TOBACCO FOLLOWING BARE AND NATURAL WEED FALLOW AND PURE STANDS OF CERTAIN WEEDS[1]

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INTRODUCTION

In colonial days the growers of tobacco of necessity planted the crop on newly cleared land. It was soon observed that virgin soil produced good yields as well as leaf of high quality well suited to the market demands of the period. Even at that early date the growers of the crop found that after a given field had been used for growing tobacco for a short period the soil became less productive. Consequently the early settlers continually cleared the forested areas in order to consistently produce the desired type of tobacco. It is commonly recognized even today that recently cleared forested land produces a grade of leaf having a fine texture and light body that for many purposes commands a relatively high market price. In recent years, however, the wooded areas have become so limited that it is necessary for growers to produce the major part of the crop on fields that have been cultivated continuously or intermittently for a comparatively long period.

This practice has ultimately resulted in depletion of the available plant-food reserves of the soil so that it has become increasingly necessary to supply soil deficiencies in plant food in the form of manures and fertilizers. It has generally been possible to maintain high yields of tobacco in continuous culture by these practices, provided parasitic diseases do not come in to damage the crop, but it is a common occurrence for the quality of the leaf produced under continuous culture to become unsuited to market demands. In an effort to overcome these difficulties a number of rotation systems in combination with manures and fertilizers have been tried with a fair degree of success. These practices, however, have not proved satisfactory on all soils and with all crop combinations.

The importance of the several plant-food constituents in maintaining yields and values of tobacco has received attention for flue-cured (*10*)[3] and Maryland leaf (*8*). It is always necessary that these constituents be supplied to the plant in available forms either by the soil or as manures and fertilizers applied to the soil.

The possible contributing factors concerned in the effect of a given crop on the succeeding crop in the rotation have been previously discussed in detail in a paper (*5*) that gives a review of the literature bearing upon these relationships.

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[3] Italic numbers in parentheses refer to Literature Cited, p. 844.

It was early recognized (1891) that weed plants occurring as adventitious vegetation along waysides and elsewhere could be used in preparing composts, since they are relatively rich in plant-food constituents (*9*). It was pointed out that the different species varied in composition, as shown by published analyses. Additional data giving analyses of weeds under North Dakota conditions also have been published (*6*). More recently Eisenmenger (*2*, *3*) has conducted studies on the organic decomposition products resulting when plants belonging to various species are incorporated with the soil.

The culture of tobacco in Maryland is unique in that nowhere else in the United States has the crop been grown continuously in a given area for so long a period, about 300 years. This section has furnished the industry with the parent stock for varieties from which many of our important commercial types have developed (*4*). In addition, it has furnished the testing ground for developing practical methods of maintaining yields and quality of tobacco when grown on a given soil for a long period. Killebrew (*7*) in 1880 pointed out that yields could be maintained by the use of manures and fertilizers but that the quality of the product was often unsatisfactory. Further observations in many of the older tobacco-producing States were also presented in regard to the maintenance of yields and quality of tobacco on newly cleared lands and in fields that were allowed to lie idle for a period of years. Patterson (*11*) reported in 1900 that Maryland soils which had lost their capacity to produce high-quality tobacco as a result of continued use in growing this crop could be renovated by allowing them to revert to broomsedge and old-field pine. It has been observed repeatedly, in connection with various experiments conducted over a period of years at the Upper Marlboro tobacco field station, that on cultivating land which had been occupied for a time by native vegetation, consisting of broomsedge or other weeds, tobacco of exceptionally fine quality was obtained for the first and second years following this type of vegetation cover. The crop produced under these conditions more nearly approached that obtained on newly cleared forested areas than under any other set of conditions yet found.

The cause of failure to obtain the type of leaf growth desired in continuous culture is not clear. The exhaustion of plant nutrients undoubtedly is often an important factor, as well as the building up of parasite populations that injure or destroy the growing plant. The development of soil toxins or other substances or conditions deleterious to growth of tobacco appears sometimes to enter the complex, but direct proof or identification of such conditions has not been developed. Apparently the physical condition of the soil induced by, or associated with, the development of adventitious vegetation is a dominant factor in the favorable effects obtained. The mulch produced by the accumulated debris associated with natural weed fallow, by rendering available potassium or other plant foods from the soil minerals (*12*), may be a factor in the favorable effects reported. This mulch also prevents wind and water erosion, which transports considerable topsoil under some conditions.

In an earlier publication (*1*) it was pointed out that it has been possible consistently to produce high-quality leaf under Maryland conditions when the crop follows a natural weed fallow of sufficient duration.

PROCEDURE

Since it had been observed that high-quality tobacco (*Nicotiana tabacum* L.) was consistently produced for the first year or two after a growth of natural weed cover, it seemed desirable to study the subject experimentally. Accordingly, in 1922 experiments were undertaken with tobacco grown after natural weed fallow on plots at the tobacco field station, Upper Marlboro, Md. These plots immediately adjoined those employed in tests with legumes and other cover crops, the results of which have been reported elsewhere (*1*, *5*). The plots as originally designed were one-eighth of an acre in size (36 by 151¼ feet). The tobacco plants were transplanted in rows 36 inches apart and 34 inches apart in the drill. There were two series, in one of which tobacco was grown in a 2-year rotation with weeds. After removal of the tobacco crop in early fall the land was left undisturbed about 20 months until it was plowed for the next tobacco crop in the spring of the second year. In another series the plots were occupied by weeds for an additional year. The period between the successive crops of tobacco in this instance was about 32 months. The soil was undisturbed during these periods, since any disturbance would have altered the natural vegetation cover.

These plots were subdivided crosswise in 1925, one-half of each plot being kept free of weeds by frequent hoeing during the summer months. This procedure was adopted in order to determine whether the bare fallow was as effective in maintaining yields and values as the weed fallow. The tobacco on these plots was fertilized with a 1–7–5 mixture applied at the rate of 1,000 pounds per acre during the period 1925–33 and with a 2–8–12 mixture applied at the rate of 750 pounds per acre beginning with 1934. These mixtures were prepared from nitrate of soda, superphosphate, and high-grade sulfate of potash.

Since tobacco following the natural weed fallow made up of adventitious vegetation consistently gave good yields and values, it was deemed desirable to determine whether any of the several species occurring in the weed complex were more effective than the others. In 1931 tests were inaugurated to determine the effects of some of the more common species on the yields and quality of the tobacco crop when grown in substantially pure stands. The plants growing in the natural weed fallow varied to some extent from season to season, apparently depending upon a variety of conditions, more particularly the weather prevailing during the seed-germination period. There was always a more or less dense cover of vegetation throughout the summer months. In the first year, summer annuals predominated, and there was considerable mixture of legumes and nonlegumes. In the second year, some of these annuals reseeded themselves and in some instances wild grasses, including small broomsedge (*Andropogon virginicus* L.) were observed, but the period was too short for establishment of this old-field weed. The trumpetcreeper (*Tecoma radicans* (L.) Juss.) frequently came in to a considerable extent the second year from old roots remaining in the soil. Frequently in the first year evening-primrose (*Oenothera*) species were prevalent during the spring.

The weed species included in the pure-culture test were annual sweetclover, Hubam strain (*Melilotus alba* Desr.), rabbitfoot clover (*Trifolium arvense* L.), common ragweed (*Ambrosia artemisiifolia* L.),

wild pea (*Strophostyles helvola* (L.) Britton), partridge-pea (*Cassia chamaecrista* L.), horseweed (*Erigeron canadensis* L.), lambsquarters (*Chenopodium album* L.), and annual lespedeza, Kobe strain (*Lespedeza striata* (Thunb.) Hook. and Arn.). Any of these species may occur in the natural weed fallow to a greater or less extent. However, rabbitfoot clover, wild pea, partridge-pea, common ragweed, and horseweed are the species ordinarily found. It was soon observed that seed of rabbitfoot clover and horseweed commonly germinated in the fall. These species, therefore, passed the winter in the seedling stage, whereas wild pea, lambsquarters, partridge-pea, and common ragweed came up in the spring.

The question at once arose as to the procedure necessary to grow these species in pure stands. There was little or no information available in regard to growth habits or requirements of most of the above-mentioned plants. Since they are generally regarded as objectionable, the only information available was concerned with eradication. However, it may be mentioned here that rarely are any of these species troublesome weeds in cultivated crops. In the earlier years of the tests the young plants obtained from old fields were transplanted in rows 1 foot apart, except wild pea, lespedeza, and sweetclover, which were grown from seed. It has been found possible in recent years to grow practically all of these plants from seed. The procedure followed in seeding ragweed, horseweed, and lambsquarters has been to scatter seed heads over the plots on which they are to be grown after the land has been prepared by a light harrowing. The weed crop was generally unfertilized and grew 1 year, followed by tobacco the second year. The tobacco at the Marlboro location was fertilized with a 2–8–12 mixture applied at the rate of 600 pounds per acre. The fertilizer materials used in compounding this mixture were nitrate of soda, dried blood (one-half the nitrogen from each), superphosphate, and high-grade sulfate of potash.

One series consisted of individual plots, not duplicated, of some of these weed species and a control bare-fallow plot. (See table 4.) The plots of this series were one-hundredth of an acre (10½ by 41½ feet), with a 2-foot space between plots. Plantings of tobacco were made in rows 3½ feet apart on each of the treatments. The plants were set 29 inches apart in the row. The tobacco was grown in a 2-year rotation with the species shown. The weed growth on these plots was turned under just prior to or immediately after the first killing frost in the fall.

Another series of tests was carried out, consisting in most instances of duplicate plots (see table 5), with all of the above-mentioned species and, in addition, a bare-fallow and a natural weed-fallow plot. The plots in this series were one-seventieth of an acre (10½ by 59¼ feet). Plantings of tobacco were made in three rows to the treatment, 3½ feet apart, with plants spaced at a distance of 29 inches in the drill. A space of 2 feet was provided between plots to prevent cross feeding. The weed growth in these plots was mashed down in the fall and covered with fine-mesh woven wire to prevent the wind from blowing the material from the small areas involved. As a rule the land was plowed for tobacco in the following April.

The above-described tests at Upper Marlboro were located on Collington sandy-loam soil.

In 1933 additional tests were begun at the Pee Dee Experiment Station, Florence, S. C., on Marlboro sandy loam. The plots in this series were one-fortieth of an acre (16 by 68 feet). The plots were separated by a 2-foot space to prevent washing and cross feeding. The rows for tobacco were spaced 4 feet apart and the plants were set 2 feet apart in the drill. The weeds (see table 6) were transplanted in 8 rows to the plot, 2 feet apart. The season's weed growth was chopped up with a stalk cutter after the first killing frost and turned during January for the tobacco crop the following summer. The tobacco was fertilized with a 3–8–6 fertilizer at the rate of 1,000 pounds per acre. The weed growth received no treatment. The fertilizer mixture used in this series was prepared from nitrate of soda and cottonseed meal, each supplying one-half of the nitrogen; superphosphate; and sulfate and muriate of potash, two units or one-third of the potash being derived from the muriate.

The methods used in culture and handling of the tobacco crops grown in these tests will not be considered in detail, but it should be stated that these methods conformed to the best generally accepted local practices. Every effort was made to give each treatment uniform methods of culture and handling. For example, the transplanting was made across the several plots of each series instead of in the direction of a given treatment, so as to equalize plants as to size, freedom from disease, and vigor. Representative samples were selected from each grade of the several treatments after they were stripped, graded, and weighed. The weights thus obtained were used in making calculations of yields. These samples were later submitted to experienced judges of Maryland tobacco, who assigned values. Calculations of gross values per acre were based on these figures.

It was not a simple matter to grow the several wild species of plants in pure culture, since it was necessary frequently to remove by hand any extraneous species appearing in the cultures. Where the cultures were in rows it was possible to remove the undesired kinds with less expenditure of labor. However, in order that the surface of the soil might be covered thoroughly, broadcast seeding was adopted where possible. It has been evident during the later years that many of the weeds have not grown so well as in the earlier years of the test. This has been particularly evident with the partridge-pea.

EXPERIMENTAL RESULTS

Since the weather has a dominant influence on the survival of transplants and the subsequent growth of the tobacco crop, it cannot be neglected in any attempt to arrive at a better understanding of the growth factors operating under field conditions. The rainfall, as recorded at the location of the experiments at Upper Marlboro, Md., and Florence, S. C., arranged in 10- and 11-day periods, is shown in tables 1 and 2. It is practically impossible to summarize the complete records, since frequently short intervals of 1 or more days occurred when the rainfall or temperature was so abnormal as to determine to a large extent the final growth of the crop. It has happened that 5 to 10 inches of rain in a 24- to 48-hour period resulted in almost complete crop failure. Excessive temperature of a few days' duration at times may produce effects from which the crop never completely recovers. The temperature data are not presented for the Maryland location, but should not be greatly different from

those published for Washington, D. C., about 15 miles distant. The temperature data applicable to the South Carolina location are those published by the United States Weather Bureau for Florence, S. C.

TABLE 1.—*Rainfall at Upper Marlboro, Md., for 10- and 11-day periods during the growing seasons, 1925–37*

Month and date	Rainfall during growing season												
	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937
April:	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
1–10	0.20	1.02	1.83	0.00	0.70	2.80	2.11	0.53	1.98	0.22	3.45	2.11	1.14
11–20	.66	.26	.07	.93	4.15	.45	.22	2.11	3.90	2.13	.31	.14	.10
21–30	.80	.33	4.09	3.99	2.34	.00	.66	.63	.00	.49	.77	.18	5.66
Total	1.66	1.61	5.99	4.92	7.19	3.25	2.99	3.27	5.88	2.84	4.53	2.43	6.90
May:													
1–10	.26	.02	1.92	.29	1.19	.00	2.01	2.04	1.98	1.96	.90	1.32	.79
11–20	.77	.82	.54	.46	.39	1.60	.66	3.24	1.13	1.88	.57	1.32	1.23
21–31	1.13	.09	.57	1.02	2.56	1.03	1.15	.66	2.43	2.03	1.36	.16	2.21
Total	2.16	.93	3.03	1.77	4.14	2.63	3.82	5.94	5.54	5.87	2.83	2.80	4.23
June:													
1–10	.00	1.04	.00	.42	.66	.53	3.33	.38	.87	.14	1.91	.18	.61
11–20	.04	.52	3.25	1.13	3.02	.36	.31	2.11	.66	1.34	1.26	.77	6.31
21–30	1.73	.89	.34	2.28	2.61	.35	.99	.26	.85	.76	.38	1.37	1.47
Total	1.77	2.45	3.59	3.83	6.29	1.24	4.63	2.75	2.38	2.24	3.55	2.32	8.39
July:													
1–10	2.83	1.56	.48	.07	1.99	5.38	5.11	1.07	3.07	.59	2.79	1.01	2.63
11–20	.32	2.56	.60	2.35	.74	.00	1.71	.97	.50	.07	.80	.17	2.05
21–31	3.55	.65	.33	.00	.14	1.11	.56	.22	4.78	1.52	.41	2.53	.08
Total	6.70	4.77	1.41	2.42	2.87	6.49	7.38	2.26	8.35	2.18	4.00	3.71	4.76
August:													
1–10	1.12	.54	.07	.89	.90	.00	.76	1.69	.05	.32	.80	.28	.73
11–20	.85	3.70	2.43	11.72	.00	.12	3.22	.56	1.81	1.30	.37	.08	1.44
21–31	.65	2.37	3.06	1.15	.45	.04	6.11	.05	8.20	.49	1.08	3.60	5.13
Total	2.62	6.61	5.56	13.76	1.35	.16	10.09	2.30	10.06	2.11	2.25	3.96	7.30
September:													
1–10	.62	2.48	1.85	2.10	1.33	.22	.43	2.94	.49	4.34	8.00	.10	1.40
11–20	.92	.0	.44	1.47	1.28	.58	.32	.00	.97	5.29	.08	.15	.26
21–30	.23	1.61	.00	.74	1.10	.00	1.23	1.17	.68	1.04	.28	2.32	.44
Total	1.77	4.09	2.29	4.31	3.71	.80	1.98	4.11	2.14	10.67	8.36	2.57	2.10
Total for 6 months	16.68	20.46	21.87	31.01	25.55	14.57	30.89	20.63	34.35	25.91	25.52	17.79	33.68

TABLE 2.—*Rainfall at Florence, S. C., for 10- and 11-day periods during the growing seasons, 1933–36*

Month and date	Rainfall during growing season for—				Month and date	Rainfall during growing season for—			
	1933	1934	1935	1936		1933	1934	1935	1936
April:	*In.*	*In.*	*In.*	*In.*	July:	*In.*	*In.*	*In.*	*In.*
1–10	0.05	0.46	1.12	6.70	1–10	1.01	0.40	1.40	0.35
11–20	1.33	.61	.59	.00	11–20	1.86	2.47	.96	1.10
21–30	.12	.00	.81	.24	21–31	3.83	1.19	3.13	1.73
Total	1.50	1.07	2.52	6.94	Total	6.70	4.06	5.49	3.18
May:					August:				
1–10	1.47	.00	.30	.05	1–10	.10	.76	.05	2.74
11–20	.00	3.64	1.40	.00	11–20	.88	.35	.91	.17
21–31	3.24	1.52	.26	.12	21–31	.04	2.27	3.66	1.21
Total	4.71	5.16	1.96	.17	Total	1.02	3.38	4.62	4.12
June:					September:				
1–10	1.24	1.36	.60	1.54	1–10	2.30	1.62	5.57	1.47
11–20	1.24	.16	.66	4.82	11–20	.00	1.25	.77	2.88
21–30	1.42	2.30	.00	.51	21–30	.00	.76	.64	1.93
Total	3.90	3.82	1.26	6.87	Total	2.30	3.63	6.98	6.28
					Total for 6 months	20.13	21.12	22.83	27.56

The effects of natural weed fallow and bare fallow on acre yields, gross value, and average price per pound of tobacco (table 3) represent a continuation and extension of previously published data (*1*). The earlier years (1922–24) are not reported again, since it is desired to point out in the present paper the advantage of weed fallow as compared to bare fallow. The results presented are for the years 1925–37, which is the period in which a direct comparison was made between bare and natural weed fallow. Period averages are presented to show trends under the two systems.

TABLE 3.—*Effects of vegetation cover on the yield, gross value, and average price per pound of leaf tobacco, Upper Marlboro, Md., 1925–37*

[1,000 pounds per acre of 1-7-5 fertilizer used in 1925–33; 750 pounds per acre of 2-8-12 fertilizer in 1934–37]

Treatment	Acre yield									
	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934
2-year rotation:	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Weed fallow	1,264	1,152	1,504	1,080	1,204	1,064	936	1,224	1,180	1,500
Bare fallow	1,328	1,144	1,374	768	900	776	696	928	688	740
3-year rotation:										
Weed fallow	1,344	1,268	1,488	1,168	1,192	1,080	1,024	1,548	1,064	1,588
Bare fallow	1,412	1,240	1,380	800	916	784	636	948	544	933
	Acre value									
2-year rotation:	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Weed fallow	426	415	426	328	503	230	271	317	295	410
Bare fallow	458	389	318	198	276	111	92	82	74	58
3-year rotation:										
Weed fallow	456	441	429	390	431	185	308	418	346	531
Bare fallow	487	435	329	333	243	122	67	96	65	82

Treatment	Acre yield							Average price per pound			
	1935	1936	1937	1925–28	1929–32	1933–37	1925–37	1925–28	1929–32	1933–37	1925–37
2-year rotation:	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Cents*	*Cents*	*Cents*	*Cents*
Weed fallow	1,220	1,098	920	1,250	1,107	1,184	1,180	-------	-------	-------	-------
Bare fallow	784	720	696	1,154	825	726	888	-------	-------	-------	-------
3-year rotation:											
Weed fallow	1,040	1,528	1,009	1,317	1,211	1,246	1,257	-------	-------	-------	-------
Bare fallow	752	888	666	1,208	821	757	915	-------	-------	-------	-------
	Acre value										
2-year rotation:	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*				
Weed fallow	347	311	134	399	330	299	339	32	30	25	29
Bare fallow	111	106	59	341	140	82	179	30	17	11	20
3-year rotation:											
Weed fallow	270	495	150	429	336	358	373	33	28	29	30
Bare fallow	121	130	41	396	132	88	196	33	16	12	21

The data presented in table 4 give yield and value of tobacco following pure cultures of local weeds and following bare fallow. This series differs from that shown in table 5 in that the weeds were plowed under in the fall. The plots were duplicated in most cases in the series shown in table 5. The plot numbers will indicate whether the results shown are averages of duplicate plots or were obtained from single treatments. The weed growth in this series was not plowed under until spring, usually in April.

TABLE 4.—*Acre yield, gross value, and average price per pound of leaf tobacco grown in 2-year rotation with pure cultures of the local weeds, Upper Marlboro, Md., 1931–37*

[600 pounds per acre of 2–8–12 fertilizer applied to the tobacco crop on all treatments; weeds plowed under in fall]

Treatment	Yield per acre								Average price per pound
	1931	1932	1933	1934	1935	1936	1937	Average 1931–37	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Cents*
Rabbitfoot clover	782	1,069	669	1,263	950	938	696	910	
Ragweed	844	1,276	831	1,175	913	976	875	984	
Wild pea	932	1,275	1,006	1,513	1,351	1,113	800	1,141	
Fallow	900	981	757	863	801	764	600	809	
Partridge-pea	1,100	1,264	931	1,250	1,026	988	651	1,030	
Horseweed	894	1,269	732	1,163	700	875	513	878	
Lespedeza	982	1,019	638	1,163	801	901	575	868	
	Value per acre								
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	
Rabbitfoot clover	176	243	99	249	194	246	44	179	20
Ragweed	160	362	143	168	202	282	73	199	20
Wild pea	139	322	193	132	267	297	83	205	18
Fallow	173	163	59	52	115	157	33	107	13
Partridge-pea	154	281	175	242	197	226	47	189	18
Horseweed	128	360	144	251	146	241	32	186	21
Lespedeza	143	192	77	126	164	251	51	143	16

TABLE 5.—*Acre yield, gross value, and average price per pound of leaf tobacco grown in 2-year rotation with pure cultures of the local weeds, Upper Marlboro, Md., 1931–37*

[600 pounds per acre of 2–8–12 fertilizer applied to the tobacco crop on all treatments; weeds plowed under in spring]

Plot No.	Treatment	Yield per acre									6-year average price per pound	5-year average price per pound
		1931	1932	1933	1934	1935	1936	1937	Average 1931–37	Average 1932–37		
1	Annual sweetclover (Hubam strain)	*Lb.* 844	*Lb.* 1,287	*Lb.* 1,042	*Lb.* 1,261	*Lb.* 1,143	*Lb.* 1,173	*Lb.* 901	*Lb.* 1,093	*Lb.* 1,135	*Ct.*	*Ct.*
2, 9	Rabbitfoot clover	1,003	1,335	1,313	1,025	1,124	1,396	1,007	1,172	1,200		
3, 10	Ragweed	1,018	1,440	1,309	1,492	1,291	1,322	1,068	1,277	1,320		
4, 11	Wild pea	1,146	1,453	1,160	1,274	1,105	1,330	924	1,199	1,208		
5, 12	Fallow	1,059	1,327	1,147	1,020	1,098	1,090	828	1,081	1,085		
6, 13	Partridge-pea	1,085	1,344	1,287	1,309	1,221	1,146	950	1,191	1,210		
7, 14	Horseweed	1,189	1,379	1,177	1,235	1,210	1,212	949	1,193	1,194		
8	Lambsquarters	932	1,286	901	884	459	806	613	840	825		
15	Lespedeza	1,068	1,208	1,269	963	1,090	1,174	954	1,104	1,110		
16	Natural weed fallow		1,243	1,086	1,217	1,204	1,164	929		1,141		
		Value per acre										
1	Annual sweetclover (Hubam strain)	*Dol.* 193	*Dol.* 284	*Dol.* 278	*Dol.* 340	*Dol.* 264	*Dol.* 257	*Dol.* 80	*Dol.* 242	*Dol.* 251	22	22
2, 9	Rabbitfoot clover	156	320	314	140	257	382	107	239	253	20	21
3, 10	Ragweed	161	434	409	407	375	424	143	336	365	26	28
4, 11	Wild pea	179	352	286	171	233	353	123	242	253	20	21
5, 12	Fallow	203	291	223	186	158	274	82	202	202	19	19
6, 13	Partridge-pea	222	334	350	332	265	260	119	269	277	23	23
7, 14	Horseweed	284	447	278	295	312	344	106	295	297	25	25
8	Lambsquarters	214	307	184	100	49	147	61	152	141	18	17
15	Lespedeza	247	219	181	196	179	343	102	210	203	19	18
16	Natural weed fallow		392	278	294	298	334	117		286		25

The results presented in table 6 were obtained from tests at the Pee Dee Experiment Station, Florence, S. C. These tests covered only a

short period of time (1933–36) but were located on a soil differing from that upon which the other tests were conducted. The flue-cured type of tobacco was grown at Florence, and this type differs from that produced in the other tests, which is known as Maryland leaf.

TABLE 6.—*Acre yield, gross value, and average price per pound of leaf tobacco grown in a 2-year rotation with pure cultures of some of the local weeds at Florence, S. C., 1933–36*

[800 pounds per acre of 3–8–6 fertilizer applied to tobacco on all plots]

Treatment	Yield per acre					Average price per pound
	1933	1934	1935	1936	Average 1933–36	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Cents*
Ragweed	1,758	1,873	1,877	1,330	1,710	
Partridge-pea	1,254	1,697	1,700	1,240	1,473	
Horseweed	1,698	1,650	1,653	1,308	1,577	
Lambsquarters	774	932	927	810	861	
Natural weed fallow	1,022	1,365	1,408	1,393	1,297	
	Value per acre					
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	
Ragweed	224	410	413	328	344	20
Partridge-pea	100	342	342	337	280	19
Horseweed	219	346	351	341	314	20
Lambsquarters	72	147	148	226	148	17
Natural weed fallow	115	276	297	410	275	21

The percentage of plants harvested from the several treatments shown in table 5 is given in table 7. These data serve to illustrate survival and ultimate growth of tobacco following the various plant species included in the test. The effect of bare and natural weed fallow on size, weight per square foot, percentage of moisture, and fire-holding capacity of leaf tobacco is shown in table 8. The data in this table include physical measurements of properties associated with some of the rather elusive factors of quality. One leaf of average size selected from each of 50 normal plants for the years shown was used to ascertain the size, weight per square foot, and moisture-absorbing capacity when the cured leaf is handled under controlled temperature and humidity. Fire-holding capacity was determined on 50 leaves selected and handled in the same manner.

TABLE 7.—*Percentage of the tobacco plants harvested on each treatment when the crop was grown in 2-year rotation with pure cultures of local weeds, Upper Marlboro, Md., 1931–37*

Plot No.	Treatment	1931	1932	1933	1934	1935	1936	1937	Average	
									1931–37	1932–37
		Per-cent	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*
1	Annual sweetclover (Hubam strain)	100	100	100	92	97	100	100	98	98
2, 9	Rabbitfoot clover	97	100	100	91	99	100	97	98	98
3, 10	Ragweed	100	100	100	95	100	99	100	99	99
4, 11	Wild pea	100	100	91	95	91	100	91	95	95
5, 12	Fallow	100	100	100	95	100	100	100	99	99
6, 13	Partridge-pea	100	100	100	97	100	100	100	100	100
7, 14	Horseweed	100	100	93	100	100	97	100	99	98
8	Lambsquarters	100	100	83	71	54	67	76	79	75
15	Lespedeza	100	100	100	83	96	79	100	94	93
16	Natural weed fallow	-------	100	100	100	100	90	97	-------	98

TABLE 8.—*Effects of bare and natural weed fallow on amount of moisture, size, weight per square foot, and fire-holding capacity of leaf tobacco*

Treatment	Amount of moisture in the leaf, 1935	Average size of leaf				
		1929	1931	1932	1935	Average
2-year rotation:	*Percent*	*Square feet*	*Square feet*	*Square feet*	*Square feet*	*Square feet*
Weed fallow	21.85	1.19			1.10	1.15
Bare fallow	19.43	.75			.67	.71
3-year rotation:						
Weed fallow	21.16	.99	1.67	1.49	1.19	1.34
Bare fallow	19.75	.92	1.02	.88	.75	.89

Treatment	Weight per square foot					Fire-holding capacity				
	1929	1931	1932	1935	Average	1929	1931	1932	1934	Average
2-year rotation:	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Seconds*	*Seconds*	*Seconds*	*Seconds*	*Seconds*
Weed fallow	6.05			5.84	5.95	13.5	47.3	16.9	55.8	33.4
Bare fallow	9.22			7.70	8.46	5.4	17.8	12.0	28.9	16.0
3-year rotation:										
Weed fallow	6.83	4.27	7.28	5.99	6.09	9.9	50.2	14.3	71.0	36.4
Bare fallow	7.90	5.16	8.78	7.26	7.28	6.5	23.0	12.0	22.0	15.9

DISCUSSION

Successful culture of tobacco does not depend simply on the tonnage produced per acre, for the product must meet market demands as to color, aroma, texture, elasticity, body, fire-holding capacity, ability to undergo the aging process with improvement, and other requisites of quality. These diverse and exacting demands can be met only by close attention to details of culture and handling. It is not uncommon for the grower to observe all precautions known to him in regard to these details and yet fail to produce high-quality leaf, owing to the use of undesirable soil, improper cropping systems, inadequate fertilization, the invasion of parasites, and other causes not well understood.

A system that consistently gives good yields of high-quality leaf is always worthy of consideration. It is clearly evident from the data presented in table 3 that high-quality leaf was consistently produced when the tobacco was grown after a natural weed fallow. The crop that followed bare fallow decreased in value until the returns did not defray the cost of production. It is evident that in the earlier years of the test the portions of the plots that were kept bare produced as high crop yields and values as the portions on which the weeds were allowed to grow. The yields and values were maintained under the 3-year system, while the 2-year system showed some falling off though not to any great extent. It is possible that there was an improvement under the 3-year weed rotation, since the top prices paid for Maryland leaf tobacco were much higher during the earlier years of the test than those prevailing in recent years. The yields per acre remained at the same high level of about 1,200 pounds per acre under both the 2- and 3-year systems. The values appear to have fallen off under the 2-year system, since the average of the first 4 years was somewhat higher than that for the last 5 years. The total gross value following the 3-year system of natural weed fallow was

above $350 per acre for the last 5-year period, which is to be regarded as exceptionally good. Only in the very dry year of 1930 and the very wet years of 1935 and 1937 were the values materially reduced after natural weed fallow. The average price per pound, which serves as a good index of quality, appears to have fallen off in the 2-year system but was maintained at a high level for the tobacco grown in the 3-year system.

The relative merits of some of the wild species commonly occurring in the natural weed fallow as a cover crop for tobacco are well illustrated in table 4. It is evident that all of the species used resulted in increases in yield as compared to bare fallow, when the average for the period is considered. The poorest results obtained in this series were those with lespedeza. The highest gross values per acre were obtained from wild pea, with ragweed a close second. In some seasons the plot with horseweed as the cover crop produced tobacco that showed a high gross value per acre, and the average price per pound from this treatment was slightly higher than from any others. The yields and values obtained in this series, in which the weeds were plowed under in the fall, were lower than where the weed cover was allowed to remain on the soil until spring. It is possible that wind and water erosion was largely responsible for these differences.

Where spring plowing was practiced the highest yields in the series (table 5) were obtained from the ragweed cover. This plot also produced the highest gross value per acre and the highest average price per pound. It is significant that the next highest gross value and average price per pound were obtained from the plot with horseweed as the preceding cover. Natural weed fallow followed horseweed in gross value of tobacco produced and gave the same average price per pound for the tobacco as that obtained from the horseweed plot. In contrast with these results, reduction in yield and value occurred on the plot where lambsquarters was the cover crop (fig. 1), as compared to bare fallow. There also appears to have been no advantage from lespedeza as a cover crop, since the yield and value of the leaf produced was almost the same as on bare fallow. Sweetclover, rabbitfoot clover, and wild pea did not always show a decided advantage as cover crops to precede tobacco in this series. Partridgepea appears to have produced some increase in yields and values as compared with bare fallow.

The chief virtue of the weed cover for the succeeding tobacco crop appears to be its effect in inducing a rapid and uniform growth of tobacco from transplanting time to maturity. The tobacco following ragweed (fig. 2) serves as a good example of this effect. In those cases in which the plants do not grow uniformly, as with the lambsquarters (fig. 1) and lespedeza (fig. 3), the stunted plants as a rule show no very definite symptoms under Maryland conditions except those associated with brown root rot. Under South Carolina conditions, when tobacco follows lambsquarters, nematodes often are the most apparent cause for failure of the tobacco plants to grow. It is possible that the inhibitory growth factors not yet indentified are the same in both instances and that the two visible causes, brown root rot and nematodes, are only secondary invaders. It has been observed in the case of tobacco following annual lespedeza under Maryland conditions that seemingly the failure to grow uniformly

FIGURE 1.—Tobacco following (*A*) lambsquarters, and (*B*) horseweed. Upper Marlboro, Md., August 16, 1935. (See table 5 for yields and values.)

FIGURE 2.—Tobacco following (*A*) common ragweed, and (*B*) wild pea. Weeds in background. Upper Marlboro, Md., July 20, 1933. (See table 5 for yields and values.)

FIGURE 3.—Tobacco following (*A*) annual lespedeza, and (*B*) horseweed. Upper Marlboro, Md., September 6, 1934. (See table 5 for yields and values.)

and rapidly is due to brown root rot. Tobacco following lespedeza in some locations frequently shows a heavy invasion of nematodes, while in other locations black root rot (*Thielaviopsis basicola* (B. and Br.) Ferraris) is the most evident cause for failure of the crop to develop normally. Again, the most apparent causes may be only secondary.

While the tests conducted in South Carolina were not so extensive and were not continued for so long a period as those in Maryland, the results secured were nonetheless positive (table 6). Highest yields and values were obtained where ragweed was grown as the preceding cover (fig. 4, *A*). Horseweed gave results that were almost as good as those obtained from ragweed (fig. 4, *B*). The poorest yields and values obtained in the South Carolina tests were from lambsquarters (fig. 4, *C*). Natural weed fallow and partridge-pea, as preceding cover for tobacco, produced, as a rule, high yields and values. Under South Carolina conditions the highest average price per pound was obtained from the natural-weed-fallow combination.

The low yield from lambsquarters was the result, at least in part, of the loss of many plants (table 7) that were stunted in early growth and did not reach sufficient size for harvesting, while the low value can be attributed largely to irregular maturing of the crop because of the stunting. The same situation applies to a greater or less extent to tests with annual lespedeza and some of the other legumes represented in these experiments. The differences in growth following lambsquarters and horseweed are not the result of varying amounts of plant material turned under, since the amount in each case was approximately the same (fig. 5). Differences in the quantity of organic material would appear not to be the explanation for differences in growth of tobacco following the various species.

It is significant that natural weed fallow consisting of adventitious vegetation of 2 years' duration has consistently maintained yields and values of tobacco following this weed cover. The explanation is not evident, but it is clear that this effect is not due simply to allowing the land to lie idle since in bare fallowing the crop has decreased in yield and value. In an effort to learn something as to the factors involved, in 1935 one-half of the bare-fallow plot of the 2-year rotation was covered in the fall (September 25) with weeds harvested from old fields from soils of the Collington series. These weeds were removed in the spring of 1936 prior to preparing the land for tobacco. On one-half of the bare-fallow portion of the 3-year rotation, weeds harvested the fall before and stored under cover until spring were plowed under when the land was prepared for tobacco. The actual quantities used were not determined, but an attempt was made to supply approximately the same quantity of vegetation as was growing on the natural weed-fallow plots. The results are shown in table 9. The data indicate that a vegetation cover over winter seems to be necessary for favorable effects. When plowed in the spring, the soil under the weed fallow and weed mulch over winter was more friable and moist than that on bare-fallow areas. It may be pointed out that where excessive pasturing of livestock is practiced the favorable effects reported from natural weed fallow would not be expected since the field would then tend to approach the bare-fallow conditions.

FIGURE 4.—Tobacco following (*A*) common ragweed, (*B*) horseweed, and (*C*) lambsquarters. Pee Dee Experiment Station, Florence, S. C., June 12, 1936. (See table 6 for yields and values.)

TABLE 9.—*Effect of a weed mulch, and of weeds plowed under in the spring, on yield and value per acre of tobacco, Upper Marlboro, Md., 1936*

Treatment	Yield per acre	Value per acre	Treatment	Yield per acre	Value per acre
2-year rotation:	*Pounds*	*Dollars*	3-year rotation:	*Pounds*	*Dollars*
Bare fallow	720	106	Bare fallow	888	130
Weed mulch over winter	1,080	339	Spring application of weeds	760	116
Natural weed fallow	1,098	311	Natural weed fallow	1,528	495

The tobacco crop may not under all conditions be grown to better advantage after natural weed fallow. In some instances complicating diseases such as bacterial wilt and nematodes are harbored by the prevailing weed growth. The light thin-bodied leaf (table 8) produced as a rule following natural weed fallow, is not suitable for all tobacco-manufacturing purposes. Certain economic relations are

FIGURE 5.—*A*, Growth of horseweed; *B*, comparative growth of lambsquarters, Upper Marlboro, Md., August 17, 1931.

to be considered, since in some districts good tobacco soils are scarce and high-priced. It appears, however, that the natural weed-fallow system can be used to advantage where the necessary land is available, a light-bodied leaf is desired, and there are no complicating disease relationships. The beneficial action of the natural weed fallow, especially when combined with intelligent fertilization of the tobacco crop, is reflected in a uniformly high market value per acre and average price per pound, which shows that the product meets current demands for most manufacturing purposes.

A leaf of larger size, with a higher moisture-absorbing capacity and a lighter weight per square foot, is produced on the weed-fallow plot than on the bare-fallow area (table 8). The weight per square foot may be said to represent the so-called body factor, which is so often used in the industry in describing one of the essentials of quality. Weight per square foot varies widely from season to season. This variation appears to be associated with rainfall, since light weight per square foot is definitely related to wet season and more particularly to ample and well-distributed rainfall in July and August.

The fire-holding capacity of leaf tobacco (table 8) is important if it is to be used for smoking purposes. This is particularly true of

Maryland tobacco, since its reputation has been built up largely on its good burning qualities. It is evident that the natural weed fallow has produced leaf tobacco showing a much higher fire-holding capacity than bare fallow, although there is the usual variation from season to season, due, in part at least, to variations in rainfall.

SUMMARY

Since it had been observed that high-quality tobacco was consistently produced for the first year or two after a growth of natural weed cover, experiments were initiated to determine the value of natural weed fallow for preceding tobacco in the rotation as compared with that of certain crop plants and some of the wild species commonly occurring in the natural weed fallow. These comparisons were based on bare fallow as a control.

It is clearly evident from the results herein presented that tobacco which is fertilized intelligently and grown after natural weed fallow of sufficient duration possesses in large measure those desirable characteristics that are observed in the crop grown on virgin land. The crop grown after bare fallow has shown a rapid decline in yield and gross value.

The tests conducted with individual weed and crop-plant species have consistently shown that certain species are much more desirable than others as cover crops to precede tobacco. Tobacco following ragweed and horseweed was markedly superior both in yield and value to that following bare fallow. On the other hand, tobacco following lambsquarters was inferior in yield and value to that following bare fallow. In these tests annual lespedeza has shown no advantage as a cover crop to precede tobacco; sweetclover, rabbitfoot clover, and wild pea have not always shown a decided advantage; while partridge-pea has produced some increase in yield. Although the natural weeds occurring in these tests consisted principally of species that produced high-quality leaf in pure stands, it is possible that those found to be objectionable might predominate, under some conditions, with a resulting harmful effect on the succeeding tobacco crop. It is hardly to be expected that a given weed species would have the same effect on tobacco on all soils or under all conditions.

The generally beneficial effect of the weed fallow was that it promoted a quick start and very rapid and uniform growth of the tobacco plants from transplanting time to maturity. Within normal limits this result is, in turn, associated with a uniformly high market value per acre and average price per pound.

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