MULTIPLE CROPPING EVALUATION STUDY IN BEQA'A LEBANON

République Libanaise
Bureau du Ministre d'Etat pour la Réforme Administrative
Centre des Projets et des Etudes sur le Secteur Public
(C.P.E.S.P.)

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Publication No. 60

July, 1978

الجمهورية اللبنانية
مكتب وزير الدولة لشؤون التنمية الإدارية
مركز مشاريع ودراسات القطاع العام

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H. G. Nasr, M. Alameddin, and L. Tannir[2]

ABSTRACT

Enghteen single, 56 double and triple cropping practices were agronomically and economically evaluated under the Beqa'a Lebanon conditions (six months frost free season) with water not being a limiting factor. Several double and triple cropping practices were superior in net returns and production to most of the single crops. The most economical single crops were sugarbeet, onions and sudax (sorghum and sudan grass cross) at a net profit of 6908, 3583 and 2683 LL/ha, respectively. Among the double and triple cropping practices, wheat/cucumber, onions/corn silage, potatoes/corn silage, lentils/potatoes, field beans/corn silage, barley grain/field beans, barley+vetch silage/field beans/corn silage, corn silage/cron silage, lentils/corn grain, lentils/fields beans, barley+vetch silage/corn silage/ turnip, barley+vetch silage/corn silage/corn silage, barley+vetch silage/sunflower, safflower/corn silage and barley grain/corn grain were very productive and profitable at 7492, 4530, 4298, 4091, 3520, 3414, 3216, 3133, 3080, 2928, 2923, 2711, 2699, 2589 and 2528 LL/ha respectively. The number of days to harvest required for the above practices ranged from 195 to 354. The yields were high but declined with later dates of planting. Crops after legumes yielded more thant hose after cereals when occupying the same period of growth.

Additional index words: Intensive cropping, crop rotation, crop yield, crop net returns.

With the present world food shortages, increasing food production can no longer depend only on the increase of arable land and of yield of monoculture crops, but also on increasing the efficiency of land uti-

1 - Contribution from the Faculty of Agricultural Sciences, American University of Beirut as Journal Number 496 C. Financed partially by the Lebanese National Council for Scientific Research.

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lization for farming. Multiple cropping, the growing in sequence of more than one crop per year and on the same piece of land, is one system of agriculture that allows for more efficient use of agricultural land.

The potential of this system is not yet very well explored in the world and particularily in the Middle East. In the Beqa'a Plain of Lebanon, where the frost-free season is less than seven months, multiple cropping studies were conducted by Guiragossian (1971), and Nasr and Ghosheh (1973). The results showed that some cropping practices (barley grain/corn grain, barley grain/field beans, barley silage/corn silage, barley silage/corn grain, and corn silage/corn silage) and one triple cropping practice (barley silage/corn silage/corn silage) were superior to single crops in both yield and net returns. These studies, however, were limited to few field crops. The objectives of this experiment were to explore further the feasibility of double and triple cropping practices including forage crops, grain legumes, cereal grains, oil crops and other food crops utilized in the region.

MATERIALS AND METHODS

Several double and triple cropping practices were tested and economically evaluated against several winter and spring single crops in three consecutive years (1972-73, 1973-74, 1974-75) under the irrigated conditions of the Beqa'a Plain of Lebanon. The climate at the site of the experiment (Agricultural Research and Education Center of the American University of Beirut), is continental with an average annual rainfall of about 450mm mostly falling in the period between November and April. During this period, the occurence of frost is quite common and a result the growing season for warm season crops is shortened to about six months.

The winter crops in this study were barley+vetch mixture for silage, and barley grain in all three years, lentils and wheat in 1973-74 and 1974-75, and chickpeas in 1973-74. These were planted on November 20, 1972, December 1, 1973, and November 23, 1974. Several crops followed each of the winter crops making double and triple cropping practices. Also in an adjecent field which was kept fallow in the months of November to February, several crops (popatoes, onions, safflower, broad beans, sunflower, chickpeas, and sugarbeet) were planted in February, and others (field beans, corn silage, corn grain, soybean silage, Soybean grain, and sudax) were planted in April. Immediately after harvest, different crops were grown making several double cropping practices. Crops grown after winter fallow were also evaluated as single crops. A summary of the cropping practices tested is reported in Table 1.

The dates of planting of the second or third crop in any cropping practice was about two days after the harvesting of the preceeding crop. Proper application of nitrogen and phosphorus fertilizers was done for each of the crops planted. The seedbed preparation was convetional for the first crop and for the crops following the fall planted crops, and minimal for the others. All crops were irrigated at weekly intervals except the winter crops which were grown under rainfed conditions with bi-weekly spring supplemental irrigation, and the February planted crops which were started under rainfed conditions.

The plot size of the winter crops including the fallow was 1000 m^2 in each of the three seasons. The crops following them were 103.5 m^2 in 1972-73 and 90.0 m^2 in 1973-74. In 1974-75, the plot size was 40.0, 112,5, and 150.0 m^2 for each of the crops following winter fallow, barloy + vetch silage and barley grain, lentils and wheat, respectively. The rates of planting applied were those appropriate to each individual crop. Irrigation furrow were opened at 75 cm spacings. Most crops were grown in single row/ridge. Some requiring narrower row spacing were planted in two rows/ridge (50 cm wide) such as millets, field beans, soybeans, broadbeans, chickpeas, sugarbeet and sidax, or three rows/ridge such as barley, lentils, wheat and onions. The furrows of wheat, barley and lentils were opened immediately after planting and used later for spring irrigations.

Grain and forage yields per plot were determined and converted to tons/ha. The wet silage yields were corrected to tons/ha at 75% moisture. The corn grain yields were based on 15% kernel moisture. The area harvested for yield determinations varied between crops and ranged from 9.0 m^2, in the case of crops grown after winter fallow in 1974-75, to 1000 m^2 in the case of fall planted crops. The other crops ranged in area harvested from 30.0 m^2 to 90.0 m^2. Plant height and number of days to harvest were also determined for all crops; however, only the number of days for some cropping practices are reported in this paper.

Table 1. Summary of cropping practices tested in 1972-73 to 1973-75 in the Beqa'a Plain, Lebanon.

Cropping practice*	1972-73	1973-74	1974-75
Single			
Fall planted	2	5	4
Winter planted	5	6	6
Spring planted	6	5	4
Doubles	29	46	30
Triples	9	10	4
Total	51	72	48

⋆ Fall planted	=	Barley+vetch silage, barley grain, lentils, chickpeas and wheat.
Winter planted	=	Chickpeas, sugarbeet, potatoes, safflower, sunflower, onions, and broadbeans.
Spring planted	=	Soybean silage, soybean grain, corn silage, corn grain, sudax, and field beans.

No particular experimental design was followed in this study except in the 1973-74 experiment where the design was a randomized complete block with two replications, and data reported are based on replication averages. Replications were absent in the 1972-73 and 1974-75 experiments. Also the 1973-74 data were not statistically analyzed. The lack of replications as well as statistical analyses were due to two reasons: first, the large differences expected in the performance of different crops did not necessitate statistical analyses, and second, the further complications in field operations resulting from replications. To compensate for this, larger plots were used than is normally practiced in replicated trials.

A complete economic analysis (format in Table 2) was done for each of the cropping practices studied. The procedure used was that of Stickley and Kizirian (1970). Gross returns were determined on the basis of current wholesale prices of crop produce.

RESULTS AND DISCUSSION

Among the fall planted crops only chickpeas resulted in a loss (Table 3), whereas the others resulted in profit with wheat being the highest at 1201 LL/ha. Sugarbeet, among the winter and spring planted single crops, returned 6908 LL/ha. (one year data), followed by onions and sudax at 3583 and 2683 LL/ha, respectively. Other single crops returning reasonably well were potatoes, sunflower and field beans at 2202, 2027 and 1604 LL/ha, respectively; whereas corn returned 1124 and corn silage 927 LL/ha.

Several double and triple cropping practices, on the basis of two or three years data, proved productive and profitable. However, only one, wheat/cucumber at 7492 LL/ha (one year data) was more profitable than sugarbeet, the highest returnable single crop. It is important to note here that sugarbeet, as a government subsidized crop with high prices and limited planted areas, does not allow for conclusive comparisons.

Also onions and potatoes, when grown in large planted areas, tend to have substantial drop in price affecting the gross returns.

In comparison to onions, several cropping practices were equal or

Table 2. Items inculded in the economic analysis.

Items

1. Land rent
   a. With irrigation water
   b. Without irrigation water
2. Seed
3. Fertilizer
   a. Phosphorus
   b. Nitrogen
4. Transporting seeds and fertilizers
5. Seed bed preparation
6. Planting
7. Irrigation (Labor and fuel)
8. Weed control
9. Furrow opening
10. Harvesting
11. Burlap sacks or boxes
12. Guarding
13. Total
14. Unforseen expenses 1% of 13
15. Total (13+14)
16. Interest 7% of 15.
17. Total (15+16)
18. Tons/ha
19. Lebanese pounds (LL)/ton
20. Gross retruns (LL/ha) 19x18
21. Net returns (LL/ha) 20-17

TABLE 3. Yield and net returns of single, doubles and triple cropping practices grown in the Beqa'a Lebanon during 1972-73 to 74-75.

Cropping Practices+	Yield (tons/ha) 1972-73	1973-74	1974-75	Mean	Net returns LL/ha ‡ 72-73	73-74	74-75	Mean
S I N G L E S								
1 BS + VS	27.63	35.10	20.51	27.74	+ 669	+1046	+ 494	+ 736
2 BG + ST	2.50 + 4.07	5.42 + 2.80	4.00 + 2.60	3.97 + 3.15	+ 708	+1326	+ 691	+ 908
3 WhG + ST	----------	5.40 + 3.20	5.85 + 4.07	5.63 + 3.64	-----	+1172	+1229	+1201
4 LG + ST	----------	1.34 + 1.00	1.30 + 1.00	1.32 + 1.00	-----	+ 693	+1107	+ 900
5 Ch - FP	----------	.90	----------	----------	-----	- 530	-----	-----
6 Ch - WP	1.84	2.06	3.22	2.37	+ 151	- 294	+ 597	+ 151
7 Bb	----------	3.12	----------	----------	- 278	-----	-----	-----
8 Sf	3.25	3.31	3.05	3.20	+1410	+ 790	+1640	+1280
9 Sun	5.07	3.17	3.62	3.95	+3248	+ 640	+2192	+2027
10 Sgb	----------	----------	107.68	----------	-----	-----	+6908	-----
11 On	43.30	34.65	61.00	46.32	+3248	+2760	+4742	+3583
12 Pot	16.67	21.69	24.00	20.79	+1099	+2647	+2860	+2202
13 SoyS	21.78	----------	----------	----------	- 274	-----	-----	-----
14 SoyG	2.83	1.93	----------	2.38	+1916	- 297	-----	+ 805
15 Fb	2.29	2.79	3.47	2.85	+1590	+1175	+2047	+1604
16 CnS	55.95	54.38	51.50	53.94	+1317	+ 503	+ 960	+ 927
17 CnG	10.07	9.57	6.40	8.68	+2149	+1287	- 65	+1124
18 SxS 4C	98.83	110.25	85.18	98.09	+2560	+3075	+2413	+2683
D O U B L E S								
1 BS + VS/CnS	27.63/50.21	35.10/66.08	20.51/44.44	27.74/53.57	+1450	+2351	+1102	+1634
2 BS + VS/CnG	27.63/ 7.68	35.10/ 9.77	----------	31.36/ 8.72	+1751	+2593	-----	+2172
3 BS + VS/Sun	27.63/ 3.58	35.10/ 3.85	20.51/ 3.62	27.74/ 3.68	+2489	+2376	+3232	+2699
4 BS + VS/Sf	27.63/ 2.12	35.10/ 1.65	----------	31.36/ 1.88	+1019	+ 356	-----	+ 688
5 BS + VS/SoyS	27.63/31.89	----------	----------	----------	+ 622	-----	-----	-----
6 BS + VS/SoyG	27.63/ 1.11	35.10/ 2.71	----------	31.36/ 1.91	+ 335	+1854	-----	+1095
7 BS + VS/Fb	27.63/ 2.71	35.10/ 2.98	20.51/ 2.77	27.74/ 2.82	+2534	+2726	+1684	+2315
8 BS + VS/On	----------	35.10/32.35	----------	----------	-----	+3506	-----	-----
9 BS + VS/SxS4C	----------	35.10/80.49	20.51/65.38	27.76/72.98	-----	+2503	+1571	+2038
10 BG + St/CnS	2.50+ 4.07/53.51	5.42+ 2.80/48.01	4.00+ 2.60/41.57	3.97+ 3.15/47.69	+1922	+1877	+1472	+1737
11 BG + St/CnG	2.50+ 4.07/10.71	5.42+ 2.80/ 9.39	4.00+ 2.60/ 7.79	3.97+ 3.15/ 9.29	+2965	+2872	+1748	+2528
12 BG + St/Sun	2.50+ 4.07/ 3.23	5.42+ 2.80/ 3.31	4.00+ 2.60/ 1.69	3.97+ 3.15/ 2.74	+2131	+2756	+ 882	+1923
13 BG + St/SoyS	2.50+ 4.07/33.24	----------	----------	----------	+ 835	-----	-----	-----
14 BG + St/SoyG	2.50+ 4.07/ 1.28	5.42+ 2.80/ 2.21	----------	3.96+ 3.43/ 1.79	+ 461	+2274	-----	+1368
15 BG + St/Fb	2.50+ 4.07/ 3.39	5.42+ 2.80/ 3.11	4.00+ 2.60/ 3.44	3.97+ 3.15/ 3.31	+3716	+3310	+3215	+3414
16 BG + St/Pot	2.50+ 4.07/ 8.34	5.42+ 2.80/ 7.85	4.00+ 2.60/10.00	3.97+ 3.15/ 8.73	+ 633	+1516	+1503	+1217
17 BG + St/Ch	2.50+ 4.07/ 1.55	----------	----------	----------	+ 716	-----	-----	-----
18 BG + St/FMG	2.50+ 4.07/ 2.40	5.42+ 2.80/ 1.46	----------	*3.96+ 3.43/ 1.93*	- 49	+ 919	-----	+ 435

TABLE 3. Cont...

Cropping Practices+	Yield (tons/ha) 1972-73	1973-74	1974-75	Mean	Net returns LL/ha ‡ 72-73	73-74	74-75	Mean
D O U B L E S								
19 BG + St/PMG	2.50+ 4.07/ 3.33	5.42+ 2.80/ 2.20	----------	3.96+ 3.43/ 2.76	+ 313	+1231	-----	+ 772
20 WhG + St/CnS	----------	5.40+ 3.20/50.73	5.85+ 4.07/41.66	5.63+ 3.64/46.19	-----	+1866	+2090	+1978
21 WhG + St/CnG	----------	5.40+ 3.20/ 6.84	5.85+ 4.07/ 6.34	5.63+ 3.64/ 6.59	-----	+1730	+1825	+1778
22 WhG + St/Sun	----------	5.40+ 3.20/ 2.15	----------	----------	-----	+1062	-----	-----
23 WhG + St/SoyS	----------	5.40+ 3.20/ 1.81	----------	----------	-----	+1165	-----	-----
24 WhG + St/Cu	----------	5.40+ 3.20/23.54	----------	----------	-----	+7492	-----	-----
25 LG + St/CnS	----------	1.34+ 1.00/54.36	1.30+ 1.00/49.50	1.32+ 1.00/51.93	-----	+1625	+2562	+2094
26 LG + St/CnG	----------	1.34+ 1.00/12.58	1.30+ 1.00/ 8.29	1.32+ 1.00/10.43	-----	+3624	+2535	+3080
27 LG + St/Sun	----------	1.34+ 1.00/ 3.52	1.30+ 1.00/ 1.77	1.32+ 1.00/ 2.64	-----	+1963	+1573	+1768
28 LG + St/Soy G	----------	1.34+ 1.00/ 1.83	----------	----------	-----	+ 733	-----	-----
29 LG + St/Fb	----------	1.34+ 1.00/ 3.36	1.30+ 1.00/ 2.66	1.32+ 1.00/ 3.01	-----	+3056	+2799	+2928
30 LG + St/Pot	----------	1.34+ 1.00/14.77	1.30+ 1.00/12.00	1.32+ 1.00/13.38	-----	+3501	+4680	+4091
31 LG + St/FMG	----------	1.34+ 1.00/ 1.80	----------	----------	-----	+ 662	-----	-----
32 LG + St/PMG	----------	1.34+ 1.00/ 2.71	----------	----------	-----	+1029	-----	-----
33 Ch - FP/CnS	----------	.90/65.62	----------	----------	-----	+ 879	-----	-----
34 Ch - FP/CnG	----------	.90/ 8.54	----------	----------	-----	+ 793	-----	-----
35 Ch - FP/Sun	----------	.90/ 3.27	----------	----------	-----	+ 480	-----	----
36 Ch - FP/Soy G	----------	.90/ 1.81	----------	----------	-----	- 537	-----	-----
37 Ch - FP/Cu	----------	.90/16.16	----------	----------	-----	+2350	-----	-----
38 Ch - WP/CnS	1.84/60.49	2.06/55.80	3.22/46.48	2.37/54.3	+2353	+1754	+3092	+2400
39 Ch - WP/CnG	----------	----------	3.22/ 5.55	----------	-----	-----	+2106	-----
40 Ch - WP/PMG	1.84/ 3.12	2.06/ 1.04	----------	1.95/ 2.08	+ 492	-1066	-----	- 287
41 Ch - WP/Pot	----------	----------	3.22/ 8.00	----------	-----	-----	+1971	----
42 Bb/CnS	----------	3.12/65.90	----------	----------	-----	+2146	-----	----
43 Sf/CnS	3.25/31.30	3.31/41.30	3.05/37.27	3.20/36.62	+2448	+1908	+3410	+258
44 Sun/CnS	5.07/34.97	3.17/40.15	----------	4.12/37.56	+4258	+1609	-----	+2934
45 Sun/PMG	5.07/ 2.68	3.17/ .73	----------	4.12/ 1.70	+3442	- 181	-----	+1681
46 On/CnS	43.30/28.47	34.65/32.49	61.00/34.98	46.32/31.98	+3843	+3419	+6329	+4531
47 Pot/CnS	16.67/51.68	21.67/62.71	24.00/42.10	20.79/52.16	+2675	+5510	+4710	+4298
48 Pot/Soy S	----------	21.67/22.90	----------	----------	-----	+3752	-----	----
49 SoyS/SoyS	21.78/21.74	----------	----------	----------	- 150	-----	-----	-----
50 SoyG/CnS	2.83/36.12	----------	3.47/39.44	2.85/51.04	+2805	-----	-----	-----
51 Fb/CnS	2.29/44.70	2.79/68.99	----------	----------	+2823	+3784	+3953	+3520
52 Fb/PMG	2.29/ 1.77	----------	51.61/54.45	53.98/55.66	+1163	-----	-----	----
53 CnS/CnS	55.95/49.37	54.38/63.16	----------	48.27/12.66	+2969	+2668	+3762	+3133
54 CnS/Pot	----------	----------	----------	----------	-----	-----	+3599	----
55 CnG/CnS	10.07/26.80	----------	----------	----------	+2548	-----	-----	-----
56 CnG/PMG	----------	9.57/ .74	----------	----------	+ 580	-----	-----	-----

TABLE 3. Cont.

Cropping Practices+	Yield (tons/ha) 1972-73	1973-74	1974-75	Mean	Net returns LL/ha‡ 72-73	73-74	74-75	Mean
			TRIPLES					
1 BS + VS/CnS/CnS	27.63/50.21/48.79	35.10/66.08/21.56	20.51/44.44/37.79	27.74/53.57/36.04	+2970	+2385	+2778	+2711
2 BS + VS/CnS/Tu	----------	35.10/66.08/ 9.64	20.51/44.44/25.45	27.78/55.26/17.54	-----	+2957	+2889	+2923
3 BS + VS/CnG/CnS	27.63/ 7.68/ 8.70	----------	----------	----------	+1626	-----	-----	-----
4 BS + VS/Sf/SoyS	27.63/ 2.12/ 4.10	----------	----------	----------	+ 752	-----	-----	-----
5 BS + VS/Sun/PMS	27.63/ 3.58/ 6.90	35.10/ 3.85/ 6.90	----------	31.46/ 3.71/ 6.85	+2310	+1759	-----	+2035
6 BS + VS/SoyS/SoyS	27.63/31.89/11.33	----------	----------	----------	+ 692	-----	-----	-----
7 BS + VS/SoyG/PMS	27.63/ 1.11/ 4.50	----------	----------	----------	+ 85	-----	-----	-----
8 BS + VS/Fb/PMS	27.63/ 2.71/11.40	----------	----------	----------	+2743	-----	-----	-----
9 BS + VS/Fb/CnS	----------	35.10/ 2.98/35.20	20.51/ 2.77/30.30	27.8/ 2.87/32.75	-----	+3498	+2933	+3216
10 BS + VS/Fb/Tu	----------	----------	20.51/ 2.77/12.42	----------	-----	-----	+2176	-----
11 BG + St/CnS/CnS	2.50+ 4.07/53.5/4.45	----------	----------	----------	+1619	-----	-----	-----
12 BG + St/CnS/Tu	----------	5.42+ 2.80/48.0/ 8.46	----------	----------	-----	+2480	-----	-----
13 BG + St/Ch/PMS	2.50+ 4.07/1.55/4.50	----------	----------	----------	+ 616	-----	-----	-----
14 BG + St/Fb/Tu	----------	5.42+ 2.80/3.11/2.75	----------	----------	-----	+3204	-----	-----
15 BG + St/PMG/Tu	----------	5.42+ 2.80/3.33/11.93	----------	----------	-----	+2141	-----	-----
16 LG + St/CnS/Tu	----------	1.30+ 1.00/49.50/1.84	----------	----------	-----	+1241	-----	-----
17 LG + St/Fb/Tu	----------	1.30+ 1.00/2.66/1.65	----------	----------	-----	+2781	-----	-----
18 LG + St/PMG/Tu	----------	1.30+ 1.00/2.71/11.99	----------	----------	-----	+1958	-----	-----

+ BS + VS = Barley + Vetch silage, BG + St = Barley Grain + Straw, Wh G + St = Wheat Grain + Straw, LG + St = Lentils Grain + Straw, Ch - FP = Chickpeas - Fall planted, Ch - WP = Chickpeas - Winter planted, Bb = Broadbeans, Sf = Safflower, Sun = Sunflower, Sgb = Sugarbeet, On = Onions, Pot = Potatoes, SoyS = Soybean Silage, SoyG = Soybean Grain, Fb = Fieldbeans, CnS = Corn Silage, CnG = Corn Grain, SxS4C = Sudax Silage 4 Cuttings, FMG = Foxtail Millet Grain, PMG = Proso Millet Grain, PMS = Proso Millet Silage, Cu = Cucumber, Tu = Turnip. ‡ LL = Lebanese pound, 1 $ U.S. was about 2.20 LL in 1973, 2.25 LL in 1974, and 2.30 LL in 1975.

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better in their net profit. These, in addition to wheat/cucumber, were onions/corn silage, potatoes/corn silage, lentils/potatoes, and field-beans/corn silage at 4530, 4298, 4091 and 3520 LL/ha respectively. It is also very important to emphasize here that the cropping practice of onions/corn silage was 953 LL/ha more profitable than onions as a single crop, with an additional production of 31.98 tons/ha of silage.

Other double and triple cropping practices with high net profit were barley grain/field beans, barley+vetch silage/field beans/corn silage, corn silage/corn silage, lentils/corn grain, lentils/field beans, barley+vetch silage/corn silage/turnip, barley+vetch silage/corn silage/corn silage, barley+vetch silage/sunflower, safflower/corn silage, and barley grain/corn grain at a retrun of 3414, 3216, 3133, 3080, 2928, 2923, 2711, 2699, 2589, and 2528 LL/ha, respectively. Also few practices based on one year data, exhibited a high potential, these were corn silage/potatoes, barley+vetch silage/onions, barley grain/field beans/turnip, and lentils/field beans/turnip gave 3599, 3506, 3204 and 2781 LL/ha, respectively.

The yield of these high profitable practices was in most cases higher than what the average farmer commonly obtains (Table 3). This was due to the proper management practices that included variety, fertilization, rate of planting, irrigation, and weed control. In certain cases the yields were low mainly due to the shortness of the growing season. This was reflected mostly in corn silage, sunflower and the millets. the yield of corn silage when grown as a single crop was 53.94 tons/ha. This was similar to its yield when grown in double cropping after barley+vetch silage, lentils, winter planted chickpeas, potatoes, field-beans, and corn silage which yielded 53.57, 51.93, 54.30, 52.16, 51.04 and 55.66 tons/ha, respectively, making most of these practices among the very profitable ones. However, when corn silage was grown after barley grain, wheat grain, safflower, onions, soybean grain and corn grain, its yield dropped to 47.69, 46.19, 36.62, 37.56, 31.98, 36.12, and 26.80 tons/ha, respectively. This was due in most cases to later dates of planting of the corn.

In tripple cropping, corn silage yielded 36.04 tons/ha when grown after barley+vetch silage/corn silage and 32.75 tons/ha when grown after barley+vetch silage/field beans. However, its yield dropped considerably when grown after barley+vetch silage/corn grain and barley grain/corn silage to 8.70 and 4.45 tons/ha, respectively, Proso and foxtail millets grown as second or third crop generally yielded very low, making such cropping practices unprofitable.

Also, corn silage, corn grain, and sunflower, yielded better after legumes than after cereal crops when occupying the same growth period. Corn silage yielded 65.6 tons/ha after fall planted chickpeas vs 46.19 tons after wheat, and 51.93 tons after lentils vs 47.69 tons after barley grain. Corn grain yielded 10.43 tons/ha after lentils vs 9.29 tons after barley grain and 8.54 tons/ha after fall planted chickpeas vs 6.59 tons after wheat. Sunflower yielded 3.52 and 3.52 and 3.27 tons/ha when grown after lentils and fall planted chikpeas vs 2.24 and 2.15 tons/ha after barley and wheat, respectively.

Number of days to harvest (Table 4) reflects the length of the season occupied by the various cropping practices. Only, most of the singles, and the most profitable 14 doubles and 5 singles are reported. Among the singles, sugarbeet occupied the most days (240) followed by wheat, barley grain and lentils. Sudax occupied 188 days constituting 4 cuttings. The double cropping practices varied in length of growing period from 195 days in corn silage/potatoes or fieldbeans/corn silage to 323 days in the case of barley grain/corn grain or lentils/corn grain. The successful triple cropping practices occupied the land from 338 to 354 days of the year. This longer utilization of the land provides for more net income as well as more work opportunity for the farmer and his family. Also, when extending the season his farm equipment can be utilized more efficiently.

Table 4. Days to harvest of some single, double and triple cropping practices grown in 1972-73 to 1974-75.

Cropping practice*	Days of harvest 1972-73	1973-74	1974-75	Mean/ crop	Mean/ practice
SINGLES					
BS+VS	175	159	168	167	167
BG=BG+ST	204	194	199	199	199
WG=WhG+ST	---	208	233	221	221
LG=LG+ST	---	194	199	197	197
SF	149	153	156	153	153
Sun/GnS=Sun/CnS	142	141	151	145	145
Sgb	---	---	240	---	240
On	183	146	173	167	167
Pot	142	132	125	133	133
SoyG	135	176	---	156	156
Fb	114	105	103	107	107
CnS	114	113	90	106	106
CnG	142	141	119	134	134
S×S 4C	193	192	179	188	188
DOUBLES					
BS+VS/Sun	175/111	159/117	168/116	167/115	282
BG+St/CnG	204/120	194/130	199/121	199/124	323
WhG+St/Cu	-------	208/100	-------	------	308
LG+St/CnG	-------	194/130	199/121	197/126	323
LG+St/Fb	-------	194/ 96	199/ 98	197/ 97	294
LG+St/Pot	-------	194/ 98	199/103	197/101	298
Sf/CnS	149/ 56	153/ 75	156/ 85	153/ 72	225
Sun/GnS	142/ 63	141/ 75	-------	142/ 69	211
On/CnS	183/ 63	146/ 75	173/ 84	167/ 74	241
Pot/CnS	142/ 89	132/ 89	126/108	133/ 95	228
SoyG/CnS	135/ 70	135/ 70	-------	-------	205
Fb/Cns	114/ 91	105/ 89	103/ 85	107/ 88	195
CnS/CnS	114/ 91	113/ 96	113/ 82	113/ 90	203
CnS/Pot	-------	-------	113/ 82	-------	195
TRIPLES					
BS+VS/CnS/CnS	175/ 88/ 73	159/103/ 75	168/ 88/ 92	167/ 93/80	340
BS+VS/CnS/Tu	----------	159/103/ 96	168/ 88/ 92	164/ 96/94	354
BS+VS/Fb/CnS	----------	159/ 99/ 79	168/ 88/ 82	164/ 99/81	344
BG+St/Fb/Tu	----------	194/ 96/ 48	---------	----------	338
LG+St/Fb/Tu	----------	194/ 96/ 48	---------	----------	338

BS + VS = Barley + Vetch Silage, BS + ST = Barley Grain + Straw, WhG + St = Wheat Grain + Straw, LG + ST = Lentils Grain + Straw, SF=Safflower, Sun = Sunflower, Sgb = Sugarbeet, On = Onions, Pot = Potatoes, Soy G = Soybean Grain, Fb = Field beans, Cns = Corn Silage, CnG = Corn Grain, S × S4C = Sudax Silage 4 cutting, Cu = Cucumber, Tu = Turnip

CONCLUSION

With the exception of sugarbeet as a single crop, several double and triple cropping practices exhibited superiority over the singles in both production and net returns. Such practices include forage crops, cereal grains, grain legumes, oil crops, and other food crops such as onions, potatoes, cucumber and turnip. Many of the cropping practices included two of the above mentioned types of crops.

Therefore, it can be concluded from this study that certain double and triple cropping practices can be successfully grown under the Beqa'a conditions of Lebanon and similar semi-arid and temperate climates of the world provided water is not a limiting factor. Also, the wide variety of field crops present in the successful cropping practices allows the farmer for a large selection of crops that meet his needs. Moreover, such intensive cropping system will result in better farm income, more efficient utilization of land, water and light resources as well as farm family labor, and more world food output.

REFFERENCES

1. Guiragossian, V. 1971. Production of field crops under a double cropping system in the Beqa'a Plain, Lebanon. M.S. Thesis. Faculty of Agricultural Sciences, American University of Beirut, Beirut, Lebanon.

2. Nasr, H.G., and D. Ghosheh. 1973. Maize and sorghum in a multiple cropping study in the Beqa'a, Lebanon. Proceedings, VIIth Meeting of the maize and sorghum section of EUCARPIA. In print.

3. Stickley, S.T., and H.M. Kizirian. 1970. Determining maximum-profit farm plants in the central Beqa'a (Lebanon). Mimeo pamphlet No. A.E.S. 7, Faculty of Agricultural Sciences, American University of Beirut, Beirut, Lebanon.

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