day length untill 142 days of age. The birds were provided with 16 hours light from 142 days of age until end of the experiment.

Feeding:

From 6 to 20 weeks of age, birds were fed according to composition of rations given in Table 4. The birds were fed ad libitum except the alternate-day groups where the birds were deprived of feed on alternate day.

Table 4

Composition of rations used in Part I

Ingredient %	Starter ration	Ration used in control and alternateday group	Scratched ration
Maize	54.5	45.0	-
Groundnut cake	34.0	20.0	-
Rice Polish	-	25.0	92.0
Fish meal	10.0	5.0	2.5
Mineral mixture[1]	1.5	2.5	2.5
Shell grit	-	2.5	2.5
Rovimix[2]	25 g	25 g	25 g
Rovibe[3]	-	-	25 g
Analysis CP (%)	23.0	16.5	12
ME(Kcal/kg)	2930	2875	2715

1. Mineral mixture - containing - Ca-32%, P-6%, Cu 100 ppm; Mn.027%, I.0.01%, Fe 1000 ppm, Zn.0.26% and Fluorine 0.03%.
2. Rovimix each gram contains -Vit A-40,000, IU; Vitamin B_2-20 mg and Vitamin D_3 5000 I.U.
3. Rovibe each gram contains Vit. B_1-4 mg, Vit B_6 -8mg, Vit. B_{12} 40 mg; Niacin 16 mg, Calcium Pantothenate 40 mg and Vit.E 40 mg.

The composition of ration of full fed and alternate-day feeding groups was same. The scratched ration, consisting chiefly of rice polish, was analysed for proximate composition (Table 5).

Table 5

Proximate Analysis of Rice Polish

Contents	Parts
Moisture	5.44 %
Ether extract	11.33 %
Ash	14.00 %
Soluble ash	6.85 %
Insoluble ash	7.15 %
Crude Fibre	12.40 %
Crude Protein	11.90 %
N.F.E.	50.37 %

From 20 weeks the second part of the experiment was started. The rations used in this period are presented in Table 6. The ration No. I (control) was supplied to three groups of birds T_1, T_3 and T_5 and groups T_2, T_4 were provided with ration No. 2 and last group T_6 was put on ration No. 3 for immediate recovery. The first phase of feeding schedule was continued from 20 to 30 weeks of age. At 30 weeks of age the ration No. 3 was discontinued and ration No. 2 was also supplied to the group T_6 and putting the groups T_2, T_4 and T_6 in the same plane of nutrition as the birds recovered the restriction effect and no difference in egg production compared to the full fed groups. The birds were fed the experimental ration rest of the periods i.e. 30 to 50 weeks depending on the

production performances.

Table 6

Composition of experimental ration under Part II

Ingredients %	Ration 1	Ration 2	Ration 3
Maize	50.00	50.0	45.0
Groundnut cake	14.0	23.0	30.0
Rice Polish	25.0	15.0	4.0
Fish meal	5.0	6.0	10.0
Jowar	-	-	5.0
Mineral mixture	2.5	2.5	2.5
Shell grit	3.5	3.5	3.5
Rovimix	25 g	25 g	25 g
Rovibe*	25 g	25 g	25 g
Analysis CP %	16	18.75	21.3
Me Kcal/kg	2870	2850	2770

*Rovibe was omitted from the rations No. 1 and 2 at beginning of the second phase of experiment i.e. 30 weeks onwards.

Trapnesting:

Birds after 18 weeks age was confined daily in individual cages until the record of age and body weight at the sexual maturity and the weight of first eggs from all the birds were obtained.

Observations:

Body weights of individual birds were recorded at 6, 13, 20, 30, 40 and 50 weeks of age.

Egg production:

The daily egg production for each replicate was recorded till the end of experiment. The egg production for different periods were calculated on hen-day and hen-housed basis.

Egg weight:

Egg weight of all eggs were recorded at 30, 40 and 50 weeks of ages. The average weight of the egg during these period was estimated.

Mortality:

The mortality was recorded for the both periods i.e. growing and laying period separately. The cause of death was ascertained as far as possible by post-mortem examination performed by Veterinary Pathology Department.

Fertility and Hatchability:

Data on fertility and hatchability were obtained twice during the experiment. Fifty eggs were incubated from each group and %fertility and hatchability were calculated as given below:

$$\% \text{ Fertility} = \frac{\text{Number of fertile eggs}}{\text{Total number of eggs set}} \times 100$$

$$\% \text{ Hatchability (Total egg set-TES)} = \frac{\text{Number of chicks hatched}}{\text{Total number of egg set}} \times 100$$

$$\% \text{ Hatchabiligy (Fertile egg set-FES)} = \frac{\text{Number of chicks hatched}}{\text{Number of fertile eggs}} \times 100$$

Feed consumption:

Feed consumption records were kept for both periods. The feed efficiency for body weight gains during 6 to 13 and 13 to 20 weeks of age were calculated.

Feed efficiency for egg production was calculated in terms of feed required to produce a dozen of eggs and also to produce one kilogram egg mass by for treatment during the three phases of experimental periods.

Performance Efficiency Index (PEI) - PEI was also calculated for the three phases of laying individually for each treatment and was calculated as given below:

$$PEI = \frac{\text{Average egg weight x percent production}}{\text{Daily feed consumption per bird.}}$$

Economics:

The chick cost, mortality and feed cost was considered as inputs. No handling and processing charges were incorporated. It was based only on the cost of individual feed ingredients.

The egg price and cost of culled birds was taken as return. The eggs prices were calculated at the rate fixed by the university from time to time.

Statistical analysis:

Data were subjected to analysis of variance. Wherever significant differences occured means were subjected to critical difference test. All the percentage were transformed to Arcsin angles before statistical analysis wherever needed (Steel and Torrie, 1960).

*

4. RESULTS AND DISCUSSION

Part I

Body weight:

The first part of the experiment was conducted on 6 weeks old chicks having an average body weight of 320 g. The initial body weight among three treatments were statistically non-significant. Three different methods of feeding were applied till 20 week age and the effect on body weight has been presented in table 7 and their analysis of variance in table 8.

The body weight of scratched fed birds decreased due to treatments referred above in a consistent pattern and at 13 weeks of age the significant differences were observed. The highest 13 weeks body weight 766 g was observed in pullets fed ad libitum (control), where as body weight of pullets of alternate-day and scratched fed groups were 727 g and 612 g, respectively. The birds belonging to the scratched feeding group were significantly lighter in comparison to the birds fed ad libitum and alternate-day. There was no significant difference in body weight of birds fed ad libitum and alternate-day at this age (13 weeks).

The analysis of variance (Table 8) indicated that the mean body weights at 20 weeks of age were significantly affected by different treatments. The highest mean body weight (1260 g) was observed in birds fed ad libitum (control) followed by 1105 g and 960 g for birds fed on alternate-day and scratched fed regimes, respectively.

Table 7

Means standard errors of body weight of chickens subjected to full, alternate-day and scratched feeding from 6 to 20 weeks age.

Methods of feeding	Mean body weights (g) at 6th week	13th week	20th week
Control (Full feeding)	$317^{a} \pm 4.560$	$766^{a} \pm 8.380$	$1260^{a} \pm 28.250$
Alternate-day feeding	$323^{a} \pm 2.000$	$727^{a} \pm 22.270$	$1105^{b} \pm 11.316$
Scratched feeding	$320^{a} \pm 4.495$	$612^{b} \pm 7.118$	$960^{c} \pm 20.520$

Figures having similar superscript do not differ significantly at 5 % level of probability.

Table 8

Analysis of variance of body weight of chickens subjected to different methods of feeding at different ages.

Source of variation	6th week df	6th week MS	13th week df	13th week MS	20th week df	20th week MS
Between treatments	2	699	2	512991.5**	2	1798763**
Between replications	2	2212.5	2	12910.5	2	5075
Between treatment x replication	4	108	4	6475.5	4	14609.75
Error	234	1006.17	232	16945.56	231	36367.11

** $P < 0.01$

It was further revealed from table 7 that the loss in body weight was drastic at a later stage (after 13 weeks of age) than at the beginning of the treatment. At 13 weeks the deviation in body weight from control was 39 g in restricted and 154 g in scratched fed group. At 20 weeks the difference increased to 155 g and 300 g, respectively when compared to control (Fig. 1).

The present observations were in agreement with those obtained by Gowe et al. (1960), Hollands and Gowe (1961), Fuller and Dunahoo (1962), Gardiner and MacIntyre (1962), MacIntyre and Gardiner (1964), Reddy et al. (1974) and Narahari et al. (1975).

No significant differences were obtained between alternate-day and control feeding in body weight gain as reported by Nair and Ramakrishna (1977), but contrary to this Khan et al. (1977) found a difference in body weight gain of 500 g in White Rock birds fed on alternate-day compared to control. Nir and Nitson (1979) reported that although chicks adapted to intermittent deprivation of feed and showed increased body weight during the feeding period due to increased anabolism but despite of this overall growth rate was less.

During the rearing period of 14 weeks, the body weight gain varied according to the feeding methods. There was maximum feed intake per bird in the scratched group with poor feed utilization as compared to the other groups. The higher feed intake in the scratched fed group was, perhaps due to

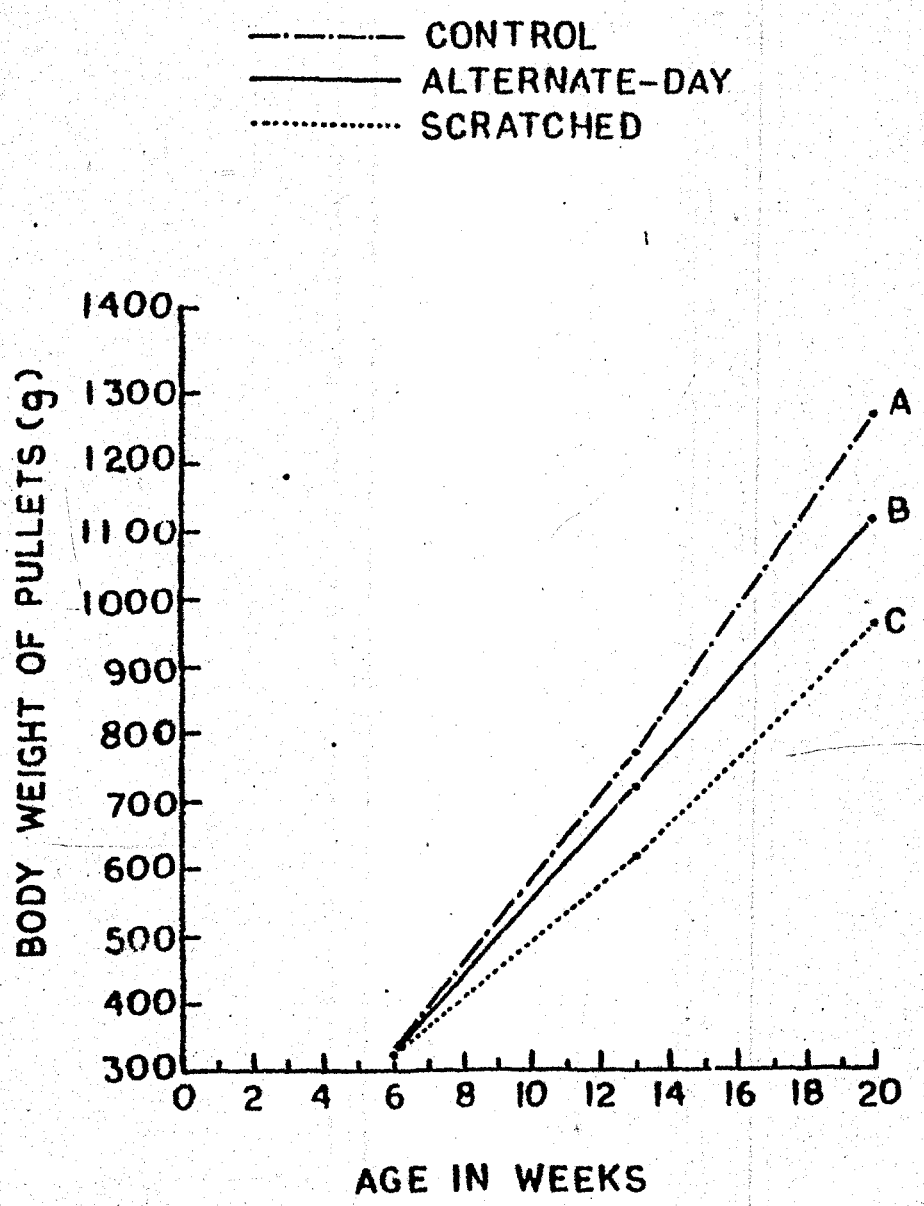

FIG. 1 BODY WEIGHT OF PULLETS SUBJECTED TO CONTROL, ALTERNATE-DAY AND SCRATCHED FEEDING FROM 6 TO 20 WEEKS OF AGE.

poor energy content of the ration provided to the birds. The poor utilization of scratched ration may also be due to its imbalanced nature and high crude fibre content.

Smith (1967) reported that 11 percent protein did not depress body weight. This observation is contrary to the present findings. The reason for this may be the proper energy content in Smith's ration compared to low energy and protein in the scratched ration of the present exepriment. Brake and Garlich (1980) reported that 10.8 percent protein diet during 5 to 20 weeks of age depressed body weight and a ration containing 12.5 percent protein with high energy (3000 Kcal/kg) diet improved body weights. This is in agreement with present findings. High rice bran content in grower ration may have adverse effect on body weight gain as reported by Kratzer and Leslie (1980). They reported that a 60 percent level of rice bran in ration reduced growth in chicks and turkey poults.

Feed consumption and feed efficiency:

The effect of different methods of feeding on the commulative feed intake per bird from 6 to 20 weeks of age has been presented in table 9 and their analysis of variance in table 10.

During 6 to 13 weeks of age there was similar feed intake in scratched and full feeding programme, but the kg of feed required to gain one kg body weight (feed efficiency) was better in control group (4.56) than the scratched fed group (7.09). The poor utilization in later group is perhaps due to imbalance of nutrients in ration which was low in energy

Table 9

Average feed consumption per bird and feed efficiency as subjected to three methods of feeding.

Methods of feeding	6-13 weeks		14-20 weeks	
	Feed intake (g)	Feed efficiency	Feed intake (g)	Feed efficiency
Control (Full feeding)	2050[a]	4.565	3503[a]	7.091
Alternate-day feeding	1600[b]	3.960	2500[b]	6.611
Scratched feeding	2071[a]	7.092	4356[c]	12.517

Figures having similar superscripts do not differ significantly at 5 percent level of probability

Table 10

Analysis of variance of average feed consumption per bird subjected to three methods of feeding.

Source of variation	6-13 weeks		14-20 weeks	
	df	MS	df	MS
Between treatments	2	0.2035*	2	2.591**
Between replications	2	0.0025	2	0.0165
Error	4	0.0115	4	0.0345

* $P < 0.05$

** $P < 0.01$

and protein and high in crude fibre content.

During 14 to 20 weeks age, there were considerable differences in feed intake of birds of various treatments. Birds of scratched group consumed maximum feed 4356 g per bird during this period compared to 3503 g in control and only 2500 g in alternate-day feeding programme. The feed efficiency was in a reverse order. It was poorest in the scratched group followed by control and alternate-day feeding programme, respectively. Poor feed efficiency in scratched group was perhaps due to imbalanced ration. Best feed efficiency was observed in case of birds fed on alternate-day feeding during this period.

In the present study, birds of alternate-day fed group consumed 4100 g per bird during 6 to 20 weeks of age compared to 5553 g in control group. During the rearing period there was about 26 percent feed saving in alternate-day feeding over control. This group had most efficient feed utilization due to low intake of feed.

The observations of present study with respect to feed utilization in alternate-day feeding group are in agreement with the observations of Jackson (1970). Bjornstad and Hvidstein (1973) also reported similar findings.

Contrary to the observation reported above Ogata et al. (1970) noted that pullets fed on low energy diet based on extracted rice bran (77.7 percent of ration) ate more feed and exhibited poor feed efficiency. Similar is the observation of present study also in case of scratched feeding which is

mainly based upon rice polishing. There was about 16 percent higher feed intake compared to control with poor feed efficiency. This is further supported by the findings of Lillie et al. (1966).

Part II

Birds on different methods of feeding during growing period were pooled together at 20 weeks of age and were randomly re-distributed into two groups of 33 birds each treatment. One group was alloted to control and other to phase feeding. In other words there were six treatments during laying period (20 to 50 weeks of age) as given below:

Code	Treatments	
	Growing period	Laying period
T_1	Control	Control
T_2	Control	Phase
T_3	Alternate-day feeding	Control
T_4	Alternate-day feeding	Phase
T_5	Scratched feeding	Control
T_6	Scratched feeding	Phase

Birds of control groups were fed according to normal standard and phase groups were fed according to the production status of the birds.

Body weights:

The mean body weights for 6 treatments at 30, 40 and 50 weeks of ages have been presented in table 11 and the statistical analysis of variance in table 12.

The analysis of variance at 30 weeks of age indicated that the phase feeding had significant effect on the mean body weights. The body weight of the ad libitum fed control group (T_1) was 1311 g. It was followed by 1351, 1318, 1390, 1264 and 1466 g for T_2, T_3, T_4, T_5 and T_6 groups, respectively. The pullets of group T_6 which were allowed higher on protein diet (Table 6) having 21.3 percent crude protein from 20 to 30 weeks of age showed higher body weights than the body weights of the birds which were receiving 16 percent crude protein (T_1, T_3 and T_5) and 18.75 percent crude protein (T_2 and T_4), respectively. Pullets of T_5 group reared on 16 percent protein after an initial scratched feeding till 20 weeks of age had minimum body weight which was significantly lower than the other groups indicating that at low plane of nutrition birds are not able to fully recover the lower initial body weights due to scratched feeding, where as the pullets of T_6 group recorded the highest body weight even though these birds were also from the scratched fed group.

At 40 weeks of age also (Phase II) the phase feeding had a significant effect on body weights. The mean body weights of the pullets reared on two planes of nutrition i.e. at 16 percent protein (T_1, T_3 and T_5) had 1490, 1479 and 1508 g which were statistically similar but are significantly lower

Table 11

Means and standard errors of body weight(g) of layers subjected to different treatments.

Treatments		Treatment code.	Age in weeks		
Feeding upto 20 weeks	After 20 weeks		30	40	50
Control	Control	T_1	$1311^{ab} \pm 65.680$	$1490^{a} \pm 28.897$	$1505^{ab} \pm 28.980$
	Phase	T_2	$1351^{ab} \pm 21.725$	$1485^{a} \pm 23.409$	$1535^{ab} \pm 27.547$
Alternate -day feeding	Control	T_3	$1318^{ab} \pm 31.975$	$1473^{a} \pm 31.610$	$1536^{a} \pm 35.245$
	Phase	T_4	$1390^{a} \pm 27.133$	$1566^{b} \pm 33.946$	$1585^{a} \pm 47.195$
Scratched feeding	Control	T_5	$1264^{b} \pm 21.953$	$1508^{a} \pm 44.069$	$1425^{b} \pm 31.978$
	Phase	T_6	$1466^{c} \pm 22.971$	$1577^{b} \pm 25.432$	$1531^{a} \pm 27.878$

Figures having at least one superscript in common do not differ significantly at 5 % level probability.

Table 12

Analysis of variance of body weights of chickens subjected to different treatments during 20-50 weeks of age.

Source of variation	30 weeks		40 weeks		50 weeks	
	df	MS	df	MS	df	MS
Between treatments	5	150134**	5	55624**	5	78112*
Error	171	36464	166	9471	160	31281

* $P < 0.05$

** $P < 0.01$

compared to phase fed groups (T_2, T_4 and T_6) at 18.75 percent protein.

The same plane of nutrition as in Phase II was continued in all the groups during Phase III (from 40 to 50 weeks of age). The effect of treatments was significant for body weights at 50 weeks also. Body weights in all the groups except in T_5 were similar. There was slight reduction in body weight of T_5 group which may perhaps be due to higher rate of lay in this group compared to others.

These results on body weight indicates that the depressing effect of controlled feeding was rapidly over come during laying period and appeared to have no adverse effect on body weight of the birds.

The findings of the present study are in agreement with Hollands and Gowe (1961), Reddy et al. (1974) and Narahari et al. (1975) who concluded that the birds subjected to early restriction had comparable body weight with the full fed birds following restoration of full feeding. But Fuller and Dunahoo (1962), Gardiner and MacIntyre (1962), MacIntyre and Gardiner (1964), Berg and Berse (1961), Deaton and Quisenberry (1963) and Strain et al. (1965) reported that the feed restricted birds remained smaller even during the laying period in comparison to the weights of the full fed group. The results of the present experiment do not support the above findings. The disagreement may be due to the fact that the feed restriction continued for a longer duration in above referred studies and birds could not find enough time before active laying to recover the lost body weight.

Age, body weight and weight of first egg at sexual maturity:

The average age at sexual maturity as affected by different treatments has been furnished in table 13 and their analysis of variance has been presented in table 14.

It may be seen from the table that the scratched fed group of birds took longest time 163 days to attain sexual maturity followed by alternate-day (158 days) and control group (152 days). These differences were statistically significant. It appears that feed restriction as in the case of scratched feeding prolonged the age of sexual maturity.

It also appears from these results that attainments of certain level of body growth is necessary for the birds to start lay. For example, in the present study birds attained 1250 to 1300 g body weight before the start of lay. Though the body weight at sexual maturity is statistically different yet range is only 50 g to explain the above point.

Similar results pertaining to age at sexual maturity of restricted fed birds were obtained by several workers. Strain et al. (1965) found that the 30 percent feed restriction in White Leghorn from 5 to 21 weeks prolonged the age of sexual maturity by 15 days. Lillie et al. (1966) reported a significant delay in maturity of White Leghorn fed 75 percent from 8 to 20 weeks.

In general feed restriction to a level of 10-40 percent of ad libitum delays sexual maturity in White Leghorn birds

Table 13

Effect of three methods of feeding on age at sexual maturity, body weight and weight at first egg.

Method of feeding	Age at sexual maturity (days)	Body weight at sexual maturity (g)	Weight at first egg (g)
Control (Full feeding)	$152^{a} \pm 1.089$	$1294^{ab} \pm 14.341$	$37.32^{a} \pm 0.432$
Alternate-day feeding	$158^{b} \pm 0.933$	$1304^{a} \pm 23.751$	$39.11^{b} \pm 0.459$
Scratched feeding	$163^{c} \pm 0.785$	$1256^{b} \pm 13.067$	$40.81^{c} \pm 0.511$

Figures having at least one superscript in common do not differ significantly at 5 % level of probability.

Table 14

Analysis of variance of age at sexual maturity, body weights and weight at first egg.

Source of variation	Age		Body weight		Weight at first egg	
	df	MS	df	MS	df	MS
Between treatments	2	1785.50**	2	40968.5*	2	182.5**
Between replications	2	111	2	36333.5	2	0.50
Between treatments x replications.	4	59.25	4	9473	4	8.0
Error	171	58.08	171	13116.42	171	12.46

* $P < 0.05$

** $P < 0.01$

by 7-31 days. Smith (1967) found that low protein (11 percent) level in diet at rearing period caused a delay in sexual maturity. Wolf et al. (1970) reported that low energy and low protein diets fed during the rearing period affected the sexual maturity. Reddy et al. (1974) found that the sexual maturity was delayed by 1 to 23 days between full fed and most severely restricted groups. Vaidya and Sathe (1974) noticed a delay of 9 to 14 days and 11 to 17 days in age of sexual maturity at Ist egg and 50 percent production, respectively. Reddy et al. (1975) reported that the restricted groups took 32 to 16 days less , to attain peak production compared to control. Nair and Ramakrishna (1977) found no significant difference on sexual maturity between skip-a-day programme and ad libitum feeding. Gous (1978) reported that the low lysine and low protein diets fed from 8-20 weeks of age resulted in delayed sexual maturity.

On the basis of present findings it may be concluded that different methods of controlled feeding from 6 to 20 weeks age followed by phase feeding delayed sexual maturity to a lower degree.

The mean body weights at sexual maturity differed significantly for alternate day and scratched fed groups (Table 13 and 14). The alternate-day fed groups had significantly higher body weight (1304 g) than control (1294 g) and scratched fed (1256 g) at sexual maturity. This perhaps is due to higher plane of nutrition in restricted fed group during the Phase I. On an average birds attained

a body weight between 1256 to 1304 g before start of lay. Though this difference is statistically significant but it is quite narrow. It may be hypothesised that a particular body weight is necessary for the birds to start lay.

These results are in agreement with the findings of Schneider et al. (1955), Milby and Sherwood (1956), Strain et al. (1965) and Narahari et al. (1975). All these workers have reported that there was a recovery in the body weight of restricted birds after withdrawal of restriction.

From table 13 and 14, it is also evident that the pullets from scratched fed groups laid bigger eggs 40.8 g compared to 37.3 g and 39.1 g of control and alternate-day fed group, respectively. It is clear that there is a positive correlation between egg size and age at sexual maturity and egg weight does not appear to be related with body size at sexual maturity. In this study, the birds of scratched group have lowest body weight at sexual maturity but laid eggs of largest size. This might be due to better development of reproductive organs as reported by Watson (1975) for the restricted reared broiler pullets. However, no trend was apparent between body size and egg size of first egg.

Egg production:

The data on egg production have been presented in table 15 and 17 and their analysis of variance in table 16 and 18.

Table 15

Average hen day* egg production (%) of birds subjected to various treatments.

Treatments			Percent hen-day production upto the age of		
Feeding upto 20 weeks	After 20 weeks	Code	250 days	300 days	350 days
Control (Full feeding)	Control	T_1	$50.30^{a} \pm 1.005$ (59.20)	$49.87^{a} \pm 0.722$ (58.50)	$49.58^{a} \pm 0.584$ (58.00)
	Phase	T_2	$51.08^{a} \pm 1.110$ (60.50)	$50.16^{a} \pm 0.811$ (59.00)	$48.62^{a} \pm 0.670$ (56.30)
Alternate day feeding	Control	T_3	$49.23^{a} \pm 1.218$ (57.40)	$49.92^{a} \pm 0.593$ (58.50)	$49.00^{a} \pm 0.504$ (57.00)
	Phase	T_4	$47.73^{a} \pm 1.879$ (54.80)	$48.94^{a} \pm 1.317$ (56.90)	$48.95^{a} \pm 1.011$ (56.90)
Scratched feeding	Control	T_5	$48.23^{a} \pm 1.332$ (55.60)	$49.90^{aa} \pm 0.943$ (58.50)	$49.90^{a} \pm 0.732$ (58.50)
	Phase	T_6	$55.83^{b} \pm 0.957$ (68.50)	$55.48^{b} \pm 0.443$ (67.90)	$54.35^{b} \pm 0.543$ (60.00)

*All the percentages were transformed to Arcsin angles. The figures within parenthesis are original scale.

Figures having similar superscripts do not differ significantly at 5 % level of probability.

Table 16

Analysis of variance percentage of egg production (hen-day) per bird subjected to various treatments (Using angular transformation).

Source of variation	250 days		300 days		350 days	
	df	MS	df	MS	df	MS
Between treatments	5	869.96**	5	864.42**	5	929.22**
Error	627	175.02	927	113.04	1227	99.25

** $P < 0.01$

Table 17

Average hen-day* egg production (%) from sexual maturity to 100, 150 and 200 days of lay as affected by different treatments.

Treatments			100 days (%)	150 days (%)	200 days (%)
Feeding upto 20 weeks	After 20 weeks	Code			
Control (Full Feeding)	Control	T_1	$53.14^{abc} \pm 0.492$ (64.00)	$51.57^{a} \pm 0.521$ (61.6)	$50.83^{ab} \pm 0.451$ (60.11)
	Phase	T_2	$54.31^{b} \pm 0.772$ (66.0)	$52.21^{a} \pm 0.600$ (62.50)	$50.06^{a} \pm 0.552$ (58.8)
Alternate day feeding	Control	T_3	$54.60^{ab} \pm 0.818$ (66.5)	$52.52^{a} \pm 0.449$ (63.0)	$51.11^{ab} \pm 0.176$ (60.6)
	Phase	T_4	$51.93^{c} \pm 1.571$ (62.0)	$51.65^{a} \pm 1.093$ (61.6)	$51.14^{ab} \pm 0.843$ (60.6)
Scratched feeding	Control	T_5	$52.33^{c} \pm 0.816$ (62.6)	$52.23^{a} \pm 0.605$ (62.5)	$51.42^{b} \pm 0.505$ (61.1)
	Phase	T_6	$60.02^{d} \pm 0.808$ (75.0)	$57.50^{b} \pm 0.414$ (71.1)	$55.86^{c} \pm 0.148$ (68.5)

*All the percentages were transformed to Arcsin angles. The figures within parenthesis are original scale.

Figures having similar superscript do not differ significantly at 5 % level of probability.

Table 18

Analysis of variance of egg production from sexual maturity to 100, 150 and 200 days under different treatments.

Source of variation	100 days		150 days		200 days	
	df	MS	df	MS	df	MS
Between treatments	5	880.96**	5	746.13**	5	862.28**
Error	594	46.23	894	45.52	1194	47.44

** $P < 0.01$

It is clear from table 15 that the percent hen-day egg production is similar in all the treatments at all ages except in the treatment T_6. The T_6 group (scratched cum phase) laid significantly at higher rate than the other groups at all ages studied in this experiment. So it may be concluded that though the initial body weight depression, due to scratched feed had an adverse effect on sexual maturity, but when the birds were allowed to regain body weight at laying stage (after 20 weeks of age) on higher plane of nutrition, they laid eggs at much higher rate than control (Table 15). The rate of lay was high enough to compensate for delay in sexual maturity of 11 days. In general, superiority of phase feeding during laying period could not be observed in any treatment group except T_6 (Fig. 2).

The results presented above agree with the findings of several workers. Gowe et al. (1960) concluded that feed restriction of pullets during growing period increased the intensity of egg production after the delay in sexual maturity. Walter and Aitken (1961) reported that the feed restriction during rearing period caused a change in pattern of egg production. Birds commenced production later but laid at a higher rate than the full fed controls. Hollands and Gowe (1961) observed that despite of delay in sexual maturity the restricted birds laid more number of eggs in the first and second production years, due to greater development of endocrine glands. The endocrine development

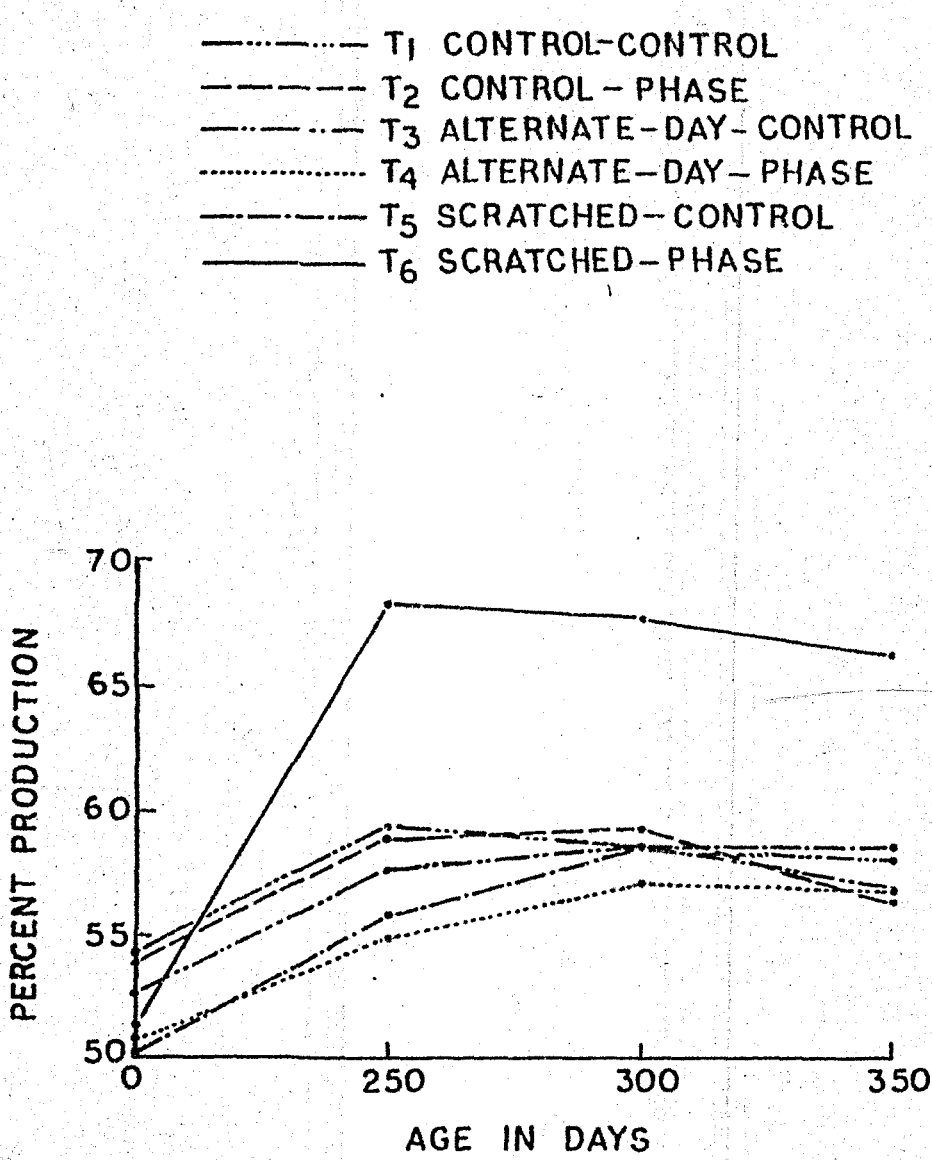

FIG. 2. PERCENT HEN-DAY EGG PRODUCTION AS INFLUENCED BY DIFFERENT DIETARY TREATMENTS

was also interrelated with the rapid development of reproductive organs associated with faster rate of growth of ovarian follicles (Watson, 1975). These changes might explain the persistence and the improvement in production after a compensatory weight gain.

Scott et al. (1969) stated that Single Comb White Leghorn required 18 g of protein per day during Phase I (20 to 42 weeks of age), 16 g during Phase II (from 42 weeks of age to a rate of lay of 65 percent) and 15 g of protein per day during Phase III (rate of lay below 65 percent). Cave (1978) reported that the severe nutrient restriction imposed by the whole grain growth rations had no statistically significant effect on overall egg production irrespective of whether production was measured to a common age or over a given period from sexual maturity. Grain reared birds tended to have a lower percent egg production. However, the difference was significant at 5 percent probability level. Voitle et al. (1970) observed that skip-a-day programme with broiler breeder pullets delayed sexual maturity, increased total egg production and reduced the interval between 25 and 50 percent production. Bjornstad and Hvidstein (1973) fed birds only every second day and found higher egg yield compared to the full fed controls.

Reid et al. (1951) found that an 18 percent protein ration was superior for egg production. Heywang et al. (1955) showed that 15 percent protein at a higher energy level was comparable to an 18 percent level for egg production.

Contrary to these Miller et al. (1956) and Thornton et al. (1957) and Smith (1967) reported no effect on egg production when increased the protein level ffom 12 to 21 percent, where as Nivas and Sunde (1969) reported that phase feeding during 11 months increased egg production significantly. Wolf et al. (1970) reported low energy feeding during 9-18 weeks period gave better egg production.

Miller and Smith (1977) reported effect of varying protein levels on performance of brown egg type birds and concluded that the diet with 18 percent protein were economically better than any feeding level. Solun et al. (1978) showed that restricted feeding of replacement pullet had an important and positive effect on productivity, maintained throughout their productive lives.

It appeared that low nutritive feed restriction i.e. scratched diets from 6 to 20 weeks of age subsequently followed by higher (Phase I) nutrients at the beginning of the reproductive cycle had better response in egg production than the other nutritive plane of feeding.

Egg weight:

The effect of different dietary treatments on mean egg weight at various stages of laying is presented in table 19. The analysis of variance is shown in table 20. It is evident that the T_3, T_4, T_5 and T_6 group pullets at 30 weeks of age laid significantly bigger eggs compared to T_1 and T_2 groups. The largest egg size was in T_6 group (50.8 g) where as in control it was 47.0. Although statistically non-significant

Table 19

Means and standard errors of egg weights of birds subjected to different treatments.

Treatments			Egg weight(g) at the age of		
Feeding upto 20 weeks	After 20 weeks	Code	30 weeks	40 weeks	50 weeks
Control	Control	T_1	$47.05^{a} \pm 0.564$	$56.46^{ab} \pm 0.419$	$58.59^{abc} \pm 0.430$
	Phase	T_2	$47.22^{a} \pm 0.119$	$55.29^{c} \pm 0.288$	$58.00^{b} \pm 0.623$
Alternate day feeding	Control	T_3	$49.22^{b} \pm 0.541$	$58.25^{c} \pm 0.526$	$61.05^{c} \pm 0.540$
	Phase	T_4	$49.44^{b} \pm 0.807$	$56.75^{ac} \pm 0.247$	$60.44^{c} \pm 0.227$
Scratched feeding	Control	T_5	$49.59^{b} \pm 0.927$	$58.05^{bc} \pm 1.000$	$59.17^{abc} \pm 0.681$
	Phase	T_6	$50.82^{b} \pm 0.615$	$57.30^{c} \pm 0.674$	$59.58^{ac} \pm 0.451$

Figures having at least one superscript in commondo not differ significantly at 5 % level of probability.

Table 20

Analysis of variance of egg weights at various stages of age under different treatments.

Source of variation	30 weeks		40 weeks		50 weeks	
	df	MS	df	MS	df	MS
Between treatments	5	6.49**	5	3.62*	5	3.624**
Error	12	1.25	12	1.03	12	0.793

* $P < 0.05$

** $P < 0.01$

but there was slightly higher egg weights in phase fed groups compared to their controls. But it is certainly clear that egg weight of birds which were maintained at lower plane of feeding either by feed restriction or by scratched feeding laid significantly heavier eggs. It also appears to have positive relationship with age of sexual maturity of birds. Scratched feeding during growing period followed by phase feeding in laying period (T_6) group of birds laid larger eggs than other groups.

The superiority of phase fed groups with respect to size of eggs over control were slowely narrowed down with the advancement of age. At 30 weeks of age the egg size difference from control to largest egg size group was 3.77g and it narrowed down to 1.77 g at 40 weeks and 1.55 g at 50 weeks of age. There is an-other point evident from the table 19 that the alternate day fed group during growing period laid continuously larger sized eggs whereas egg size difference had narrowed down in the scratched fed groups.

Thornton et al. (1957) reported that egg weight was reduced drastically in birds fed at 11 percent protein level in laying diet. Smith (1967) reported increased protein level in diet favourably affected egg weight. Berg and Bearse (1957) reported increased protein and energy level in diets (14 to 18 percent protein; 1100 to 1450 caloric ME/lb) improved in egg weight. Nivas and Sunde (1969) reported that intake of 18 to 20 g protein per day

resulted in significantly higher egg weight than birds fed 14 or 16 g protein. The results of above studies are in agreement with the findings of present study.

Feed consumption:

The data on average feed consumption of pullet during the 3 phases of laying period is presented in table 21. The consumption was highest in T_4 group upto 30 weeks of age followed by T_6, T_3, T_1, T_2 and T_5 groups. From 30-40 and 40 to 50 weeks of age, the average feed consumtion of each group was quite similar.

Table 21

Average feed consumption per bird subjected to different methods of feeding during laying period.

Treatment			Feed consumption(g)		
Feeding upto 20 weeks	After 20 weeks	Code	20-30 weeks of age	30-40 weeks of age	40-50 weeks of age
Control (Full feeding)	Control	T_1	6350	7410	7650
	Phase	T_2	6110	7570	7200
Alternate-day feeding	Control	T_3	6525	7410	7760
	Phase	T_4	7500	7500	7920
Scratched feeding	Control	T_5	5950	7100	7430
	Phase	T_6	6800	7780	7510

In second phase, highest feed consumption per pullet was recorded in T_6 group (7780 g) and minimum consumption (7100 g) in T_5 group. On the other hand, during the last phase maximum consumption was found in T_4 (7920 g) and minimum in T_2 (7200 g) group followed by T_5 (7430 g), T_6 (7510 g), T_1 (7650g) and T_3 (7760 g) groups, respectively.

It is also revealed from table 21 that initial restricted fed groups (alternate-day and scratched feeding) from 6 to 20 weeks of age consumed slightly more feed than control. Overall consumption in groups T_3, T_4 was more which came from alternate-day fed groups than control.

These results are in agreement with those reported by Strain et al. (1965) that in White Leghorn feed consumption from 147-500 days was slightly more in restricted group but difference was much less than the amount of feed saved during the growing period. Vaidya and Sathe (1974) and Watson (1975) reported that feed consumption per bird during laying period was higher in case of restricted groups. Cave (1978) reported that the quantity of breeder ration consumed per egg laid did not differ significantly between different diet and treatments.

Feed efficiency:

Feed efficiency for different phases of laying period was calculated as kg of feed consumed per dozen eggs and kg of feed consumed per kg egg mass. The results showing the effect of different dietary treatments on feed efficiency have been presented in table 22. It is evident from the table that the pullets of the group T_6 showed better feed efficiency for egg production ih comparison to the pullets of other restricted groups. The feed efficiencies in T_6 group pullets during three phases of feeding were 2.13, 1.83 and 2.16 as compared to 1.94, 1.98 and 2.36, respectively in control groups. The improved feed efficiencies (feed/dozen and feed/kg) were observed during 30 to 40 weeks period.

Table 22

Effect of different treatments on feed efficiency (kg feed per dozen of egg and per kg of egg mass) and performance efficiency index (PEI) during various stages of laying.

Treatment			Feed (kg)/dozen egg			Feed (kg)/kg egg mass			PEI		
Upto 20 weeks of	After 20 weeks	Code	20-30 weeks	30-40 weeks	40-50 weeks	20-30 weeks	30-40 weeks	40-50 weeks	20-30 weeks	30-40. weeks	40-50 weeks
Control (Full feeding)	Control	T_1	1.942	1.980	2.363	3.441	2.922	3.344	29.03	34.64	29.54
	Phase	T_2	1.693	2.065	2.573	2.987	3.111	3.697	32.27	32.63	26.86
Alternate day feeding	Control	T_3	2.009	1.976	2.587	3.402	2.825	3.532	29.60	35.64	28.58
	Phase	T_4	2.375	2.107	2.417	4.005	3.094	3.333	24.89	32.70	29.98
Scratched feeding	Control	T_5	2.380	1.803	2.187	3.997	2.583	3.080	28.31	39.77	31.96
	Phase	T_6	2.138	1.831	2.163	3.507	2.663	3.025	32.08	37.92	32.52

The feed efficiency of the pullets of scratched fed groups during growing period and subsequently higher plane of nutrition during laying period was better than rest of the groups. The poor feed efficiencies were recorded in T_3 and T_4 groups. Milby and Sherwood (1956), Walter and Aitken (1961), Vaidya and Sathe (1964), Narahari et al. (1975) and Singh et al. (1975) reported that the pullets reared on restricted feeding showed better efficiency of feed utilization. In constrast to the findings of this study, Reddy et al. (1974) noticed that the feed efficiency of the restricted birds did not improve during the laying period.

Performance Efficiency Index (PEI):

The performance efficiency index during 3 phases of laying period is presented in table 22.

The PEI during the three phases was found better in the pullets of group T_6 having 32.8, 37.92 and 32.52, respectively. It was indicated that high plane of nutrition improved egg production and reduced feed intake as well as egg size. The low PEI of the T_4 group might be due to relatively lower egg production and poor feed efficiency. In contrast to these results Reddy et al. (1974) reported no apparent difference in PEI between full fed and the restricted groups.

Fertility and hatchability:

The data on fertility and hatchability at 40 and 50 weeks of age are presented in table 23. The statistical analysis is given in table 24.

Table 23

Effect of different methods of feeding on fertility and hatchability (fertile egg and total egg basis) of eggs during laying period.

Treatments			No. of eggs set	Fertility (%)	Hatchability (%)	Total (%)
upto 20 weeks	After 20 weeks	Code				
Control (Full feeding)	Control	T_1	100	77.72 (95.5)	68.92 (86.4)	64.93 (82.0)
	Phase	T_2	100	73.69 (92.1)	68.24 (86.2)	63.04 (79.4)
Alternate day feeding	Control	T_3	100	75.01 (93.3)	66.50 (84.1)	62.03 (78.0)
	Phase	T_4	100	75.01 (93.3)	54.12 (65.7)	51.35 (61.0)
Scratched feeding	Control	T_5	100	70.36 (88.7)	72.45 (90.7)	63.89 (80.6)
	Phase	T_6	100	85.93 (99.5)	65.11 (82.3)	65.03 (82.2)

Figures within parenthesis are original scale.

Table 24

Analysis of variance of fertility and hatchability of eggs subjected to various treatments.

Source of variation	Fertility		Hatchability		Total	
	df	MS	df	MS	df	MS
Between treatments	5	50.08	5	22.57	5	54.07
Error	6	30.65	6	64.61	6	23.45

It appears that method of feeding has no effect on fertility and hatchability of eggs. These results are in agreement with the findings of Sunde et al. (1954), Milby and Sherwood (1956), Vaitle et al. (1974), and Cave (1978). All these workers reported that feed restriction during rearing period had no adverse effect on fertility and hatchability. The results of our study also agree with this trend.

Mortality:

The percent mortality in groups subjected to three methods of feeding during rearing period from 6 to 20 weeks has been presented in table 25. During this period only 3 birds died which can be considered as normal mortality and could hot be assigned as treatment effect.

The percent mortality in laying period subjected to different dietary treatment is presented in table 26.

Number of birds died in each group varied from 0 to 3 during 30 weeks laying period and is considered normal mortality and could not be assigned as treatment effect.

Strain et al. (1965) and Lillie et al. (1966) reported that the restricted feeding in White Leghorn, growers mortality was increased by 2 percent and layer mortality reduced by 2 percent. Controlled feeding with high energy diet in White Rock layers resulted in reduced mortality (Singsen et al., 1954).

Milby and Sherwood (1956) reported that in White Rock and New Hampshire birds, restricted feeding did not show any

Table 25

Percent mortality during growing period under three methods of feeding.

Methods of Feeding	Total No. of birds	Mortality during 6-13 weeks	Mortality during 14-20 weeks
Control (Full feeding)	90	0.00(Nil)	1.23 (1)
Alternate-day feeding	90	0.00 (Nil)	0.00 (Nil)
Scratched feeding	90	1.23 (1)	1.25 (1)

Figures in parenthesis are number of birds died.

Table 26

Percent mortality during laying period under different methods of feeding

Treatments			No. of birds (total)	Mortality during		
Upto 20 weeks	After 20 weeks	Code		20-30 weeks	30-40 weeks	40-50 weeks
Control (Full feeding)	Control	T_1	30	3.33(1)	3.44(1)	0.00(Nil)
	Phase	T_2	30	3.33(1)	3.44(1)	0.00(Nil)
Alternate day feeding	Control	T_3	30	3.33(1)	3.44(1)	3.56(1)
	Phase	T_4	30	0.00(Nil)	3.33(1)	6.89(2)
Scratched feeding	Control	T_5	30	0.00(Nil)	0.00(Nil)	6.66(2)
	Phase	T_6	30	0.00(Nil)	3.33(1)	3.44(1)

Figures in parenthesis are number of birds died.

differences in mortality. Vaidya and Sathe (1974) found that the over all mortality of the birds reared on restricted feeding was similar to the mortality of the groups reared on full feeding. Narahari et al. (1975) reported no differences in the laying house mortality. The results of our studies were in line with the findings of most of these workers.

Economic returns:

Gross return was calculated on the basis of income from egg and culled birds over feed cost from 0 to 50 weeks.

The data on economics is presented in table 27 and 28.

It may be observed that the relative economy in saving of feed cost from 0 to 20 weeks of age per bird in alternate day and scratched fed groups were Rs 1.65 and 2.63 over the control (Table 27).

The economy was altered due to phase feeding from 20 to 50 weeks of age as represented in table 28. The higher monetary returns from T_6 and T_5 were because more eggs were produced with less feed cost and less mortality as compared to birds of control. The out-turn of T_4 group was the lowest.

The data on input, output and profit as influenced by various treatments are in agreement with the reports published by Issacks et al. (1960), Vaidya et al. (1974) who also reported higher monetary returns from restricted groups.

Table 27

Cost of birds upto age of 20 weeks as affected by different treatments.

Items	Methods of feeding		
	Control	Alternate day	Scratched
A. Number of birds	90	90	90
B. *Cost of birds (@ Rs 7.35 per bird) at 6 weeks of age	Rs661.50	661.50	661.50
C. **Feed cost from 6-20 weeks	Rs 581.40	432.31	344-63
Total (B+C)	Rs1242.90	1093.81	1006.13
Saving per bird over control	-	1.65	2.63

* Rate of day old chick Rs 3.30 and feed cost upto 6 weeks Rs 4.05; Total Rs 7.35 per chick.

**Rate of starter Rs 149.55; Ration used Part I Rs 117.28 and Scratched ration Rs 60.67 per quintal.

Table 28

Economic returns as influenced by different treatments

Items	Treatments					
	T_1	T_2	T_3	T_4	T_5	T_6
A. Number of birds	30	30	30	30	30	30
B. Cost of birds (Calculated from table 27)	Rs 414.30	Rs 414.30	Rs 364.50	Rs 364.50	Rs 334.20	Rs 334.20
C. *Feed cost from 20 to 50 weeks	718.50	773.10	717.70	853.10	706.80	869.80
D. Total Exp. Rs (B+C)	1132.80	1187.40	1082.20	1217.60	1041.00	1204.00
E. **Income from Eggs	1530.75	1505.60	1503.65	1516.35	1523.30	1670.40
F. ***Income from culled birds	403.25	415.00	405.00	418.50	406.50	434.00
G. Total Income (E+F)	1934.00	1920.60	1908.65	1934.85	1929.30	2104.40
Gross Profit (G-D)	806.20	733.20	826.45	717.25	888.30	900.40
Profit per bird	26.87	24.44	27.54	23.90	29.61	30.01

*Rate of feed - Layer mash I Rs 119.96 (later on 115.51); Layermash II Rs 133.14 (later on 127.19) and layermash III Rs 148.82 quintal.

**Rate of egg - Large 0.45 paise; Small 0.40 paise each.

***Rate of culled bird Rs 8.00 only/kg live weight (assumed).

It may be concluded that scratched feeding during the growing stage is economically superior than standard (control) and alternate-day feeding. Scratched combined with phase feeding during laying period (T_6) became most profitable followed by T_5 group (scratched cum normal feeding). Phase feeding was not found economically superior over their control.

*

5. SUMMARY AND CONCLUSION

Birds tend to over eat than required for efficient reproduction. In order to check this, controlled feeding (alternate-day and scratched) has been tried. Phase feeding during laying period is another method of improving efficiency of egg production. Both these methods of feeding were combined and studied in the present experiment to find their suitability to improve the efficiency of egg production.

Two hundred seventy 6 weeks old chicks were randomly divided into 9 groups of 27 females and 3 males each. Three groups were kept as controls (according to NRC,Standard) Three groups on alternate-day and three scratched feeding programme upto 20 weeks of age. At 20 weeks of age the second part of the experiment was started. From each of the three treatments (Part I) 66 birds were selected randomly and divided into two groups. One group was as control and the other was subjected to phase feeding. In this way, there were six treatments and the experiment continued upto 50 weeks of age. Body weight, feed consumption, age at sexual maturity, egg production, egg weight and mortality etc. were observed.

Following are the salient findings of the present experiment:

1. The birds under restricted feeding programme grew at slower rate than birds on control. The decrease in body-weight was dependent on the different methods of feeding.

The body weight of birds decreased and at 13 weeks of age significant differences in body weight were observed. At 20 weeks of age the decrease was 155 g in alternate-day and 300 g in scratched fed groups compared to control.

2. The mean commulative feed intake per bird was found to be the highest in scratched fed group, followed by control and alternate-day fed groups. Twenty six percent feed saving was observed in alternate-day feeding. The feed efficiency was poorest in scratched fed group followed by control and alternate-day fed groups. The best feed efficiency was observed in case of birds fed on alternate-day feeding.

3. With the introduction of phase feeding at 20 weeks of age, the pullets tried to compensate the depression in body weight. At 30 weeks of age the pullets of the group (T_6) which were allowed higher plane of nutrition showed highest body weights than the rest of the groups. During 30-40 weeks age (Phase II) the mean body weights of the pullets reared on two planes of nutrition was similar but are significantly lower compared to phase fed groups. During phase III at 50 weeks the body weight in all the groups except in T_5 were similar.

4. The scratched fed group birds took longest time 163 days to attain sexual maturity followed by alternate-day 158 days and the control 152 days.

In relation to mean body weight at sexual maturity, the alternate-day fed group had higher body seight 1304 g

than control 1294 g and scratched fed 1256 g, respectively from 6 to 20 weeks of age. The higher plane of nutrition during phase I may be attributed to improved body weight gain.

The heavier egg weights in the scratched fed birds with delay in sexual maturity, the scratched group had lower body weight at sexual maturity but egg weight of largest size.

5. The superiority of phase feeding for egg production during laying period could not be observed in any treatment group except T_6. The egg production was similar in rest of the treatments. The T_6 group laid significantly higher rate compared to all others. So it was concluded that low plane of nutrition as provided by scratched feeding from 6 to 20 weeks of age followed by higher plane of nutrition in phase feeding (21.3 percent protein) at the beginning of the productive cycle had best response in egg production than the other nutritive treatments.

6. The mean egg weight obtained during the first phase of laying cycle was higher in restricted groups. There was slightly higher egg weight in phase fed groups compared to their control. The egg size were gradually narrowed down with advancement of age. Overall the alternate-day fed group laid continuously larger eggs during the whole laying period, but the egg size difference had narrowed down in scratched fed group.

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