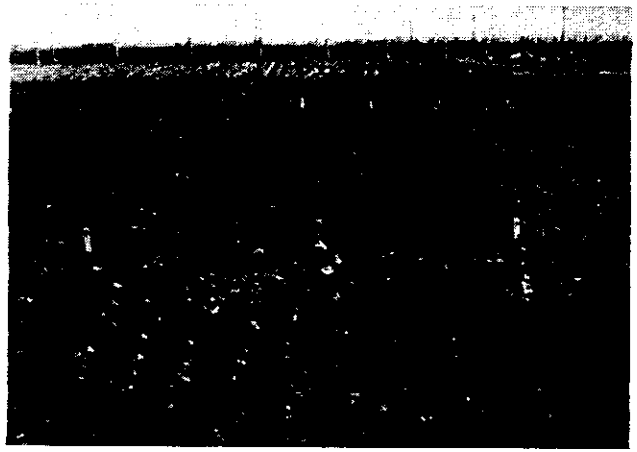
FORAGE PRODUCTION TRIALS IN THE BEQA'A, LEBANON, 1958-1963



Test Plots for Legumes

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by
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and
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by

W.W. Worzella, S. Abu-Shakra, and D.W. Bray*

INTRODUCTION

The superiority of a system of farming which utilizes forages in the production of livestock, as compared to grain or specialized crops produced for cash, is becoming more generally recognized. Such a system of farming tends not only to maintain soil productivity but also to contribute to economic stability.

In the Middle East the exploitive monoculture of wheat or barley practiced over many years has resulted in lower and lower crop yields. With the inclusion of forage crops in the rotation, much improvement could be made in soil productivity, increased crop yields, and supplies of roughage and feed for livestock.

Research involving forage crops in the Middle East is very limited. The present investigations were carried out to determine the relative productivity and quality of several important forage crops grown under both irrigated and dryland conditions.

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MATERIALS AND METHODS

The experiments on forage crops were conducted at the Agricultural Research and Educational Center located in the north central Beqa'a plain, Lebanon. The soil is high in clay content, low in organic matter and phosphorus, high in potassium content and is calcareous with a pH of about 8.0.

Insecticides were used to control insect pests and the plots were kept free from weeds by hoeing and cultivation. The irrigated plots were watered once a week during the dry periods of the growing season. A good seed bed was prepared and the row crops were planted thickly and later thinned to the desired number of plants per row. Alfalfa and the dryland crops were planted in rows 15 and 25 cms. apart, respectively. Alfalfa was seeded in March while sorghum, sudangrass, millet, corn and soybeans were planted in April or May. The dryland crops were planted about the middle of November. All legume seeds were inoculated with the proper inoculation just prior to planting.

The dryland experimental plots received a uniform application of 6 kgs. of P_2O_5 per dunum (1000 square meters). Twenty kgs. of P_2O_5 and 12 kgs. of nitrogen per dunum were applied to all of the irrigated crops, except alfalfa which received only the 20 kgs. of P_2O_5 per dunum. The fertilizer was broadcast and worked into the soil by disking. The non-legume crops received an additional one or two applications of 4 kgs. of nitrogen per dunum as a side dressing, at the time when the first nitrogen deficiency symptoms were observed in the plants.

The experiments were laid out in randomized block and split plot designs with each treatment replicated four times. Plots consisted of 2 or 3 rows, 50 cms. or 75 cms. apart, depending on the crop, and 5 meters in length. Four meters of one or two of these rows were harvested for the forage yield. Each plot for the alfalfa and dryland crops was 2 x 6 meters in size. From each plot two or three square meters were harvested for yield and chemical analysis. The yields of forages from the dryland crops were calculated to a 12.5 percent moisture basis. The forage yields of alfalfa and the row crops grown under irrigation are reported on an air-dry basis. The statistical analysis methods used were according to those described by Snedecor (6) and Cochran and Cox (2).

EXPERIMENTAL RESULTS

The data on forage yields are reported in tons per dunum of the crops grown under irrigation and kilograms per dunum for those produced under dryland. The protein data are expressed in percent of dry matter. The results of the various trials will be discussed separately under irrigated experiments and dryland experiments.

IRRIGATED EXPERIMENTS

Forage Sorghum Variety Trials

The forage sorghums were planted between April 20 and May 15 with the first crop harvested usually in August and the second crop in October. The forage yields from 10 varieties grown at the Agricultural Research and Education Center during the 4-year period 1960-63 are reported in Table 1.

Table 1. Average yield of forage sorghum varieties grown under irrigation in the Beqa'a during the 4-year period 1960-63.

Variety	Forage yield (air-dry) - tons/du.				Average	
	1960	1961	1962	1963	3-year 1961-63	4-year 1960-63
Atlas	2.9	2.9	2.8	2.5	2.9	2.8
Rox	2.9	2.9	3.4	2.4	3.1	2.9
Axtell	3.2	2.9	3.8	2.7	3.3	3.2
Ellis	2.5	2.5	3.0	2.3	2.7	2.6
White Collier	2.6	3.8	5.0	2.3	3.8	3.6
RS. 301F	3.5	4.2	3.1	2.8	3.6	3.4
Rancher	2.7	1.2	1.7	1.1	1.9	1.7
Local (Broomcorn)	2.1	2.6	3.0	3.2	2.4	2.6
De Kalk FS. 22	—	4.8	3.7	2.5	3.7	—
Stavium	—	6.0	2.1	3.5	3.9	—
LSD (5% level)	0.5	0.5	0.4	0.4	0.25	0.22

It will be noted that the varieties of sorghum vary widely in total forage production, with some yielding twice as much fodder as did others. In addition to variation in yield, the varieties differed widely in

other important characteristics which must be considered in choosing a suitable variety. Some varieties produced large quantities of forage at the first date of cutting but little subsequently (White Collier), while others (RS 301F, Axtell, DeKalb FS. 22, Rox and Atlas) produced high amounts of forage at both of the harvesting dates. The late maturing tall growing variety Stavium, produced only one cutting of coarse-stemmed fodder, while three cuttings of high quality fine-stem forage were obtained from the variety Rancher. The Local (Broomcorn) variety stools sparingly and has tall stalks with few leaves. In selcting a variety, therefore, consideration should be given to the time or month the fodder is available as a feed, its quality, and total fodder yield. On the basis of quality and total yield the varieties RS 301F, Axtell, De Kalb FS. 22, Rox and Atlas perform well when grown under irrigation in the Beqa'a, Lebanon. The varieties White Collier and Stavium produced high yields of fodder that was coarser than that harvested from the other varieties. Rancher is an early maturing variety selected for its low prussic acid content, which makes it safe for pasture purposes in areas where this is a problem.

Sudangrass Variety Trials

Six varieties of sudangrass were appraised for their fodder production during the 5-year period 1959-63. The data, in tons per dunum, are reported in Table 2.

Table 2. Average yield of forage of sudangrass varieties grown under irrigation in the Beqa'a during the 5-year period 1959-63.

Variety	Forage yield (air-dry) - tons/du.					Average	
	1959	1960	1961	1962	1963	4-year 1960-63	5-year 1959-63
Piper	1.1	1.5	2.9	1.9	2.0	2.1	1.9
Sweet Sudan	1.3	1.7	2.1	1.8	1.7	1.8	1.7
Greenleaf	1.3	1.5	2.1	1.9	2.0	1.9	1.8
Wheeler	—	0.9	1.5	1.4	1.7	1.4	—
Lahoma	—	1.5	2.2	2.2	2.1	2.0	—
Tift	—	1.6	2.5	1.9	2.3	2.1	—

Sudangrass can be used as a pasture or made into hay. It produced three cuttings of palatable and nutritional hay each year at the Center.

The hay yields are lower than those obtained for the sorghums but thei forage quality is superior. The average hay yield for the 4-year period 1960-63 varied from 1.4 tons per dunum for the variety Wheeler to 2.1 tons for Piper and Tift. Except for the variety Wheeler, the other varieties yielded about the same. Sweet Sudan is extremely palatable; the stems are both sweet and juicy. Piper, a low prussic acid content variety, produced a good yield and should be used in pastures to avoid livestock losses from prussic acid poisoning.

Forage Millet Variety Trials

The results of forage yield trials for six varieties of millet grown in the north central Beqa'a, Lebanon, are shown in Table 3.

Table 3. Average yield of forage of millet varieties grown under irrigation in the Beqa'a during the 5-year period 1959-63.

Variety	Forage yield (air-dry) - tons/du.					Average
	1959	1960	1961	1962	1963	1959-63
Manata	0.33	0.43	0.47	0.87	0.60	0.54
Proso	0.40	0.39	0.45	0.94	0.80	0.60
Hursk	0.32	0.42	0.48	—	—	—
Star	1.29	1.11	3.35	1.42	1.76	1.80
German	0.59	0.92	1.07	1.02	0.94	0.91
Gahi - 1	—	—	—	2.94	1.39	—

Millet, in forage production, is largely limited to its use as an emergency crop, or as a late-sown catch crop. Millet requires warm weather for its growth and outranks all other crops as regards efficiency in the use of water. Some varieties require only 60 to 70 days from seeding to maturity. The two varieties, Manata and Proso, are very early and are used primarily for grain purposes. Two hay crops were obtained per year by replanting the same plots immediately after the first harvest. High quality forage, made up of leafy and fine-stemmed plants containing much grain, was produced by Manata and Proso, but the total yields were relatively low. The later maturing variety, German produced an average of 0.91 tons per dunum, from one harvest. The late maturing variety, Star, yielded 1.80 tons per dunum from two harvests obtained from the same seeding. Except for the variety Star,

the forage yields for the millets are too low to compete under irrigation with other crops, such as sorghum, corn and alfalfa.

Trials with Different Crops

The forage yield and the protein content was determined for sorghum, corn, soybeans and corn-soybean mixture, when grown under irrigation during the 2-year period 1962-63. The data are reported in Tables 4 and 5 and the growing plants illustrated in Figure 2.

Figure 2. - Soybeans and corn grown for forage.

Table 4. Average yield of different forage crops grown under irrigation in the Beqa'a during 1962 and 1963.

Crops	Forage yield (air-dry) - tons/du		Average
	1962*	1963	
Sorghum	3.00	2.92	2.96
Corn	1.99	2.09	2.04
Soybean	0.96	0.84	0.90
Corn-soybean	1.67	1.53	1.60
LSD (5% level)	0.48	0.23	0.20

* Data from M.S. Thesis 1963 by Maun (5).

Table 5. Protein percentage of forage crops grown under irrigation in the Beqa'a during 1962 and 1963.

Crops	Protein percentage		Average
	1962*	1963	
Sorghum	5.34	5.55	5.45
Corn	5.43	7.12	6.28
Soybean	10.83	12.69	11.76
Corn-soybean	7.09	7.80	7.45
LSD (5% level)	0.66	—	—

* Data from M.S. Thesis 1963 by Maun (5).

The high fodder yield of 2.96 tons per dunum obtained from sorghum was the result of two cuttings obtained from the original planting. To obtain the second cutting, required a supplementary application of four kg. of nitrogen per dunum and an extension of the irrigation period for one and one-half to two months, beyond that required by the corn and soybean crops. The average protein content obtained for the sorghum forage was 5.45 percent, the lowest of the four crops under study. The forage yields obtained from corn was 2.04 tons per dunum containing an average of 6.28 percent protein. The corn-soybean mixture produced 1.60 tons of forage with 7.45 percent of protein. Soybeans, when grown alone, yielded 0.90 tons per dunum with the hay containing the highest protein content of 11.76 percent.

The sorghum crop produced the most total protein per dunum, 161.3 kg. The total protein per dunum produced by corn, soybeans, and the corn-soybean mixture was 128.1, 105.8 and 119.2 kg., respectively. Growers who have sufficient water for irrigation and are interested in producing large amounts of fodder can use sorghums for their forage needs. Satisfactory yields of high quality forage, however, can be produced using corn and the corn-soybean mixture.

Alfalfa Variety Trials

Hay yields of several alfalfa varieties were obtained from plots established in 1958 and in 1962. The yield data reported in Table 6, are from non-replicated plots, while those in Table 7 represent the averages

from four plots for each variety. Four or five cuttings of alfalfa hay were made each season from each plot.

Table 6. Average yield of hay of alfalfa varieties grown under irrigation in the Beqa'a during the 3-year period 1959-61.

Variety	Forage yield (air-dry) - tons/du.			Average
	1959	1960	1961	
Jordanian	2.2	2.7	2.6	2.5
African	2.1	2.4	2.5	2.3
Chilean	2.2	2.3	2.6	2.3
Du Puits	1.5	1.4	1.0	1.3
Ranger	1.7	1.3	1.2	1.4
Vernal	1.7	1.4	1.3	1.5
Hairy Peruvian	1.7	2.1	2.4	2.1
Ladak	1.5	1.7	1.1	1.4
Grimm	1.3	1.1	0.9	1.1

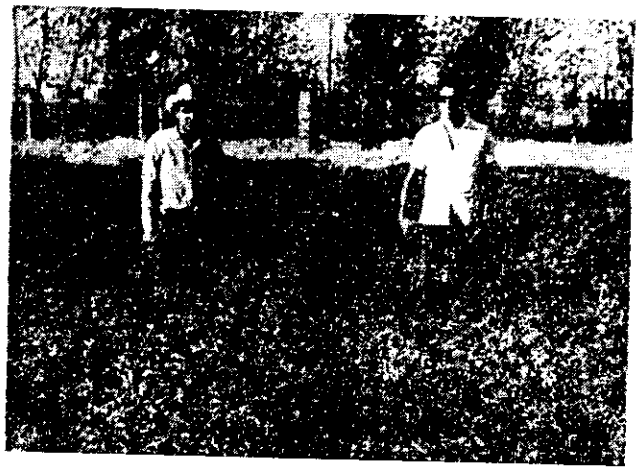
Table 7. Average yield of hay of alfalfa varieties grown under irrigation in the Beqa'a during 1962 and 1963.

Variety	Forage yield (air-dry) - tons/du.		Average
	1962*	1963	
Hairy Peruvian	1.72	1.86	1.79
Chilean	1.48	1.79	1.64
African	1.45	1.72	1.58
Composite (AUB)	1.71	1.79	1.75
Calif. Common	1.49	1.88	1.69
Moapa	1.52	1.75	1.64
Luzerne de Provence	1.29	1.69	1.49
Damascus (source)	1.29	1.69	1.49
LSD (5% level)	0.21	0.21	0.15

* Alfalfa planted in March 1962 so only four cuttings harvested.

It will be noted that the varieties varied greatly in adaptability as reflected by differences obtained in total hay yields. The data obtained

during the 1959, 1960 and 1961 seasons indicate that the varieties Jordanian, African, Chilean and Hairy Peruvian performed best. The winter hardy varieties, such as Grimm, Ladak and Ranger do not appear to be adapted to this area and produced low forage yields. The alfalfa hay yields obtained during 1962 and 1963 indicate that Hairy Peruvian and Composite (AUB) produced the highest forage yields of 1.79 and 1.75 tons per dunum, respectively. Alfalfas, such as, Luzerne de Provence (Figure 3) and the Damascus seed source, recover slowly after cutting, remain dormant later in the Spring and go dormant earlier in the Fall when compared to the other varieties.



A B

Figure 3. - The alfalfa variety A (Hairy Peruvian) grows rapidly, whereas B (Luzerne de Provence) recovers slowly after cutting a hay crop.

The high yields of hay obtained indicate that alfalfa is well adapted to this region and can be grown satisfactorily as a forage crop. For adequate production of alfalfa, however, the grower must control the alfalfa weevil *(Phytonomus variabilis)* each Spring with insecticides, apply large amounts of phosphorus fertilizer, have sufficient water for irrigation and use adapted varieties.

DRYLAND EXPERIMENTS

The monthly precipitation and total rainfall varied widely from season to season which affected the total yields and protein percentage of the forages produced under dryland conditions in the Beqa'a, Lebanon. The annual total precipitation, in millimeters, at the Agricultural Research and Educational Center was 316, 219, 285, 470 and 525 for the seasons ending in 1959, 1960, 1961, 1962 and 1963, respectively.

Trials with Different Crops

Forage yields were obtained under dryland conditions for oats, rye, vetch, and for the mixtures oats-vetch, oats-Austrian winter peas, and rye-vetch during the 5-year period 1958-1963. The average yields, in kilograms per dunum, are reported in Table 8.

An inspection of the data reveals that both the crop and the season greatly affected the amount of forage produced. The largest yields were produced during the 1960-61 season, which received less than the average rainfall of 376.5 mm. obtained at the Center during the 8-year period of 1956-63. The 285 mm. of rain received in 1960-61, however, was used efficiently by the crops as it was distributed rather uniformly during each of the months from November 1960 through April 1961. On the other hand, only average hay yields were obtained during the 1961-62 and 1962-63 seasons when the rainfall was above normal or 470 and 525 mm., respectively. The average yields in 1961-62 were reduced by the dry period of March 1962 during which period only 10.5 mm. of rain was recorded. In the 1962-63 season no rain was obtained in November 1962 and the first effective rain for seed germination was received on December 5, 1962 when 17.1 mm. was recorded at the Center. All of the crops produced little plant growth that Fall and the total forage yields for the season were reduced. The average temperatures varied little from season to season and did not appear to influence the yields significantly. However, winter injury was noted each year in the Austrian winter peas which affected their production.

Of the six crops or crop mixtures studied it appears that the oats-vetch mixture and oats produced the largest amount of forage when grown under dryland conditions in the north central Beqa'a. On the basis of the 5-year average the oats-vetch mixture yielded 238 and oats

Table 8. Average yield of forage crops grown under dryland in the Beqa'a during the 5-year period 1958-63.

Crops	Forage yield (12.5% moisture) - kg./du.					Average		
	1958-59	1959-60*	1960-61*	1961-62**	1962-63**	3-year 1958-61	2-year 1961-63	5-year 1958-63
Oats	212	215	434	160	155	287	157	237
Vetch	94	157	221	180	255	157	217	181
Oats-vetch	190	166	359	197	276	238	236	238
Oats-Austrian winter peas	194	165	356	—	—	239	—	—
Rye	—	—	—	84	63	—	73	—
Rye-vetch	—	—	—	188	264	—	226	—
LSD (5% level)	22	11	29	45	35	22	26	18

* Data from M.S. Thesis 1961 by Manghirmalani (3).
** Data from M.S. Thesis 1963 by Beg (1).

alone 237 kgs. per dunum of forage. Vetch when planted alone yielded 181 kgs. per dunum of hay under similar conditions. Rye did not appear well adapted, and considerable winter injury was observed in the plants of the Austrian winter peas.

Protein Content of Forage Crops

The protein content was determined on the forage of the six crops or crop mixtures grown under dryland conditions during the 4-year period 1959-63. The data obtained are reported in Table 9.

The percent protein in the forage harvested during the first two years was considerably higher than that from the crops harvested in 1962 and 1963. Since the crops were harvested each year at about the same relative stage of maturity, the dry seasons of 1959-60 and 1960-61 were likely responsible for the higher protein percentage in the resulting forage. This is in agreement with the known fact that forages produced during drier seasons usually contain a higher protein content than those grown during the year of higher rainfall.

Of the crops studied the hay produced by vetch contained the highest percentage of protein with a 4-year average of 15.2. In a 2-year average, 1959-61, the forage from the oats-Austrian winter peas mixture contained as much protein as that from vetch. The protein content in the oat hay varied from 6.1 to 15.3 percent with an average of 10.9 percent. When oats and vetch were grown in a mixture the resulting forage contained 12.8 percent protein.

On the basis of the yield and protein percentage the oats-vetch mixture appears to be the best for forage production under the dryland conditions in the north central Beqa'a, Lebanon. On the basis of the 4-year average the oats-vetch mixture produced 30.5 kgs. of total protein per dunum, while oats and vetch, when grown alone, made 25.8 and 27.5 kg. of protein per dunum, respectively.

Worzella, Abu Shakra and Nasr (7) reported grain yields of over 300 kgs. per dunum for barley when grown under similar conditions and the same seasons as the forage crops at the Center. The comparable forage yields that were obtained in this study (Table 8) for the 5-year period 1958-63 were 181 to 238 kgs. per dunum. It is evident that if

Table 9. Average protein percentage of forage crops grown under dryland in the Beqa'a during the 4-year period 1959-63.

Crops	Protein percentage				Average		
	1959-60*	1960-61*	1961-62**	1962-63*	2-year 1959-61	2-year 1961-63	4-year 1959-63
Oats	15.1	15.3	6.1	7.0	15.2	6.5	10.9
Vetch	17.5	16.9	12.2	14.2	17.2	13.2	15.2
Oats-vetch	16.2	15.6	8.6	10.9	15.9	9.7	12.8
Oats-Austrian winter peas	18.0	17.3	—	—	17.7	—	—
Rye	—	—	9.4	9.0	—	9.2	—
Rye-vetch	—	—	11.4	13.3	—	12.4	—
LSD (5% level)	0.9	0.9	0.5	0.8	0.7	0.7	0.7

* Data from M.S. Thesis 1961 by Manghirmalani (3).
** Data from M.S. Thesis 1963 by Beg (1).

the grower is concerned only with grain and forage yields that are harvested, none of the six forage crops studied can compete with the higher grain yields (plus straw) obtained by growing barley. The supplementary effects of forage crops, such as soil improvement, addition of nitrogen, etc. are well known, and are being investigated at the Center with dryland crop rotation experiments. It appears that new and improved grasses and legumes with higher yielding potential will need to be available in order to compete with barley and increase the forage production of the area.

Inoculation of Forage Crops

Four species of legumes were used to evaluate the effect of inoculation of seed on forage yield and forage protein when grown under dryland conditions at the Center. The study was conducted during the 2-year period 1960-62 and the results are reported in Tables 10 and 11.

The date reveal that inoculation of the legume seeds did not influence the resulting forage yields. In each of the legume species studied the forage yield obtained was essentially the same from both the inoculated and non-inoculated plots. Likewise, the data in Table 11 shows that the protein content of the forage was not influenced by the inoculation treatment. Since lentils, peas and vetch have been grown extensively in this area, it may be assumed that the cross-inoculation group of the bacteria *(Rhizobium leguminosarum)* which is specific to the group peas, vetch, and lentils, is present naturally in the soils at the Center.

However, further studies should be conducted since such factors as the drought experienced in March 1962, may have greatly affected the nodulation on the roots.

Table 10. Effect of inoculation on forage yield (12.5% moisture) in kg. per dunum, of four species of legumes grown under dryland in the Beqa'a during the 2-year period 1960-62*.

Species	Inoculated		Non-inoculated	
	1960-61	1961-62	1960-61	1961-62
Vetch	255	574	282	533
Austrian winter peas	179	419	170	424
Canadian field peas	197	269	226	254
Lentils	292	581	265	570
Average	231**	462***	236**	446***

* Data from M.S. Thesis 1962 by Maniruzzaman (4).
** LSD (5% level) for 1960-61 = 49.
*** LSD (5% level) for 1961-62 = 59.

Table 11. Effect of inoculation on the protein percentage in the forage of four species of legumes grown under dryland in the Beqa'a during the 2-year period 1962-63*.

Species	Inoculated		Non-inoculated	
	1960-61	1961-62	1960-61	1961-62
Vetch	17.7	16.5	17.2	16.7
Austrian winter peas	24.0	15.4	23.7	15.6
Canadian field peas	20.9	18.1	20.2	17.8
Lentils	19.9	17.4	19.4	17.1
Average	20.6**	16.9***	20.1**	16.8***

* Data from M.S. Thesis 1962 by Maniruzzaman (4).
** LSD (5% level) for 1960-61 = 1.7.
*** LSD (5% level) for 1961-62 = 0.6.

SUMMARY

Trials were conducted to determine the relative productivity and quality of several important crops used for forage. The crops were grown under irrigated and dryland conditions at the Agricultural Research and Educational Center located in the north central Beqa'a, Lebanon, during the 5-year period 1958-63.

Varieties of sorghum varied widely in forage yield, quality and time of fodder production. The varieties RS. 301F, Axtell, DeKalb FS. 22, Rox and Atlas perform well under irrigated conditions.

Sudangrass and millet varieties produced forage containing more leaves and fine-stem stalks and of higher quality than that obtained from the sorghums. They produced much less forage per dunum than was obtained from the sorghum.

When grown under comparable conditions, sorghum (two cuttings) produced 2.96 tons per dunum of fodder containing 5.45 percent protein while corn produced 2.04 tons of fodder with a protein percentage of 6.28. The corn-soybean mixture yielded 1.60 tons per dunum with 7.45 percent protein and soybeans 0.90 tons of forage containing 11.76 percent protein.

The total protein per dunum produced by sorghum, corn, soybeans and the corn-soybean mixture was 161.3, 128.1, 105.8 and 119.2 kgs. per dunum, respectively.

The alfalfa varieties Jordanian, African, Chilean, and Hairy Peruvian performed best when grown under irrigation. Alfalfa hay yields of more than two tons per dunum were obtained from harvesting four to five cuttings per season.

Under dryland conditions forage yields were influenced greatly by the crop used and the season. On the basis of the 5-year average the oats-vetch mixture produced 238 kgs. per dunum of fodder, oats 237. kgs. and vetch 181 kgs. Rye and Austrian winter peas were not as adapted as the other crops.

On the basis of both yield and protein percentage in the forage the oats-vetch mixture appears to be best for forage production for the dryland conditions in north central Beqa'a, Lebanon. The oats-vetch mixture produced 30.5 kgs. of total protein per dunum, while oats and vetch when grown alone made 25.8 and 27.5 kgs., respectively.

Inoculation treatment of the legumes, peas, vetch and lentils did not influence the yield or percentage of protein in the forage when the crops were grown under dryland conditions.

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