A study of twenty cropping sequences of feed and fodder crops commonly grown in North India was made for two consecutive years beginning from kharif, 1969 at the I.A.R.I. farm, New Delhi, to evaluate them for their yield potential (fresh as well as dry), nutritive value, the number of milch animals whose requirements for maintenance and production could be fully met from one hectare, their economics as crop and dairy enterprise and labour employment potential. The effect of different cropping systems on the fertility status of soil was also determined by analysing the soil samples for physical properties before and after experimentation and for chemical properties after each crop. The experiment was laid out in a randomised block design with four replications. In each replication, the twenty plots were arranged in four-tiers each of five plots (of net size 9.1 m x 6.1 m) and the twenty treatments were allotted to the plots at random. The recommended cultural practices for the cultivation of different crops and standard techniques for analysing the soil and plant samples were used.

The results obtained were subjected to appropriate statistical analysis. The main findings are summarised below:

1. Dairy farming with productive milch cattle was found to be highly remunerative when developed along with a multiple cropping system involving high yielding and nutritive fodder crops. The cultivation of fodders for feeding dairy cattle for milk production was found to be more economical than selling the produce directly in the market. The best five fodder-based
cropping patterns found on the basis of both profitability and the number of milch animals whose requirements for maintenance and production were fully met from a hectare of land were:

a) Sorghum - berseem - bajra
b) Bajra - turnip - oats - maize+cowpea
c) Bajra - mustard - oats - cheena
d) Maize+cowpea - berseem - bajra and
e) Hybrid napier - intercropped with berseem

2. A 3-crop cropping pattern involving sorghum (kharif), berseem (rabi) and bajra (summer) was found to be superior to others in its dry-matter yield, nutritive value, number of milch animals that could be supported per hectare and its economic profits through dairy enterprise. With a total production of 2034 q/ha of green fodder which, when converted into dry-matter, amounted to 395 q/ha, this cropping pattern could supply per day per hectare 7.6 kg D.C.P. and 62.3 kg T.D.N., which would meet the full requirement of maintenance and production of 8.8 buffaloes each of 650 kg body-weight, yielding 3000 litres of milk per lactation per annum of 7 per cent butter-fat or 10.9 buffaloes of 400 kg body-weight, giving 2000 litres of milk per annum with 7.5 per cent butter-fat. The corresponding figures for cows with similar yield potentials and body-weights of 400 and 350 kg and butter-fat 4.0 and 4.5 per cent were 11.1 and 13.6 respectively. The net returns were Rs 5990 per hectare as a crop enterprise, but as a dairy enterprise the net income obtained was Rs 13740 per hectare and Rs 16320 per hectare from high yielding buffaloes and cows and Rs 15040 and Rs 16420 per hectare from buffaloes and cows with 2000 litres milk yield respectively. The additional income through dairy enterprise was of the order of Rs 12750, Rs 12330, Rs 2050 and Rs 8430 per hectare from corresponding groups of animals. This cropping
pattern was however, not very satisfactory from the viewpoint of maintaining soil fertility. It would hence be necessary to use part of the profit for attending to soil fertility maintenance. Berseem with its multicut regime and vigorous regenerating ability could help in maintaining continuous green fodder supply during winter. Similarly, bajra during summer could provide forage at an interval of about 45 days. Its luxurious vegetative growth with comparative high nutritive value, during scarcity period could prove beneficial for dairymen.

3. The 4-crop sequence, bajra - turnip - oats - maize + cowpea was found to be the second best cropping pattern with the highest green fodder yield of 2408 q/ha and 381 q/ha of dry-matter. A hectare of land under this crop sequence produced 6.8 kg D.C.P. and 71.8 kg T.B.N. which were enough to sustain 8.5 buffaloes or 10.9 cows each yielding 3000 litres of milk or 10.9 buffaloes or 13.9 cows with 2000 litres of milk yield per year. The economic returns were of the order of Rs 6840 per hectare through crop enterprise alone but through dairying the income went up to Rs 17370 and Rs 17220 per hectare from 3000 litres milk yielding buffaloes and cows and Rs 1480 and Rs 14510 per hectare from 2000 litres milk yielders respectively. Inclusion of a short duration crop of turnip was found to be beneficial in maintaining the continuous flow of fresh roughage to the cattle.

4. Inter-cropping of hybrid napier with pea (grain) as well as with berseem fodder was found to be a sound system of forage husbandry. In addition to high potentials for green fodder and dry roughages, this provided a good amount of nutrients for raising dairy animals and also
improved the soil fertility status. Hybrid napier with pea (G) though better in its carrying capacity on account of a little higher production of T.O.N. than berseem-based combination, suffers from the draw-back of supplying the green fodder only for a limited period of the year. This could, therefore, be cultivated in a small area of the farm to utilize its supply during lean period of fodder availability. The net additional returns per hectare through dairy enterprise were above Rs 12,000 per hectare over crop business, if high yielding buffaloes and cows are kept. On the other hand, hybrid napier intercropped with berseem produced 2040 q/ha green fodder having 308 q/ha dry-matter. With its per day per hectare yield of 7.8 kg O.C.F. and 51.5 kg T.O.N., this combination could support 7.3 buffaloes or 9.2 cows each yielding 3000 litres of milk per year or 9.0 buffaloes or 11.2 cows of 2000 litres milk yield per year on a hectare of land. The additional income through dairy enterprise was about Rs 10,000 per hectare from 3000 litres milk yielding animals and above Rs 6500 per hectare from the cattle giving 2000 litres of milk per year. This combination led to improvements in the physical and chemical properties of the soil.

5. Among the fodder-based rotations other than those already mentioned, the following yielded more than 200 t/ha, (a) maize+cowpea - turnip - oats - maize+cowpea (221 t/ha) and (b) maize+cowpea - berseem - bajra (203 t/ha). The 4-crop sequence, bajra - mustard - oats - cheena could produce only 193 t/ha due to the comparatively low yield of mustard and cheena during zaid and summer seasons respectively.

6. The net income per hectare through dairy enterprises, whether with buffaloes or with cows having similar yield potential, were almost of the
same order. However, the level of income through dairy enterprise depended upon the number of animals that could be supported on a hectare of land.

7. As a crop enterprise, the feed crop sequences were found to be more economical than the fodder-based crop rotations; for example, the maize (G) - oats (G) - mung (G) sequence netted an income of Rs 9700 per hectare while the best three crop fodder sequence gave a net return of Rs 6110 per hectare only.

8. Inter-cropping of hybrid napier with pea (G) would cost much less (Rs 3370 per hectare) than with a multicut crop of berseem fodder (Rs 4510 per hectare). In spite of higher cost of production of the latter, the net income from both the sequences through crop enterprise was almost of same order i.e. above Rs 4900 per hectare.

9. Inclusion of a summer crop like bajra with its two cuts and high water requirements increased the cost of production of the cropping pattern, sorghum - berseem - bajra by Rs 250 as against the summer maize+cowpea in the sequence, sorghum - berseem - maize+cowpea.

10. Lucerne with a green fodder yield of 1057 q/ha and 213 q/ha dry-matter provided the highest amount of D.C.P. (9.6 kg per hectare per day) followed by berseem-based crop sequences like maize+cowpea - berseem - bajra (7.9 kg), hybrid napier intercropped with berseem (7.8 kg) and sorghum - berseem - bajra (7.6 kg). On the basis of the total yield of D.C.P. per hectare, hybrid napier occupied the first position with an yield of 15.8 q/ha, followed by berseem with an yield potential of 15.1 to 17.7 q/ha. As an individual crop, bajra (summer) contributed the maximum by yielding 11.6 kg D.C.P. per day followed by hybrid napier (at 10.5 kg).
The yield per day of total digestible nutrients was the highest (17.5 kg) in the 4-crop sequence comprising bajra, turnip, oats and maize+cowpea followed by the 3-crop feed-based rotation maize - oats - mung with 67.9 kg and 4-crop fodder sequence of maize+cowpea - turnip - oats - maize+cowpea with 67.7 kg/ha per day. Lucerne alone yielded 34.9 kg/ha per day.

Total yield of T.D.N. contributed by individual crop was the highest from hybrid napier, oats (grain) and lucerne with 164.7 q/ha, 117.0 q/ha and 98.2 q/ha respectively.

Pusa Giant berseem was found to be very suitable for multiple cropping because of its ability to provide the maximum green fodder supply in its early cuts and thereby making available the field for the next summer crop in time (end of March).

A combination of turnip (zaid) and oats (rabi) was found to be better than oats with two cuts of green fodder. Oats in two cuts provided on an average 520 q/ha green fodder having 11.7 q/ha D.C.P. and 98.2 q/ha T.D.N., while with a zaid crop of turnip and one cut of oats (rabi), the green fodder supply went up to 1310 q/ha with 13.7 q/ha D.C.P. and 121.9 q/ha T.D.N. The dry-matter yield indicated the same trend too i.e., 140 q/ha from oats with two cuts as against 156 q/ha from turnip and oats.

Of the zaid crops, turnip yielded about 265 q/ha more green fodder than mustard (147 q/ha), with a corresponding difference of 26.4 kg/ha of D.C.P. and 258 kg/ha T.D.N. A similar trend was observed when their yields were considered along with rabi oats fodder.

The dry-matter yield of the cropping patterns involving grain crops of maize - oats - mung was 346 q/ha as against the average yield of 329 q/ha with fodder-based sequences and 315 q/ha with feed and fodder combinations.
17. Soil analyses indicated that the fodder-based rotations T-11 (maize + cowpea - berseem - maize), T-12 (sorghum - berseem - maize + cowpea) and T-18 (maize + cowpea - turnip - oats - maize + cowpea) were the best of all other cropping patterns with reference to physical and chemical properties of the soil, while T-2, T-13, T-14 and T-19 did not show encouraging results. This drawback would hence need to be corrected by the appropriate application of manure and fertilizers.

18. The necessity of K2O application for berseem cultivation was brought out by this study thereby stressing the need to revise the popular opinion that Delhi soil contained adequate amounts of potassium.

19. A combination of multi-cut crops like intercropping of napier hybrid grass with berseem showed the highest labour employment potential of 321 man-days per hectare per year followed by a combination of sorghum - berseem - bajra with man-power requirement of 298 in a year.

20. The study also gave optimistic indications of reducing underemployment and unemployment in the country through dairy farming, as this could enhance the employment potential by 5 to 6 times.