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Productivity and quality of arable crops and soil fertility as influenced by ley farming in hot region of Rajasthan

SUBHASH CHANDER[1], K.C. SHARMA, H.S. JAT[2] AND RAJ PAL MEENA[3]

Central Sheep & Wool Research Institute, Arid Region Campus, Bikaner, Rajasthan 334 006

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ABSTRACT

To assess the impact of 4 year ley farming with 2 grasses: i.e. Cenchrus (*Cenchrus ciliaris*) and sewan (*Lasiurus sindicus*), a field experiment was conducted on low fertile coarse sandy soil at Bikaner, Rajasthan during June 2000–December 2004. Two cutting schedules (half yearly and yearly) and 3 varieties (CAZRI-75, CAZRI-358 and CAZRI-1106 of *Cenchrus* and CAZRI-30-5, CAZRI-317 and CAZRI-319 of sewan) were grown in split plot design with 3 replications. The impact of 4 years ley farming on arable crops *viz*., moth bean (*Phaseolus aconitifolius* Jacq.) and pearl millet [*Pennisetum glaucum* (L.) R. Br.] were studied. The data reveal that sewan grass leys, half yearly cutting of leys have markedly higher biomass production than *Cenchrus* and yearly cutting schedules. Among the varieties, CAZRI-75 (*Cenchrus*) and CAZRI-30-5 (sewan) produced significantly higher biomass when compared with other varieties. The nutrient uptake of leys followed the trend of yields. The ley crops, their cutting schedules and cultivars failed to exert any significant influence on succeeding arable crops performance. However, ley farming has 107.3 and 88.7% higher moth bean and pearlmillet yield than control (no ley) due to greater moisture retention and soil fertility improvement.

Key words: *Cenchrus ciliaris*, Cuttings, Ley farming, Nutrients availability, Soil fertility, Straw, Varieties, Yield

Soil resources are the most important natural wealth for the sustainable development of agriculture in the world. But ruthless exploitation of this wealth has resulted in degradation of land and environment, and fragile socio-economic condition of the people, who depend on these resources for their survival and sustenance. Due to poor farming practices and transfer of agricultural land for non-agricultural use has lead to excessive erosion, nutrient depletion, soil salinization, waterlogging, compaction, vegetation loss, increased sedimentation, chemical pollution from industrial effluents, pesticides, fertilizer, and mining degradation. In regions where soil surface has perennial grass/legume cover and remain undisturbed, the organic matter builds up and erosion losses are minimized. Thus inclusion of perennial grass/legume component for different duration in rotation with arable crop (ley farming) is a main approach of poor farmers to restore soil fertility and improve food and fodder availability. Ley farming provides security against weather vagaries and economic risks when compared with continuous arable cropping, and it can be adopted in semi-arid and arid areas for the improvement of soil fertility, to enhance crop productivity as well as animal production and to check soil erosion. Loss of perennial pastures is not only causing fodder scarcity but also severe erosion of loose soil from bare and barren land surface. Hence, ley farming seems to be a good option to meet out the food and fodder demand as well as conserving the natural resources and soil fertility of this region. In view of this, present study was carried out with objective of manipulation of soil fertility with leys of perennial pastures and to evaluate their effect on the productivity and quality of major arable crops grown in hot arid region under National Agricultural Technology Project of Arid Agro-ecosystem.

MATERIALS AND METHODS

This experiment was conducted at Research Farm of Central Sheep and Wool Research Institute, Arid Region Campus, Bikaner, Rajasthan in split plot design replicated thrice. Four year leys of two perennial pasture grasses viz. Cenchrus (*Cenchrus ciliaris*) and sewan (*Lasiurus sindicus*), and two cutting schedules i.e. half yearly and annual were taken as main plots and three varieties each

Corresponding author: (Email: sbhgill@yahoo.com)
Present address: [1]Senior Scientist, DWR, Karnal, Haryana 132 001. [2]Senior Scientist, CSSRI, Karnal, Haryana 132001. [3]Scientist, DWR Regional Station, Dalang Maidan, Himachal Pradesh

of Cenchrus (CAZRI-75, CAZRI-358 and CAZRI-1106) and sewan (CAZRI M 30-5, CAZRI-317 and CAZRI-319) were taken as sub-plots. Besides these leys of grasses, a control treatment was kept fallow for all the 4 years. The soil of the experimental field was single grained coarse sand having pH 8.8 and 8.9, EC 0.24 and 0.27 dS/m, organic carbon 0.147 and 0.112%, available nitrogen 84.67 and 72.13 kg/ha, available phosphorus 4.17 and 1.76 kg/ha and available potassium 48.21 and 56.25 kg/ha in 0-15 and 15-30 cm depth of soil, respectively. The size of each treatment plot was 15 m × 10 m. The row-to-row spacing was kept 50 cm and a seed rate of 6 kg/ha of Cenchrus and 8 kg/ha of sewan was used for sowing of these pasture grasses on well prepared land with the commencement of rainy season in 2000. After completion of 4 years of ley, two arable crops *viz*. moth bean (*Phaseolus aconitifolius* Jacq.) 'RMO-40' and pearl millet [*Pennisetum glaucum* (L.) R. Br.] 'HHB-67' were grown during *kharif* 2004-05 on grasses leys as well as on control treatment. Two life saving irrigations were given by tube-well water to both the crops at tillering and flowering to avoid severe drought during growth period. Soil samples were collected every year from each treatment and every replication from inter-row spacing at a depth of 0-15 cm and analysed for various properties as per the standard procedures. Soil moisture status (0 to 15 cm depth) was recorded at weekly interval during crop growth period *i.e.* first to tenth week. Plant samples were also collected from all the treatments and subjected to N:P:K contents analysis as per standard procedures. The data were subjected to appropriate statistical analysis by using MSTAT software package.

RESULTS AND DISCUSSION

Biomass productivity by leys

Biomass productivity of sewan (total yield 29.39 tonnes/ha) was significantly higher when compared with Cenchrus (25.69 tonnes/ha). Half yearly cutting schedule recorded significantly higher biomass productivity than annual cutting schedule (Table 1) during initial 2 years (2001 and 2002) but reverse was true in 2003 and in 2004 both the cutting schedules have statistically similar productivity. This may be ascribed to the fact that in half yearly cutting schedule, two cuts were taken whereas only one cut was taken in annual cutting schedule, hence, some total yield of two cuts was higher than one cut yield taken at longer interval. Chander *et al*. (2004) and Patidar *et al*. (2008) also reported higher productivity of *sewan* than cenchrus.

'CAZRI 75' among Cenchrus varieties, and 'CAZRI M 30-5' among sewan varieties recorded the highest biomass productivity than the other varieties. These findings were in corroboration with the findings of Vyas *et al.* (2003).

Table 1. Biomass productivity of leys as influenced by varieties of grass and cutting schedules (t/ha)

Treatment	2001	2002	2003	2004
Grasses				
Cenchrus	2.87	11.08	7.68	4.07
Sewan	3.53	12.53	8.84	4.49
SEm±	0.13	0.31	0.15	0.08
CD (P=0.05)	0.45	1.06	0.53	0.29
Cutting schedule				
Half yearly	3.30	12.47	7.70	4.23
Annual	3.09	11.16	8.81	4.33
SEm±	0.05	0.15	0.14	0.11
CD (P=0.05)	0.18	0.52	0.49	NS
Varieties				
Cenchrus				
CAZRI-75	3.13	12.56	9.03	4.91
CAZRI-358	2.46	9.69	7.24	3.67
CAZRI-1106	3.00	10.80	6.78	3.62
Sewan				
CAZRI M-30-5	3.88	13.87	9.54	5.47
CAZRI-317	3.52	12.48	8.84	4.22
CAZRI-319	3.22	11.41	8.10	3.79
SEm±	0.11	0.44	0.21	0.14
CD (P=0.05)	0.33	1.32	0.64	0.42

Nutrient uptake by grass leys

Uptake of N and P was significantly higher in sewan than Cenchrus and in half yearly cutting schedule than annual cutting schedule (Table 2) during all the years of study except in 2004 for N and, 2003 and 2004 for P uptake where both cutting schedules were at par. However, K uptake was found significantly higher in sewan than cenchrus in all the years of study and in half yearly cutting schedule than annual cutting schedule in 2003 only. This might be ascribed to higher dry fodder productivity by sewan grass than cenchrus and by half yearly cutting schedule than annual cutting schedule. Among varieties 'CAZRI 75' of Cenchrus and 'CAZRI M 30-5' of sewan recoded the highest nutrients uptake which was significantly higher than their respective other varieties during the period of study. Vyas *et al.* (2003) also reported the superiority of improved varieties of Cenchrus compared to indigenous varieties grown in hot arid regions of Gujarat.

Soil moisture status during arable crops season

Under different grasses, their varieties and cutting schedules soil moisture status did not differ significantly among themselves. In general, the soil moisture content was lower in control plots than grasses leys plots (except

Table 2. Nutrients uptake (kg/ha) by leys of pasture grasses and their varieties under different cutting schedules (on dry biomass basis)

Treatment	Nitrogen				Phosphorus				Potassium			
	2001	2002	2003	2004	2001	2002	2003	2004	2001	2002	2003	2004
Grasses												
Cenchrus	48.4	224.8	149.0	70.4	5.44	27.69	16.13	8.14	39.0	137.3	86.8	53.3
Sewan	63.9	264.3	173.3	83.5	7.42	32.57	18.56	10.33	50.2	162.8	97.2	63.8
SEm±	1.9	2.2	2.7	2.7	0.29	0.45	0.26	0.28	1.0	1.2	0.9	1.2
CD (P=0.05)	6.4	7.5	9.2	9.4	1.01	1.55	0.91	0.96	3.5	4.1	3.1	4.2
Cutting schedule												
Half yearly	61.1	266.8	154.0	77.4	7.26	34.90	16.94	9.31	43.9	150.8	85.5	58.8
Annual	51.0	222.1	167.4	76.6	5.87	26.78	17.62	9.09	44.8	149.5	98.7	58.0
SEm±	1.1	1.2	1.4	1.1	0.24	0.26	0.33	0.23	0.7	1.2	0.7	0.8
CD (P=0.05)	3.9	4.2	5.0	NS	0.84	0.90	NS	NS	NS	NS	2.4	NS
Varieties												
Cenchrus												
CAZRI-75	56.6	267.4	178.8	87.9	6.25	32.64	18.96	10.80	44.1	149.4	102.9	67.3
CAZRI-358	39.7	189.9	137.6	62.8	4.44	23.26	14.48	6.97	33.5	127.0	83.3	47.3
CAZRI-1106	49.5	216.0	132.9	61.2	5.70	27.00	14.24	7.24	39.3	136.1	75.3	46.3
Sewan												
CAZRI M-30-5	76.0	299.5	195.6	105.6	8.53	38.83	20.99	13.68	55.8	184.4	99.2	79.3
CAZRI-317	61.9	260.9	171.5	76.0	7.04	31.21	18.56	9.28	48.9	158.5	97.2	59.5
CAZRI-319	55.1	233.8	153.9	67.8	6.77	29.66	17.01	7.96	46.1	149.4	90.7	53.1
SEm±	2.4	2.5	3.0	3.6	0.51	0.54	0.82	0.45	0.6	1.2	1.5	1.7
CD (P=0.05)	7.1	7.5	9.0	10.7	1.52	1.62	2.47	1.36	1.7	3.6	4.4	5.1

Table 3. Soil moisture content (%) of experimental field during crop growth period of Moth bean and Pearl millet crops (*kharif*, 2004)

Treatment (leys)	Crop growth duration (weeks)									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Grasses										
Cenchrus	7.91	5.17	5.32	4.80	7.57	5.57	3.14	7.32	6.63	6.39
Sewan	7.93	5.90	5.43	4.25	7.34	5.67	3.39	7.87	6.50	5.62
SEm±	0.11	0.27	0.12	0.21	0.13	0.09	0.10	0.17	0.15	0.29
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cutting schedule										
Half yearly	7.87	5.94	5.27	4.90	7.29	5.45	3.13	7.45	6.47	6.09
Annual	7.97	5.13	5.48	4.14	7.62	5.67	3.41	7.74	6.67	5.92
SEm±	0.10	0.14	0.11	0.16	0.12	0.10	0.09	0.11	0.13	0.23
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Varieties										
Cenchrus										
CAZRI-75	8.31	5.10	5.40	4.58	7.52	5.99	3.12	7.38	6.76	6.43
CAZRI-358	7.77	4.79	5.33	4.83	7.15	5.33	3.21	7.01	6.70	6.41
CAZRI-1106	7.67	5.62	5.22	4.98	8.03	5.38	3.10	7.57	6.45	6.33
Sewan										
CAZRI M-30-5	7.58	5.34	5.65	4.70	7.28	6.18	3.36	7.89	6.46	5.46
CAZRI-317	8.18	6.16	5.78	4.41	7.30	5.64	3.70	7.43	6.44	5.88
CAZRI-319	8.02	6.22	4.89	3.63	7.44	5.19	3.13	8.29	6.60	5.52
SEm±	0.27	0.51	0.37	0.57	0.39	0.40	0.27	0.48	0.26	0.34
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Grass leys	7.92	5.54	5.38	4.52	7.45	5.61	3.27	7.60	6.57	6.01
Control (no leys)	7.59	5.02	4.42	3.07	8.68	5.48	2.90	7.68	5.47	5.65
Increase over control (%)	4.40	10.40	21.70	47.20		2.40	12.80		20.10	6.40

Table 4. Effect of pasture grasses leys on growth and yield of Moth bean (*kharif*, 2004)

Treatment (leys)	Mothbean							Pearlmillet						
	Plant height (cm) 60 DAS	Dry weight/ plant (g) 60 DAS	Pods/ plant	Seed grain/ pod	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Plant height (cm) 60 DAS	Tillers/ plant	Ear length (cm)	Grains/ ear	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg /ha)
Grasses														
Cenchrus	18.4	20.3	25.8	5.0	25.0	199	731	122.6	6.6	26.9	1,262	11.9	716	1,904
Sewan	18.8	21.5	27.4	5.1	26.1	224	799	124.7	7.1	28.3	1,311	12.2	858	1,924
SEm±	0.3	0.4	0.8	0.1	0.8	10	22	1.9	0.9	0.7	37	0.6	46	67
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cutting schedule														
Half yearly	18.1	21.7	25.4	5.1	25.4	221	751	123.7	6.9	27.2	1,281	12.0	738	1,911
Annual	19.1	20.1	27.8	5.0	25.7	202	779	123.6	6.8	28.1	1,292	12.1	836	1,923
SEm±	0.5	0.6	0.9	0.3	0.6	10	18	2.0	1.0	0.9	39	0.7	51	73
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Varieties														
Cenchrus														
CAZRI-75	18.6	19.9	27.9	4.8	24.4	211	754	126.4	6.8	28.6	1,276	12.1	805	2,045
CAZRI-358	18.7	20.8	25.8	5.1	24.9	192	713	118.1	6.7	27.8	1,249	11.5	602	1,645
CAZRI-1106	18.0	21.4	25.6	5.0	25.9	194	726	126.3	6.4	24.3	1,261	12.1	742	2,023
Sewan														
CAZRI M-30-5	19.1	19.7	25.8	5.0	26.2	231	834	119.0	6.7	26.9	1,297	11.8	843	1,820
CAZRI-317	18.5	21.9	27.7	4.9	25.1	217	783	123.8	8.1	28.7	1,321	12.4	868	1,922
CAZRI-319	18.7	21.7	26.8	5.4	26.8	223	780	128.3	6.6	29.3	1,315	12.2	862	2,045
SEm±	0.6	0.9	1.0	0.4	0.9	15	46	5.3	1.3	1.7	45	1.1	89	153
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Grass ley	18.6	20.9	26.6	5.0	25.6	211	765	123.7	6.9	27.6	1,287	12.0	787	1,916
Control (no leys)	14.1	15.2	16.7	4.4	23.5	102	387	102.6	4.6	20.8	914	10.8	417	1,643
Increase over control (%)	31.9	37.5	59.3	14.6	8.7	107.3	97.7	20.6	50	32.7	40.8	11.1	88.7	16.6

*DAS-Days After Sowing

in 5th week). Rao *et al.* (1997) also reported from arid zone of India that the leys treatment retains more rainwater in the root profile.

Growth, yield attributes and yield of crops

The data recorded on growth yield attributes and yield of both the crops of moth bean and pearlmillet (Table 4) reveal that the plant height was not significantly influenced either by grass leys, their varieties or by cutting schedules. The plant height recorded in control plot no leys was considerably lower than grass ley plots of mothbean and tillers plant, grains/ear and 1,000 grain weight (pearlmillet). Similarly number of pods/plant, number of grains/pod and 1,000-grain weight were not statistically influenced either by grasses, their varieties or cutting schedules. These parameters were remarkably higher (59.3, 14.6 and 8.7% higher pods/plant, grains/pod and 1000-grain weight in mothbean and 50, 40.8 and 12.0% higher tillers/plant, grains/ear and 1,000 seed weight of pearlmillet) in grasses leys as compared to control.

The grain yield of crops was not significantly affected by grass leys, their varieties or cutting schedules (Table 4) but it was conspicuously more in leys (107.3%) than control (102 kg/ha). Similarly straw yield was also statistically at par among different grass leys, varieties and cutting schedule but it was higher by 97.7% in grass leys (765 kg/ha) when compared with control (387 kg/ha). Kirby *et al*. (1996) reported yield gain and economic benefits for the farmer from the adoption of ley farming. These benefits vary with the frequency of grain cropping, the legume species used and the commodity price relativities. Similarly Yeates *et al.* (1996) also found mungbean and sorghum as suitable arable crops for ley farming in Australia on the basis of analysis of 3 sites in the Northern Territory.

Rao *et al.* (1997) also reported from arid zone of India that the leys farming practice of 4 or more years produced significantly higher pearl millet grain and straw yield than conventionally cultivated field. Nevens and Reheul (2002) also studied the N release from ploughed 3-year-old grazed grasslands leys in the subsequent 3 seasons of forage crops on a sandy loam soil and they found that silage maize in the ley–arable rotation out yielded continuous maize on permanent arable plots by 85, 21 and 2% at mineral N fertilization rates of respectively 0, 75 and 180 kg N/ha.

Table 5. Effect of pasture grasses leys on plant nutrients content (%) and soil fertility status after harvest of moth bean (*kharif*, 2004)

Treatment (leys)	Nutrient content in grain			Organic carbon	pH	EC	Available nutrient in soil (kg/ha)		
	N	P	K	(%)			N	P	K
Grasses									
Cenchrus	3.63	0.42	0.40	0.27	8.46	0.70	153.7	7.80	187.4
Sewan	3.71	0.44	0.45	0.23	8.42	0.61	152.5	7.75	181.0
SEm±	0.17	0.03	0.06	0.02	0.03	0.06	2.7	0.19	3.9
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cutting schedule									
Half yearly	3.55	0.42	0.40	0.27	8.44	0.59	152.1	7.67	184.6
Annual	3.79	0.43	0.44	0.23	8.44	0.71	154.2	7.89	183.8
SEm±	0.15	0.02	0.05	0.03	0.01	0.09	2.1	0.16	7.9
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Varieties									
Cenchrus									
CAZRI-75	3.61	0.43	0.39	0.27	8.50	0.74	154.8	7.89	192.4
CAZRI-358	3.72	0.42	0.42	0.26	8.49	0.64	155.6	7.93	193.3
CAZRI-1106	3.56	0.40	0.41	0.27	8.40	0.71	150.7	7.53	176.4
Sewan									
CAZRI M-30-5	3.74	0.43	0.45	0.23	8.41	0.61	152.3	7.75	183.2
CAZRI-317	3.65	0.44	0.45	0.21	8.38	0.59	156.1	7.97	175.0
CAZRI-319	3.75	0.44	0.42	0.24	8.46	0.62	149.2	7.67	184.8
SEm±	0.11	0.04	0.03	0.04	0.05	0.10	3.7	0.4	9.7
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Grass leys' mean	3.67	0.43	0.42	0.25	8.44	0.65	153.1	7.80	184.2
Control (no leys)	3.47	0.39	0.42	0.11	8.80	0.48	84.7	5.59	119.8
Increase over control (%)	5.80	9.00		116.70		35.40	80.8	39.50	53.8

Table 6. Effect of pasture grasses leys on plant nutrients content and soil fertility status after harvest of pearl millet crop (k*harif*, 2004)

Treatment (leys)	Nutrient content in grain (%)			Nutrient content in straw (%)			Organic carbon (%)	Soil pH	Soil EC (dsm^{-1})	Available nutrient in soil(kg/ha)		
	N	P	K	N	P	K				N	P	K
Grasses												
Cenchrus	1.77	0.32	0.57	0.51	0.15	1.63	0.256	8.55	0.44	127.1	5.99	189.9
Sewan	1.69	0.36	0.51	0.56	0.17	1.71	0.213	8.62	0.38	131.2	5.90	200.9
SEm±	0.11	0.06	0.08	0.07	0.01	0.09	0.013	0.08	0.07	1.9	0.10	4.5
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cutting schedule												
Half yearly	1.75	0.35	0.49	0.49	0.18	1.74	0.244	8.59	0.41	128.4	5.77	195.7
Annual	1.71	0.33	0.58	0.58	0.14	1.60	0.225	8.58	0.41	130.0	6.12	195.2
SEm±	0.13	0.08	0.09	0.08	0.02	0.10	0.016	0.09	0.09	2.0	0.10	4.9
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Varieties												
Cenchrus												
CAZRI-75	1.81	0.31	0.53	0.47	0.16	1.59	0.256	8.53	0.46	128.2	5.95	201.4
CAZRI-358	1.74	0.34	0.61	0.55	0.14	1.68	0.262	8.55	0.38	130.1	6.26	177.9
CAZRI-1106	1.76	0.31	0.56	0.50	0.15	1.62	0.252	8.57	0.39	123.1	5.73	190.4
Sewan											0.00	0
CAZRI M-30-5	1.78	0.39	0.54	0.53	0.16	1.67	0.215	8.56	0.44	133.7	5.99	200.5
CAZRI-317	1.62	0.32	0.49	0.59	0.18	1.75	0.220	8.62	0.42	131.0	5.77	195.8
CAZRI-319	1.68	0.37	0.49	0.54	0.17	1.72	0.209	8.68	0.38	128.9	5.90	206.5
SEm±	0.19	0.09	0.11	0.09	0.02	0.16	0.021	0.11	0.10	3.7	0.20	7.1
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Grasses leys' mean	1.73	0.34	0.54	0.53	0.16	1.67	0.235	8.59	0.41	129.2	5.95	195.4
Control (no leys)	1.67	0.34	0.52	0.44	0.11	1.74	0.116	8.78	0.27	75.6	5.02	101.3
Increase over control (%)	3.60		3.90	20.50	45.50		102.6		51.90	70.9	18.40	93.0

Nutrient concentration of crops

The nutrients contents in grains as well as straw were statistically similar in different grasses, their varieties and cutting schedules of leys. The perusal of data reveals that the nutrients content ranged in between 3.47 to 3.75% N, 0.39 to 0.44 % P and 0.39 to 0.45 % K in moth bean grains while in pearlmillet 1.62 to 1.81% N 0.31 to 0.39% P and 0.49 to 0.61% K. This indicates that nutrients contents were not influenced by grass leys, however, their corresponding values were comparatively lower in control treatment.

Fertility status of soil after harvest of crops

Soil OC, pH, EC and available nitrogen, phosphorus and potassium in soil were not significantly influenced either by grasses, their varieties or cutting schedules (Table 5). The data revealed that the soil organic carbon content was remarkably higher under grass leys (0.247 and 0.235% after moth bean and pearmillet) when compared with control (0.114 and 0.116%) but was statistically at par under different grasses, their varieties and cutting schedules. Lal (2004) reported ley farming as an efficient technological option for soil C sequestration in India. Soil pH was lower under grass leys-mothbean (8.44) than control- mothbean (8.80). But, it was higher in 4 years grassed ley – pearlmillet (8.78) than no ley-pearlmillet system (8.59). Similarly EC was higher under grasses leys than control. Available N, P and K content were also higher (80.9, 39.8 and 53.8% respectively) under grass leys-mothbean (153.1 kg N/ha, 7.80 kg P/ha and 184.2 kg K/ha). Similarly, available N, P and K recorded in grass leys- pearlmillet system was 70.9, 18.4% and 93.0% higher than no ley-pearlmillet system. Grain yield and straw yield data of pearl millet crop grown on grass leys reveal that grain yield was 88.7% higher on grass leys (787 kg/ha) when compared with control (417 kg/ha) treatment. Similarly straw yield was 16.7% higher on grasses leys (1,917 kg/ha) when compared with control (1,643 kg/ha) treatment (Table 6). Gangwar *et al.* (1992) also reported ley farming as a better option for improving crop productivity and soil-fertility under semi arid conditions.

Soil fertility changes - Ley farming

Fig. 1. elucidates that when the overall means of or-

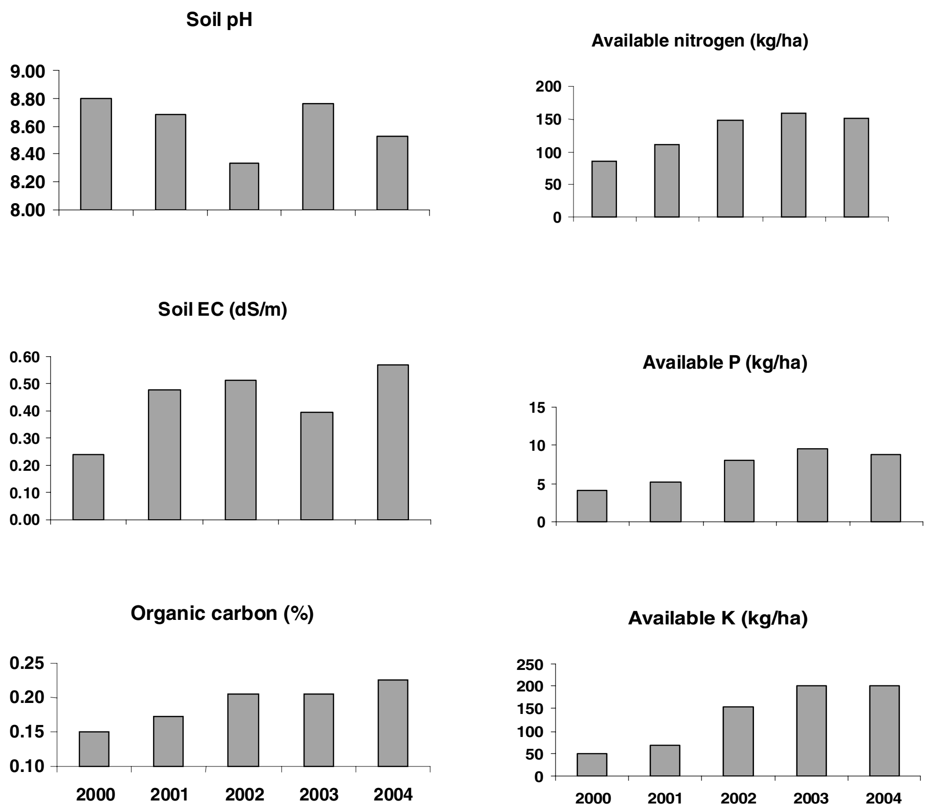

Fig. 1. Organic carbon, pH, EC and available major nutrients of the experimental field soil under grass leys (0-15 cm)

ganic carbon, pH, EC and available N:P:K were compared over the years, there was successive improvement in soil organic carbon content (0.15, 0.17, 0.21, 0.21 and 0.23% in 2000,2001,2002, 2003, 2004, respectively), slightly lowering of soil pH (8.80 in 2000 to 8.53 in 2004), increase in soil EC (0.24 to 0.57 dS/m) and noticeable increase in available N (84.67, 110.49, 148.08, 158.40 and 150.85 kg/ha), available P (4.17, 5.31, 8.05, 9.52 and 8.77 kg/ha) and available K (48.22, 68.99, 152.89, 200.17 and 200.21 kg/ha in 2000, 2001, 2002, 2003, 2004, respectively). This might be due to the addition of organic matter by roots and leaves of growing plants of perennial grasses and increased microbial activity which might have also induced mineralization of fixed soil nutrients. Application of life saving irrigation might have contributed to enhanced EC, Microbial activity and mineralization process especially in the upper soil surface. Whitbread (2008) also suggested that grass and legume leys incorporated into farming system can potentially improve soil fertility, crop yields and profitability especially longer-term pasture phase (>1 year) may substantially change soil fertility. Rao *et al.* (1997) studied ley farming (with *Cenchrus ciliaris*) as an alternative farming system in the Indian arid zone and found a six year ley would provide yields equivalent to 40 kg N/ha. They also reported that ley farming is allowing the soil to recoup and make it more living with improved organic matter and better microbial activity.

Consequently higher productivity of moth bean and pearl millet can be achieved through their cultivation after leys of perennial pasture grasses (Cenchrus and sewan). These leys showed great impact on soil moisture retention and fertility and may prove a boon for resources conservation and live stock production in this hot arid region. Half yearly cutting schedule and cultivars CAZRI-75 (Cenchrus) and CAZRI M-30-5 (sewan) are best for ley farming.

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