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TECHNICAL PAMPHLET NO.

9.

AN ANALYSIS OF THE DATA OBTAINED FROM THE RUN-OFF PLOTS AT HALEFKA AND SYKHARI

1939 - 1944

C Y P R U S F O R E S T D E P A R T M E N T.

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N I C O S I A.

AN ANALYSIS OF THE DATA OBTAINED FROM THE RUN-OFF PLOTS AT HALEFGA AND SYKHARI 1939-1944.

In 1939 the Forest Department laid out experiments at Halefga and Sykhari to determine water and soil loss on the exposed southern slopes of the Northern Range. At the same time different treatments were tried out in the hope of ascertaining their possible effect on the soil and water loss. The full data from the Halefga experiment have been collected and analysed and include an account of the vegetation, while for Sykhari the figures dealing with rain, water and soil loss have been incorporated. An account of the vegetation will follow later in the season, when a plant count can be made.

LAY OUT OF HALEFGA EXPERIMENT

The Halefga experiment consisted of 2 batteries of 3 plots each, situated not far from Halefga Forest Station at an altitude of ca 2000 feet. The average slope is 50% for A Battery + 52% for B Battery, the aspects being south for A Battery + south slightly west for B Battery.

The plots are on Trypanian limestone, a uniform slope falling away from the base of the cliff, the soil, which is unevenly distributed, being moderately deep with occasional boulders showing on the surface. The batteries are placed with their greatest length following the downward trend of the slope, and the dimensions of each plot is 24' long by 6' broad. To ascertain the run-off from each, concrete walls a foot high were constructed around them, except at the base where a broad band of concrete holds a channel for collecting water. The walls were based on the parent rock to prevent seepage from one plot to the other, and their height made sufficient to eliminate errors caused by splashing. Arrangements were made for the collection of rain water and silt as well as for measurement of rainfall and these records have since been kept. The land on which these plots are situated is privately owned land outside the forest with scattered carob trees and scanty natural vegetation, consisting of perennial shrubs and subshrubs barely a foot high, shortlived annuals and a few scattered tufts of perennial grass. The whole area is heavily grazed and much trampled over by flocks of goats on their way to and from nearby mandras.

The treatment given to the two batteries was identical except for one important factor, that of grazing. Round A Battery a barbed wire fence was erected, while B Battery was left open for grazing. The treatment otherwise was as follows: 1 plot in each, i.e. No. 1 & 4, had three shallow ditches 18" wide made at ca 6' interval, No.2 and 5 had a wide trench ca 3" at top of trench and 12-15" deep constructed 18' from bottom of plot, while plots 3 and 6 were left without treatment for control.

LAY OUT OF SYKHARI EXPERIMENT.

At Sykhari 2 similar batteries were laid out but consisting only of 2 plots each, the dimensions being similar, i.e.24'x6'. These batteries are actually situated within the forest boundary, but vegetation was as scanty as at Halefga, stones and bare ground forming 92-93% of the area at the beginning of the experiment and no shrubs were then found within the plots. The aspect of geological formation and soil is very similar to Halefga, but the altitude is only 1060 feet, and the slope is 34% in A Battery and 37% in B Battery. The meteorological observations have revealed that though the rainfall at Sykhari is heavier over the five year period, the distribution is less even and covers a shorter period of the year. The lay-out of the batteries at Sykhari was similar to the Halefga

experiment.....

experiment with the exception of the omission of the plot with 3 contour ditches; thus each battery consists of one plot with a deep trench and one control plot, A Battery being fenced in as protection against grazing and B Battery being left grazed. In 1940-41, however, another experiment with no bearing on this was laid out immediately enjoining it and this has resulted in almost complete protection from grazing since that date. The figures obtained from A and B respectively cannot therefore be used comparatively but are nevertheless of considerable interest.

CRITICISM OF PRESENT LAY OUT.

Before proceeding it might be well to mention some criticism that can be made of a layout of this nature. First it may be noted that the relatively short length of the plots makes it impossible for any accumulative run-off to takeplace, so the relatively high absorption figures quoted later on may on the basis of this be too optimistic. It would furthermore seem as if the walling in had the same effect as contour terracing is known to have in reducing the run off, for both grazed as well as ungrazed plots show a marked drop in their water run off. This will be dealt with more fully in a later paragraph. The same argument would again apply to the figures for soil loss, and apart from the losses of soil that presumably had been loosened by the first lay out of the experiment and which therefore must be considered as accidental, the loss of soil has been practically negligible. Another objection can be raised against the walling in of B Battery, for though the walls are very low and permit easy access of animals, they are sufficiently high to be a protection against incessant trampling; the animals on their way forth and back would not step over the wall unless intent on grazing, so it may perhaps be assumed that the figures for B Battery are a little more favourable than they would have been, had the walls been level with the ground. The level walls were difficult to construct on the uneven ground, but perhaps a way may be found for future experiments.

A still further objection can be raised agains the broad concrete base holding the channel for conducting water. This base is flush with the ground, i.e. ca 50% slope and is ca 1 foot wide. The reason for the objection is not very obvious in the B Battery where the vegetation still is scanty, but in A Battery where the vegetation above is thick it is clear that the concrete base sets up xerophytick conditions as an outcrop of rock would do. A truer picture would therefore be obtained if an extra foot was allowed in future experiments before plant counts were taken.

VEGETATION.

When the experiment was laid out in 1939, mapping of the vegetation in the two control plots, No.3 and 6, was done, the following classifications being used: Stone, shrubs, perennial grass tufts, and bare ground; the latter however, must not be considered completely bare, but as carrying a scanty vegetation of small, presumably unpalatable annual grasses and herbs. The shrubs present were Teucrium polium, Echium sericeum, Lithospernum hispidulum and some Asphodel ramosus. The tufted grass was all Andropogon hirtum.

At the remapping done in 1944 it was considered desirable to go into greater detail, to map the shrubs by symbols indicating the species and to indicate whether bare ground carried annuals or not, but when comparisons are done the first classification has been adhered to. All six plots were mapped in 1944.

The following.....

The following tables will show the difference in vegetation in the five year period, all figures quoted being % of total area:

A Battery No.3	1939	1944	increase +	decrease −
Stones	10.6	3.9		6.7
Tufts	8.4	14.1	5.7	
Shrubs	.9	5.0	4.1	
Bare	80.1	77.0		3.1
B Battery No.6				
Stones	4.9	4.4		.5
Tufts	4.0	0.6		3.4
Shrubs	.8	2.9	2.1	
Bare	90.3	92.1	1.8	

It will be seen from these figures that the general tendency with grazing is for a greater baring of the ground, for while the shrubs have increased somewhat, the tufted grass has largely disappeared. The total increase in ground cover in No.3 is 9.8% as against a decrease of cover in No.6 of 1.4%, a difference of over 10%.

If all the figures for each battery are taken and an average given, the percentages are slightly different but the tendency remains the same.

A Battery

	Plot 1,2 & 3 Average 1944	Plot 3. 1939	increase	decrease.
Stones	5.1	10.6		5.5
Tufts	15.4	8.4	7.0	
Shrubs	5.4	.9	4.5	
Bare	74.1	80.1		6.0

B BATTERY.

	Plot 1,2 & 3 average 1944	Plot No.3 1939	increase	decrease
Stones	4.4	4.9		0.5
Tufts	2.7	4.0		1.3
Shrubs	3.2	.7	2.5	
Bare	89.7	90.4		0.7

These figures are bound to present a fairly high margin of error as such an average does not make allowances for the different distributions in the individual plots, but nevertheless the same tendency remains: considerable increase in the tufted grass and shrubs in the protected areas, while the grazed areas show a decrease in grass and a slight increase in shrubs only.

As the shrubs present provide grazing only for the hardiest animals with a tendency for more and more unpalatable species to appear, the economic importance of this factor is easily understood. More knowledge, however, is wanted on palatability of species, both amongst shrubs and grasses.

From the ecological point of view this experiment is of considerable interest, as it establishes the fact that the present vegetation on similar slopes in the Northern Range is a sub climax and that the present hardy and xerophytic plants can be partially or wholly eliminated by the simple expedient of protection from grazing. This is not surprising, similar experiments elsewhere have yielded the same evidence, but whether the vegetation in A Battery represents the final climax in vegetation is not yet known. From the past history of the Island one might infer that these areas would revert first to scrub and finally to high forest, but as seeding trees and shrubs now have been largely eliminated on these slopes some seeding or planting would be necessary if reconvertion to forest was considered advisable.

The actual difference in appearance of the two batteries is not easily imagined from the figures quoted here, for whereas

the ground.....

the ground in the grazed plots is everywhere visible among the plants the grass tufts growing in the protected area are so thick and vigorous that very little bare ground is seen among them, and these tufts have reached an average height of 2'6" to 3'3" compared with a maximum of 2' outside. It does appear, however, that complete protection for more than a certain period would have an adverse effect on their growth, for the biggest tufts have now passed their prime, are beginning to die in the centre and bare ground is again to be seen. The rest period suggested for an improvement of species in untreated soil is three years, after which it is possible that controlled grazing might take place, but further experiments will be needed to establish this.

The upturned soil of the ditches and trenches represent a slightly different problem, for as they were invaded by pioneer species, mainly in the forms of thistles, they have not yet reached the climax found in the undisturbed soils above and below them. It will be seen however, that the tufts are now well on the way to establishment after the fifth winter, so possibly controlled grazing might be introduced after such a period. If grazing was introduced before grasses were established, strips of economically inferior vegetation would persist, and unless grazing was strictly controlled the strips might remain in this sub-climax stage indefinitely.

As regards the actual distribution of species, no specific indication was made of individual plants in the 1939 mapping (the only species mentioned were Echium sericeum, Teucrium polium, Lithospernum hispidulum and some squills (presumably Asphodel ramosus), so unfortunately no direct comparisons can be made, but direct comparison between the plots now after 5 years protection of the one yield some very interesting results. The following table shows the distribution of shrubs in the two areas, the figure representing the area covered in sq.ft., except in the case of thistles where the figure indicate actual numbers. (Helianthemum obtusifolium is a minute shrublet, it was apparently not included in the 1939 count so for reasons of comparisons it was not included in the previous table relating to vegetation).

(See table "A").

It will be clear from the above that the Echium and Teucrium are the most tolerant species, while Phagnalon and the Satureias make a greater demand on the stability of their habitats. These latter are most frequently found within the forest, and their presence here tends to confirm the suggestion that a forest society may be the ecological climax. That Thymus capitatus, that most common plant in the overgrazed hummocks bordering the plains, should only be found in grazed area, is both interesting and significant. The preponderence of Helianthemum obtusifolium is not obvious except on close examination, as the plant is so insignificant, but its presence in such abundance in the grazed area and entire absence in the protected plot gives it possibilities as a future indicator. The plant count was taken after the spring flora was over but the following annuals were found and indentified:- Unfenced plot: Triticum ovatum, Atractylis cancellata, Crupina crupinastrum, Carthamus glaucus were all abundant. In the fenced plot a few of the above species were found mainly in the ditches and near the concrete base, but the following plants were found amongs the grass tufts: Avena sp. two Plantago sps., Mercurialis annua, Scabiosa sp., Sideritis curvidens, Allium sp. and Convolvalus sp. The change to a more mesophytic community is noted not only in the decrease of the hardier composites, but also in the appearance of such plants as Avena and Mercurialis.

RUN-OFF

As mentioned previously record of rainfall and run-off were kept at both experiments for a period of five years, and though blockage of pipes from the experiment to the water retaining barrels have occasionally occurred and thus introduced a certain error in these figures, they can on the whole be taken to be reliable. (Only in one instance when a blatant error was obvious, have corrections been made in the interest of true representation). It must also be noted that any blockages that took place were always found in the pipes of the grazed experiment thus rendering the final figures more conservative than they might otherwise be.

As no rainfalls during the summer months, it was natural to treat each rainy season as a unit, and for reasons of comparison figures from both experiments are included here. The following tables shows the annual rainfall and run off both in actual volume and also the latter calculated as % of total rainfall.

(See tables"B" and "C")

By studying the monthly reports of rainfall it was obvious that very little difference was apparent in run-off after light rains, so in order to ascertain more facts about the efficiency of the methods employed other tables giving the run-off figures for heavy rains were prepared. By a heavy rain is in this case meant any rain of more than 1" rainfall or anything over ½" falling within the space of one hour. It is obvious that it is rains of volume and velocity such as these that are most likely to do damage if uncontrolled and also provide the greater volume of water for catchment. The following tables give a summary of the heavy rains at both stations both in actual volume and in %.

(See tables "D" and "E").

Two important facts become obvious at once when stydying these figures, the first being that all run-off figures are lower in the last year than the first, and the second fact is the way in which the greater part of this drop has taken place between the first and second rainy season. This is particularly obvious when studying the table recording heavy rains at Halefka. As the drop is present in all cases it must be assumed that the very act of enclosing the area with a cement wall has had a mechanical effect on the water system. By cutting off the stream of water from above that normally would be carried down during a heavy rain, the velocity of the water within the plot is reduced, the slower moving water seeps into hitherto undiscovered crannies in the subsurface rocks. a new water system is taken into use and developed with subsequent rains, particularly when no disturbance of the surface soil obstructs the way to these new found water ways.

Bearing this in mind, the judgement of the figures must be largely comparative, but on this basis they yield a large number of interesting facts. It will be noticed how the effect of a large deep trench is immediate in reducing the run-off, while the shallow ditches are only effective when coupled with protection from grazing. As shallow ditches are easily interfered with by trampling animals, they may even in certain cases act as water conductors so that the run off from them is greater than from non treated slopes. This is borne out by the records from No.4 plot, Halefka, for the years 1941-1943. It would appear that trenching in one form or the other, coupled with protection from grazing, is the most efficient means of reducing run-off but in order to ascertain the full value of this treatment, much longer experiments should be laid out. It is obvious, however, from the tables attached, that trenching alone can cut run-off down by nearly one half within the first year, a fact that might well be remembered when plans for land use are laid in the future

As regards vegetation, its effect on reducing run-off is not so spectacular but nevertheless it is a very steady effect. It will be noticed that all the lowest run-off figures are found in protected plots and also that protection alone in the untreated plot No.3.Halefka has achieved as low a run-off as treanching has done in No.5, and at the same time No.3 now carries a better and more valuable natural vegetation. The following figures from Halefka where B Battery was left grazed for the whole 5 years period will illustrate the value of the steadying influence of vegetation.

	A Battery Run off from heavy rain	B.Battery Run off from heavry rains	
1939-40	7.2%	13.1%	The percentage is
1940-41	3.8%	5.4%	calculated on the
1941-42	2.6%	5.2%	volume of water
1942-43	1.5%	2.1%	fallen as heavry
1943-44	1.4%	2.5%	rain.

The figures for 1943-44 is particularly significant,as the rain which fell in heavy rains during that season was nearly double in volume of that of any previous season and more than three times as much as the 1939-40 fall of heavy rains. It will be seen that the figure for the grazed battery has gone up while for the ungrazed is still on the decrease though the decrease is slight. The difference throughout of the Halefka and Sykhari figures, all the latter being lower, are most likely accounted for by the more favourable degree of slope at Sykhari; This would cause a lower velocity of run-off water and thus a more efficient seepage system may be developed. Apart from the disadvantage of a slope of 50% the Halefka plots were furthermore subject to heavy trampling on account of the close proximity of mandras. This trampling may partly be responsible for the large run-off during the first winter, and these figures may then be taken to give a fair indication of the degree of run-off from all overgrazed and trampled southern slopes of the northern range of the same degree of slope. A run off of 15% during heavry rains is considerable and constitutes a danger to the community

SILT.

The figures quoted for silt collected from these experiments are not impressive, in fact it would seem that in this type of country, with its absorbent rocks and many boulders formin, pockets for soil deposit, the dreaded soil erosion does not appear to be quite the menace it is elsewhere. This is probably, so, but nevertheless a small but significant point can be abstracted from these figures and must not be overlooked. The first soil loss in all cases must be presumed to be accidental i.e. caused by the loosening of soil that took place when the experiment was set up, but the significant fact is found in 1943-44 when a winter of heavy rains set in, and yet the relatively well covered A Battery lost more soil than did the exposed and sparsely covered B Battery. The explanation is undoubtedly to be found in the fact mentioned elsewhere of the baring of ground beneath tufts of grass; the large tufts cast too deep a shade for anything to grow between them, and so conditions are once again set up favourably for the removal of soil. From the figures it would appear that this is not likely to happen before the 5th winter. Otherwise the figures are not impressive though they seem to point to the fact that shallow ditches without control of grazing are inadvisable, as they lead to a steadier annual loss of soil.

Conclusions.

The following conclusions may be deducted from the above facts

Soil ....

Soil Loss.

The loss of soil from slopes of this type is not considerable and it may be safely assumed that if water loss can be kept in control soil loss will look after itself.

Water Loss.

Though water loss in this type of area is not relatively great, a high run-off is found on much trampled slopes which must have an adverse effect on the easily erodible lands below. These water losses can be controlled by either mechanical or natural means and the best results will probably be obtained from a combination of both.

Mechanical Aids.

The effect of mechanical interference with the soil is both immediate and immense, but lay-out as well as upkeep must be properly done or the beneficial value is either lost or even converted to an adverse influence. The immediate good effect of trenching is slightly offset by the appearance of unwelcome vegetation on the upturned soil, but if a rest period of 4-5 years is allowed nature overcomes that by a natural succession to more palatable species. Shallow ditches are useless in a grazed area as they are unable to withstand trampling, but proved more efficient than any other method when completely protected from grazing.

Vegetation.

Slow but sure, is Nature's way of recovery, and if she had her way, man-made interference would not be necessary, for protection from grazing has been proved to be an efficient and certain way of improving the soil's water-holding capacity. As has been stated before, however, it cannot be said for these experiments that the improvement was brought about only by the vegetation as the wall above the plots acted as a water retaining agent. The effect of plants on the water-holding capacity is annually greater steadyin, and lasting as well as having the advantage of cheapness though it appears that when carried beyond a certain point soil loss again seems to take place. What is wanted apparently is not complete protection but a management of the vegetation which could probably be achieved with controlled grazing. Protection alone can in a couple of years achieve the same results in water retention as can expensive trenches when the latter are grazed, while at the same time an improvement in species takes place within the protected area.

The experiments have proved beyond doubt that by protection alone the quantity and quality of vegetation is affected, the tendency being for the xerophytic species to disappear and for the mesophytic species to appear. What the species would be in other parts of Cyprus on other sites and soils would have to be proved by experiments, but it definitely confirms the hypothesis that much of the aridity and semi-aridity in Cyprus is man-made and could be combated if sufficiently firm measures were adapted.

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TABLE SHOWING DISTRIBUTION OF SPECIES, HAIFFKA 1944. Figures represent area in sq. ft.

A Battery	Echium sericeum	Phagnalon rupestre	Lithospermum hispidulum	Satureia Juliana and graecca	Teucrium polium	Asphodel ramosus	Urgine maritima	Thymus capitatus	Helianthemum obtusifolium	Thist Numbe
No. 1	2.1	1.8		0.6	1.5					66
No. 2	6.4			1.7	2.8					56
No. 3	2.4	2.4		0.9	1.5	0.03	4.8			54
Total	10.9	4.2		3.2	5.8	0.03	4.8			176
B Battery										
No. 4	2.9		0.01		0.6			0.6	3.7	42
No. 5	0.8	0.8	0.6		2.2				5.6	89
No. 6	1.5				2.	0.2	0.1	0.4	3.1	31
	3.2	0.8	0.61		4.8	0.2	0.1	1.0	12.4	162
				% of area covered with shrubs						
A Battery	38%	14%		11%	20%	present	17%			
B Battery	20%	3%	2%		19%	1%	present	5%	50%	

Distribution of species expressed in % of area covered with shrubs.

TABLE "B"

RECORDS OF RAINFALL AND RUN-OFF
SYKHART ANNUAL SUMMARIES 1939-44.

YEAR	BATTERY A FENCED.						BATTERY B unfenced but no grazing since 1941.								
	Rain in inches.	Duration in hours.	Plot No.1 Trenched. Run-Off gl.	Silt pt.	Silt lb. oz.	Plot No.2 Control. Run-Off gl.	Silt pt.	Silt lb. oz.	Plot No.3 Trenched Run-off gl.	Silt pt.	Silt lb. oz.	Plot No. 4 Control Run-off gl.	Silt pt.	Silt lb. oz.
1939-40	19.68	75.50	9	2	5/8	23	6	1/8 15	10	3½	1½	20	2⅛	3½
1940-41	15.10	86.45	7	1⅞		12	7	3	10	6⅝	3	10	2⅝	1½
1941-42	26.89	152.30	9	7¼		17	5⅜		19	3	5½	21	5⅝	
1942-43	29.58	169.10	10	6½		20	¼		11	1		17	5	
1943-44	25.56	91.30	5	5⅞		9	4⅜		5	6⅛		8	⅛	
Total for whole period.	116.81	575.45	43	0⅛		83	7⅛	1 2	57	4	10	77	7⅝	5

Run-off expressed in % of total rainfall.

		Plot No.1 %	Plot No.2 %	Plot No.3 %	Plot No. 4 %
1939-40	1476 gl.= 100%	0.6	1.6	0.7	1.4
1940-41	1125 gl.= 100%	0.6	1.1	0.9	0.9
1941-42	2016 gl.= 100%	0.5	0.9	0.9	1.1
1942-43	2214 gl.= 100%	0.5	0.9	0.5	0.8
1943-44	1917 gl.= 100%	0.3	0.5	0.3	0.4

TABLE "C"

Halefka annual records of rainfall and run-off. 1939-44

YEAR.	Rain in inches.	Duration in hours.	Plot 1 fenced 3 contour ditches. gl.pt.lb.oz.	Plot No.2 fenced 1 trench gl.pt.lb.oz.	No.3 fenced control gl.pt.lb.oz.	No.4 grazed 3 contour ditches. gl.pt.lb.oz.	No.5 grazed 1 trench gl.pt.lb.oz.	No.6 grazed control gl.pt.lb.oz.
1939-40	16.71	61.05	24 2 1 8	28 3 5 5	56 6¾ 7 3	58 4 5 12	40 2½ 7 4	46 1⅛ (x) 4 6
1940-41	10.84	52.50	12 7½ 1 ½	18 ½ 1 2¾	29 7½ 1 8½	34 1 2	21 4½ 1 8½	39 5½ 11⅛
1941-42	18.95	101.0	18 4 2	30 5¾ 2	37 6 6	49 14½ (x)	33 1 14	46 7½ 3
1942-43	21.34	152.25	19 5½ 2½	32 4 3	31 4¾ 4	38 1½ 9½	24 2 4	33 4¼ 5½
1943-44	19.79	97.35	9 4⅜ 1 13	25 4⅛ 10	23 4¾ 1 14	27 1⅝ 10	24 3	36 2⅝ 3
Total for Whole period.	87.63	474.55	84 7⅜ 4 10	135 1½ 7 6¾	179 5½ 11 3½	207 5⅛ 9 0	143 1¾ 10 1½	202 4⅞ 5 12¾

Run-off expressed in % of total rainfall.

	%	%	%	%	%	% (xxx)
1939-40 1260 gl.=100%	1.9	2.3	4.3	4.6	3	5.3
1940-41 810 gl.=100%	1.6	2.2	3.7	4.2	2.7	4.9
1941-42 1422 gl.=100%	1.3	2.1	2.6	3.5	2.3	3.3
1942-43 1602 gl.=100%	1.2	2.0	1.9	2.4	1.5	2.1
1943-44 1485 gl.=100%	0.6	1.7	1.6	1.8	1.6	2.4

REMARKS.

(x) No. 6 pipe blocked during a heavy rain suggested that 20 gallons be added to total for year.

(xx) Pipe of 5 blocked during 2 heavy rain.

(xxx) This figure is based on 66 gls. as suggested above.

TABLE "D"

Sykhari Summary of heavy rains and their run-Off 1939-44

YEAR.	Rain in inches	Duration in hours.	A BATTERY FENCED No.1 Gl.	Pts.	Lbs	Ozs.	No.2. Gls.	Pts.	lbs.	Ozs.	B BATTERY GRAZED till 1941 No.3 Gls.	Pts.	Lbs.	Ozs.	No.4 Gls.	Pts.	Lbs.	Ozs.	Remarks
1939-40	7.07	15.50	6	2⅛			16	2¼			13	6	5¼	1½	16	0¾			3
1940-41	6.19	17	3	7⅜			8	0⅜			3	6	2		6	6¼			
1941-42	19.29	89	8	3⅛			14	1				16	2¼		18	6½			
1942-43	18.40	67.30	8	7⅝			15	3⅝				9	6¼		16	0			
1943-44	17.65	61.30	6	1⅝			8	6½				5	4⅛		7	6			

Percentage calculated on the amount of heavy rain not of total rainfall.

	Gls.	%	%	%	%	
1939-40	531	1.2	3.1	1.2	3.0	
1940-41	459	0.8	1.7	1.4	1.4	
1941-42	1449	0.6	1.	1.1	1.3	
1942-43	1377	0.6	1.1	0.7	1.2)	protected from
1943-44	1323	0.5	0.7	0.4	0.6)	grazing since 1941.

TABLE "E"

Halefka Summary of heavy rains and their run-off 1939-44.

YEAR.	Rain in inches	Duration in hours.	A BATTERY FENCED No.1 3 contour ditch run-off silt gl. pt. lb. ozs.	A BATTERY FENCED No.2 Trenched Run-off silt gl. pt. lb. oz.	A BATTERY FENCED No.3 control Run-off silt gl. pt. lb. oz.	B BATTERY GRAZED No. 4 3 ditches. Run-off silt gl. pt. lb. oz.	B BATTERY GRAZED No. 5 trenched run-off silt gl. pt. lb. oz.	B BATTERY GRAZED No.6 Control Run-off silt gl. pt. lb.
1939-40	3.80	7	12 6¾ 1 8	13 0¾ 5 5	36 4½ 7 3	40 3½ 5 12	27 6 7 4	23 4½ +
1940-41	5.07	10.30	6 6¾	10 4½	21 0½	21 3½	12 7½	27 2
1941-42	6.76	24.30	8 5¾	13 7½	17 2½	34 3	17 2	25 6½
1942-43	5.48	37.45	4 2½	7 3¼	7 0¾	12 4	5 5¾	7 6¾
1943-44	13.23	55.30	8 5¾	22 2¼	19 6	23 2½	21 3	30 2¾

Percentage calculated on the amount of heavy rains, not of total rainfall.

	gl.	%	%	%	%	% x
1939-40	288=100%	4.4	4.5	12.7	14.0	9.3	15.1 =
1940-41	378=100%	1.8	2.8	5.8	5.7	3.4	7.2
1941-42	504=100%	1.5	2.8	3.4	6.8	3.6 Ø	5.1
1942-43	414=100%	1.0	1.8	1.7	3.0	1.4	1.9
1943-44	990=100%	0.9	2.2	2.0	2.3	2.1	3.0

REMARKS.

\+ Pipe of 6 blocked, suggest addition of 20 gls. to total.

: 5 pipe blocked, total should be higher.

x Percentage based on volume of heavy rains during year.

= Based on a runoff of 43 gls. see +.

Ø Figure not corrected for probable error.