Lettuce

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GLASSHOUSE LETTUCE

An Economic Survey in Lancashire

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AGRICULTURAL ENTERPRISE STUDIES IN ENGLAND AND WALES

University departments of Agricultural Economics in England and Wales have for many years undertaken economic studies of crop and livestock enterprises. In this work the departments receive financial and technical support from the Ministry of Agriculture, Fisheries and Food.

A recent development is that departments in different regions of the country are now conducting joint studies into those enterprises in which they have a particular interest. This community of interest is being recognised by issuing enterprise reports in a common series entitled "Agricultural Enterprise Studies in England and Wales", although the publications will continue to be prepared and published by individual departments.

Titles of recent publications in this series and the addresses of the University departments are given at the end of this report.

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PREFACE

The field work for this survey was carried out by Roger Ashley (temporary assistant), Ian Baldwin (now at Hadlow College, Nr. Tunbridge, Kent) and the late Keith Lingard.

A preliminary draft of the report was prepared by Ian Baldwin and Keith Lingard was revising, expanding, and re-writing the report at the time of his unexpected and distressingly early death. Had he lived, there would have been in this report a substantial chapter on management built up from an amalgam of interest and experience in horticulture and econometric methods which were unique to Keith Lingard. That material had not developed to the point where it could be included here. For the rest, editing has been limited to the minimum necessary to prepare the report for publication.

W. J. Thomas
Professor of Agricultural Economics

CHAPTER ONE

INTRODUCTORY REVIEW

Glasshouse Lettuce Production

Until the 1950's the acreage of glasshouse lettuce in England and Wales had remained for a long time around 700 acres despite some increase in the total area under glass. By the mid 1960's there had been an expansion of about 200 acres in glasshouse lettuce although the total area under glass had fallen roughly 400 acres. This change marked the beginning of the gradual movement of consumer preference away from the tougher outdoor, over-wintered lettuce towards the glasshouse product. It was also helped by the availability of improved glasshouse lettuce varieties and an increase in the import duty in 1953.

From 1966 onwards, in response to the Horticultural Improvement Schemes of 1964 and 1966, there has been a steady increase in the total glasshouse acreage. During the same period the acreage of glasshouse lettuce increased even faster, so that by 1970 it had topped the 1400 acre mark.

Lettuce is more important in cold than in heated houses, because there is less opportunity to grow an alternative winter crop in a cold house. The lettuce acreage, however, has roughly doubled in both types, although unheated houses have carried most of the total expansion of glass. The lesser relative importance of lettuce in heated houses is certainly not fully shown by the percentages devoted to lettuce (say, 70 per cent and 15 per cent of cold and heated houses, respectively) in winter because of the greater potential for double cropping in heated houses.

Lancashire is a particularly important area for glasshouse lettuce production. Only Essex and Hertfordshire in the past decade - only Essex since 1969 - have larger total glasshouse acreages and no other county matches Lancashire's glasshouse lettuce area. It is not altogether surprising, therefore, that almost one-fifth of the total glasshouse

lettuce area of England and Wales is to be found in the county of Lancashire. As with the national pattern, a larger proportion of the cold than the heated houses in Lancashire is devoted to lettuce production. For both, however, the proportions are well above the national level.

Imports of Glasshouse Lettuce

Imports of lettuce into the U.K. in the period October to May rose from 2,000 tons in 1951 to 9,200 in 1961. Subsequently, as domestic acreage increased, the level of imports rose more slowly reaching a peak of 12,000 tons in 1966-67 since when it has fallen to the current level of 11,000 tons per annum.

The sharp decline in imports in 1953 and 1963 coincided with the raising of the import duty applicable to the period 1st March - 31st May from £0.25 per cwt to £1.00 in 1953 and to £1.50 per cwt in 1963. The effectiveness of these increases as a means of containing the levels of imports was only temporary. This observation supports those who consider the tariff an ineffective protective measure, since by its very nature it allows competitors who reduce cost and thus increase efficiency to overcome its effect. At the same time, domestic producers 'protected' by a tariff do not feel the same incentive to cut costs and obtain a similar increase in efficiency. For a country which is predominantly export orientated, such as the Netherlands, it may well be that progressive increases in import duty, as levied by the importing country may be a more effective method of increasing the efficiency of the exporting countries' horticultural industries than the adoption of internal economic policies such as cheap credit or subsidies by that country.

For the last ten years the Netherlands has been far and away the most important source of imported lettuce. Her market share rose from 77 per cent. in 1960 to a peak of 93 per cent. in 1966; currently, with imports from the U.S.A.* and Israel gaining an increasing market share, it has dropped to 82 per cent.

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* These are imports in the period October to May. They include lettuce of the 'cos' and 'curly' type mainly from U.S.A. and Israel, whereas supplies from the Netherlands are all of the 'butterhead' type.

This recent decline, together with the increased output from the domestic producers may tend to suggest that supplies from British producers are competing more favourably both in quality and size with the Dutch lettuce. Certainly the price differential between the traditionally more expensive imported lettuce and the home produced lettuce has been getting smaller in recent years. The Netherlands, however, has not always enjoyed this role of dominant supplier. In the early 1950's, France, Italy and Spain supplied between 60 and 70 per cent. of our import needs. These were mainly outdoor over-wintered lettuce - thus the increased market share of the Netherlands towards the end of the decade was probably attributable to the production of a quality (i.e. glasshouse) lettuce from an increased glasshouse acreage.

Competition

The degree of competition that U.K. glasshouse lettuce producers face from overseas depends more on the distribution of imported supplies within the period October to May than either the absolute levels of imported supplies or changes in these levels from year to year. The pattern of seasonal supplies has not significantly changed in the last five years and the relevant figures for the 1969-70 season are presented in Table I.1.

Table I.1. Winter Lettuce Supplies 1969-70 ('000 tons)

Source	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Total
Imports	0.2	1.0	2.1	2.2	1.8	1.4	1.5	0.5	10.7
Home Production from Glass	0.1	0.4	0.8	0.4	0.7	1.9	6.2	4.5	15.0
Total	0.3	1.4	2.9	2.6	2.5	3.3	7.7	5.0	25.7

From this it can be seen that 70 per cent. of total imports enters the U.K. in the period from December to March, a time when domestic supplies are low. Subsequently, imported supplies tail off, as home production increases; some

65 per cent. of total home glasshouse production is normally marketed in a six week period centred around Easter.

This concentration of home produced supplies in April is explained by the fact that 60 per cent. of the total glasshouse lettuce acreage is cold glass, and since it is only feasible to grow a crop of unheated lettuce in either autumn or spring most growers tend to opt for the latter so as to interfere least with production from their main glasshouse crop. In addition to this constraint, both heated and cold lettuce producers gear their production to the Easter and Christmas markets.

The absolute price differential between imported Dutch lettuce and home produced lettuce marketed in the December-February period has been fairly steady in recent years but, allowing for rising prices, the relative difference has diminished and this perhaps indicates that the quality and size of the U.K. produced lettuce is now competing more successfully with its imported counterpart. One obvious effect of this could be some substitution of domestically produced lettuce for imports in the mid-winter period.

CHAPTER TWO

GLASSHOUSE LETTUCE AND AIMS OF THE SURVEY

Glasshouse Lettuce Scheduling

Traditionally the glasshouse lettuce crop is considered as a winter catch crop, providing employment and income to growers during out-of-season months, and therefore has little influence on the basic glasshouse cropping system. The decision to include it in the annual rotation will depend not only on the possible alternative winter crops but also on the length of time that the 'summer' crop occupies the glasshouse. Most usually a glasshouse lettuce crop follows a crop of tomatoes, but in theory can be grown at any time from August to May and can thus be dovetailed into most cropping schedules, such as predominantly flower or cucumber cropping systems.

With the exception of vegetable plant production, which to be profitable requires a prearranged and guaranteed market, lettuce is the only feasible supplementary crop in cold glasshouses. Because a minimum temperature is required for growth into a marketable commodity, the lettuce crop must either follow the main crop in the autumn or precede it in the spring. Normally, however, only one lettuce crop is grown and the glasshouse remains fallow for up to two months between the end of the 'summer' crop and the period when the lettuce crop occupies the ground. This provides adequate time for the necessary soil cultivation activities to be performed.

Glasshouse lettuce can be grown at any time during the winter months in heated glasshouses, providing the heating system is of a capacity to give the necessary temperature lift. Heating systems with a capacity to maintain 35-38^{o} F. under any weather conditions will give little more than frost protection and free standing air-heaters are often used in this way. This temperature lift is sufficient to enable the autumn crop to be harvested later and the spring crop earlier than is possible in a completely cold glasshouse. One side effect of this is that the maincrop

can occupy the glasshouse for a longer time period or, alternatively by sacrificing a few weeks at the end of the maincrop or by delaying planting of the maincrop, it is possible to combine two lettuce crops with the maincrop.

Heating systems with a capacity to maintain 45-55^{0} F. under any weather conditions permit lettuce to be grown in the cold winter months of December, January and February and, with astute management, enable up to three crops of lettuce to be grown in conjunction with a shortened maincrop.

Thus the integration of a lettuce crop into the glasshouse cropping programme is by no means a simple affair. For a grower specialising in the production of a constant supply of lettuce from October to May, the problem is to fit in as many crops as possible consistent with profit maximisation.

For the grower who does not specialise in such a way, the most appropriate lettuce crops will be those that interfere least with the production of the maincrop, whilst contributing something to profit.

For management purposes, glasshouse lettuce can be classified into three main groups according to the time of cutting.

(i) Autumn Lettuce (i.e. Lettuce cut between October and mid-December.)

(a) In cold houses, seed is sown in early August, the crop matures in late October and early November.

(b) In heated houses lettuce may be grown with no heat as in (a) or sown at the end of August, to mature from November to mid-December using some heat.

The autumn crop competes with the domestic outdoor crop in October and with imported glasshouse lettuce in November and December.

(ii) Winter Lettuce (i.e. lettuce cut between mid-December and early March.)

This crop can only be grown with heat, and seed may be sown from September to mid-December. Winter lettuce is technically the most difficult to produce and competes with imported supplies.

(iii) Spring Lettuce (i.e. lettuce cut between mid-March and the end of May.)

(a) In cold houses, the seed is sown in late October for a crop which will mature in March, or is sown in January and early February for a crop to supply the Easter and subsequent trade.

The better natural light and temperature conditions of autumn and spring enable the crop to mature more quickly than in mid-winter. Heating allows the crop to grow in colder ambient temperatures but without reducing the time to reach maturity. A reduction in the time from sowing to cutting can in theory be achieved by the adoption of modern techniques such as soil blocking, pelleted seed, supplementary lighting and machine planting. However, the single factor that has most influence on the length of time that the crop occupies the glasshouse is the choice of variety.

Glasshouse lettuce varieties are of two main types - 'forcing' and 'non-forcing'. Most of the forcing varieties are descended from the Cheshunt 5B variety and exhibit many characteristics of that lineage. Grown at high minimum temperatures they will produce a compact hearted lettuce under adverse light conditions in a short period of time; for this reason they are best suited to winter cropping. Enrichment of the atmosphere with carbon dioxide can further speed up the time to maturity, especially in conjunction with higher temperatures. The cropping density is somewhat higher* than with the non-forcing varieties which produce a larger, more leafy but smaller hearted lettuce. This latter type requires less heat and is therefore better suited to the autumn and spring cropping schedules. Grown in the winter period, they can take up to two weeks or more longer to mature than 'forcing' varieties.

Marketing

The maintenance of freshness is the most important objective in the successful marketing of a perishable crop such as glasshouse lettuce. Consequently the major glasshouse lettuce production areas developed

* See sections on 'spacing' in chapters three and four. (pp.16 and 27)

reasonably close to areas of high population density. Pre-packing a lettuce in an individual polythene bag has made it possible to produce further away from the areas of consumption and also increases the 'shelf-life' of the product at the retail outlet. Furthermore, speedier transport also enables growers to exploit more distant markets. Nevertheless the conventional channels of marketing, via primary and secondary wholesalers to retailers, are still used for selling the bulk of glasshouse lettuce.

Aims of the survey

It is one of the tasks of a Department of Agricultural Economics to carry out field studies of economic aspects of the agricultural and horticultural industries. Information gathered can in turn provide a basis for advisory work. In setting up this lettuce survey, the general position and problems outlined in the preceding pages provided the basic framework. Bearing in mind that lettuce is only part of the glasshouse rotation, these considerations provided a three fold aim for this survey.

(1) To relate the Lancashire Glasshouse Lettuce Industry to the Glasshouse Industry of that county and to the Glasshouse and Glasshouse Lettuce Industries of the U.K.

(2) To collect and analyse physical and financial input-output data for the 1969 to 1970 heated and cold glasshouse lettuce crops in Lancashire;

(3) To evaluate the extent to which the theoretical possibilities of lettuce crop scheduling developed by research workers and disseminated by advisers, were being adopted in the field.

Glasshouse lettuce production in Lancashire

Glasshouse lettuce was first grown on a commercial scale in Lancashire in the early 1920's, centred around the Marton area of Blackpool on the Fylde coast. It was introduced initially as a substitute

for the mint crop grown under glass which supplied the local confectionery trade. The popularity of lettuce, as a follow-on crop to tomatoes, increased towards the end of the decade as the Lancashire aeroplane house began to replace the lean-to and vinery types.

Traditional methods - that is lettuce pricked into the glasshouse bed in November, from a September sowing, at 6" x 6" or 7" x 7" spacing and cutting in March or April - lasted until the 1950's. Even at the present time, when it is possible with astute management for a lettuce crop to mature from planting in under ten weeks, it is noticeable that traditional practices still remain on many nurseries. However, growers have found that they could achieve improved lettuce crop production as a direct result of the introduction of new varieties and insecticides.

It is not possible from the available statistics to determine the exact geographical location of the 370 acres of glass or of the 273 acres of lettuce grown within the county. It is likely, however, that as much as 90 per cent. of the total glass is situated on the flat coastal plain (to the west of a line drawn through Lancaster and Preston) to the north of the river Ribble in the Marton area of Blackpool and to the south of the Ribble in the Southport-Ormskirk-Preston triangle. Market gardens lying on the periphery of Lancashire Industrial towns probably account for most of the remaining ten per cent. Whereas most of these small holdings will grow a crop of lettuce of some type, it is likely that well over half of the county's glasshouse lettuce is produced around Southport at Hesketh Bank, Tarleton and Banks. The clearly visible signs of decline in the Marton glasshouse industry coupled with equally visible signs of expansion, south of the river, especially in cold glass, support this premise.

The Sample

The sample of sixty lettuce growers was divided into the three main groups as defined previously. The Spring Lettuce group was divided into Heated and Cold categories depending on whether any heat was applied to

the crop during production. This grouping conforms with the classification of the Agricultural Development and Advisory Service and allows for a comparison of the sample with the Lancashire totals, as follows:-

Table II.1 Seasonal Glasshouse Lettuce Proportions: Survey and Lancashire

Seasonal Group	Growers in Survey		Proportion of Lettuce area by Season in	
			Survey	Lancashire
	No.	acs.	%	%
Autumn	5	1.0	3	10
Winter	14	12.5	27	27
Spring Heated	20	15.0	32	30
Spring Cold	21	17.5	38	33
Total	60	46.0	100	100

The acreage surveyed represented about one eighth of the total glass in Lancashire and the size distribution of the surveyed lettuce crops is shown below.

Table II.2 Distribution of Surveyed Lettuce Crop by Group and Area

Area (in 1000 sq ft)	Autumn	Winter	Spring Heated	Spring Cold	All
Under 10	-	2	1	3	6
10 and under 20	5	2	7	4	18
20 " " 30	-	2	3	8	13
30 " " 40	-	2	3	3	8
40 " " 50	-	2	2	1	5
50 " " 60	-	1	2	2	5
60 " " 70	-	1	-	-	1
70 " " 80	-	2	-	-	2
80 " " 90	-	-	2	-	2
Total	5	14	20	21	60

CHAPTER THREE

HEATED LETTUCE CROPS

It is possible to distinguish two lettuce crops grown in heated glasshouses, the 'winter' crop being roughly a month earlier than the 'spring' crop. Although many features of the two crops are very similar, they are treated separately because the timing element itself may be important to a grower's general management, particularly planning.

(1) Winter Crop

Fourteen nurseries, with from 20,000 sq. ft. to 100,000 sq. ft. of glasshouse, produced a winter crop. On average, some 80 per cent. or 32,000 sq. ft. per holding, of the available glass was devoted to lettuce. The remainder was used for propagation of the main crop, generally tomatoes. Eight varieties of lettuce were grown, of which Valentine was the most popular.

Thirty per cent. of the houses were erected before 1950 and 35 per cent. between 1950 and 1966, these were mainly the traditional Lancashire aeroplane type. The remaining 35 per cent. built sine 1966, were either wooden or metal Venlo type houses erected under the Horticultural Improvement Scheme.

Production Costs

It is easy to indulge in sterile arguments about the relevant items for inclusion in a list of production costs. The important thing is to ensure that all comparisons are based on costs compiled to the same standard. Table III.1 is drawn up on the accepted convention that regular labour is a fixed cost. With no employment of casual labour, fuel is by far the largest item of direct cost.

Variation in planting dates, in the length of growing period and in other factors invalidate close comparisons of fuel costs. Their range was great but it appears that air heating was least expensive for growing

non-forcing varieties at £3.54 per 1,000 sq. feet compared with £9.14 for its closest rival - oil heating.

No other item of direct cost was of comparable importance, whilst water and the depreciation of specialised equipment added only a few pence per 1,000 sq. feet to costs of growing.

Labour is naturally an important ingredient in total costs and the amount used is added, at a standard hourly rate, to give a figure for total standard production costs.

Table III.1 Standard Production Costs* for Winter Lettuce per 1000 sq. ft.

Item	High Cost	Average Cost	Low Cost
	£	£	£
Seed	0.80	0.35	0.36
Box Depreciation Charge	0.01	0.01	0.01
Compost	0.34	0.31	0.14
Fertilizer	1.70	0.38	0.65
Pest and Disease Control	0.07	1.14	1.45
Water	0.12	0.10	0.09
Carbon dioxide	0.00	0.00	0.00
Glasshouse Fuel	20.00	14.76	4.72
Specialised Machinery Depreciation Charge	0.02	0.00	0.02
TOTAL DIRECT COSTS	23.06	17.05	7.44
Labour at 45p/hr.	11.99	9.69	5.77
TOTAL STANDARD COSTS	35.05	26.74	13.21
Yield per 1000 sq. ft. - dozens	136	180	170
Standard Cost per dozen cut - new pence	25.8	14.7	7.7

* See Appendix to this Chapter

Table III.1 shows the standard cost per 1000 sq. ft. of glasshouse area and per dozen cut lettuce. The range is considerable: from about

£13 to £35 per 1000 sq. ft. or from under eight to almost 26 new pence per dozen lettuce. There would seem to be no justification for the difference in the results achieved.

As a comparative performance measure for inclusion in future planning schedules and budgets, the use of full cost accounting with its arbitrary allocation of fixed costs amongst crops to produce a total cost per unit is to be deplored. The reason for this is basically, that it is the opportunity cost* rather than the total cost of production which is central to rational decision making and subsequent economic plans. In the total planning of a new business or the complete replanning of an existing business, however, total costs have to be taken into account. Economy on a house may involve greater expense in heating: one piece of equipment may involve more labour than an other to do the same job, and all such factors must be included in initial calculations. Returns from all crops must cover all costs and leave a margin if growers are to make a profit.

So long as the overheads are consistently spread amongst the various products, an allocation of items such as soil sterilisation, glasshouse repairs, and depreciation is also justified for the purpose of arriving at an acceptable market price. If the crop is harvested over a period and its price fluctuates, however, the concept of an acceptable market price may not be very meaningful.

In Table III.2, the overheads have been allocated according to the time that the lettuce crop occupied the glasshouse. On average, overheads added four new pence to the cost of a dozen lettuce. They narrowed the range in total costs - from a low of about 15 new pence to a high of about 29 new pence per dozen.

Returns

Because lettuce prices vary considerably within any one week and since this weekly information on prices was not available from the survey

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* Essentially, the effect on net income of choosing one course of action rather than another.

Table III.2 Allocation of Certain Fixed Costs according to the Number of Weeks the Winter Lettuce occupied Glasshouse (per 1000 sq. feet)

	High Cost	Average Cost	Low Cost
No. of weeks in the ground	22	17	14
Sterilization	£	£	£
Annual Cost (materials + labour at 45p/hr.)	8.00	4.90	7.84
Sterilization cost to lettuce	2.87	1.49	2.91
Glasshouse Depreciation			
Age of glass in years	30	12	1
Fixed scale depreciation p.a. over 15 year life	-	14.04	37.0
Cost to lettuce	-	4.66	10.00
Glasshouse Repairs			
Annual Cost	7.00	3.50	
Cost to lettuce	1.75	1.16	
Fixed costs allocated to lettuce	4.62	7.31	12.91
	new pence	new pence	new pence
Fixed costs: per doz.lettuce	3.4	4.0	7.5
Standard Production Costs: per doz.lettuce (from Table III.1)	25.8	14.7	7.7
Total, with certain fixed costs, per dozen lettuce	29.2	18.7	15.2

records it was not possible to try and perform the kind of sales analysis that Nicholson achieved with tomato sales data.*

* British Isles Tomato Survey 1966-67 - J.A.H. Nicholson, Wye College.

For the winter crop, the average net home price of the fourteen crops surveyed was 38p per dozen and ranged on individual holdings from 23p to 54p per dozen lettuce. Using this average price data it is however possible to calculate gross margin* performance on the 14 holdings surveyed. For both planning and comparative purposes the gross margin per week more accurately reflects performance than absolute gross margin per unit area. If we assume that total glasshouse output is directly proportional to the number of weeks that the glasshouse is cropped - a total clearly constrained to less than 52 weeks when allowance is made for the necessary steaming, flooding, and soil cultivation operations - then growers seeking maximum financial reward should aim at maximising gross margin per week rather than individual crop gross margins. This assumes that the glasshouse is cropped at all times except during the necessary cultivations or, alternatively, that there is no time when the land lies fallow.

This point may be made clearer by reference to table III.3. Holding H.33 grows a crop of winter lettuce in 10 weeks with a total crop gross margin of £67 per 1000 sq. ft. and a gross margin per week of £6.71; Holding 10 takes 16 weeks to produce a slightly larger crop with a total crop gross margin of £83 per 1000 sq. feet but a gross margin per week of £5.49. In absolute gross margin terms, therefore, H. 10 at £83 is more profitable than H.33 at £67. But over a 32 week period H.10 could only grow two crops, total gross margin 2 x £83 = £166; whereas H.33 could grow three crops, total gross margin 3 x £67 = £201. Thus, assuming the above performance could be repeated, over winter period of approximately 33 weeks H.33 would be more profitable than H.10.

From Table III.3 it can also be seen that the winter lettuce crop surveyed had a range of growing period from 10 to 22 weeks with an average of 14 weeks. The range of gross margin was from £23 per 1000 sq. feet to £83 per 1000 sq. feet with an average of £48 per 1000 sq. feet and the gross margin per week ranged from £1.85 to £6.71 with an average of £3.36.

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* Gross margin = net revenue minus direct costs.

Table III.3 Gross Margins for each Surveyed Winter Lettuce Crop (per 1000 sq. feet)

Survey Code	Yield	Net Output	Return per dozen	Gross Margin	Gross Margin per week	Number of Weeks in Ground
	doz.	£	p	£	£	
H.33	190	72.53	38	67.14	6.71	10
H.10	208	87.91	42	83.09	5.49	16
H.6	168	92.48	54	75.86	5.05	15
H.24	171	71.18	41	63.86	4.56	14
H.9	155	66.16	42	47.43	3.66	14
H.18	204	69.39	34	47.60	3.38	13
H.1	145	59.75	41	40.46	3.37	12
H.3	194	61.53	31	49.68	3.16	16
H.13	168	61.64	36	55.12	3.10	20
H.17	136	61.00	45	37.94	2.75	12
H.11	180	58.29	32	41.25	2.43	17
H.32	114	28.04	26	23.23	2.11	11
H.8	155	57.90	37	40.82	1.85	22
H.34	47	10.71	23	5.90	0.65	9
Average	159	61.3	38	48	3.36	14.4

Spacing

Theoretically the smaller forcing varieties of lettuce can be grown closer together than the larger more leafy non-forcing varieties. A.D.A.S. advisors, however, have been quick to point out that in view of the increasing demand for a larger winter lettuce plus the fact that wastage rates are higher at closer spacings, the minimum spacing for both non-forcing and forcing varieties of winter lettuce should be no less than

8" x 8". That growers have been slow to adopt this recommendation is partly due to their adherence to habitual practice and partly due to their illusion that the more "they can cram in the more they will get out".

The growers' view tends to be supported by the survey results. No less than eight different spacings and distances were recorded on the holdings. These ranged from 7" x 7" to 8" x 8" and included 7½" x 7", 7½" x 7½", 8" x 7" and 8" x 7½" with other slightly modified spacings attributable to the practice of planting on a staggered design. Despite the differential wastage rates arising from differences in actual cropped area, it was considered worthwhile to attempt to measure the effect that spacing had on the output marketed per unit area. Accordingly, the ten holdings growing non-forcing varieties were split into a close-spacing group (7" x 7") or less and a wide spacing group (8" x 7") or greater. It was found that the average marketed yield of the close spacing group was 181 doz. per 1000 sq. feet compared with 145 doz. per 1000 sq. feet for the wide spacing group. Thus, for the wider spaced lettuce to produce an equivalent monetary return to the closer spaced lettuce, it would have to obtain a 24 per cent. higher price per dozen. Because of the smallness of sample and problems caused by aggregation of different spacing distances, this conclusion must be considered tentative. If nothing else, however, the analysis does draw attention to the importance of spacing and the consequences it may have on financial output.

(2) Spring Crop

Twenty nurseries, with from 12,000 sq. ft. to 126,000 sq. ft. of glasshouse produced a heated spring crop. On average some 70 per cent. or 29,000 sq. ft. per holding was devoted to lettuce. The remainder was used for tomato propagation or an earlier or - exceptionally - a later lettuce crop. Twenty different varieties were grown of which Vitesse (5), Kwiek (5) and Valentine (3) were the most popular. Ten

per cent. of the houses used for lettuce production were pre 1939 and 25 per cent. in all were erected before 1950. A further 42 per cent. were erected between 1950 and 1966, mainly aeroplane type. The remaining 33 per cent., built since the inception of the Horticultural Improvement Scheme in 1966 were nearly all of the Venlo type, but included two mediumspan aluminium houses.

Production Costs

As in the winter lettuce sample, fuel was by far the largest item of direct cost (see Table III.4). Variations in planting dates and length of growing period make any close comparisons of these costs meaningless. However, it is of interest to note that three holdings had a higher fuel cost than the most expensive winter crop and that the average fuel cost in the spring sample is some £2.54 per 1000 sq. ft. greater than the average for the winter crop. Further examination of the survey results suggests that this is probably not so startling as might at first be imagined. The average growing period of 14 weeks for the winter crop is centred on the third week in December and covers the period from the end of October to the beginning of February. In most years the frosts and the really cold weather do not start until January by which time the winter crop is ready for cutting. The growing period for the spring crop is, however, centred on the second week in February and embraces the period from the end of December to the second week in March. In most years, therefore, the later crop will suffer the full brunt of the January and February frosts and the March winds and this will require a greater heat input. Despite the colder ambient temperatures in the months of January to March, it might be expected that because of the better light conditions during the period the average growing period of the spring crop would be considerably less than the winter crop. This hypothesis is not corroborated by the survey results; the average growing period of the winter crops surveyed was 14.3 weeks compared with an average of 14.5 weeks for the spring crop. However,

Table III.4 Standard Production Costs* for Heated Spring Lettuce (per 1000 sq. ft.)

Item	High Cost	Average Cost	Low Cost
	£	£	£
Seed	0.30	0.52	0.22
Box Depreciation Charge	0.01	0.00	0.01
Compost	0.10	0.00	0.01
Fertilizer	0.65	1.79	0.68
Pest and Disease Control	0.26	0.55	0.23
Water	0.15	0.10	0.10
Carbon Dioxide	0.00	0.00	0.00
Glasshouse Fuel	23.80	14.19	3.15
Specialised Machinery Depreciation Charge	0.00	0.00	0.00
TOTAL DIRECT COSTS	25.27	17.15	4.40
Labour at 45p/hour	11.52	11.61	9.31
TOTAL STANDARD COSTS	36.79	28.76	13.71
Yield per 1000 sq. ft. - dozens	138	188	166
Standard Cost per dozen cut - new pence	26.5	15.2	8.1

* See Appendix to this Chapter.

the four growers in the spring sample and the two growers in the winter sample who grew a crop of lettuce in ten weeks or less had fuel bills of £10.20 per 1000 sq. ft. and £2.57 per 1000 sq. ft. respectively. These are considerably less than the group averages and suggest that it is factors other than a high fuel expenditure which are responsible for a shorter average growing period.

Comparison between the winter and spring group average fuel costs can at the very most give only a general idea of the relative magnitude

of the fuel bills in these periods. A more meaningful comparison can be made by splitting the fuel costs in the two samples into groups based on the type of lettuce (forcing or non-forcing) and on the heating method. (See Table III.5)

Table III.5 A Comparison of Heating Costs based on Variety, Season, and Heating Method: (per 1000 sq. ft.)

Heating Method	Winter Lettuce				Spring Lettuce			
	Forcing Varieties		Non-forcing		Forcing Varieties		Non-forcing	
	Total	Per Week	Total	Per Week	Total	Per Week	Total	Per Week
	£	£	£	£	£	£	£	£
Oil	8.25	0.72	9.45	0.71	14.68	0.91	12.42	0.86
Coal	10.92	0.66	9.14	0.59	10.60	0.90	-	-
Air	-	-	3.54	0.27	-	-	9.18	0.63

Table III.5 generally bears out the comments already made. It shows: heating in spring (especially on a weekly basis) to be more costly than for the winter crop; forcing varieties tend to cost more for fuel than the non-forcing; oil to be marginally most expensive.

Of the other direct costs, only chemical inputs and seeds are significant. Table III.4 also shows that the range of standard costs for spring lettuce is closely similar to that for winter lettuce and that the slightly higher average standard production cost is almost offset by the modestly higher yield of the spring crop.

The effect of overhead allocation is shown in Table III.6. It is similar to the effect on the range of winter lettuce costs.

Table III.6 Allocation of Certain Fixed Costs according to the Number of Weeks that Heated Spring Lettuce Occupied Glasshouse (per 1000 sq. feet)

	High Cost	Average Cost	Low Cost
No. of weeks in the ground	14	17	16
	£	£	£
Sterilisation			
Annual Cost (materials + labour at 45p/hr.)	9.76	8.10	9.16
Sterilization cost to lettuce	2.81	2.49	2.99
Glasshouse Depreciation			
Age of glass in years	40	20	15
Fixed scale annual depreciation over 15 year life	-	-	14.04
Cost to lettuce	-	-	4.66
Glasshouse Repairs			
Annual Cost	8.00	5.00	4.00
Cost to lettuce	2.30	1.53	1.30
Fixed costs allocated to lettuce	5.11	4.02	8.95
	new pence	new pence	new pence
Fixed costs: per doz. lettuce	3.7	2.1	5.4
Standard Production Costs: per doz. lettuce cut (from Table III.4)	26.5	15.2	8.1
Total with certain fixed costs, per dozen lettuce	30.2	17.3	13.5

Returns

The average price received for the twenty crops of heated spring lettuce was 36 pence per dozen. This was only two pence below the winter crop average price and can be attributed to two factors - the exceptionally

high price achieved by one winter crop grower, and the number of spring growers obtaining relatively low prices because they were selling late in the season. Individual crops averaged receipts between 24p and 49p per dozen lettuce sold. (See Table III.7).

Table III.7 Gross margins for each Surveyed Heated Spring Lettuce Crop (per 1000 sq. feet)

Code	Yield	Net Output	Return per dozen	Gross Margin	Gross Margin per week	Number of Weeks in Ground
	doz.	£	p	£	£	
H.29	212	88.92	42	83.45	5.56	15
H.7	207	56.92	27.5	43.91	5.48	8
H.15	192	74.81	38	58.98	5.36	11
H.28	181	82.95	45	67.90	5.22	13
H.22	213	82.75	39	65.66	4.37	15
H.19	208	56.77	27	39.18	3.91	10
H.30	205	68.51	33	55.36	3.79	10
H.16	163	42.28	29	30.72	3.41	9
H.21	145	71.64	49	60.42	3.40	8
H.23	188	67.67	36	50.62	3.15	16
H.31	114	50.61	44	41.00	3.15	13
H.14	166	45.84	33.5	51.55	3.03	17
H.26	115	49.00	42	37.57	2.50	15
H.4	153	66.30	43	42.36	2.23	19
H.5	158	44.94	28	38.07	1.95	20
H.2	139	54.52	39	29.02	1.93	15
H.20	143	55.40	39	29.26	1.86	16
H.25	163	40.69	25	32.11	1.60	20
H.12	109	43.19	38	15.98	1.22	13
H.23	116	28.08	24	11.66	0.08	17
Average	164	59.00	36	44.00	3.19	14.5

The results for H.29 and H.7 reinforce the point about margin per week, made in connection with winter lettuce. Because the H.7 crop matured almost twice as quickly, the weekly gross margin was similar to that for H.29 although the price per dozen and the gross margin per 1000 square feet were both much poorer.

APPENDIX TO CHAPTER THREE

In compiling Tables III.1 and III.4, the total variable costs for each crop surveyed in the winter and spring samples were calculated and the average (arithmetic mean) for each group was then taken. The costs given in the 'high' and 'low' columns are the costs recorded on the nurseries with the highest and lowest total direct costs. The costs in the 'average' column are those recorded on the nursery that had the actual total direct cost closest to the survey average. By compiling the tables in this way certain direct costs fail to appear in Table III.1 and III.4 (Tables III.2 and III.6 are also affected in the last two rows.)

Table III.A.1 provides supplementary information on the missing items, to enable growers and advisers to allow for these costs where they are to be incurred. The costs given in Table III.A.1 apply equally to winter and spring heated crops of lettuce.

Table III.A.1 Direct Costs not appearing in Tables III.1 and 4
(per 1000 sq. feet)

Item	High Cost	Average Cost	Low Cost
	£	£	£
Supplementary light for 3 days from germination	2.50	1.90	1.05
Pricking into boxes of soilless compost	4.05	3.60	3.20
Soil blocked using soilless compost	4.70	3.70	3.30
Carbon dioxide	4.00	2.70	1.50

CHAPTER FOUR

THE COLD LETTUCE CROP

The unheated or cold glasshouse may be used to produce lettuce in Spring well before the outdoor lettuce crop is available. The length of time the cold crop occupies the glasshouse depends on the time of sowing and the variety grown. Naturally, and particularly if grown in the months February, March and April, the cold crop takes longer to mature than a heated crop. The later the cold crop is sown, however, the smaller becomes the time gained by heating, so that, in April and May, a cold crop can be grown as quickly as a heated crop. Slow growth in the cold months means that it is normally only possible to grow one crop of lettuce in an unheated house between October and May.

The average glasshouse area on the twenty-one holdings that grew a crop of unheated lettuce was 25,000 sq. ft. and ranged from 8,000 sq. ft. to 100,000 sq. ft. Almost 95 per cent. of this glasshouse area grew a crop of cold lettuce, the remaining 5 per cent. being used for the production of outdoor vegetable seedlings.

Of the glass used to grow lettuce, only 15 per cent. (all of the aeroplane type) was erected before 1950, a further 35 per cent. was built between 1950 and 1966. The remaining 50 per cent. was erected after the inception of the 1966 Horticultural Improvement Scheme, and was all of the Venlo type of glass. The higher percentage of new glass in the cold group compared with the heated groups is interesting. Certainly cold glass is cheaper to build than heated glass and it may be that growers see unheated glass as one step towards eventually obtaining a heated glasshouse. On the other hand, capital rationing coupled with fear of the consequences of E.E.C. membership may have been responsible for low investment cold glasshouses being preferred to the more expensive heated glasshouses.

In all, twelve different varieties of lettuce were grown of which Delta, grown on some 40 per cent. of the holdings was the most popular.

Table IV.1 Standard Production Costs* for Cold Glasshouse Lettuce per 1000 sq. feet.

Item	High Cost	Average Cost	Low Cost
	£	£	£
Seed	1.56	0.53	0.41
Box Depreciation	0.00	0.01	0.00
Compost	0.00	0.37	0.00
Fertilizer	4.83	1.53	0.33
Pest and Disease Control	0.00	0.35	1.33
Water	0.10	0.10	0.10
Specialist Machinery Depreciation (winch)	0.00	0.05	0.05
TOTAL DIRECT COSTS	6.49	2.94	2.22
Labour at 45p/hour	10.14	7.90	4.06
TOTAL STANDARD COSTS	16.63	10.84	6.28
Yield per 1000 sq.ft. - dozens	135.00	147.00	188.00
Standard cost per dozen cut - new pence	12.3	7.3	3.3

* See explanatory note in Appendix to Chapter 3

Production Costs

With the absence of a fuel bill of any description total direct costs at an average of £2.94 per 1000 sq. ft. are much lower than for the heated crops (Table III.1.). Seed, fertilizer and chemicals are the major items. With regular labour added, at a standard rate of 45 new pence per hour, the average standard production cost for the cold crop of lettuce is in the region of £11 per 1000 sq. ft. or 7.3 pence per dozen lettuce marketed. The ratio between low and high costs-from 3.3 pence to 12.3 pence per dozen - is comparable to that for the heated crops.

Allocation of certain fixed costs (Table IV.2.) adds about 3 pence per dozen lettuce cut to the standard cost. Despite the higher depreciation charges the absence of repair costs, lower sterilisation costs and a shorter growing period all help to keep down the allocated fixed costs and overall costs per dozen lettuce are naturally smaller in the cold than in the heated group.

Returns

The lower average yield and lower average price per dozen cut in the cold smaple results in the average net output of £53 per 1000 sq. ft. being some £7 per 1000 sq. ft. lower than the average net output of both heated groups. The higher gross margin per 1000 sq. ft. in the cold group is a result, therefore, of much lower total direct costs. The gross margin per week of £4.21 in the cold crop is higher than the gross margin per week in both the heated groups and is due to the shorter average growing period and a higher average gross margin per 1000 sq. ft. The usefulness of comparison between the Heated and Cold results is very limited. Readers must accept that they are made so as to highlight the factors responsible for the differences arising and that the results generated are not substitutes for each other in the planning of the glasshouse rotation.

Spacing

The range in spacing distances in the cold sample was from 7" x 7½" to 10" x 8". It is of interest to note that nearly 50 per cent. of the holdings

Table IV.2 Allocation of Certain Fixed Costs according to the Number of Weeks the Lettuce occupied Glasshouse (per 1000 sq. feet)

	High Cost	Average Cost	Low Cost
No. of weeks in the ground	11	11	9
Sterilization	£	£	£
Annual Cost (materials + labour at 45p/hr.)	3.71	7.42	15.40
Sterilization cost to lettuce	0.81	1.57	2.66
Glasshouse Depreciation			
Age of glass in years	3	2	1
Fixed scale depreciation p.a. over 15 year life	14.04	17.00	17.00
Cost to lettuce	2.90	3.50	2.94
Glasshouse Repairs			
Annual Cost	0.00	0.00	0.00
Cost to lettuce	0.00	0.00	0.00
Fixed costs allocated to lettuce	3.71	5.07	5.60
	new pence	new pence	new pence
Fixed costs per dozen lettuce	2.7	3.4	2.9
Standard Production Costs: per dozen lettuce (from Table IV.1)	12.3	7.3	3.3
Total with certain fixed costs per dozen lettuce	15.0	10.7	6.2

surveyed used the recommended spacing of 8" x 8". The lack of any spacing of 7" x 7" or less prevented a comparison being made between close and wide spacings as in the previous chapter.

Table IV.3 Gross Margins for each Surveyed Cold Lettuce Crop (per 1000 sq. feet)

Survey Code	Yield	Number of Weeks in Ground	Net Output	Returns per dozen	Gross Margin	Gross Margin per week
	doz.		£	p	£	£
C.7	192	10	90.00	47	87.53	8.75
C.1	180	8	64.80	36	63.19	7.89
C.16	180	11	80.00	44	78.12	7.10
C.6	188	9	57.74	30	55.72	6.19
C.18	154	7	52.72	34	43.05	6.15
C.17	154	9	48.50	31	46.48	5.17
C.9	196	15	82.47	42	76.85	5.12
C.14	135	11	50.22	37	43.83	3.89
C.10	136	10	40.47	30	38.43	3.84
C.8	128	12	47.10	36	43.25	3.60
C.20	203	18	57.50	28	55.22	3.19
C.19	162	12	40.61	25	38.12	3.17
C.3	166	19	59.50	36	55.29	3.13
C.2	181	20	63.15	35	61.01	3.05
C.12	113	15	46.27	41	44.97	2.99
C.5	171	18	52.20	30	50.45	2.80
C.13	192	20	52.00	27	49.92	2.49
C.15	147	11	27.10	18	24.69	2.24
C.4	111	22	37.16	33	35.33	1.60
C.21	40	8	12.00	30	10.20	1.27
C.11	120	11	53.40	44	52.55	4.77
Average	153	13	52.9	34	54.73	4.21

CHAPTER FIVE

THE IMPACT OF NEW TECHNIQUES

The forcing of a lettuce crop by heating does not require significantly more labour than an unheated crop. The labour rates in Table V.1 thus relate to all 55 growers whose results were considered in Chapters three and four.

New Techniques

Over the past five years developments such as pelleted seed, automatic seeding and soil blocking equipment, and automatic planting equipment, have meant that the glasshouse lettuce need only be handled once - at harvesting - during the production of the crop. If to this impressive progress in mechanization is added the development and introduction of carbon dioxide enrichment of the atmosphere, mildew resistant varieties and glasshouse prepackaging aids then clearly glasshouse lettuce husbandry is undergoing rapid change.

The availability of such techniques is not, however, synonymous with either their success or the rate of adoption by growers. In the first instance a lot will depend on the management objectives of individual growers. For the profit maximisers a new technique must, at the very least, increase total nursery net output by a greater amount than it increases costs. For those who derive maximum utility from non-monetary factors then it may be the reduced requirement or the shortened growing period that makes new techniques attractive.

The relative merits and subsequent adoption or rejection of new techniques, based on the growers' appraisal, depends in the first instance on growers being aware of the existence of the techniques. Communication between individuals and groups is the basic element in the geographical and social diffusion of innovations and will embrace such things as the impact of Research Station Open days, the frequency and calibre of advisory visits, trade and national press publicity,

Table V.1 Labour Employed in Glasshouse Lettuce Production: Man Hours per Operation

Operation	Per 1000 square feet			Per Acre
	High	Average	Low	Average
Preparation of Glasshouse				
Rotovate twice add fertilizer rake and mark out	2.25[1]	0.92	0.25[2]	40.0
Propagation				
Fill boxes and sow seed	0.46	0.20	0.05	8.70
(a) prick off seedlings into boxes filled with compost	9.36	7.74	6.04	336.0
OR				
(b) prick off seedlings into soil block made by manual machine	9.74	8.59	6.92	373.0
Planting[3]				
(a) pricked out seedling by hand	12.00	10.70	7.00	465.0
OR				
(b) blocks by hand	14.40	8.60	7.20	375.0
OR				
(c) pricked out seedling by winch[4]	8.50	7.40	3.30	322.0
Growing				
Pest and Disease Control	0.80	0.21	0.05	9.10
Irrigation: (i) hand	2.00	0.75	0.10	32.6
OR				
(ii) automatic (Semi)[5]	-	0.01	-	0.43
Harvesting				
Cutting, trimming, making boxes, cleaning up soil		10.17		442.0

Notes:
[1] Hand Forked
[2] Tractor rotovated
[3] For direct planting of week old seedlings add 0.50 man hours per 1000 sq. feet to average
[4] If blocks used with winch add 0.50 to average
[5] Semi automatic irrigation only requires to be turned on and off by hand.

growers' meetings and growers' relationships with other growers.

Adoption is the act of accepting an innovation, it is normally an individual reaction and consists of the five consecutive stages, awareness, interest, evaluation, trial and adoption. The remainder of this chapter is thus devoted to analysis of the survey results, with special emphasis on the awareness and adoption stages of the model, in the light of the new techniques available to glasshouse lettuce producers.

The general impression from the data was that although most growers were aware of new developments they were slow to adopt them: an example of this is the use of automatic or semi-automatic sprayline watering systems. These systems which have had general approval for a decade or more, have the advantage over hand watering of saving labour and enabling regulated quantities of water to be spread evenly over the crop. However, 36 of the 55 growers still hand watered their lettuce. Whilst a dozen or so justified this with comments such as "nothing else for the labour to do" or "not enough mains pressure for spraylines" at least twenty, all of whom were aware of the sprayline system, offered no reason for persisting with hand watering.

Propagation and Planting

Two methods of sowing have been in common use in Lancashire for some years. Naked seed is sown either on a prepared bed of compost on the glasshouse floor or into boxes of compost. On germination the seedlings are usually pricked out into boxes of compost, where they remain for two to three weeks before being transplanted into the final growing position. Alternatively they can be planted directly into the growing position. Pelleted seed, which consists of individual naked seeds coated with a chemically neutral and soluble covering, enables precision sowing techniques to be used for glasshouse lettuce. The pellets can be sown mechanically by drill or by hand into soil blocks, pots, or some similar container. The blocks are then subsequently

planted into the growing position. From pelleted seed sown in boxes, the resultant seedlings are transplanted into the growing position.

The advantage of pellets over the traditional method of sowing, pricking out, and transplanting is a reduction in the number of handling operations from three to two thus reducing the checks to the plants. The advantage over the direct planting method is for the heated crops only; whilst it does not for them reduce the number of handlings, it enables a relatively large number of seedlings to be kept in a small space, thus reducing fuel bills.

Thirty six growers in the survey sowed naked seed into boxes, 17 sowed naked seed into a bed on the glasshouse floor, one bought lettuce plants from another grower and only one grower used pelleted seed which he sowed by hand into peat pots. It is of interest to note that the pelleted crop occupied the glasshouse for only eight weeks, which was about the shortest period found in the survey.

In the total sample, 35 crops were planted direct on germination, 13 were pricked out into boxes and 12 pricked out into blocks. Of the 33 growers who grew a heated crop, 26 direct planted lettuce despite the fact that this practice is generally not recommended because of the relatively higher associated fuel costs.

A relatively new technique is the speeding up of the growth rate of lettuce seedlings by subjecting them to high intensity lighting for a period of three to 14 days. Although 42 growers knew about this technique, none had adopted it - perhaps for lack of information on its economic significance.

Growing On

Research work has shown that at higher temperatures a glasshouse atmosphere enriched with carbon dioxide gas to a level of between 600 and 1000 parts per million will produce a heavier lettuce more quickly. Since only four out of the 35 growers in the heated samples used carbon dioxide on lettuce it is not possible to draw any conclusive evidence about the time saved or the weight of the lettuce (as reflected in the

price received). It may, however, be relevant to remark that two of the three highest prices obtained in the winter group and the highest price in the spring heated group were for lettuce grown with carbon dioxide enrichment. On all four nurseries CO_2 enrichment was effected by the burning of propane gas. A further six growers had propane burners installed but used them only for tomatoes. Six other growers had tried CO_2 on lettuce: two thought it had no effect at all, two did not want a quicker throughput, and two could not use any time that might be saved. The remaining 21 growers had not tried CO_2 and at least four were not aware of the technique.

Harvesting

The packaging of lettuce in individual polythene bags and the replacement of the wooden returnable crate by the cardboard container are the two changes which have affected the marketing of glasshouse lettuce in the past few years. Lettuce packed in polythene bags have a longer shelf life, are more attractive and secure a better price than non-packed lettuce. Non-returnable cardboard containers facilitate easier handling although part of their popularity has undoubtedly been due to pressure on growers from wholesalers faced with large bills for depreciation, replacement, repairs and storage of wooden containers.

Lettuce was cut and rough trimmed in the glasshouse on all the nurseries in the survey. Fourteen per cent. by volume was consigned in this state in bulk bins to a secondary wholesaler. The remaining 86 per cent. was roughly graded by eye (one grower did in fact weight grade) and almost three-quarters of it was packed in polythene bags and despatched in non-returnable cardboard containers. The rest was packed straight into wooden boxes.

CHAPTER SIX

CONCLUSION

This report has presented a brief analysis of glasshouse lettuce production as surveyed in Lancashire during 1969-70. An attempt has been made to set the survey within the contexts of the county and national glasshouse industries, of the over all supply of lettuce in the months of October to May, and of the developing techniques available to glasshouse users.

In the course of reading the report it must become clear that lettuce growers are faced by a multitude of choices. Not all choices are of equal importance nor are all choices always available to an individual grower. A selected cropping programme may determine the type of glasshouse to be built and whether it shall be heated or cold. Given an existing structure and equipment, the choice of cropping programme will itself be restricted. These are probably the basic initial choices which a grower has to make.

Within the chosen system, however, there are many lesser choices which can be made from year to year, such as lettuce variety, extent of expenditure on protection of plant health, planting systems, marketing channels and even to some degree the timing of the crop. In making these lesser choices a grower may be influenced by a desire to keep his workers contented or to reduce his own manual input as well as by a need to safeguard his income. The non-income elements are possibly more important at this stage than when making the basic decisions which establish the volume of capital invested and the pattern of cash outflow and return.

Whilst absolute profit maximisation may rarely be the sole consideration, it is reasonable to suppose that no one wishes to forgo income unnecessarily in the pursuit of other objectives. Given the constraint of other objectives - which may vary from providing satisfactory employment for existing staff to avoiding the use of chemicals as far as possible - any grower needs to face the remaining alternatives open to him by asking the question 'what difference will the employment of a given alternative make to the net income of the

nursery?' Net income is, of course, the residue of receipts after expenses have been met, and therefore, the effect of alternatives on both costs and returns must be examined.

Because equipment associated with technical innovation in lettuce production may be employed in growing other crops, because a change in the timing of the lettuce crop may affect the costs, yields or prices of another crop in the rotation, because of a need to safeguard labour supply round the year, the profitability of a lettuce crop cannot be taken in isolation as an adequate criterion for choice between alternatives. The effect of a given choice upon the operation of the whole nursery around the year needs to be examined. Sometimes this will be a relatively simple exercise which can be carried out on the back of an envelope. On other occasions, such as the establishment or reorganisation of a large business where no options are excluded, sophisticated colculations and professional advice may be necessary. Each situation requires its own individual appraisal: this report should have indicated some of the factors involved and ways in which they can be measured.

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