

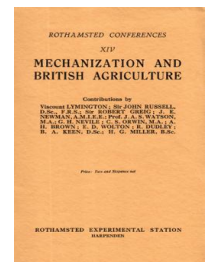
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# Mechanization and British Agriculture

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## The Maintenance of Soil Fertility Under Mechanized Farming Systems

**Sir E. J. Russell**

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## THE EFFECT OF MECHANIZATION ON SOIL FERTILITY

By SIR E. J. RUSSELL.

UNDER the old four or five course rotation the fertility of the soil was maintained by four different processes :

- (1) the straw was converted into farmyard manure.
- (2) clover was grown once in four years, as far as possible ;
- (3) the roots and the aftermath of clover were fed off on the land by sheep which received purchased feeding stuffs ;
- (4) artificial fertilisers were given in the root break and sometimes also to each crop.

These four methods when properly worked sufficed to keep the land permanently in a good state of fertility.

On a four course rotation per 100 acres of arable land the annual yield of straw would be of the order of 80 tons, producing about 300 tons of farmyard manure and this would give a dressing of 10 tons per acre to the roots and leave a little over for the "waist-coat" of dung which the old farmers like to give to a piece of backward wheat. The dung together with the feeding of the roots and the aftermath on the land ensured a dressing of animal manure for almost every crop.

The reduction of the root area, and in the amount of sheep feeding on the land, has greatly reduced the amount of animal manure available and also it has reduced the amount of treading which the land receives.

Further, the change in method of feeding animals, whereby more use is made of grass and less of arable land, greatly diminishes the amount of farmyard manure available. We do not yet know whether farmers can afford to continue an exclusive grass system for live stock, with the resulting glut of fat stock in autumn and consequent low prices. But we have to reckon with a continuance of the system because of its cheapness and we must assume that the glut will be remedied by the simple expedient of lessened production.

These tendencies become more and more intensified as mechanization advances. It is, as Prof. Watson shows (p. 27) quite possible to combine a considerable degree of mechanization with live stock farming, as indeed we are doing on the Rothamsted farm, but we must recognise that over large parts of the eastern and south-eastern counties live stock and arable farming do not now work together



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as economically as they did, and farmers are now trying instead machines and arable farming, in the hope of reducing their financial losses.

The problem thus arises: can fertility be maintained on an arable farm without the dressings of animal manure formerly given?

For some years past we have been engaged on this subject at Rothamsted and a considerable amount of information has now been obtained. We find that the importance of animal manure depends on the kind of crop.

### *Cereals*

*Wheat.*—Our experiments on wheat have gone on ever since 1843, but in recent years they have been extended to deal more fully with this problem. The experiments show that yields of the order of 30 to 40 bushels can be obtained by the use of artificial fertilisers only, and without any organic manure so long as the cultivation processes keep the land free of weeds. The results are confirmed by the practical experience of John Prout of Sawbridge-worth, Essex, who, with his son William Prout, as a profitable commercial venture grew large acreages of wheat almost continuously from 1861 to 1911 on purely mechanized lines—one of the first examples of mechanization in this country. He occasionally took a red clover crop, but it is not at all clear that this was necessary although it was probably an advantage. He used no farmyard manure but artificials only, and his scheme of manuring was based on the recommendations of Dr. Augustus Voelcker, father of our present Dr. Voelcker<sup>1</sup>. There was no sign of deterioration of yield: for the first 19 years (1862–1880) it had been 32 to 36 bushels per acre, and for the 25 years 1880–1904 it averaged 35 bushels per acre, with 2 loads of straw. The average price during this second period was 31/9 per qr. for the wheat and 25/- a load for the straw: the average cost of growing (including 25/- per acre rent) was £6 8s.: the average return was £9 8s. 10d., leaving an average profit of £3 0s. 10d. So long as the straw was saleable at 25/- and grain and wages stood at their old levels all went well.

Mr. George Bayliss also grew wheat continuously without farmyard manure, but using a scheme of artificials based on Rothamsted results: here also the process was for many years profitable, and it was all done on purely mechanized lines<sup>2</sup>. Both Mr. Prout and Mr. Bayliss worked in the days of horses, and it was the growing cost of horse labour that finally drove them out of wheat growing. It is possible that they could have continued, had they so desired, by using tractors.

<sup>1</sup> For full particulars see "Profitable Clay Farming Under a Just System of Tenant Right," John Prout, 1881; and for the later years, W. A. Prout and J. A. Voelcker, *Jour. Roy. Agric. Soc.*, 1905, 66, 35.

<sup>2</sup> Described by C. S. Orwin, "Progress in English Farming Systems. III. A Specialist in Arable Farming." Oxford, 1930.



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Barley, like wheat, is independent of farmyard manure and can be grown quite well with artificials alone. It was indeed included in the schemes of Mr. Prout and of Mr. Bayliss.

Our experience at Rothamsted has, however, brought out one important result which holds both for wheat and for barley: farmyard manure steadies the yield, and saves it from dropping so low in bad seasons as it is liable to do when artificials alone are given. Some of the results are given in Table I. This is generally true of all crops and it is one of the good qualities of farmyard manure not easily reproducible by artificials.

TABLE I.  
FARMYARD MANURE COMPARED WITH ARTIFICIALS FOR WHEAT.  
BROADBALK FIELD, WHEAT EVERY YEAR, 1852-1930.

Plot No.	Annual Manuring.	Average Yield. Bushels per acre.	Average difference between one year and the next. Bushels per acre.	Average difference as percentage of average yield.
3	Unmanured ..	11.7	4.0	34.5
8B	Complete Artificials .. ..	34.5	9.3	26.8
2B	Farmyard manure	33.5	7.0	20.8

The general conclusion is that wheat and barley could perfectly well be grown with artificial fertilisers alone, and without farmyard manure, but at a risk of some depression of yield in bad seasons. This difficulty can be mitigated by using larger quantities of artificials, but we have no evidence that it is much affected by ploughing in occasional clover leys. (Table V).

*Potatoes and Sugar Beet need farmyard manure or similar material*

When we come to potatoes and sugar beet, however, the case is entirely different. It is not usually possible to obtain with artificials alone as good yields as when farmyard manure is used. Smaller dressings of farmyard manure can be given when necessary, but in that case the dressings of artificials should be increased, especially the potassic fertiliser. Examples from our results are given in Table II.

*Mangolds and Swedes*

Mangolds come into rather a different group. So long as yields of only about 25-30 tons per acre are produced, these can be obtained almost as well by artificials supplemented with rape dust or similar organic as by farmyard manure, and the cropping can be on the

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TABLE II.  
FARMYARD MANURE COMPARED WITH ARTIFICIALS.  
LITTLE HOOS FIELD.

	Potatoes.—Tons per acre.		Mangolds.				Roots—Tons per acre.				Swedes.
	Dung and Complete Artificial	Complete Artificial (larger quantity) without dung	Year	Rich Dung	Poor Dung	Complete Artificial	Year	Rich Dung	Poor Dung	Complete Artificial	
Rothamsted—											
1921	3.6	3.8	1906	25.6	18.2	24.1	1904	15.7	13.1	12.2	
1922	9.4	8.4	1911	17.1	15.8	14.2	1908	22.4	19.1	16.9	
1922	9.4	8.3	1915	15.5	13.5	7.2	1920	21.7	18.4	16.3	
1923	12.2	12.0					1926	21.1	21.8	15.5	
1924	9.0	7.5									
Average	8.7	8.0	Average	19.3	15.8	15.2		20.2	18.1	15.2	
Seale Hayne*											
1927	7.61	6.45									

\* Equivalent artificial.



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same land year after year. Our Barnfield has carried mangolds every year since 1876 excepting in two years 1908 and 1927 when the crop failed owing to bad weather.

The average yield for 50 years 1876–1928 has been, on plots receiving the best combination of artificials, in tons per acre :

		<i>Artificials alone.</i>	<i>Artificials with Rape dust.</i>	<i>Artificials with farmyard manure.</i>
		Plot 4N (b)	Plot 4 AC	Plot 2AC
Roots	..	17.8	26.1	27.6
Leaves	..	4.1	5.3	6.3

Where higher yields of 40 to 50 tons per acre are desired it may be essential to use farmyard manure.

Swedes can do without farmyard manure in regions where yields are normally only about 15 tons per acre or less : where higher yields are possible farmyard manure is required.

*The return of the Straw to the Land*

So long as any form of indoor winter feeding of animals remains profitable the straw can be made into farmyard manure, and this is the best way of using it. But if as commonly happens, the winter feeding is itself unprofitable one cannot charge the animals with much for the farmyard manure : at present prices of artificials I should not be disposed to allow more than 10/- per ton for farmyard manure. It is very easy nowadays to lose money over winter feeding.

For some years past at Rothamsted we have been trying to use the straw in some other way. Three methods have been tried.

(1) The straw has been ploughed direct under the ground. The immediate effect of this is to reduce the amount of available plant food in the soil because the micro-organisms that decompose the straw feed on nitrate and phosphate, just like plants, and so take up for themselves what the plant ought to have had. This does not much matter in the autumn, when the plant food might be washed out if the micro-organisms did not take it, but it is a serious loss in the spring when the young plant is ready for food. So far as our older experiments went—they were done on Broadbalk—the ploughing in of the straw even in the autumn was useful only on land short of potash and here its effect was very slight. The experiment is being repeated on broader lines to see if this is the general rule.

(2) A more useful method, which has been widely adopted in many countries by farmers who do not practise animal husbandry, is to treat the straw with the necessary food for the micro-organisms so that they can decompose it before it gets into the soil. This is the basis of the so-called Adco process, discovered at Rothamsted and developed on the large scale by the Adco Syndicate, Harpenden.



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The resulting manure is quite good : some of their results are given in Table III. The practical difficulty on an English farm is usually to supply the water to wet the straw.

(3) A method now being tried at Rothamsted is to leave the straw on the ground and in autumn to drill over it a mixture of complete artificials, then to plough it under and let it rot.

In order to compare straw treated in these last two methods with farmyard manure a rotation was started on Hoos field in 1930, and is to continue for many years, in which the following are compared :

Farmyard manure.

Straw treated by the Adco process.

Straw left on ground, treated with artificials and ploughed in.

Complete artificials.

For the first two crops the two treated straws seem to be comparing very favourably with farmyard manure but we shall not be in a position to speak definitely about this till the experiment has run on for a longer period.

TABLE III.

CONVERSION OF STRAW INTO MANURE : FARMYARD MANURE AND ADKO.  
YIELDS PER ACRE.

	Rothamsted, 1930.				Orsett, Essex.	Wye, Kent.
	<i>Wheat.</i> <i>Cwt.</i> <i>per acre.</i>	<i>Barley.</i> <i>Cwt.</i> <i>per acre.</i>	<i>Turnips.</i> <i>Tons</i> <i>per acre.</i>	<i>Seeds*</i> <i>Hay. Cwt.</i> <i>per acre.</i>	<i>Potatoes</i> § <i>Tons</i> <i>per acre.</i>	<i>Mangolds</i> § <i>Tons</i> <i>per acre.</i>
Adco ..	17.2	22.8	9.7	27.9	12.6	21.5
Farmyard Manure ..	15.9	16.2	9.0	22.5	11.9	21.0
Artificials alone ..	19.8	21.3	9.5	21.8	10.1	19.0
No Manure	14.7	11.8	4.2	10.9	—	17.5

\* As dry matter.

§ Artificials added to the farmyard manure and the Adco.

### *Green Manuring*

This is a very promising method of supplying organic matter to the soil ; it is, however, more difficult than is usually supposed.

In the older farming systems it was common to grow a mustard, tares or other crop and either feed them to sheep on the land or, if they were not wanted for the sheep, to plough them in as green



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manure. Many farmers however sowed the crop even when there was no likelihood of it being wanted for the animals : it was ploughed in. This green manuring is a recognised practise on light land.

The first serious tests in this country were made with mustard and tares at the Woburn Experimental farm, then under the Royal Agricultural Society, now part of the Rothamsted organisation. The soil is light, and was expected to respond well to green manuring but it did not : the green manure was entirely without effect.

For a long time this result was regarded as exceptional due to some undiscovered peculiarity. In 1920 and 1921, however, the Rothamsted workers, H. J. Page and his colleagues, made a number of experiments here and in different parts of England by aid of a grant from the Research Fund of the Royal Agricultural Society and only in few of these was green manuring successful.

Yet there is no denying that many farmers have obtained very good results with green manuring.

The subject has recently been fully examined at Rothamsted and an explanation of the discrepancy can now be given. Green manuring succeeds only when the time of ploughing in the green crop fits in with the time of sowing of the next one. The green crop must be allowed sufficient time to decompose and produce nitrates, but the following crop must be ready to take up the nitrate before it is washed out from the soil. Those farmers who succeeded with green manuring had got the timing right : others had not. Further experiments are being made to find out more precisely how to work out the timing but meanwhile green manuring should not be trusted blindly. If it is succeeding that is proof of correct timing, but if it is not known to be successful the timing should be looked into. Once this is right, however, green manuring becomes a valuable aid to mechanized farming.

The ploughing in of a clover ley in September in preparation for wheat in October seems usually to be successful, while the ploughing in of the June clover crop instead of cutting it, followed by a bastard fallow during July, August and September is probably the most satisfactory of all methods of keeping up fertility on a mechanized cereal farm, so long as *July, August and September are dry*. But if these months be wet most of the advantage may be lost. Green manuring is by no means entirely safe.

### *Fallowing*

Recent Rothamsted experiments have shown that the old problem of the fallow is by no means cleared up. The Broadbalk wheat field has carried wheat every year since 1843 : never has there been a complete break. In 1926 and 1927, however, part of the field was fallowed : in 1928 the wheat grown after the two years fallow gave extraordinary yields.

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	Plot.	1928.		Average 77 years, 1852-1928.	
		Grain. Bushels per acre.	Straw. Cwt. per acre.	Grain. Bushels per acre.	Straw. Cwt. per acre.
No manure since 1839	3	27.9	27.8	11.8	9.9
Complete artificials ..	13	55.2	32.0	29.2	30.8
No potash .. ..	11	56.9	31.4	21.4	21.8
No potash or phosphate	10	47.0	25.8	18.8	18.1
No nitrogen .. ..	5	35.2	34.8	13.6	10.6
Farmyard manure ..	2B	48.4	61.4	33.2	34.5

The result was a remarkable increase in the yield of grain. Never in the 86 years of successive wheat growing had Broadbalk grown a crop so thick set with grain, and we are unable at present to explain it. The season was very favourable, but probably not more so than some of the great wheat seasons of the past, 1854, 1857, 1863 1894, yet in none of these was so much grain produced. Much of the effect is probably attributable to the fallow, but whether the action is the suppression of weeds, the decomposition of vegetable and other matter, or some physical change in the soil, we cannot decide. Something more seems to be involved than an increase in plant nutrients, for no fertiliser scheme we have yet tested produces so remarkable a result. The effect lasted only one year, however; the 1929 yield was about 10 per cent. below the average for the 74 years while in 1930 it had fallen about 40 per cent. below the average.

Even the sandy soil at Woburn was greatly improved for barley, but not so much for wheat, by two years fallowing; the results, however, were not nearly so striking as on Broadbalk.

Under mechanized conditions fallowing would become relatively inexpensive and could therefore be practised. Our experiments suggest that a two year fallow may be much more effective than one year. The unmanured land on Hoos field gave in 1928 after one year's fallow only 10.5 bushels instead of the 28 bushels after the two years' fallow on Broadbalk. The subject is being further studied.

The effect of fallowing depends a great deal on the weather: crops following a fallow are therefore liable to greater variations in yield than those following another crop. This is well shown by comparing the wheat yield on Broadbalk where wheat always follows wheat, with the yield on Hoosfield where it follows a fallow: the average yield is raised by the fallow, but so also is the variation from season to season. (Table IV).

#### *The "Golden Hoof" on Sandy Soil*

It is a commonplace that light soils are improved by the folding of sheep, both the manuring and the treading being important. Apparently the manuring can be satisfactorily imitated but so far the treading cannot. Experiments at Woburn showed that the



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compacting of the soil by sheep is different from that produced by implements ; it extends to a greater depth and lasts longer ; the top three inches of the soil is mainly affected. It also gives a coarser tilth. In the experiments so far made it did not increase the water holding power of the soil, indeed, the trodden part was, if anything, somewhat drier than the cultivated part : the work, however, is being continued.

TABLE IV.

EFFECT OF ONE YEAR'S FALLOW ON SUCCEEDING WHEAT CROP.  
HOOSFIELD. ALTERNATE WHEAT AND FALLOW (NO MANURE).  
DRESSED GRAIN IN BUSHELS PER ACRE.

	<i>Mean Yield.</i>	<i>Average difference between one crop and the next.</i>	<i>Average difference as percentage of Mean Yield.</i>
After fallow in 1857, 1859 and alternate years to present time .. ..	14.2	7.4	52.2
After previous wheat crop, Broadbalk ..	11.7	4.1	35.1
After fallow in 1856, 1858 and alternate years to present time .. ..	14.2	5.9	41.4
After previous wheat crop, Broadbalk ..	11.7	3.4	29.5

TABLE V. COMPARISON OF CLOVER LEY WITH FALLOW AS  
PREPARATION FOR WHEAT.

AGDELL. FOUR COURSE ROTATION. WHEAT.  
DRESSED GRAIN IN BUSHELS PER ACRE.

<i>Plot No.</i>	<i>Treatment.</i>	<i>Mean Yield.</i>	<i>Average dif- ference between one crop and the next.</i>	<i>Average dif- ference as per centage of Mean Yield.</i>
5	Unmanured, after fallow ..	24.0	9.5	39.4
6	„ „ „ clover ..	22.3	9.6	42.9
	After wheat, Broadbalk ..	11.7	2.9	24.6
1	<i>Complete Artificials—</i>			
	After fallow .. ..	28.9	10.0	34.5
2	After clover .. ..	30.4	10.9	35.8
	After wheat, Broadbalk ..	34.5	7.2	20.8
	<i>Minerals only—</i>			
3	After fallow .. ..	28.1	9.2	32.9
4	„ clover .. ..	30.6	10.4	33.8
	„ wheat, Broadbalk ..	13.5	4.8	35.2



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### *Conclusions*

(1) For cereals no difficulty need be feared in keeping up soil fertility by artificial manures alone: farmyard manure is not essential. Artificials, however, are apt to give smaller yields in bad seasons than farmyard manure, though they may give better yields than it does in good seasons. Their range of yield is higher.

(2) Potatoes and sugar beet require for the best results farmyard manure or something that has the same action in the soil.

(3) Mangolds up to about 25 tons per acre can be produced without farmyard manure by using artificials and rape dust or similar substance. We have done this regularly on the same land each year ever since 1876. Larger crops probably require farmyard manure.

(4) Swedes up to 15 or 20 tons can be produced without farmyard manure: where larger crops are possible they probably require farmyard manure.

(5) Where animals are not kept it is possible to convert the straw into an effective manure by the treatment discovered at Rothamsted and taken over by the Adco Syndicate, Harpenden.

Experiments are being made with an alternative method of leaving the straw on the ground, drilling artificials on top of it, and ploughing the whole lot under.

The ploughing under of the straw by itself has not so far given satisfactory results.

(6) Green manuring as an alternative to farmyard manure is more difficult to practise successfully than is usually supposed: the ploughing in of the green crop has to be so timed that it supplies plant food to the next crop just when the crop needs it and not before, otherwise it is liable to be washed out.

(7) The treading of sheep on light land produces effects which the cultivation implements so far tried do not produce.

Year	1876	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2113	2114	2115	2116	2117	2118	2119	2120	2121	2122	2123	2124	2125	2126	2127	2128	2129	2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140	2141	2142	2143	2144	2145	2146	2147	2148	2149	2150	2151	2152	2153	2154	2155	2156	2157	2158	2159	2160	2161	2162	2163	2164	2165	2166	2167	2168	2169	2170	2171	2172	2173	2174	2175	2176	2177	2178	2179	2180	2181	2182	2183	2184	2185	2186	2187	2188	2189	2190	2191	2192	2193	2194	2195	2196	2197	2198	2199	2200	2201	2202	2203	2204	2205	2206	2207	2208	2209	2210	2211	2212	2213	2214	2215	2216	2217	2218	2219	2220	2221	2222	2223	2224	2225	2226	2227	2228	2229	2230	2231	2232	2233	2234	2235	2236	2237	2238	2239	2240	2241	2242	2243	2244	2245	2246	2247	2248	2249	2250	2251	2252	2253	2254	2255	2256	2257	2258	2259	2260	2261	2262	2263	2264	2265	2266	2267	2268	2269	2270	2271	2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285	2286	2287	2288	2289	2290	2291	2292	2293	2294	2295	2296	2297	2298	2299	2300	2301	2302	2303	2304	2305	2306	2307	2308	2309	2310	2311	2312	2313	2314	2315	2316	2317	2318	2319	2320	2321	2322	2323	2324	2325	2326	2327	2328	2329	2330	2331	2332	2333	2334	2335	2336	2337	2338	2339	2340	2341	2342	2343	2344	2345	2346	2347	2348	2349	2350	2351	2352	2353	2354	2355	2356	2357	2358	2359	2360	2361	2362	2363	2364	2365	2366	2367	2368	2369	2370	2371	2372	2373	2374	2375	2376	2377	2378	2379	2380	2381	2382	2383	2384	2385	2386	2387	2388	2389	2390	2391	2392	2393	2394	2395	2396	2397	2398	2399	2400	2401	2402	2403	2404	2405	2406	2407	2408	2409	2410	2411	2412	2413	2414	2415	2416	2417	2418	2419	2420	2421	2422	2423	2424	2425	2426	2427	2428	2429	2430	2431	2432	2433	2434	2435	2436	2437	2438	2439	2440	2441	2442	2443	2444	2445	2446	2447	2448	2449	2450	2451	2452	2453	2454	2455	2456	2457	2458	2459	2460	2461	2462	2463	2464	2465	2466	2467	2468	2469	2470	2471	2472	2473	2474	2475	2476	2477	2478	2479	2480	2481	2482	2483	2484	2485	2486	2487	2488	2489	2490	2491	2492	2493	2494	2495	2496	2497	2498	2499	2500	2501	2502	2503	2504	2505	2506	2507	2508	2509	2510	2511	2512	2513	2514	2515	2516	2517	2518	2519	2520	2521	2522	2523	2524	2525	2526	2527	2528	2529	2530	2531	2532	2533	2534	2535	2536	2537	2538	2539	2540	2541	2542	2543	2544	2545	2546	2547	2548	2549	2550	2551	2552	2553	2554	2555	2556	2557	2558	2559	2560	2561	2562	2563	2564	2565	2566	2567	2568	2569	2570	2571	2572	2573	2574	2575	2576	2577	2578	2579	2580	2581	2582	2583	2584	2585	2586	2587	2588	2589	2590	2591	2592	2593	2594	2595	2596	2597	2598	2599	2600	2601	2602	2603	2604	2605	2606	2607	2608	2609	2610	2611	2612	2613	2614	2615	2616	2617	2618	2619	2620	2621	2622	2623	2624	2625	2626	2627	2628	2629	2630	2631	2632	2633	2634	2635	2636	2637	2638	2639	2640	2641	2642	2643	2644	2645	2646	2647	2648	2649	2650	2651	2652	2653	2654	2655	2656	2657	2658	2659	2660	2661	2662	2663	2664	2665	2666	2667	2668	2669	2670	2671	2672	2673	2674	2675	2676	2677	2678	2679	2680	2681	2682	2683	2684	2685	2686	2687	2688	2689	2690	2691	2692	2693	2694	2695	2696	2697	2698	2699	2700	2701	2702	2703	2704	2705	2706	2707	2708	2709	2710	2711	2712	2713	2714	2715	2716	2717	2718	2719	2720	2721	2722	2723	2724	2725	2726	2727	2728	2729	2730	2731	2732	2733	2734	2735	2736	2737	2738	2739	2740	2741	2742	2743	2744	2745	2746	2747	2748	2749	2750	2751	2752	2753	2754	2755	2756	2757	2758	2759	2760	2761	2762	2763	2764	2765	2766	2767	2768	2769	2770	2771	2772	2773	2774	2775	2776	2777	2778	2779	2780	2781	2782	2783	2784	2785	2786	2787	2788	2789	2790	2791	2792	2793	2794	2795	2796	2797	2798	2799	2800	2801	2802	2803	2804	2805	2806	2807	2808	2809	2810	2811	2812	2813	2814	2815	2816	2817	2818	2819	2820	2821	2822	2823	2824	2825	2826	2827	2828	2829	2830	2831	2832	2833	2834	2835	2836	2837	2838	2839	2840	2841	2842	2843	2844	2845	2846	2847	2848	2849	2850	2851	2852	2853	2854	2855	2856	2857	2858	2859	2860	2861	2862	2863	2864	2865	2866	2867	2868	2869	2870	2871	2872	2873	2874	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