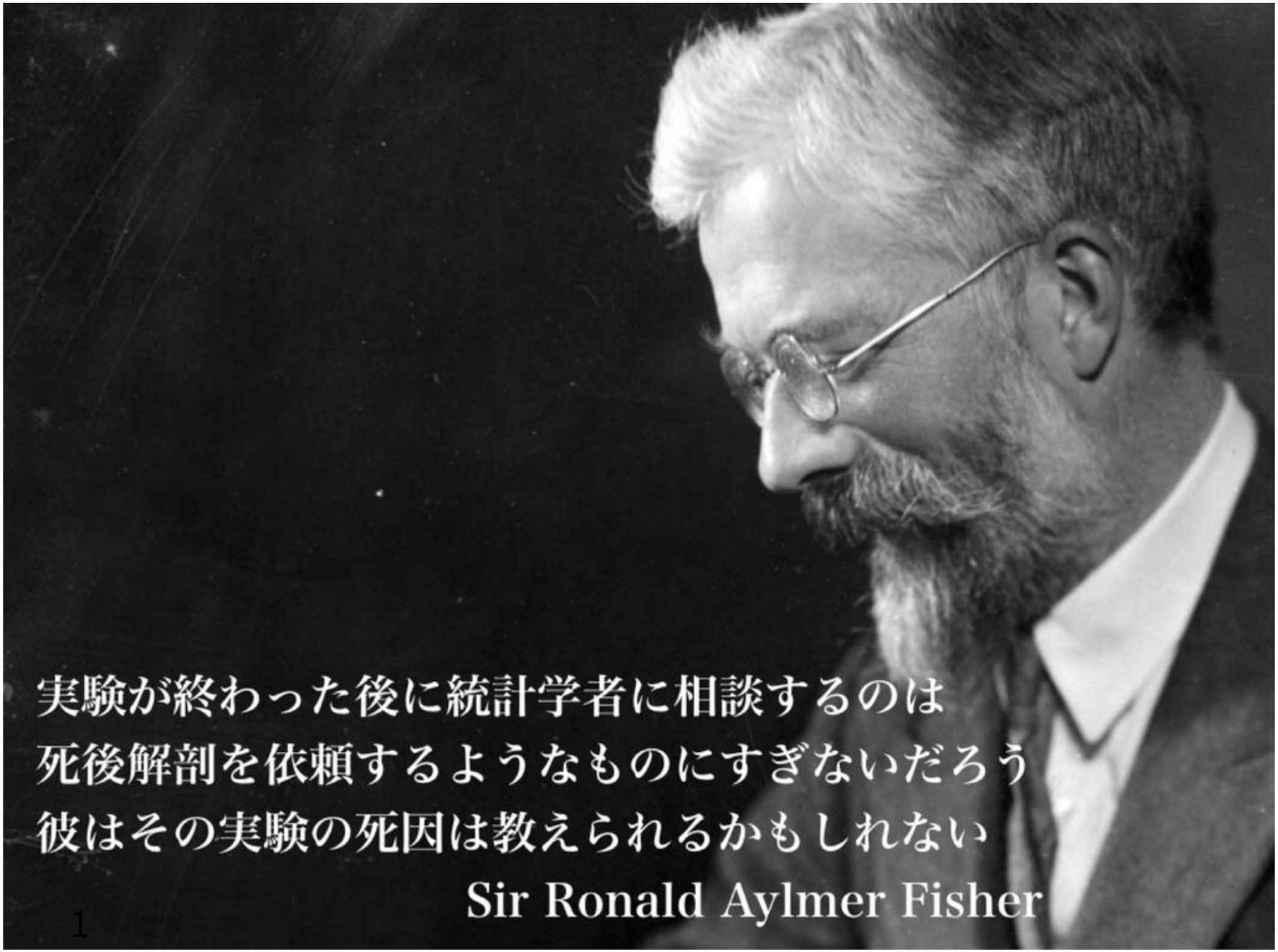
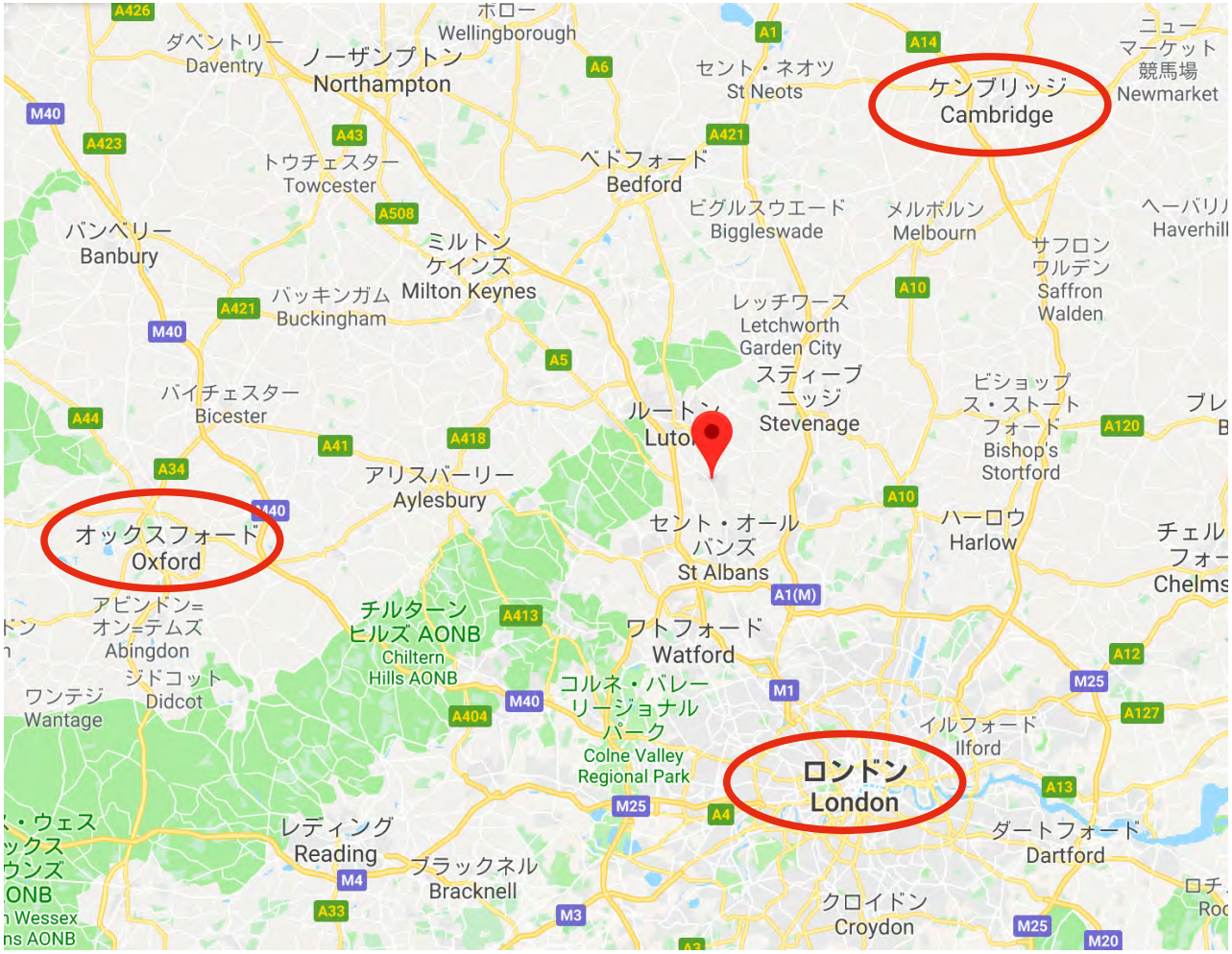

実験が終わった後に統計学者に相談するのは
死後解剖を依頼するようなものにすぎないだろう
彼はその実験の死因は教えられるかもしれない
Sir Ronald Aylmer Fisher

ふるさと

ロザムステッド農業試験場の風景

ロザムステッド農業試験場の風景



ロザムステッド農業試験場の風景

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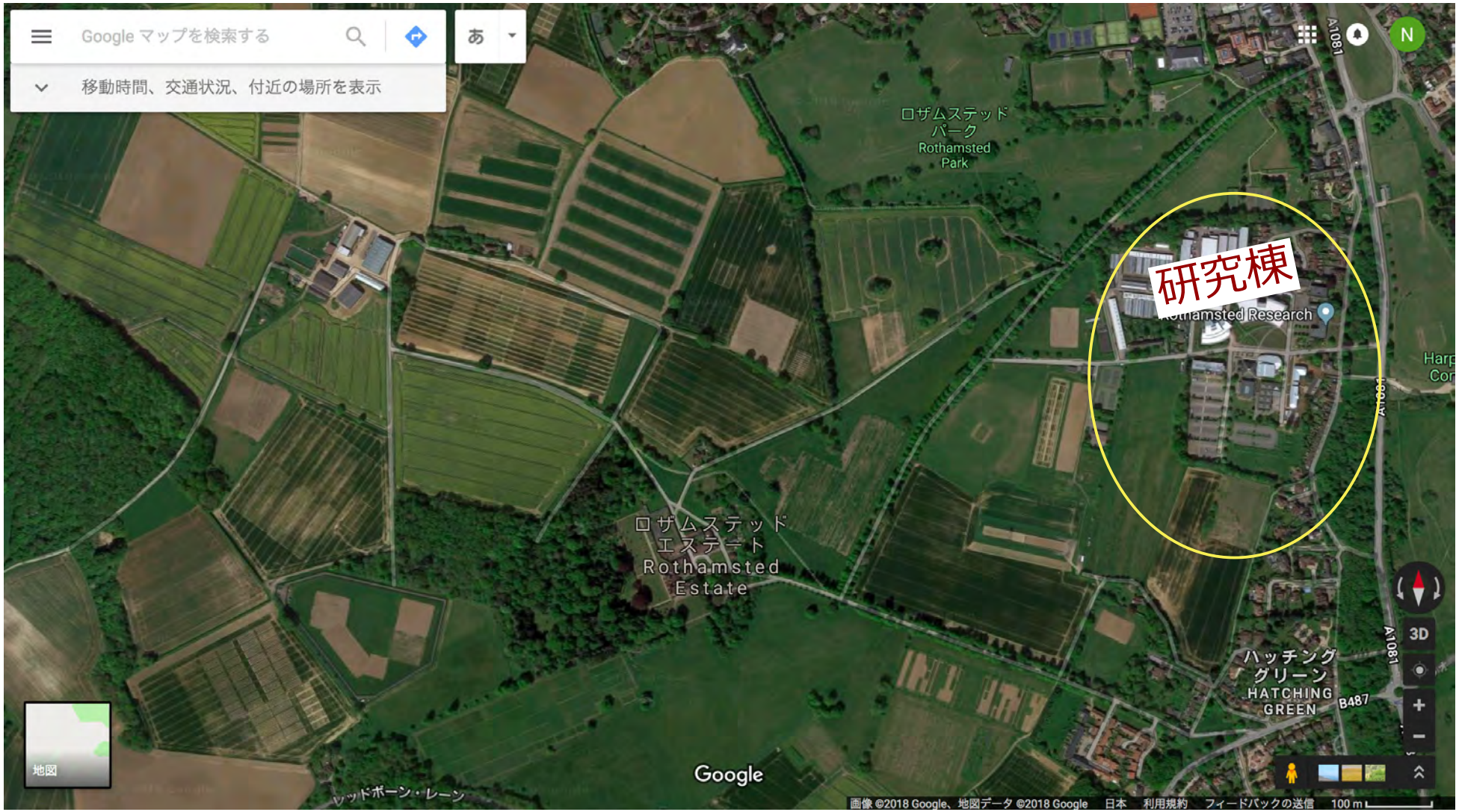

ロザムステッド農業試験場の風景

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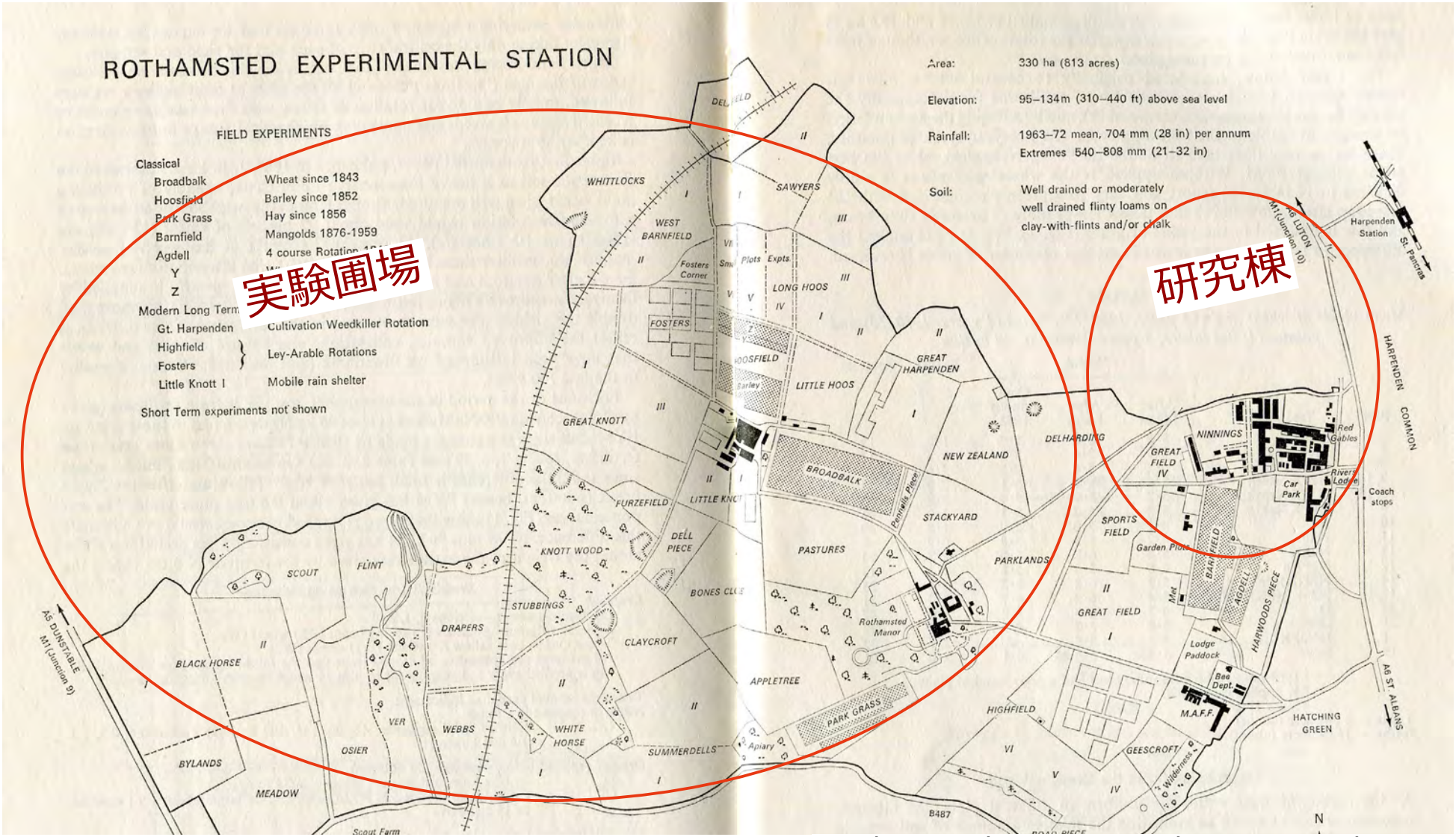


Rothamsted Experimental Station Guide 1974

ロザムステッド農業試験場の風景

1843 年に創立されたロザムステッド農業試験場では，ドイツの農芸化学者ユストゥス・フォン・リービッヒの強い影響と対峙しながら，長年にわたって土壌肥料試験を行なった（1843 年～現在）．これらの長期試験のデータ解析にはもっぱら最小二乗法が用いられてきたが，サンプルサイズが小さくしかも体系的な誤差が生じやすい農業試験にふさわしい手法では必ずしもなかった.

出典：G. Parolini 2015a, p. 304

ロザムステッド農業試験場の風景

試験研究課題（1900–1950）

1) 肥料試験（fertility trials）
2) 均一性試験（uniformity trials）
3) 品種試験（variety trials）
4) 草地試験（grassland trials）
5) 果樹試験（horticultural trials）

出典：G. Parolini 2015b, pp. 264–265, Table 1

フィッシャー来りて笛を吹く

ロナルド・A・フィッシャーの仕事場

Sir Ronald A. Fisher
(1890–1962)

ロナルド・A・フィッシャーの仕事場

Sir Ronald A. Fisher (1890–1962)

1912: ケンブリッジ大学卒業

1913–1919: 職業転々

1919–1933: ロザムステッド農業試験場

1933–1939: ユニヴァーシティ・カレッジ・ロンドン

1940–1956: ケンブリッジ大学

ロナルド・A・フィッシャーの仕事場

Sir Ronald A. Fisher (1890–1962)

1912: ケンブリッジ大学卒業

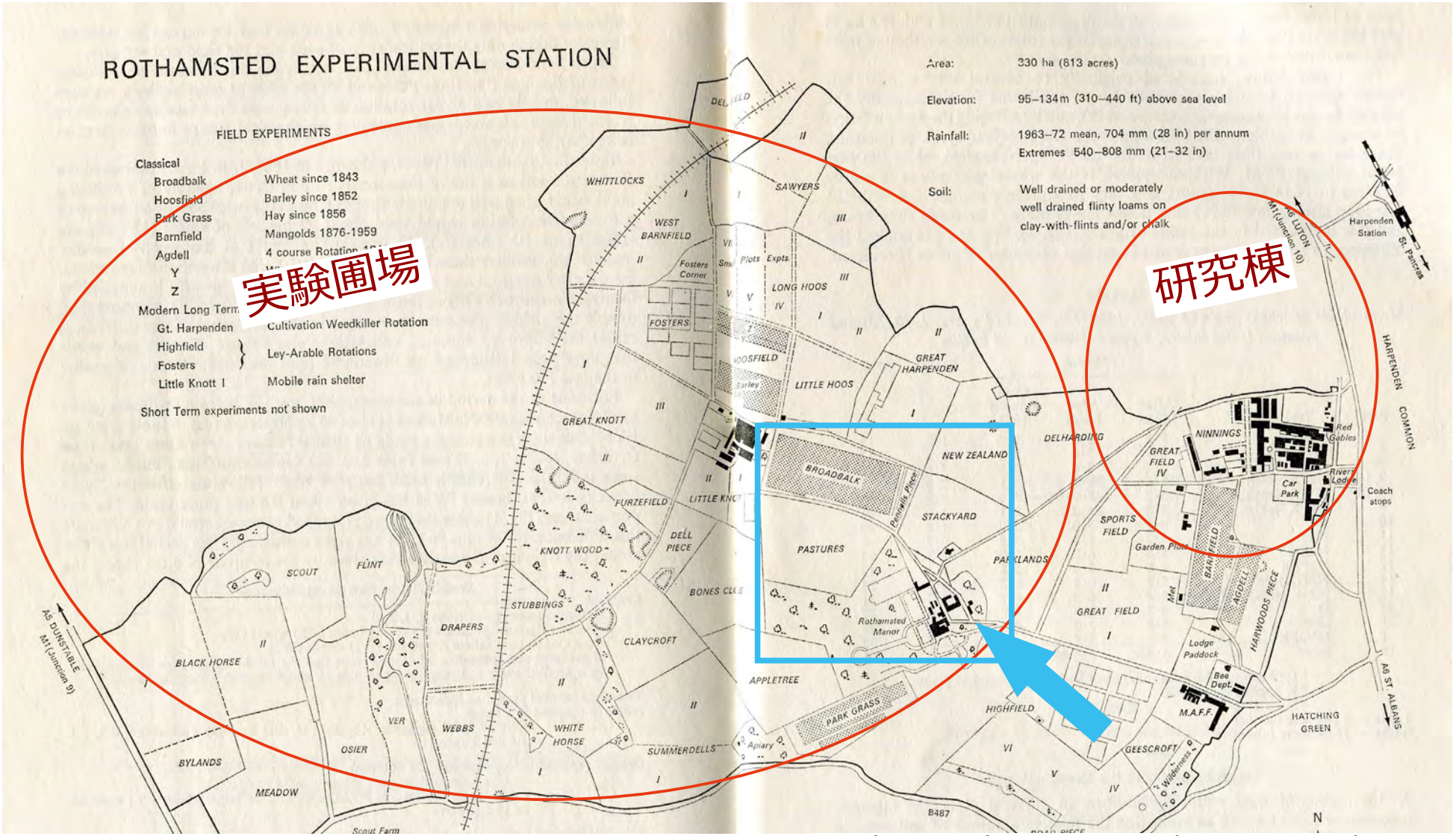
1913–1919: 職業転々

1919–1933: ロザムステッド農業試験場

1933–1939: ユニヴァーシティ・カレッジ・ロンドン

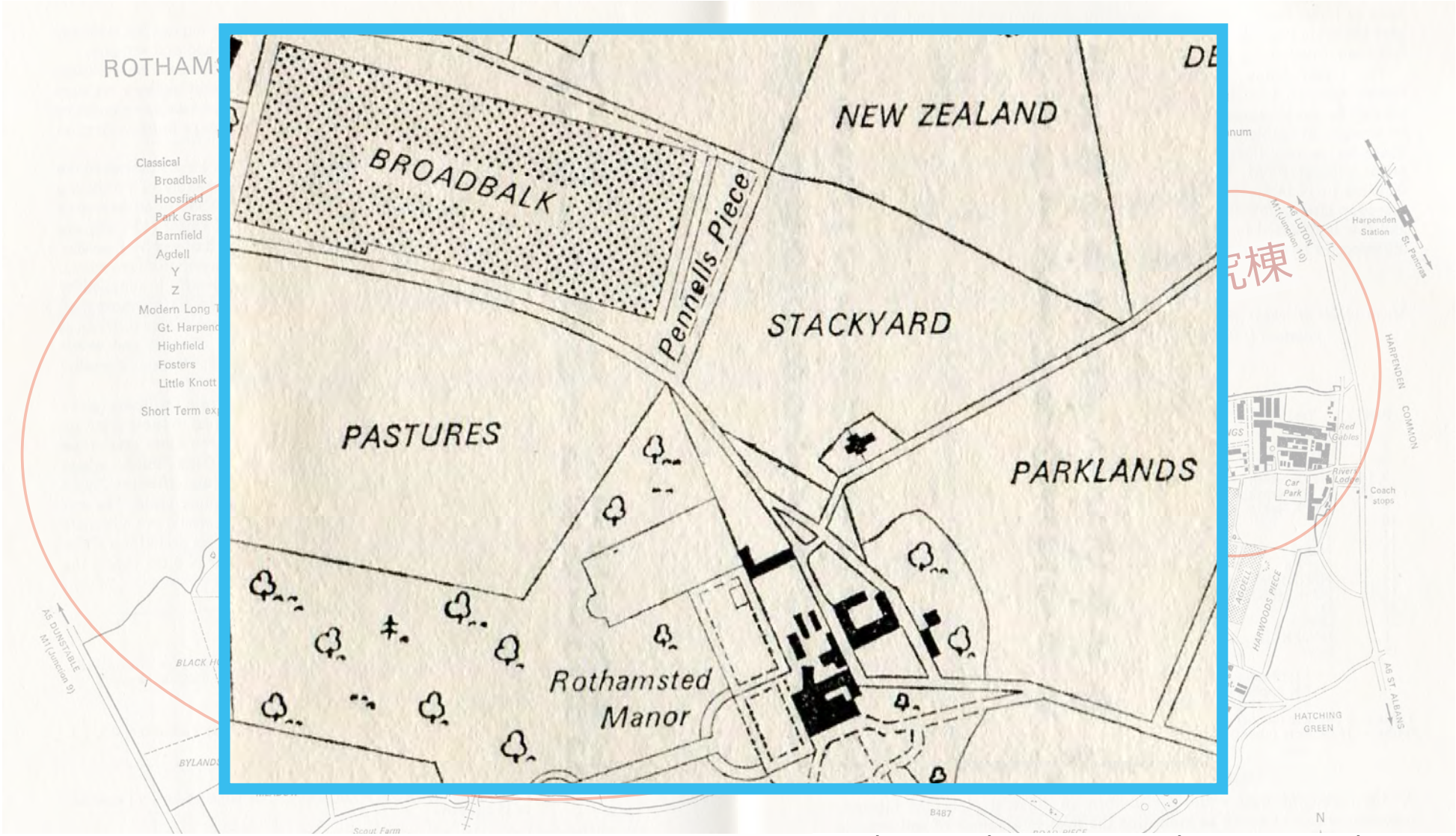
1940–1956: ケンブリッジ大学

ロザムステッド農業試験場の風景



Rothamsted Experimental Station Guide 1974

ロザムステッド農業試験場の風景



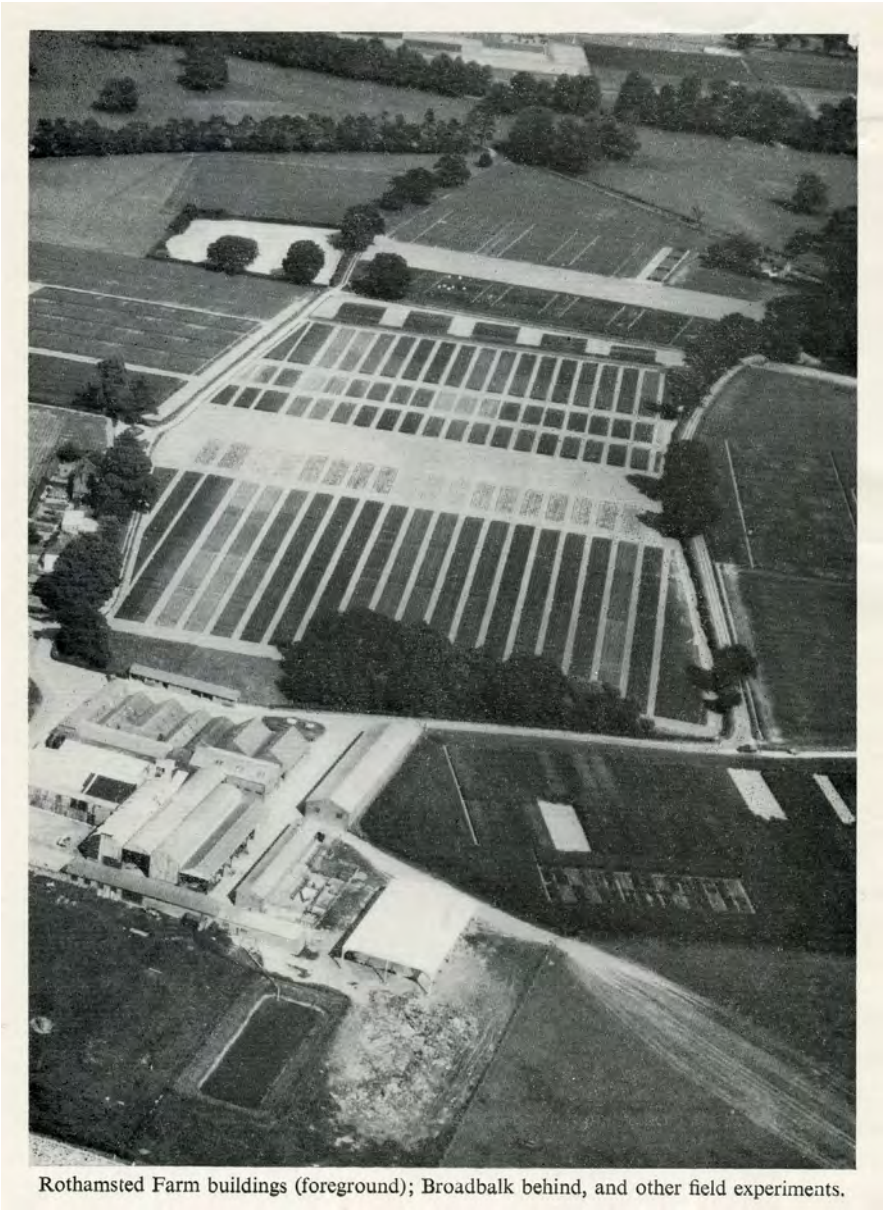
Rothamsted Experimental Station Guide 1974

ロザムステッド農業試験場の風景

Rothamsted Manor House.

Rothamsted Experimental Station Guide 1974

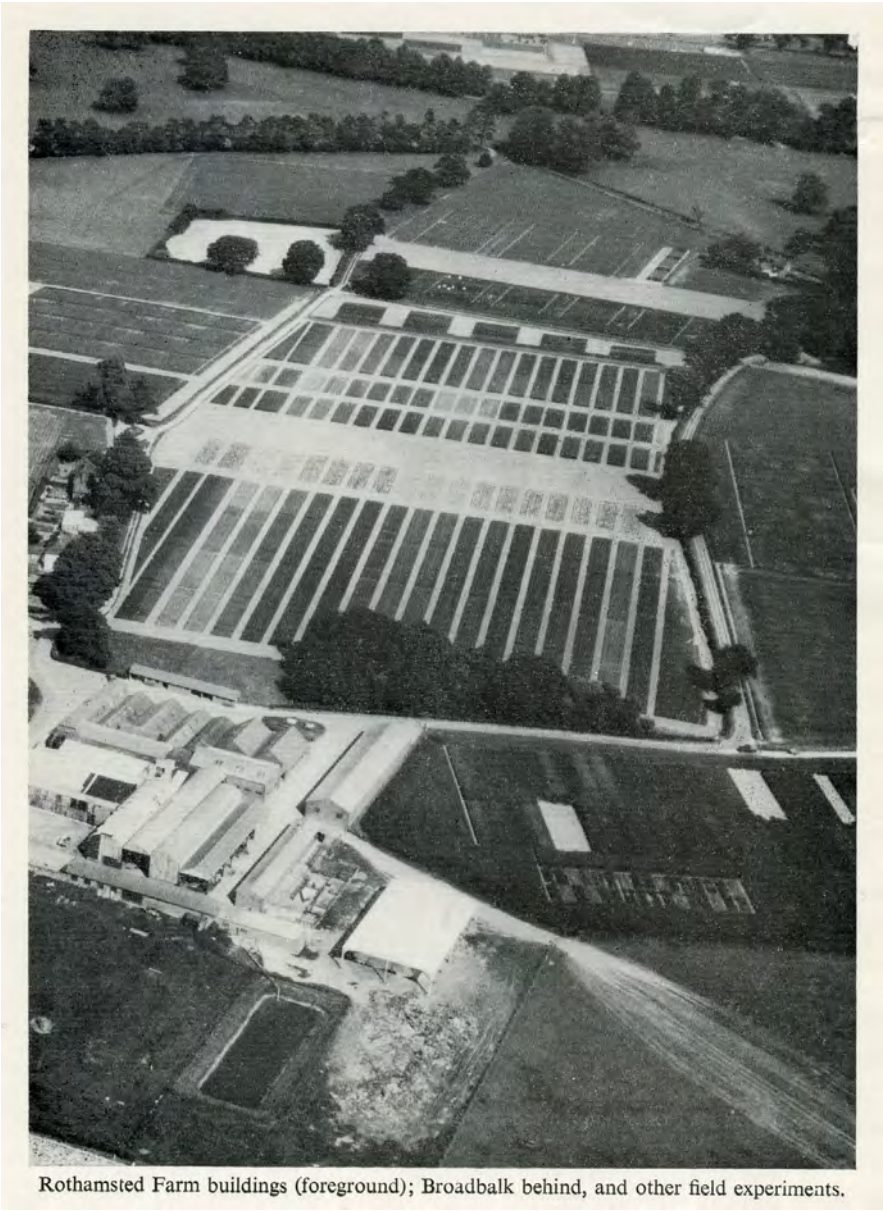
ロザムステッド農業試験場の風景



Rothamsted Farm buildings (foreground); Broadbalk behind, and other field experiments.

Rothamsted Experimental Station Guide 1974

ロザムステッド農業試験場の風景



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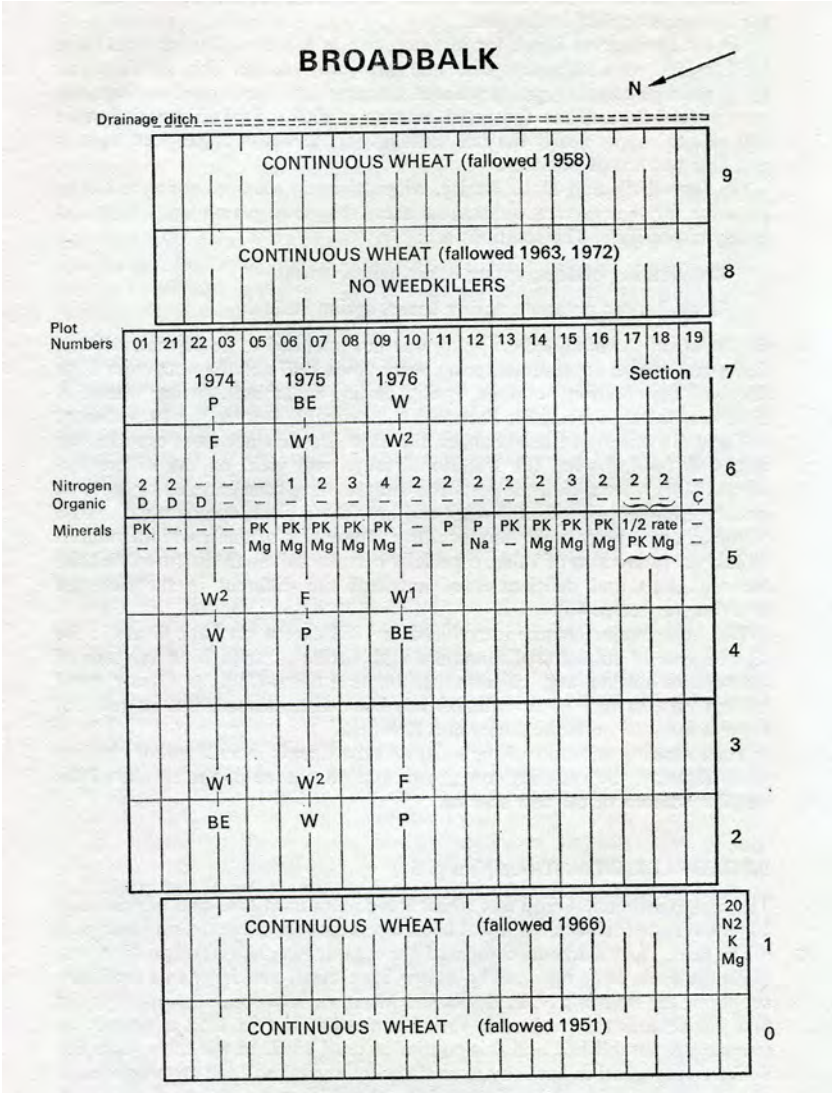
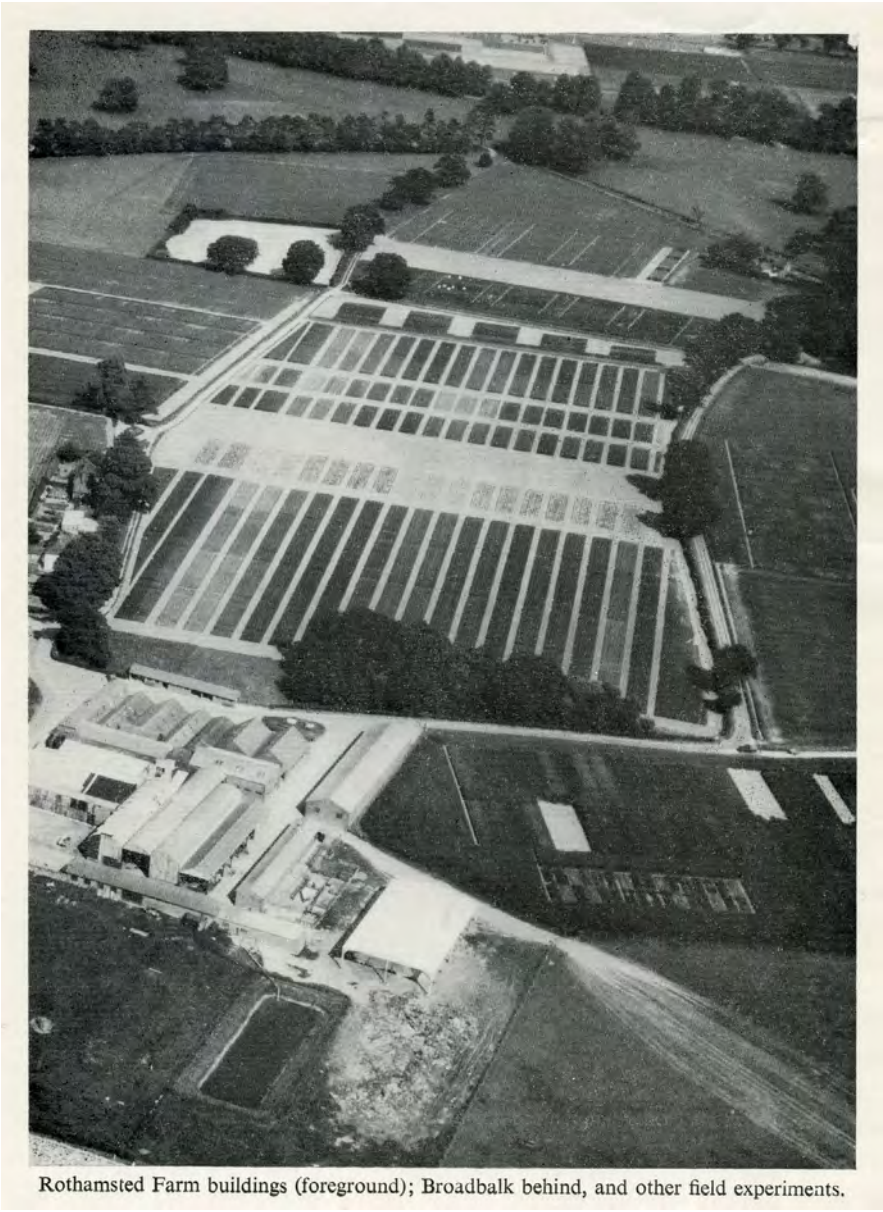


Rothamsted Experimental Station Guide 1974

ロナルド・A・フィッシャーの仕事場



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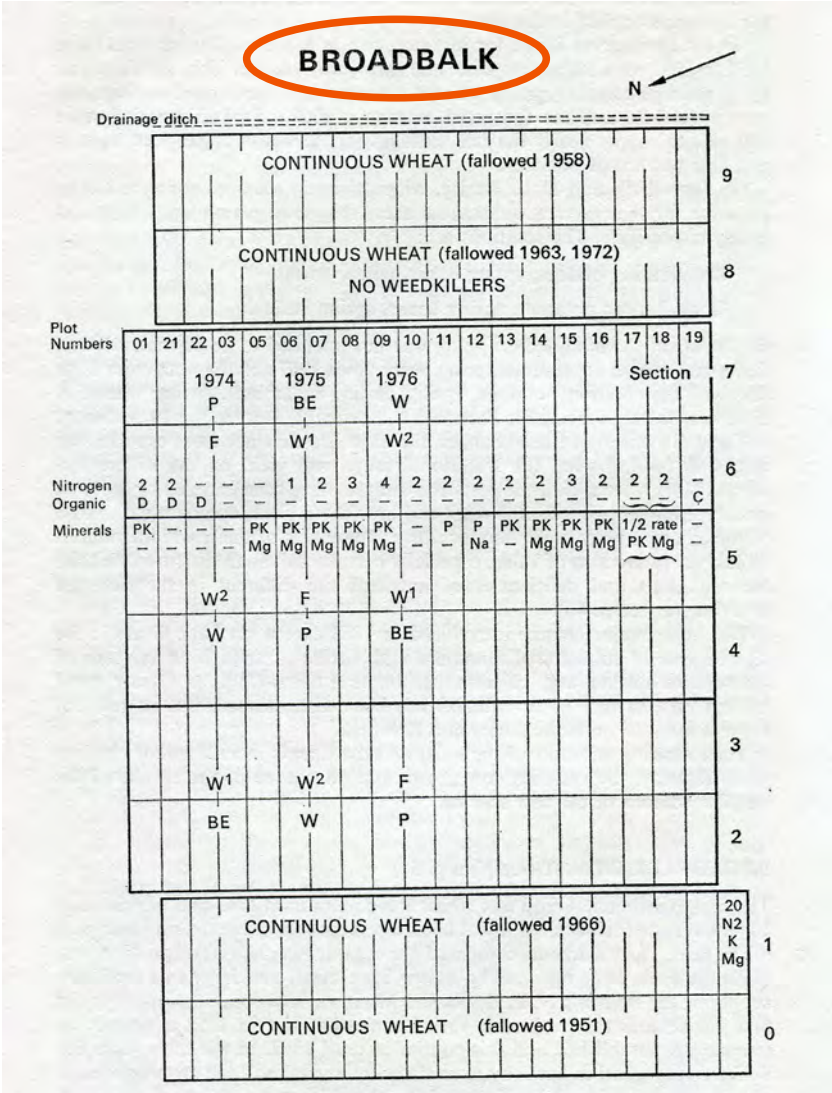

Rothamsted Experimental Station Guide 1974

ロナルド・A・フィッシャーの仕事場

Transactions of the Royal Society of Edinburgh, **52**: 399-433 (1918)

XV.—**The Correlation between Relatives on the Supposition of Mendelian Inheritance.** By **R. A. Fisher**, B.A. *Communicated by* Professor J. ARTHUR THOMSON. (With Four Figures in Text.)

(MS. received June 15, 1918. Read July 8, 1918. Issued separately October 1, 1918.)

ロナルド・A・フィッシャーの仕事場

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p. 399

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ロナルド・A・フィッシャーの仕事場

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ロナルド・A・フィッシャーの仕事場

Journal of Agricultural Science, **11**: 107-135 (1921)

STUDIES IN CROP VARIATION.

I. AN EXAMINATION OF THE YIELD OF DRESSED GRAIN FROM BROADBALK.

By R. A. FISHER, M.A.

ロナルド・A・フィッシャーの仕事場

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STUDIES IN CROP VARIATION.

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By R. A. FISHER, M.A.

p. 110

rious.

When the variation of any quantity (variate) is produced by the action of two or more independent causes, it is known that the variance produced by all the causes simultaneously in operation is the sum of the values of the variance produced by each cause separately. The variance is defined as the mean square deviation of variate from its mean, and is therefore the square of its standard deviation. The above property of

ロナルド・A・フィッシャーの仕事場

p. 111

...ps of causes. In Table II is shown the analysis of the total variance for each plot, divided according as it may be ascribed (i) to annual causes, (ii) to slow changes other than deterioration, (iii) to deterioration; the sixth column shows the probability of larger values for the variance due to slow changes occurring fortuitously.

Table II.

Plot	Annual causes	Slow changes	Deterioration	Total	P. for slow changes
2*b*	33·2	17·6	·4	51·1	·000,002
3 and 4	9·3	2·5	3·5	15·4	·004,3
5	11·7	2·7	3·0	17·5	·007,5
6	30·6	8·0	7·5	46·1	·003,1
7	50·3	13·3	7·8	71·4	·0 0 2 9
8	53·2	15·9	3·2	72·3	·0 0 1 2
10	41·8	3·7	9·2	54·7	·2 6
11	50·2	3·4	18·8	72·4	·3 8 5
12	58·4	7·8	12·2	78·4	·086

ロナルド・A・フィッシャーの仕事場

Journal of Agricultural Science, **13**: 311-320 (1923)

STUDIES IN CROP VARIATION.

II. THE MANURIAL RESPONSE OF DIFFERENT POTATO VARIETIES.

By R. A. FISHER, M.A. and W. A. MACKENZIE, B.Sc.

Rothamsted Experimental Station, Harpenden.

(With Two Charts.)

1. Introductory.

It is not infrequently assumed that varieties of cultivated plants differ not only in their suitability to different climatic and soil conditions, but in their response to different manures. Since the experimental error of field experiments is often underestimated, this supposition affords a means of explaining discrepancies between the results of manurial ex-

ロナルド・A・フィッシャーの仕事場

p. 312

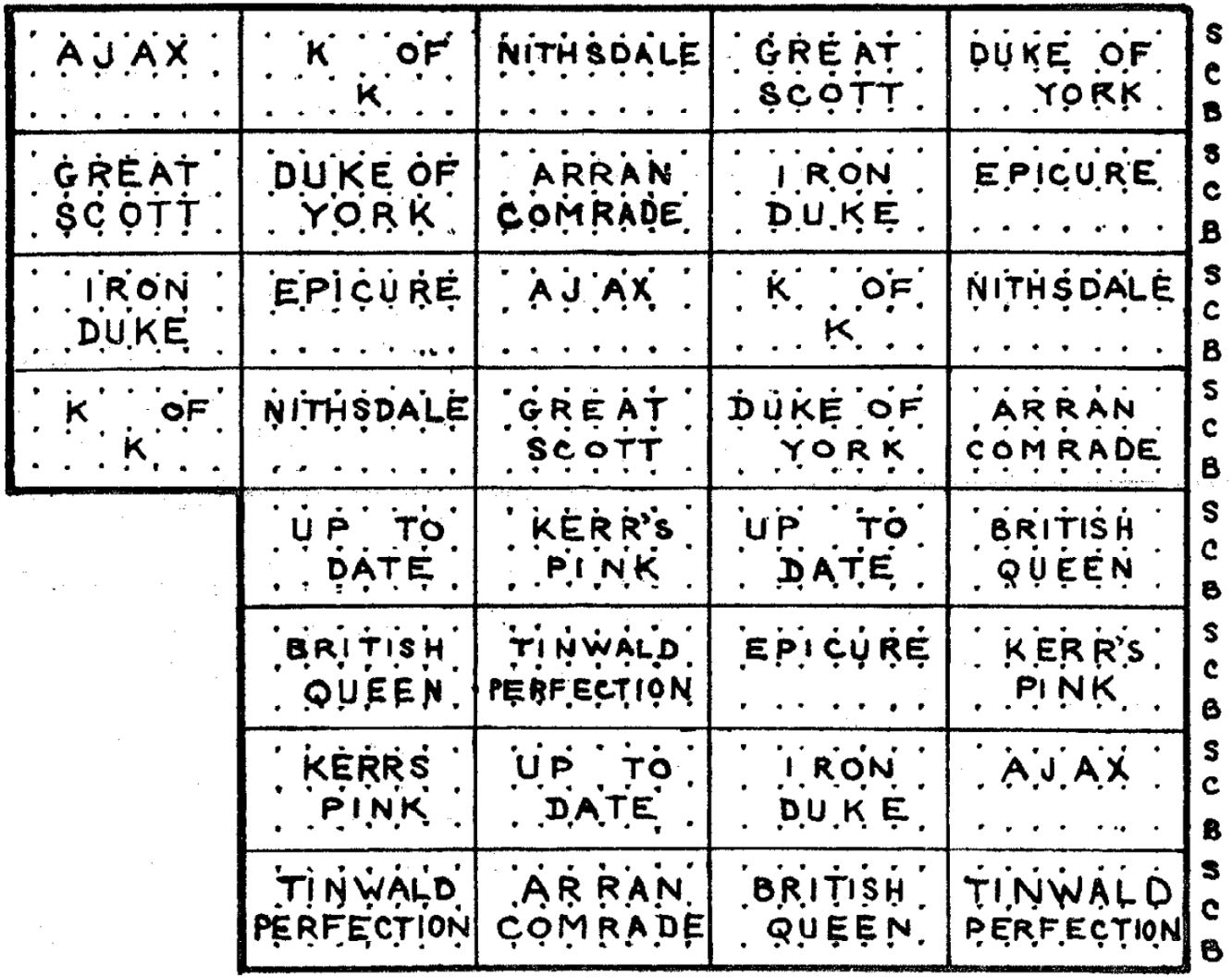


Diagram 1. Plan of experiment. Farmyard manure series.

ロナルド・A・フィッシャーの仕事場

p. 316

In Table III is shown the analysis of the variation into these four classes; the mean square deviation is found by dividing the sum of squares in each class by the number of degrees of freedom, while the standard deviation is shown in the last column. When this value is significantly greater than the standard deviation of the differences between parallel plots, we may conclude that the corresponding effect is not due to chance.

Table III.

Variation due to	Degrees of freedom	Sum of squares	Mean square	Standard deviation
Manuring	5	6,158	1231·6	35·09
Variety	11	2,843	258·5	16·07
Deviations from summation formula	55	981	17·84	4·22
Variation between parallel plots ...	141	1,758	12·47	3·53
Total	212	11,740	—	—

In comparing the standard deviations in the last column we may use

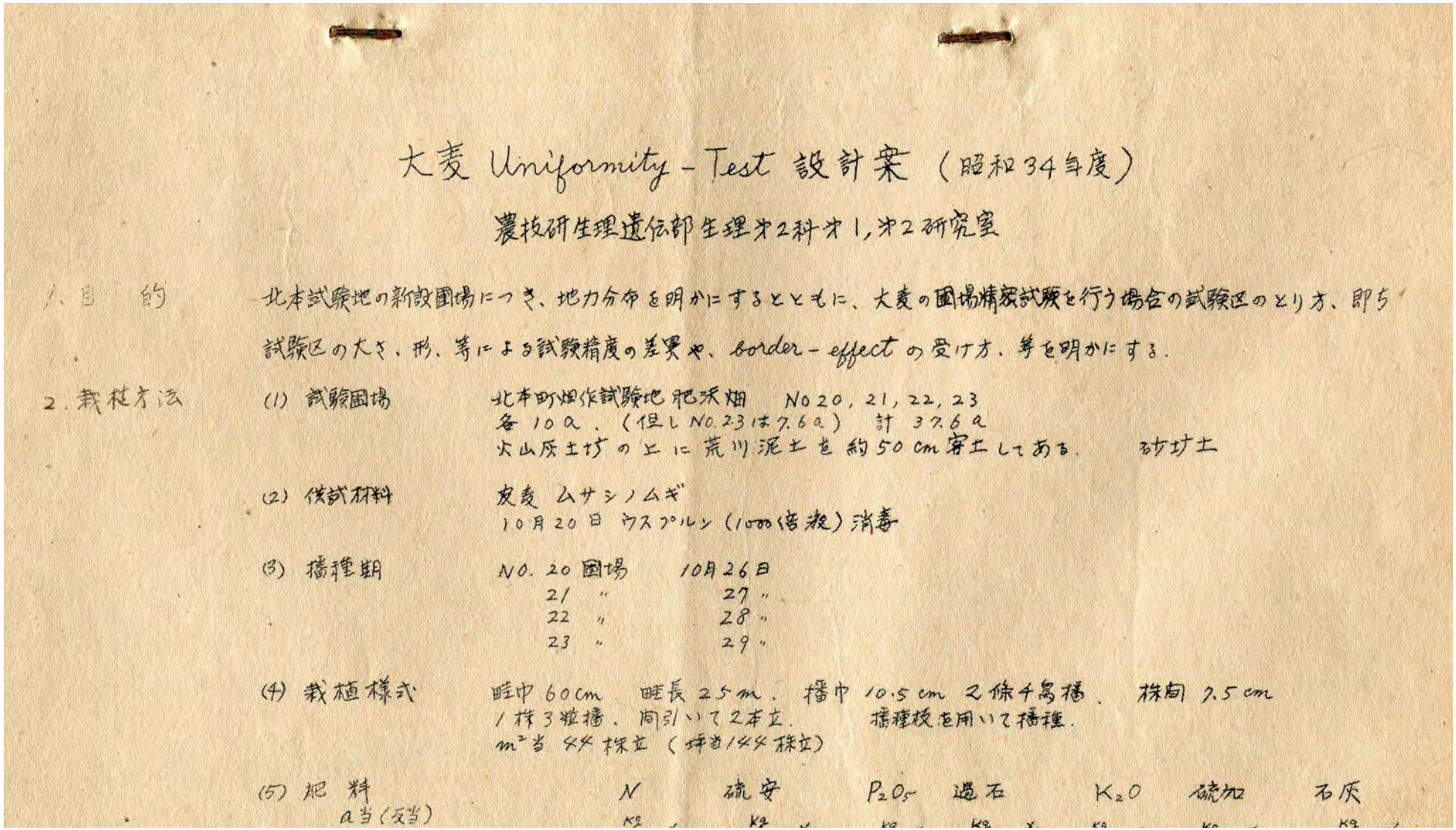
笛の音は極東の果てまで

農林水産省農業技術研究所（東京都北区西ヶ原）

『農業技術研究所八十年史』（1974）

農業技術研究所（西ケ原）全景

農業技術研究所での農業試験研究



大麦 Uniformity - Test 設計案（昭和34年度）

農技研生理遺伝部生理第2科第1，第2研究室

1. 目　的

北本試験地の新設圃場につき、地力分布を明かにするとともに、大麦の圃場精密試験を行う場合の試験区のとり方、即ち試験区の大さ、形、等による試験精度の差異や、border - effect の受け方、等を明かにする。

2. 栽植方法

(1) 試験圃場　北本町畑作試験地 肥沃畑　No 20, 21, 22, 23
各 10 a，（但し No. 23 は 7.6 a）　計 37.6 a
火山灰土坊の上に荒川泥土を約 50 cm 客土してある。　砂壌土

(2) 供試材料　皮麦 ムサシノムギ
10月20日 ウスプルン（1000倍液）消毒

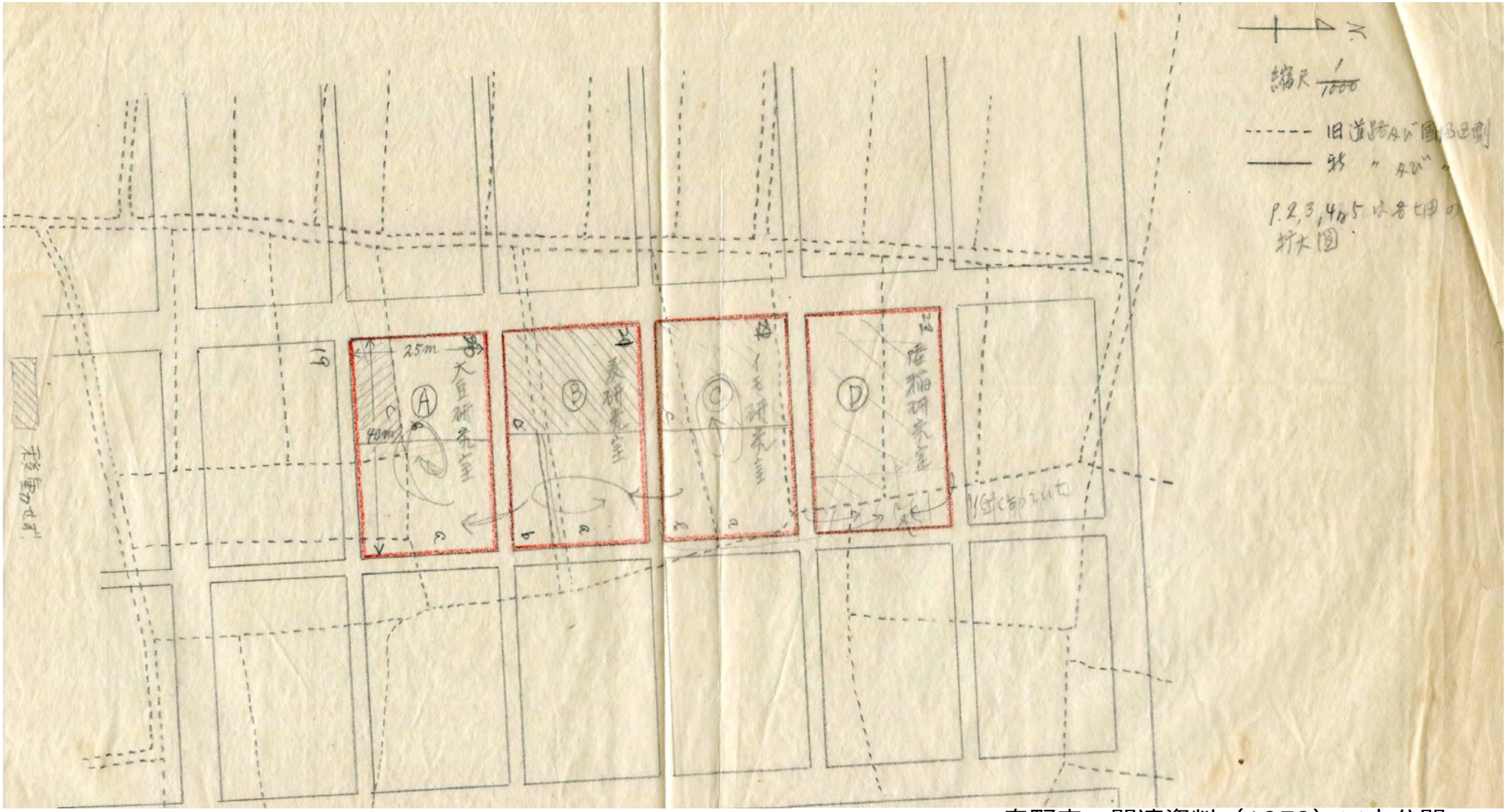
(3) 播種期　No. 20 圃場　10月26日
21 〃　27 〃
22 〃　28 〃
23 〃　29 〃

(4) 栽植様式　畦巾 60 cm　畦長 25 m，播巾 10.5 cm 2條千鳥播，株間 7.5 cm
1株3粒播，間引いて2本立。　播種板を用いて播種。
m² 当 44 株立（坪当 145 株立）

(5) 肥料　a当（反当）　N　硫安　P_2O_5　過石　K_2O　硫加　石灰

奥野忠一関連資料（1959）※未公開

農業技術研究所での農業試験研究



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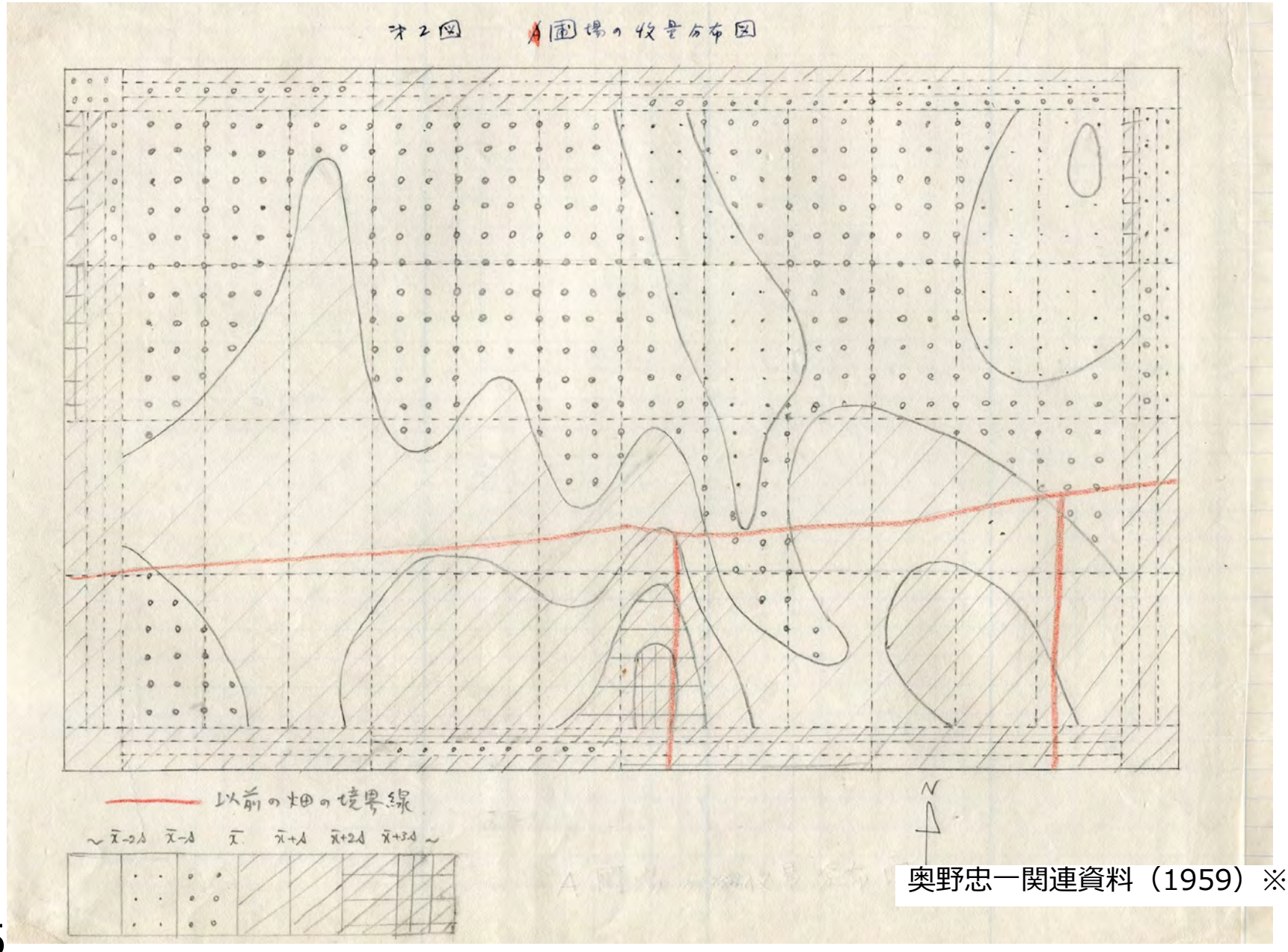

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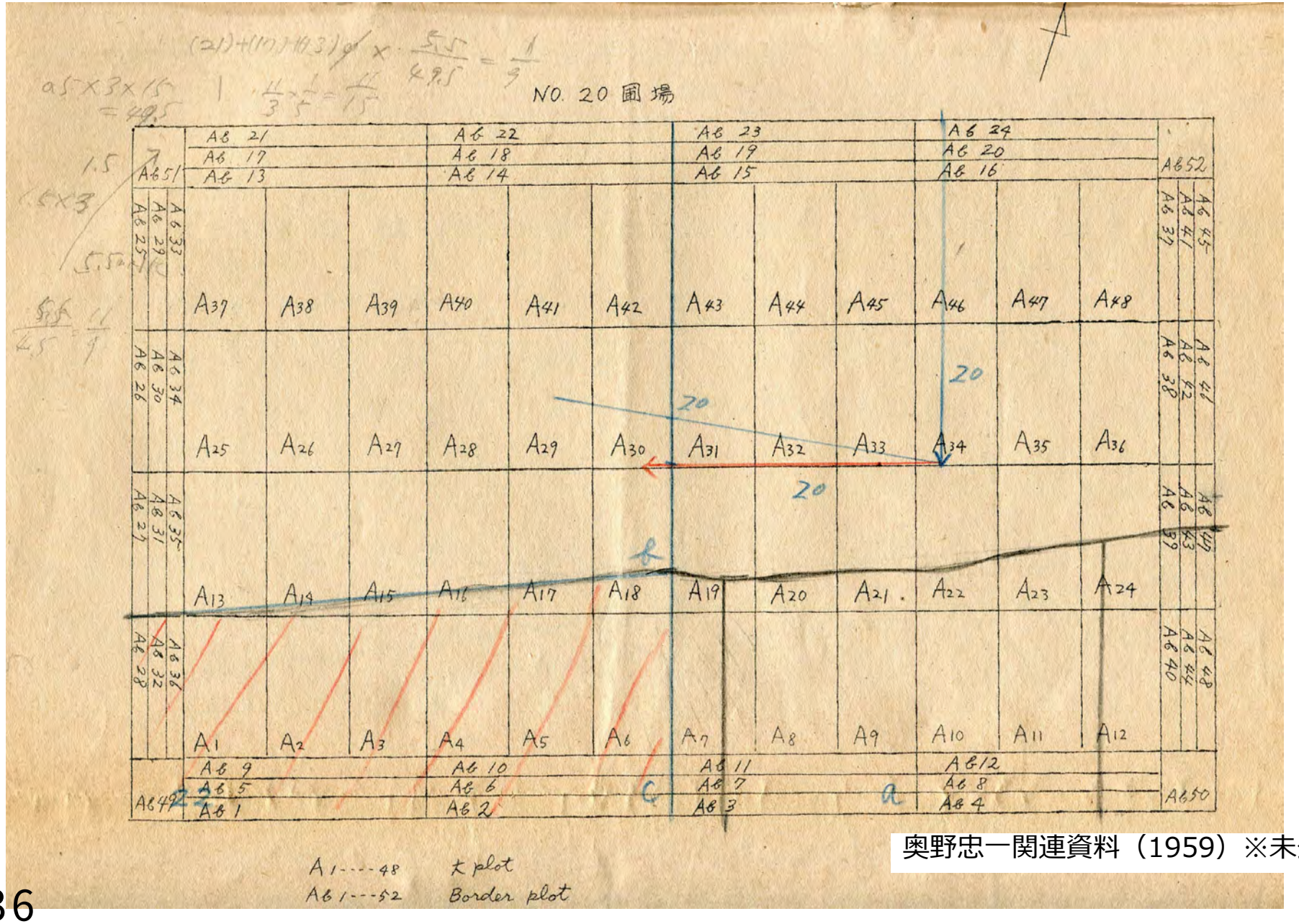

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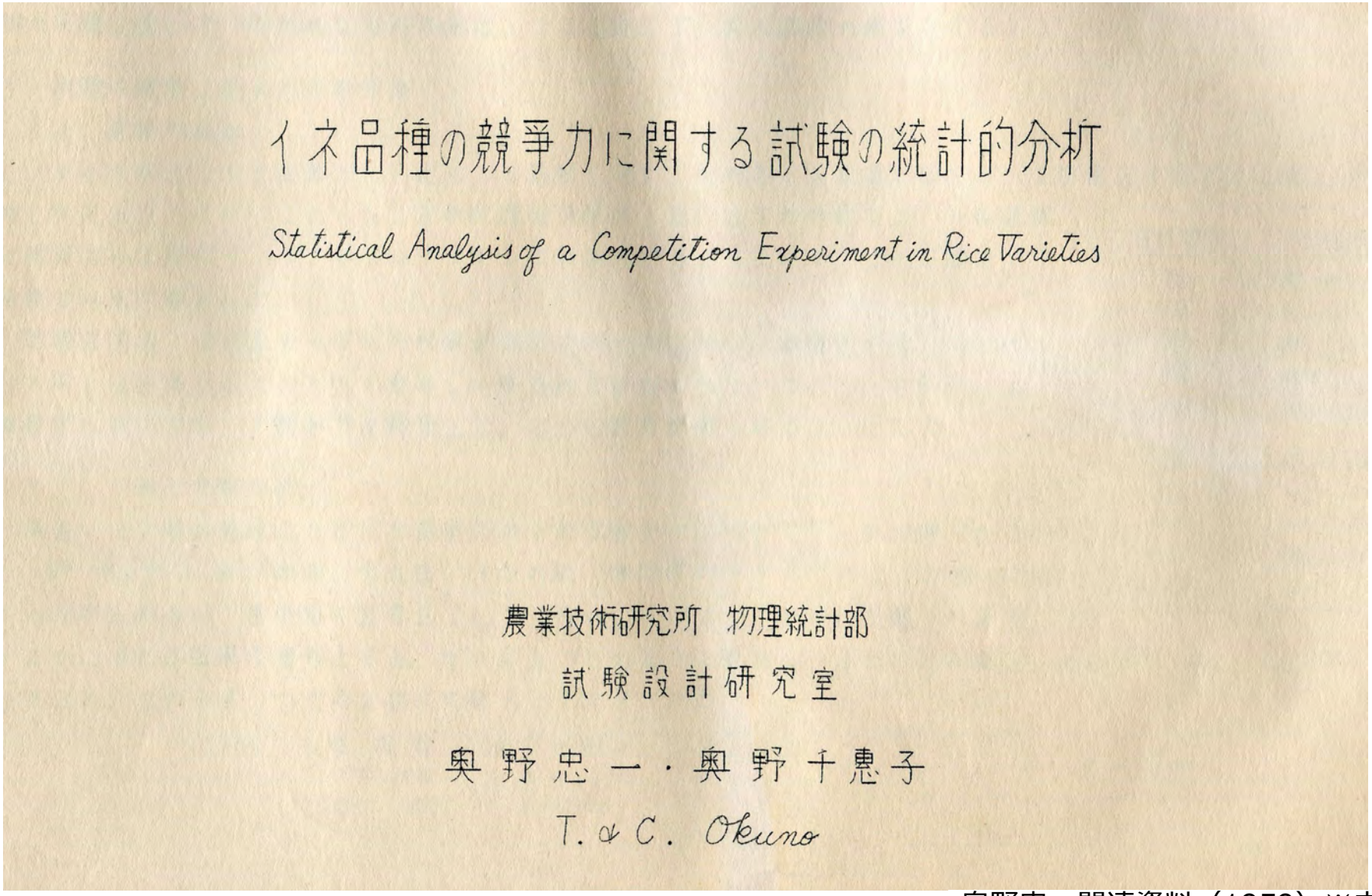
農業技術研究所での農業試験研究



イネ品種の競争力に関する試験の統計的分析

Statistical Analysis of a Competition Experiment in Rice Varieties

農業技術研究所 物理統計部
試験設計研究室
奥野忠一・奥野千恵子
T. & C. Okuno

奥野忠一関連資料（1959）※未公開

農業技術研究所での農業試験研究

1.4 Analysis of Variance and Expectation of Mean Square

Table 1.2 Analysis of Variance

Source of Variation	d.f.	Sum of Squares	Expectation of Mean Square
Total	bt^2-1	$S_T=\sum_i\sum_j\sum_K(x_{ijK}-\bar{x})^2$	
Block	$b-1$	$S_B=t^2\sum_K(\bar{x}_{..K}-\bar{x})^2$	$\sigma^2+\frac{t^2}{b-1}\sum_K\gamma_K^2$
Treatment	t^2-1	$S_T=b\sum_i\sum_j(\bar{x}_{ij.}-\bar{x})^2$	$\sigma^2+\frac{b}{t^2-1}\sum_i\sum_j(v_j+\tau_{ij}-v_.-\tau_.)^2$
Variety (H_{04})	$t-1$	$S_v=bt\sum_j(\bar{x}_{.j.}-\bar{x})^2$	$\sigma^2+\frac{bt}{t-1}\sum_j(v_j-v_.-\tau_{.j}-\tau_.)^2$
Competitive Ability (H_{03}')	$t-1$	$S_\tau=bt\sum_i(\bar{x}_{i..}-\bar{x})^2$	$\sigma^2+\frac{bt}{t-1}\sum_i(\tau_{i.}-\tau_.)^2$
Interaction (H_{02})	$\frac{1}{2}(t-1)(t-2)$	$S_\alpha=\frac{1}{4}b\sum_i\sum_j\{(\bar{x}_{ij.}-\bar{x}_{i..}-\bar{x}_{.j.})-(\bar{x}_{ji.}-\bar{x}_{j..}-\bar{x}_{.i.})\}^2$	$\sigma^2+\frac{2b}{(t-1)(t-2)}\sum_i\sum_j(\alpha_{ij}-\alpha_{i.}-\alpha_{.j})^2$
Competitive Gain (H_{01})	$\frac{1}{2}t(t-1)$	$S_\beta=\frac{1}{4}b\sum_i\sum_j\{(\bar{x}_{ij.}-\bar{x}_{i..}-\bar{x}_{.j.}+\bar{x})+(\bar{x}_{ji.}-\bar{x}_{j..}-\bar{x}_{.i.}+\bar{x})\}^2$	$\sigma^2+\frac{2b}{t(t-1)}\sum_i\sum_j(\beta_{ij}-\beta_{i.}-\beta_{.j}-\beta_.)^2$
Error	$(b-1)(t^2-1)$	$S_E=\sum_i\sum_j\sum_K(x_{ijK}-\bar{x}_{ij.}-\bar{x}_{..K}+\bar{x})^2$	σ^2

where, $\sum_K\gamma_K=0$, $\alpha_{ij}=-\alpha_{ji}$, $\alpha_{i.}=-\alpha_{.i}$, $\alpha_{..}=0$, $\beta_{ij}=\beta_{ji}$, $\beta_{i.}=\beta_{.i}$,

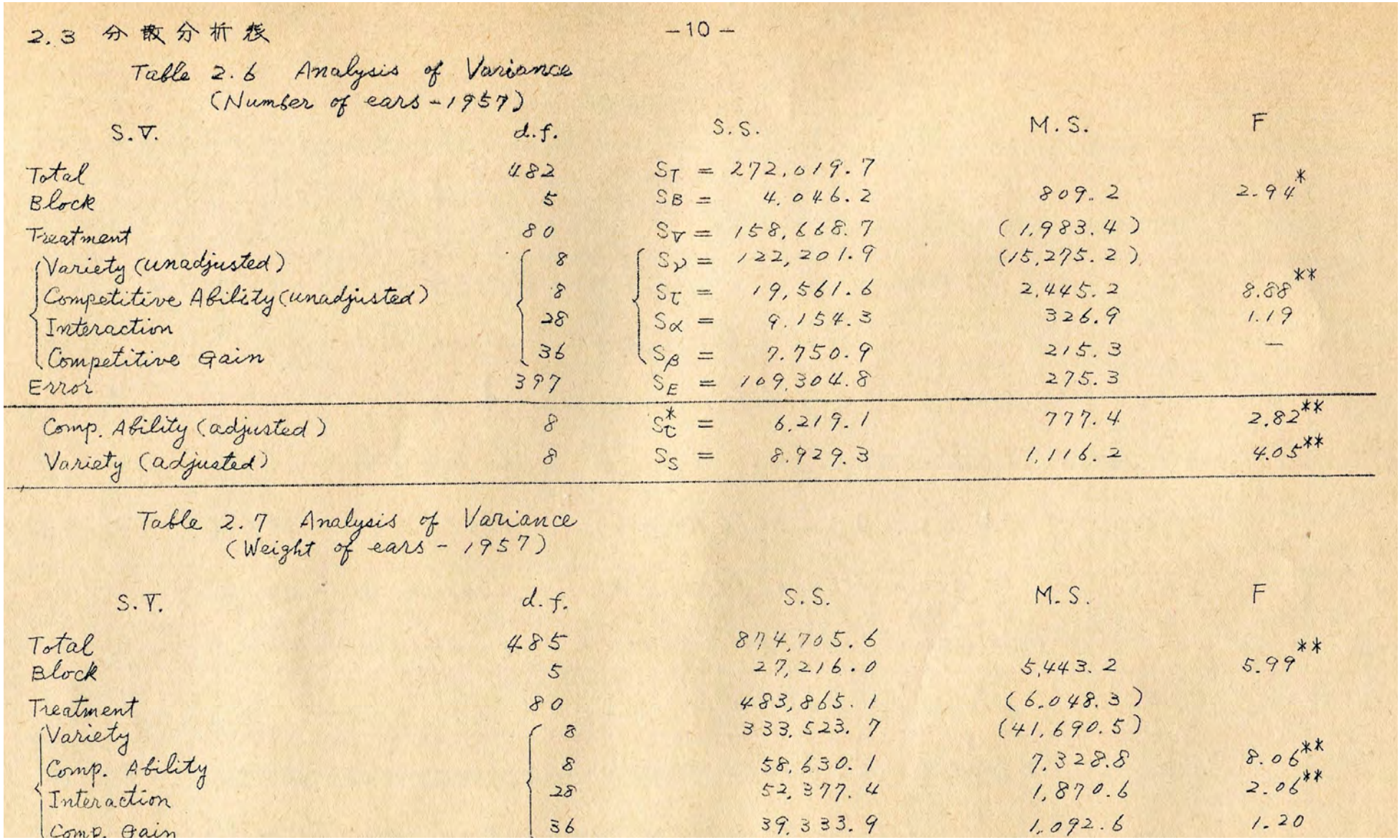
$\tau_{ij}=\alpha_{ij}+\beta_{ij}$, $\tau_{i.}=\alpha_{i.}+\beta_{i.}$, $\tau_{.j}=\alpha_{.j}+\beta_{.j}$, $\tau_{..}=\beta_{..}$

$\mu_{ij}=v_j+\tau_{ij}$, $v_j=\mu_{jj}$, $\tau_{ij}=\mu_{ij}-\mu_{jj}$

—21—

奥野忠一関連資料（1959）※未公開

農業技術研究所での農業試験研究



2.3 分散分析表 — 10 —

Table 2.6 Analysis of Variance (Number of ears - 1957)

S.V.	d.f.	S.S.	M.S.	F
Total	482	S_T = 272,019.7		
Block	5	S_B = 4,046.2	809.2	2.94*
Treatment	80	S_V = 158,668.7	(1,983.4)	
Variety (unadjusted)	8	S_ν = 122,201.9	(15,275.2)	
Competitive Ability (unadjusted)	8	S_τ = 19,561.6	2,445.2	8.88**
Interaction	28	S_α = 9,154.3	326.9	1.19
Competitive Gain	36	S_β = 7,750.9	215.3	—
Error	397	S_E = 109,304.8	275.3	
Comp. Ability (adjusted)	8	S_τ^* = 6,219.1	777.4	2.82**
Variety (adjusted)	8	S_S = 8,929.3	1,116.2	4.05**

Table 2.7 Analysis of Variance (Weight of ears - 1957)

S.V.	d.f.	S.S.	M.S.	F
Total	485	874,705.6		
Block	5	27,216.0	5,443.2	5.99**
Treatment	80	483,865.1	(6,048.3)	
Variety	8	333,523.7	(41,690.5)	
Comp. Ability	8	58,630.1	7,328.8	8.06**
Interaction	28	52,377.4	1,870.6	2.06**
Comp. Gain	36	39,333.9	1,092.6	1.20

奥野忠一関連資料（1959）※未公開

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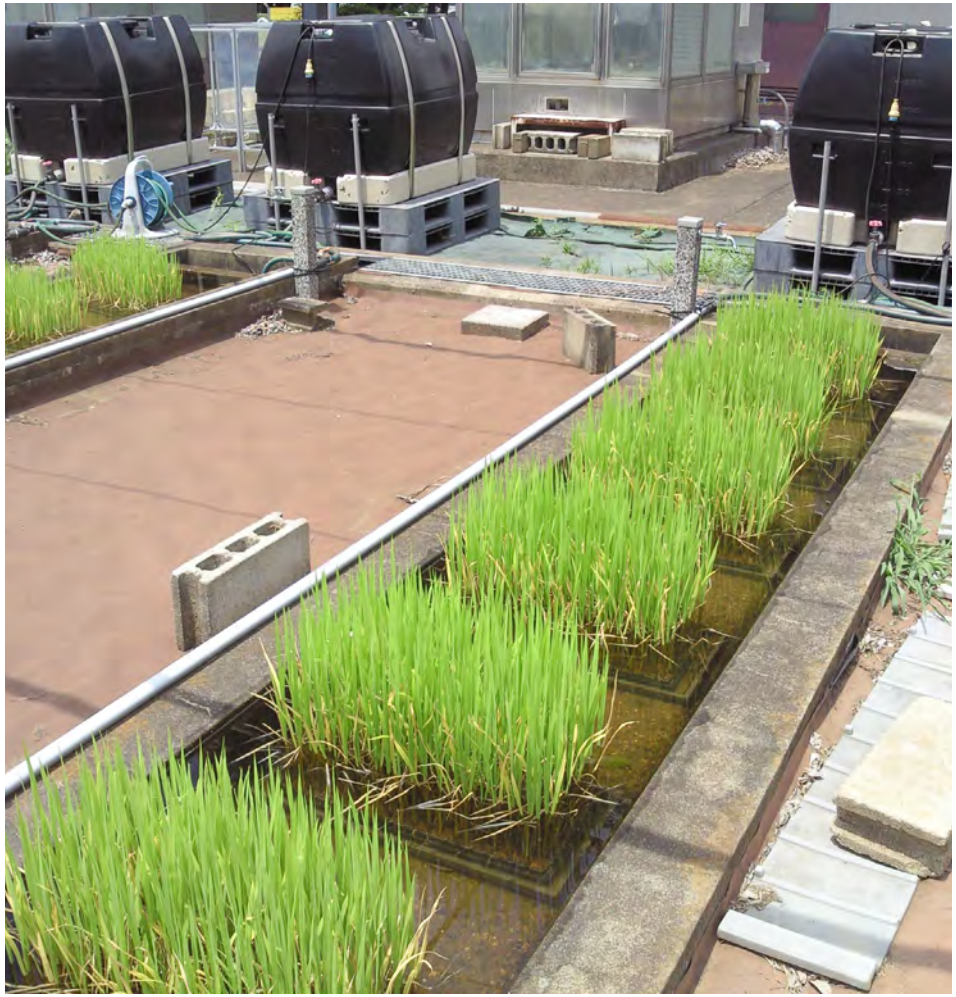
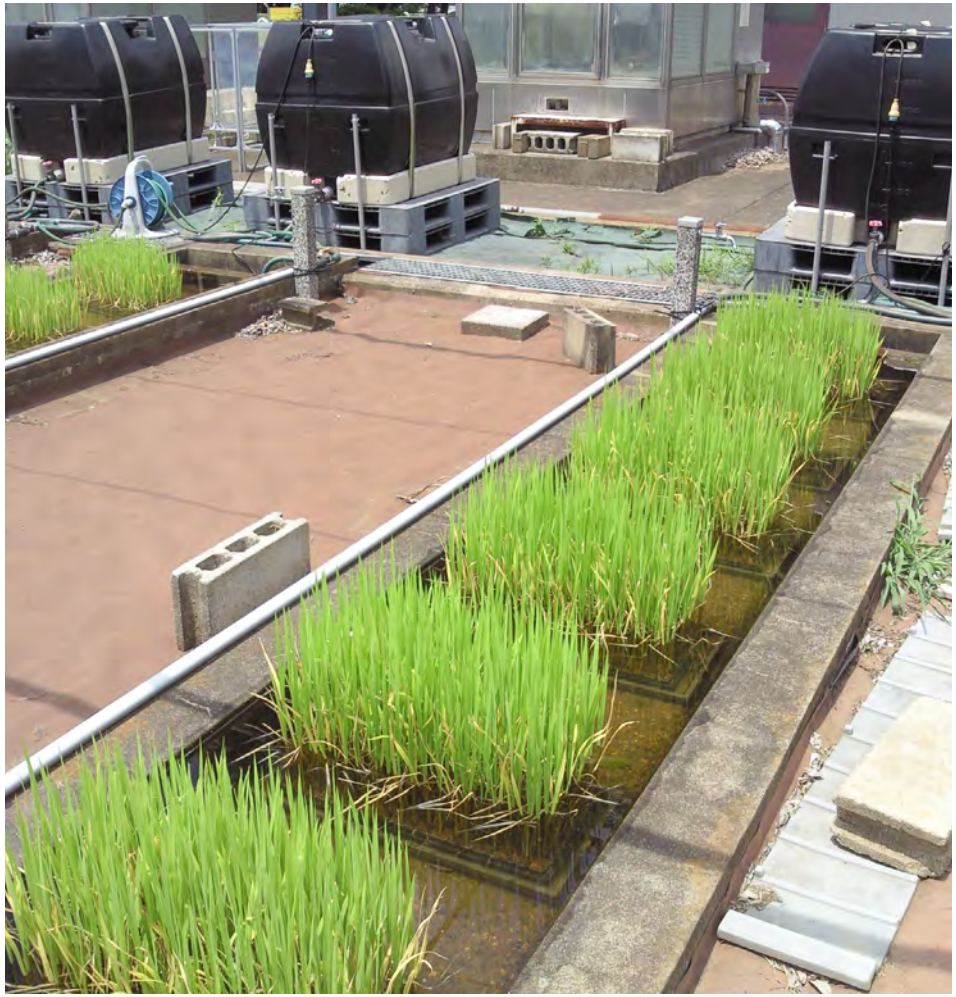


NARO 農研機構
National Agriculture and Food Research Organization



うさぎ追いしかの山

小鮒釣りしかの川

夢は今もめぐりて

忘れがたき故郷

統計データ解析の理念と方法論は，学問的土壌と実践的環境によってさまざまな変遷と分岐を遂げる．過去一世紀以上にわたる農学研究でのデータ解析のあり方を振り返ると，個別研究の場ごとに統計学の思考法は細かくチューニングされてきたことがわかる．頻度主義 vs. ベイズ主義という哲学的レイヤーとは別に，リアルな研究現場のあり方というレイヤーを考えるべきだろう．統計学は単に一般論を唱えるだけですむ学問ではない．

参考文献リスト

Dominic Berry 2015. The resisted rise of randomization in experimental design: British agricultural science, c.1910–1930. *History and Philosophy of the Life Sciences*, **37**(3): 242-260.

伊勢一男 2006. 日本の農業研究における統計学的実験計画法導入の初期について．生物科学 , **57**(3): 172-182.

Laws Agricultural Trust 1974. *Rothamsted Experimental Station Guide*. Harpenden.

三中信宏 2018. 統計思考の世界：曼荼羅で読み解くデータ解析の基礎．技術評論社.

並松信久 2016. 農の科学史：イギリス「所領知」の革新と制度化．名古屋大学出版会.

農業技術研究所 80 年史編さん委員会（編）1974. 農業技術研究所八十年史．農業技術研究所.

Giuditta Parolini 2015a. The emergence of modern statistics in agricultural science: Analysis of variance, experimental design and the reshaping of research at Rothamsted Experimental Station, 1919-1933. *Journal of the History of Biology*, **48**(2): 301-335.

Giuditta Parolini 2015b. In pursuit of a science of agriculture: The role of statistics in field experiments. *History and Philosophy of the Life Sciences*, **37**(3): 261-281.