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Carrots - Marketing

Agricultural Enterprise Studies
in England and Wales
Economic Report No. 6



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**THE ECONOMICS OF
CARROT PRODUCTION
AND MARKETING
IN BRITAIN**

by

W. L. HINTON

A COMMODITY STUDY

Issued by the

**AGRICULTURAL ECONOMICS UNIT
DEPARTMENT OF LAND ECONOMY
CAMBRIDGE UNIVERSITY**

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Foreword to the Series

The economics of particular crop or livestock enterprises have been investigated and reported on by individual departments of agricultural economics at Universities in England and Wales for several decades. In this work the departments have received (and continue to receive) generous support, financial and technical, from the Ministry of Agriculture, Fisheries and Food.

From time to time, the departments meet together with representatives of the Ministry to discuss common problems in their enterprise study work. One recent development has been the mounting of joint studies by two or more departments with a special interest in a particular enterprise. As a natural sequence, it has been decided that, although the reports will continue to be prepared and issued by individual departments, this community of interest should be recognised by giving the reports a common series title. Hence emerged the series the 'Agricultural Enterprise Studies in England and Wales'.

Recent titles of enterprise study reports and the addresses of university departments concerned are given at the back of the report.

Foreword

Sales of carrots are worth £7m a year to the farmer, £7m to the processor and £20m to the greengrocer. This report deals with the economics of production and marketing this crop. It is based on a national survey which covers a quarter of the entire acreage. The random sample was provided by the MAFF and records were collected with the co-operation of the agricultural economics departments of Leeds, Nottingham and Manchester universities.

Carrots are grown on the arable farm and have importance as a break crop quite apart from being a cash crop in their own right. The crop moreover features a sophisticated form of share cropping and contract farming, unusual in British farming, and demonstrates economies of scale in production and marketing. In Britain the carrot is a popular vegetable. The market for the crop is unique in so far as the fresh and processing trade share the supply, and their marketing is interrelated. Demand expectations for carrots are good, both for the fresh and the processed commodity, and new developments in prepacking and processed packs will emerge as incomes increase. Consumers in Britain value the nutritive qualities of the carrot; they also buy luxury fresh carrots from many parts of the world. There is increasing opportunity for Britain to export carrots in the processed form, as our production and organisation is highly developed for this purpose, but the market for fresh carrots and production for new outlets is in need of development.

The report has been written by W. L. Hinton, who co-ordinated the economic survey and developed subsequent research to present this comprehensive commodity report.

We are indebted to the farmers, merchants, and processors whose willing co-operation has made this report possible, and to the economists at the three other universities. The research also benefits from discussions with various people connected with the industry including Dr. V. D. Arthey of the Fruit and Vegetable Preservation Association and Mr. T. Laffin, formerly of ADAS. For certain statistical information on the commodity and for the random sample, members of several divisions of the Ministry of Agriculture have been most helpful, in particular Mr. F. H. Watts. In Cambridge assistance was given by various people, Mr. W. C. Housden (analysis, diagrams, and field visits), Messrs. C. W. Brooks and J. G. Davidson (field visits), and Mr. M. C. Murphy (statistical analysis).

F. G. Sturrock
Director, Agricultural Economics Unit

Summary

This commodity report concerns the economics of production and marketing of carrots in Britain. It is based on a country wide economic survey of the 1968-9 crop. The survey was organised by Cambridge in co-operation with Leeds, Manchester, and Nottingham universities, and the work was commissioned by the Ministry of Agriculture. Because of the importance of carrot merchants (farmers who market carrots from other farms) a survey of their market operation was also made.

The first chapter deals with the place of the commodity in agriculture and trade. Carrots are increasing in consumption and production in Britain and are grown on a large and expanding scale. Some forty thousand acres (16000 ha) are grown and production which exceeds five hundred thousand tons (1969-70), is second only to France in Western Europe, but in France production for processing is less important. The crop is concentrated in Eastern England where most of the canning factories are situated, and from which the nationwide distribution of fresh carrots is carried out.

Carrots are grown on the arable farm where they are an important break crop for cereals and their profitability should not be measured in accounting terms alone. The economic survey shows that in most cases the farmer grows and markets the crop but on one third of the farms the merchant grows and markets either in partnership or through renting land. Profit per acre is in proportion to the investment in the crop. It is highest for the farmer who grows and markets the crop himself and lowest for the farmer who rents out his land. Assessed profit depends on yield but for the individual farmer the contribution of the crop to farm profit depends most on his farm organisation.

The third chapter deals with the function of the carrot merchants who now market half the carrots in the country. The contractual relationship between the merchant and the farmer is discussed and the marketing organisation of the merchant is analysed and illustrated from the operations of one dealer in fresh carrots. The role of the merchant is important in the development of the market for fresh and processed carrots and this is likely to continue to be important.

The marketing of carrots throughout Britain is dominated by the growers and merchants in the Chatteris area of Cambridgeshire but growers outside this area market (mainly fresh carrots) locally in their adjacent urban centres. Scottish production is more especially based on processing and some carrots are also used for livestock feeding. Imported carrots account for some five to seven percent of the supply and are most important in May and June. Statistical relationships in supply and demand show some response in the acreage planted to the price of the previous crop, but other factors are present. There is a closer relationship between demand (expressed in consumption per head) and acreage grown. Carrot consumption may be expected to increase whether or not Britain joins the EEC. In the Common Market imports from Cyprus are likely to decline and the balance would need to be replaced. A proportion of the imports could be saved by greater attention to the production of luxury finger carrots in Britain. Some achievements have been made in research on carrots for processing but the market for fresh carrots is in need of development if the growing demand for carrots is to be satisfied as affluence increases in Britain.

Résumé

Le sujet de ce rapport est l'économie de la production et de la commercialisation des carottes en Grande Bretagne et représente le résultat d'une étude économique des récoltes de 1968-69 pour l'ensemble du pays. Cette étude a été réalisée par l'Université de Cambridge en collaboration avec celles de Leeds, Manchester et de Nottingham et subventionnée par le Ministère Britannique de l'Agriculture. Etant donnée l'importance des marchands de carottes (fermiers écoulant les carottes produites par d'autres fermes), ce rapport contient aussi une analyse de leurs techniques de commercialisation.

Le premier chapitre traite de la place occupée par ce produit agricole en agriculture et dans le com-

merce. En raison de l'augmentation de la consommation et de la production des carottes en Grande Bretagne leur culture se fait sur une grande échelle et va toujours croissant. La surface cultivée atteint quarante mille acres (16000 hectares) et la production dépasse cinq cent mille tonnes (1969-70). Après la France la Grande Bretagne est le second producteur de carottes d'Europe Occidentale mais en France la production pour la transformation est moins importante qu'en Grande Bretagne. La majorité des cultures se font dans l'est de l'Angleterre qui est aussi la région où se trouvent la plupart des fabriques de conserves et d'où les carottes crues sont écoulées vers le reste du pays.

Les carottes sont cultivées sur des terres arables et constituent une importante culture de rotation pour les céréales. De ce fait, en en mesurant le rapport, il ne suffit pas de s'en tenir à des considérations purement financières. L'étude économique révèle que dans la plupart des cas le marchand récolte et écoule ses propres carottes. Toutefois, dans un tiers des fermes considérées, le marchand cultive et écoule ses cultures en collaboration avec d'autres fermiers et, dans d'autres cas, il loue la terre qu'il travaille. Le rapport par acre est proportionné aux sommes investies dans la culture. Il est à son maximum dans le cas du fermier qui cultive et écoule lui-même sa récolte et à son minimum pour celui qui loue les terres qu'il travaille. Le rapport est déterminé par le rendement mais pour chaque fermier la contribution de la récolte au rapport total de la ferme dépend surtout de l'organisation de celle-ci.

Dans le troisième chapitre on examine le rôle du marchand de carottes qui, à l'heure actuelle, écoule la moitié des carottes récoltées en Grande Bretagne. On y discute les rapports contractuels qui existent entre fermiers et marchands et on y examine le système de commercialisation adopté par les marchands, prenant pour exemples les différentes techniques utilisées par un marchand de carottes crues en particulier. En ce qui concerne le développement de la commercialisation des carottes crues et transformées le rôle du marchand est important et continuera probablement à le rester.

Les cultivateurs et marchands de la région de Chatteris, dans le Cambridgeshire, occupent une place prépondérante dans la commercialisation des carottes à travers toute la Grande Bretagne mais les producteurs n'habitant pas cette région écoulent leurs produits (surtout des carottes crues) dans les agglomérations locales les plus proches. En Ecosse la plus grande partie des carottes récoltées subissent des transformations et on les utilise aussi pour nourrir le bétail. Les carottes importées forment cinq à sept pour cent de l'approvisionnement et leur importance se fait surtout sentir en Mai et Juin. Les rapports statistiques entre l'offre et la demande révèlent que la surface cultivée a tendance à être influencée par le prix des récoltes précédentes mais il faut également tenir compte d'autres facteurs. Il existe un rapport plus étroit entre la demande (c'est à dire la consommation par personne) et la surface cultivée. Que la Grande Bretagne joigne ou non le Marché Commun la consommation de carottes ne peut qu'augmenter. Au cas où elle deviendrait membre l'importation des carottes de Chypre diminuerait sans doute et il lui faudrait alors, pour rétablir l'équilibre, trouver d'autres fournisseurs. Il serait possible de réduire l'importation en donnant plus d'importance à la culture des carottes de luxe. Les recherches sur la transformation des carottes ont donné de bons résultats mais il faudrait maintenant développer la commercialisation des carottes crues de façon à satisfaire une demande croissante, résultat d'un niveau de vie en hausse.

Zusammenfassung

Dieser Wirtschaftsbericht befasst sich mit der Rentabilität der Produktion und des Absatzes von Mohrrüben in Grossbritannien. Er beruht auf einer wirtschaftlichen Begutachtung der Ernte im Jahre 1968/69. Die Untersuchungen wurden von der Universität Cambridge in Zusammenarbeit mit den Universitäten Leeds, Manchester und Nottingham geleitet, die vom Landwirtschaftsministerium mit der Arbeit beauftragt wurde. Wegen der wichtigen Stellung der Mohrrübenhändler (Landwirte, die Mohrrüben anderer Betriebe vertreiben) wurde ausserdem ein Überblick über deren Absatzhandel gegeben.

Das erste Kapitel befasst sich mit der Stellung des Erzeugnisses in Landwirtschaft und Handel. Anbau und Verbrauch von Mohrrüben in England steigen ständig. Der Anbau erfolgt in grossem,

immer wachsenden Umfang. Etwa 40 000 Morgen werden angepflanzt (16 000 ha), und die Erzeugung, die 500 000 to übersteigt, wird in Westeuropa nur von Frankreich überboten, aber in Frankreich ist die Erzeugung zur Weiterverarbeitung weniger wichtig. In England konzentriert sich der Mohrrübenanbau in Ostengland, wo die meisten Konservenfabriken liegen, und von wo der Vertrieb von frischen Mohrrüben über ganz England erfolgt.

Mohrrüben sind ein Erzeugnis des Ackerlandbetriebes, wo sie eine wichtige Zwischenfrucht für Getreide darstellen. Ihre Wirtschaftlichkeit sollte nicht allein mit rechnerischen Mitteln ermessen werden. Der Wirtschaftsbericht zeigt, dass in den meisten Fällen der Landwirt das Erzeugnis anbaut und es in Partnerschaft oder durch das Verpachten von Land vertreibt. Der Gewinn pro Morgen hängt von der Investierung in das Erzeugnis ab. Er ist am höchsten für den Landwirt, der es selbst anbaut und absetzt, und am niedrigsten für den, der sein Land verpachtet. Der veranlagte Gewinn hängt vom Ertrag ab, aber für den einzelnen Landwirt ist der Beitrag des Erzeugnisses zum Gesamtgewinn seines Betriebes in erster Linie eine Frage seiner Betriebsorganisation.

Das dritte Kapitel befasst sich mit der Aufgabe der Mohrrüben-grosshändler, die heute die Hälfte aller Mohrrüben im Lande vertreiben. Das vertragliche Verhältnis zwischen Grosshändler und Landwirt wird besprochen und die Marktorganisation des Grosshändlers analysiert und veranschaulicht an Hand der Erfahrungen eines Händlers für Frisch-Mohrrüben. Die Rolle des Händlers ist wichtig für die Entwicklung des Marktes für frische und weiterverarbeitete Mohrrüben, und wird sehr wahrscheinlich auch wichtig bleiben.

Der Absatz von Mohrrüben in ganz England wird beherrscht von den Erzeugern und Händlern in der Chatteris-Gegend von Cambridgeshire, aber Erzeuger ausserhalb dieses Gebietes setzen (hauptsächlich frische Mohrrüben) örtlich in ihren angrenzenden Stadtgebieten ab. Die Erzeugung in Schottland ist mehr auf Weiterverarbeitung ausgerichtet, während ein Teil der Mohrrüben auch als Viehfutter Verwendung findet. Eingeführte Mohrrüben machen etwa 7% des Angebots aus, und sind am wichtigsten im Mai und Juni. Statistiken über das Verhältnis von Angebot und Nachfrage zeigen eine gewisse Reaktion in der durchschnittlichen Anbaufläche auf den Preis der vorhergegangenen Ernte. Aber es gibt andere Faktoren. Ein engeres Verhältnis besteht zwischen Nachfrage (ausgedrückt im Verbrauch pro Kopf) und der Grösse der Anbaufläche. Der Mohrrübenverbrauch wird eine steigende Tendenz zeigen, ob Grossbritannien der Europäischen Wirtschaftsgemeinschaft beitrifft oder nicht. Im Gemeinsamen Markt ist zu erwarten, dass die Importe von Cypern zurückgehen und der Ausfall müsste ausgeglichen werden. Ein Teil der Importe könnte eingespart werden durch grössere Beachtung der Erzeugung von feinen Fingermohrrüben in Britannien. Einige Forschungserfolge wurden mit Mohrrüben zur Weiterverarbeitung erzielt, aber der Markt für frische Mohrrüben bedarf der Erweiterung, wenn man der steigenden Nachfrage nach Mohrrüben gerecht werden will bei Britanniens zunehmendem Wohlstand.

CHAPTER 1

Carrots in Agriculture and Commerce

INTRODUCTION

Prior to this study there has been no research on the economics of production and marketing of carrots in Britain. Today some forty thousand acres are grown, an increase of twelve percent since 1960 or twenty five percent since 1950. Over the same period, production, 550 thousand tons in 1969-70, has increased by forty and sixty percent respectively. Yields per acre continually improve and have risen twenty five percent in the last decade. The crop has always been important in Britain, and with an output of £7 m, now accounts for ten percent of field vegetables, which together represent seventeen percent of the annual value of farm crops.

Carrots are popular in Britain. Apart from potatoes, they are second only to cabbage in consumption, exceeding by four times that of turnips and swedes. Apparent consumption per head per year is now 15-20 lbs, an increase of fifty percent in the last twenty years. There is a marked seasonal variation in consumption according to fluctuations in yield. In Britain far more carrots are consumed than in other European Countries, except France. Western Germany (with a similar population) consumes less than half as much.

Known botanically as *Daucus Carota*, the carrot originated as a wild plant in Southern Europe, and was first documented in British records in 1597 when it was already known as a remedy for night blindness. Today its value as a protective food in human nutrition is well established. The carrot is abundant in carotene (a precursor of vitamin A), in which it exceeds all other root vegetables, and is second to fresh peas for vitamin B1 (anti-neuritic) and B2 (cellular utilisation). Like all fresh vegetables, it is rich in minerals and in vitamin C and it has importance in activating the digestive process.

Britain is nearly self sufficient in carrots, but she imports up to ten percent each year according to the level of home production. These are principally of the luxury type, which is not really the same commodity as our own, and they arrive chiefly towards the end of the home season.

The acreage of carrots grown in Britain from pre-war to the present time is shown in table 1.

Table 1. United Kingdom carrot acreage pre-war to 1970

	UNITED KINGDOM		ENGLAND AND WALES	
	Total Acres	Earlies Acres	Maincrop Acres	Total Acres
1936-38	16,449			15,330
1946-50	35,361			34,060
1951-55	29,529			28,240
1956-60	32,377			30,760
1960	36,213	2,037	32,181	34,218
1961	29,474	1,691	26,413	28,104
1962	33,121	2,184	29,071	31,255
1963	32,397	1,670	28,887	30,557
1964	27,814	1,314	24,672	25,986
1965	24,635	1,168	21,850	23,018
1966	28,513	1,750	25,018	26,768
1967	30,407	1,915	26,515	28,430
1968	35,855	1,473	31,841	33,314
1969*	43,290	4,446	36,171	40,617
1970	40,059	5,054	32,556	38,610

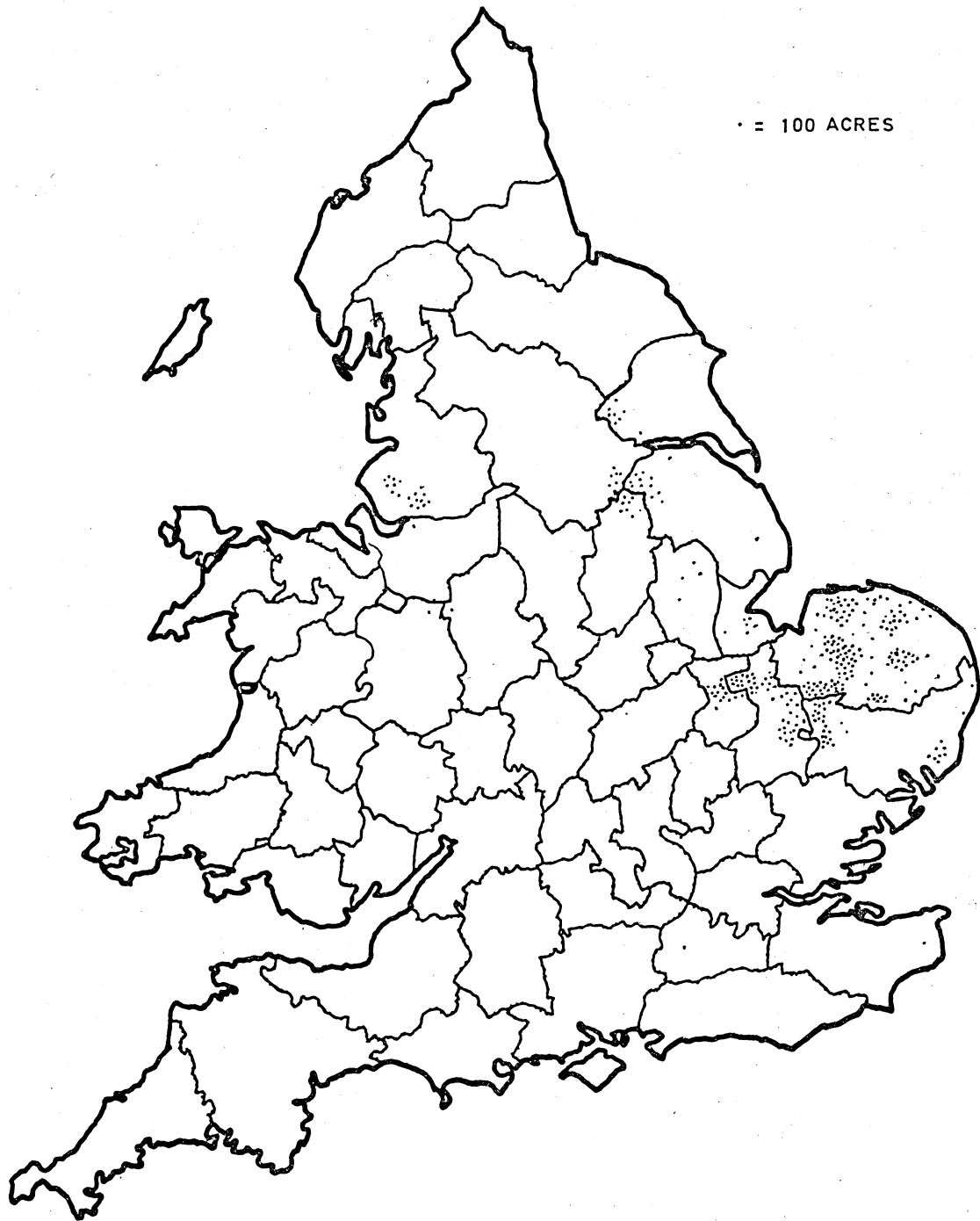
*Recorded on new basis for earlies

Source: MAFF Statistics

LOCATION OF PRODUCTION

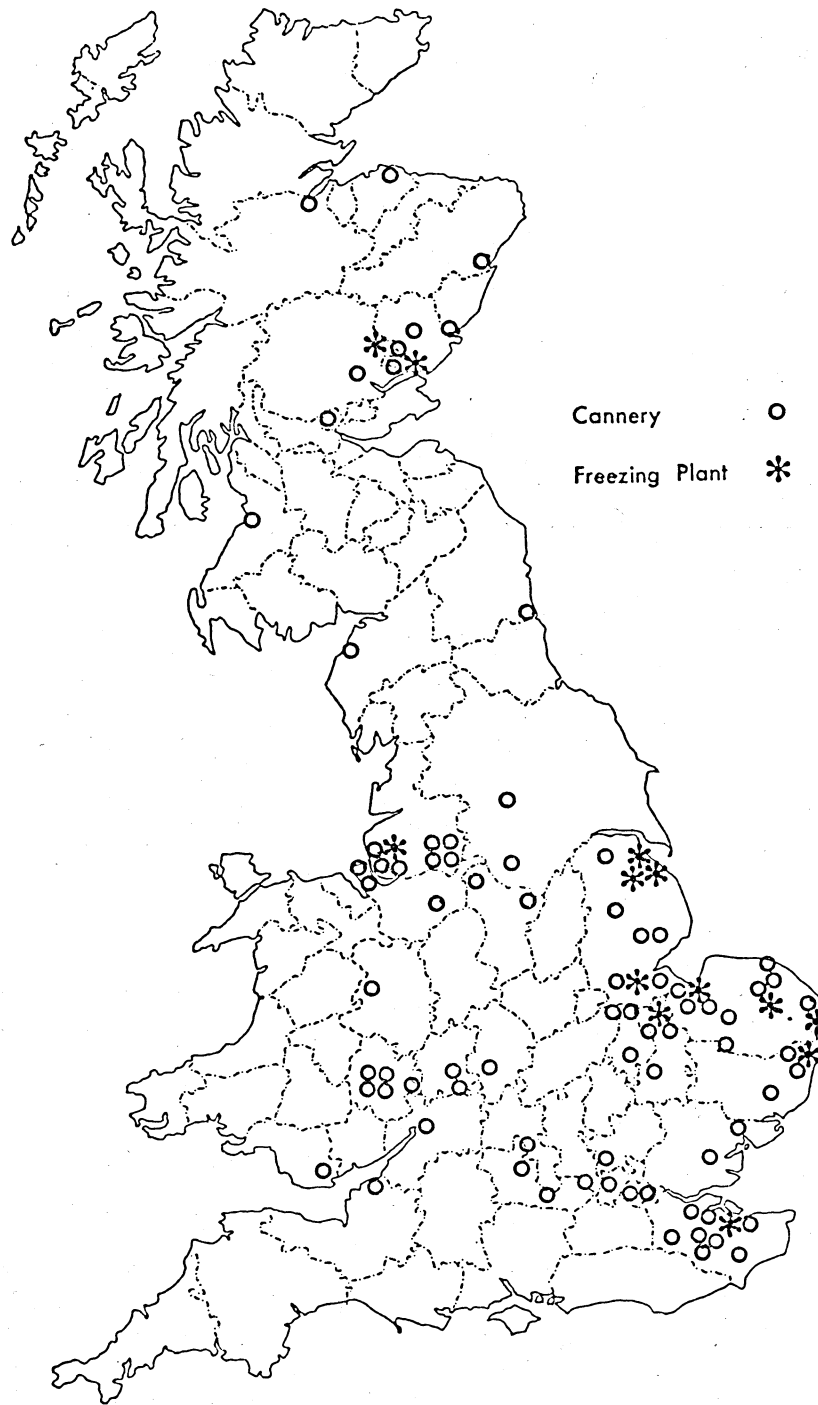
Carrots grow best on light friable soils that allow the roots to develop. Such soils also facilitate harvesting because the earth falls away from the root on lifting. Suitable conditions are found in the Fens and in the northern part of the Trent Valley and on the sand areas of Norfolk and Suffolk. Carrots are also

Figure 1. Carrot areas in England, June 1968



Source: June 4th Returns England and Wales 1968

Figure 2. Fruit and Vegetable Processing in Britain



From: Horticulture in Britain, Part 1, Vegetables

important in parts of Yorkshire and of South West Lancashire. Ninety seven percent of the crop in Britain is grown in England with nearly two thousand acres in Scotland (principally in the plain of Strathmore), and six hundred in Northern Ireland. All counties, particularly in Scotland and Northern Ireland, grow a few acres of carrots. This is to achieve partial self-sufficiency in areas remote from the main channels of the carrot trade based in Eastern England. Carrots are grown almost entirely on arable farms as a break crop in the rotation. The location of carrot production and the concentrations in England are shown in Figure 1 opposite Figure 2 which shows the location of processing in Britain (pages 10 and 11).

Table 2. United Kingdom carrot acreage 1970

University and County	All Carrots	Percent of UK	MARKET CARROTS		PROCESSING CARROTS
			Earlies*	Maincrop	
	Acres	Percent	Acres	Acres	Acres
Bedfordshire	66	0.2	35	30	1
Cambridgeshire & Isle of Ely	5,086	12.7	1,095	3,296	695
Essex	37	0.1	9	20	8
Huntingdonshire & Peterborough	1,324	3.3	124	1,078	122
Lincolnshire (Holland)	713	1.8	95	341	277
Norfolk	16,407	40.9	1,989	8,330	6,088
Suffolk	4,679	11.7	387	2,119	2,173
CAMBRIDGE REGION ..	28,312	70.7	3,734	15,214	9,364
Lincolnshire (Kesteven)	156	0.4	12	82	62
Lincolnshire (Lindsey)	1,749	4.4	70	951	728
Nottinghamshire	918	2.3	18	650	250
NOTTINGHAM REGION ..	2,823	7.1	100	1,683	1,040
East Yorkshire	768	1.9	40	484	244
West Yorkshire	818	2.0	5	664	149
North Yorkshire	68	0.2	7	61	—
LEEDS REGION	1,654	4.1	52	1,209	393
Lancashire	3,042	7.6	673	1,971	398
MANCHESTER REGION ..	3,042	7.6	673	1,971	398
Other Counties	1,779	4.4	495	765	519
ENGLAND & WALES ..	37,610	93.9	5,054	20,842	11,714
SCOTLAND	1,877†	4.7			
NORTHERN IRELAND	571†	1.4			
UNITED KINGDOM ..	40,059	100.0			

*intended for marketing by mid-September

†not broken down for market and processing carrots

Source: MAFF Statistics

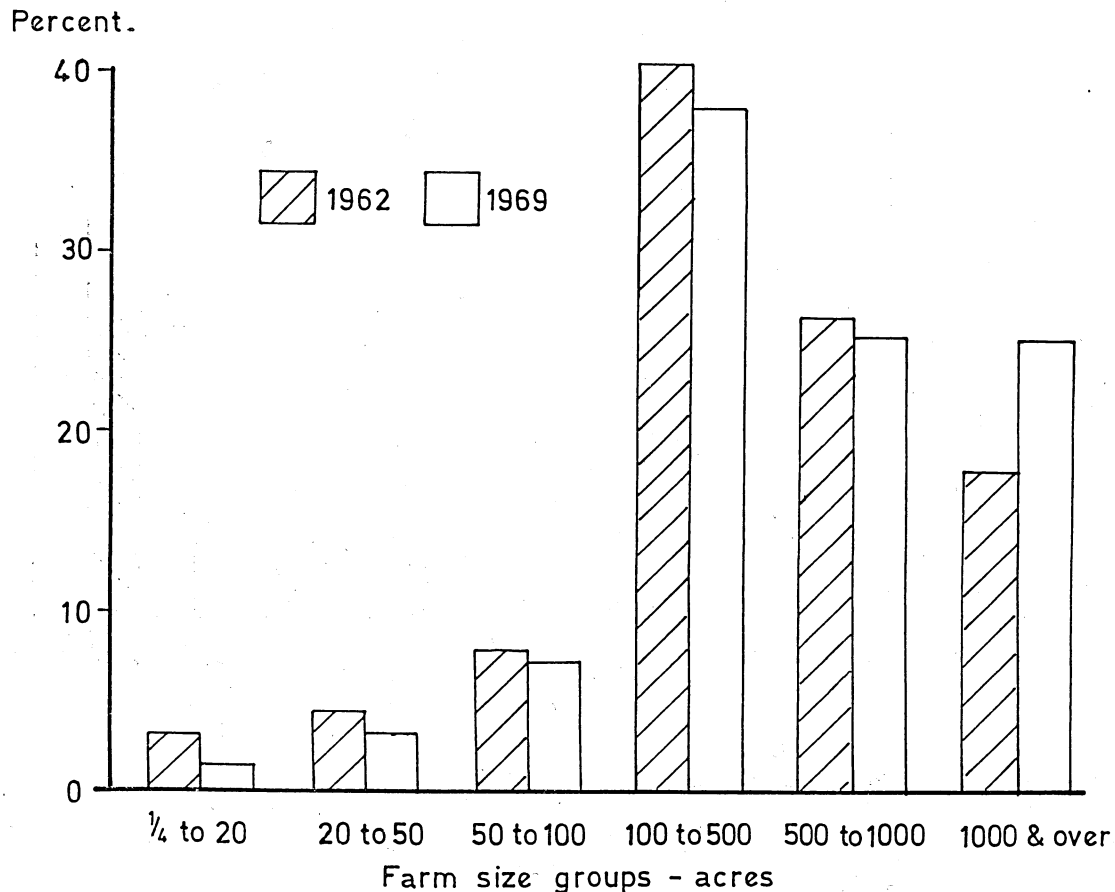
If we employ the regions in the survey (see Table 2), 71 percent of the acreage is now grown in the Cambridge region, seven percent in Nottingham, four percent in Leeds, and eight percent in Manchester. Other counties in England and Wales account for only four-and-a-half percent of the acreage. Over the last twenty years the Cambridge total has increased from 17,000 to 28,000, while adjacent Nottingham has fallen slightly from over 4,000 to less than 3,000. In Leeds (Yorkshire) the acreage has fallen more markedly from nearly four, to one and a half thousand. Manchester (Lancashire) has notably increased its acreage from a mere 200 to over 3,000. Within the Cambridge region Norfolk has gained, as has Cambridge (with the Isle of Ely), and Suffolk. Underlying the increasing acreage in the country is the expansion of demand for carrots both for the fresh market and for processing. The shift in location is due to the development of the carrot merchant business centred on Chatteris in Cambridgeshire (see Chapter 3), and the supply of experienced casual workers. The proximity of London and good road

communication to markets in other urban centres and the presence of processing factories which have expanded greatly in recent years, has also encouraged a concentration in this area.

Well over ninety percent of the carrots are main crop for market or processing. Early carrots are rather difficult to define. Bunching carrots are mainly concentrated in the market garden districts and grown intensively. Until 1969 when they accounted for some three percent of the acreage, early carrots were recorded separately in the June 4th returns for England and Wales. In 1969, however, market carrots and processing carrots were recorded separately. Market carrots now include a separate category for early carrots (those lifted by mid September). The three fold increase in 'early' carrots in this year thus merely reflects the new basis of recording (see Tables 1 and 2). Most of the truly early carrots are sold in July. After the main crop carrots start in August 'early' carrots are not distinguishable. The figures for 'market' and 'processed' carrots do not necessarily indicate the amount used for each purpose. In fact only two thirds of the crop grown for processing is actually used as such, the remainder going on the fresh market. Conversely, some carrots recorded as 'market' carrots in fact go for processing.

Rather more than half the processing factories (Figure 2) in England are established in areas of carrot concentration. In these areas most of the carrots are canned, though some are quick frozen. Factories in the Southern belt from Hereford to Kent are more concerned with other vegetables and fruit. Carrots also feature prominently in the processing factories of Eastern Scotland. Quick freezing, particularly at the coast, chiefly concerns fish and vining peas.

Figure 3. Distribution of the Carrot Acreage by Farm Size Groups, 1962 and 1969.



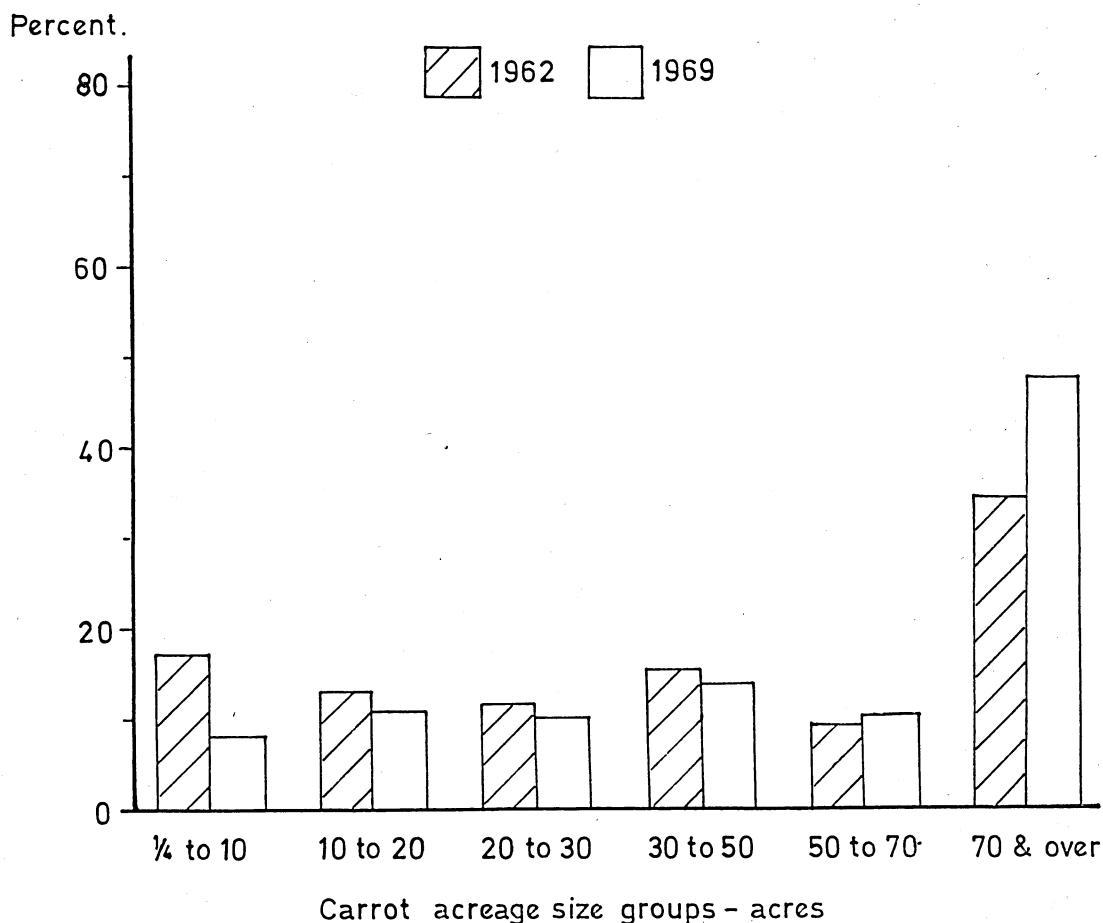
Source: MAFF statistics, England and Wales.

SCALE OF ENTERPRISE

In recent years the increase in the scale on which carrots are grown in Britain has been spectacular. Figure 3 shows the proportion of the carrots in England and Wales (the size distribution is not available for the U.K.) grown on farms of different sizes in 1962 and 1969. Just over two thousand farms grow carrots (in 1969) compared with more than twice that number in 1962, when the acreage was ten percent less. Sixty percent of the smaller farms (of less than one hundred acres) now grow twelve percent of the carrots (sixteen percent in 1962). At the other extreme, the largest farms (over a thousand acres) numbering only four percent, grow a quarter of the acreage compared with only eighteen per cent in 1962. Carrot growing is thus shifting into the hands of the bigger producers.

The area of carrots grown on each farm is shown in Figure 4 for 1969 and 1962. Five percent of all farms with over seventy acres now grow forty eight percent of the total compared with thirty four percent in 1962. Farms with less than ten acres of carrots (seventy nine percent of the farms) grow only eight percent of the crop.

Figure 4. Distribution of the Carrot Acreage by Crop Size, 1962 and 1969



Source: MAFF statistics, England and Wales.

THE MARKET FOR CARROTS

Carrots for human consumption greatly increased during the war (see Table 1) when there was a guaranteed price for carrots up to the end of the 1949 season. In 1950 output was some 330,000 tons

and by 1969 this had reached nearly 550,000 and yield has increased by fifty percent since pre war. The farm gate value of carrots in 1950 was £2 million, reaching £7 million in 1968 (a year of exceptional prices), and falling back to just below that amount in 1969. The market for processing carrots has also expanded, particularly in recent years. In 1949 (the earliest record) production of canned carrots in Britain was 13,500 tons (long tons net can content). The figure reached 25,000 in 1956, 59,000 in 1966, and 100,000 in 1969. By 1966, some sixteen percent of the crop was canned, and this total has risen steeply since and now, from twenty five to thirty percent of the crop goes for canning. Consumption per head of fresh carrots has almost doubled from eleven to twenty lbs since 1960, and that of processed carrots has quadrupled (14 oz in 1957 to 63 oz in 1969).

The home supply is supplemented by imports particularly in April, May, and June, when few home grown carrots remain. Imports are of early carrot quality and have only a limited market. (A few home grown carrots of equal quality sell on the normal fresh market or as prepacks but many are indistinguishable from the bulk, and of course carrots of similar quality go for processing). Annual imports by volume exceptionally exceed ten percent of the total supply (table 3), and they normally represent some five to seven percent of the volume. Since imported carrots demand a higher price they account for up to twenty percent by value of the total market for carrots in Britain. Imports have been selected and specially prepared to compete on our market, and to pay the transport costs from the country from which they are sent. In table 3 the price of home grown carrots is at the farm gate. To be comparable with imports this price needs to be doubled as imports are further on in the marketing process.

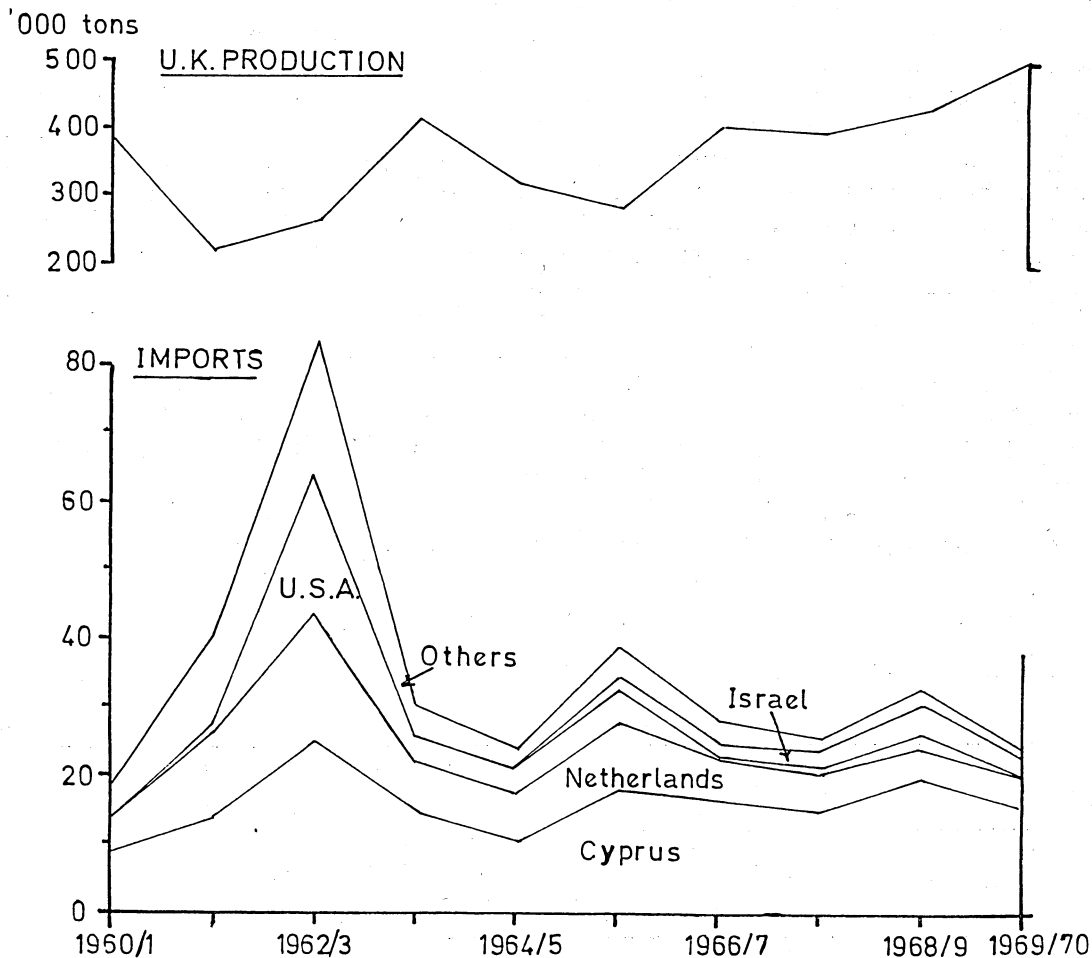
Table 3. The development in the market for carrots, 1969 to 70, total supplies, home-grown and imports.

Year	Home Grown			Imported			Total Supply	
	Total Quantity '000 tons	Price £ per ton	Total Value £ million	Quantity '000 tons	Price £ per ton	Value £ million	Quantity '000 tons	Value £ million
1936-39 (average) ..	155	3.77	.58	13	10.77	.14	168	.72
1946-50	312	9.06	2.83	6	58.44	.36	318	3.19
1951-55	267	13.53	3.61	19	47.53	.90	286	4.51
1956-60	309	11.33	3.50	23	49.36	1.14	332	4.64
1960	383	8.57	3.29	19	51.26	.97	402	4.26
1961	225	19.29	4.34	42	62.45	2.62	267	6.96
1962	264	13.78	3.64	84	61.91	5.20	348	8.84
1963	418	9.75	4.08	26	54.35	1.41	444	5.49
1964	324	12.32	3.99	24	59.54	1.43	348	5.42
1965	284	16.30	4.64	38	61.88	2.36	322	7.00
1966	407	11.42	4.65	29	54.49	1.55	436	6.20
1967	398	12.67	5.05	24	67.55	1.65	422	6.70
1968	433	17.57	7.60	34	68.43	2.38	467	9.98
1969	547	12.43	6.80	30	61.31	1.40	577	8.20

Source: MAFF Statistics.

Figure 5 shows supplies of carrots on the British market from 1960-1 to the 1969-70 season. Imports fall into significance when it is realised that one interval on the scale giving production represents ten times the quantity on the scale showing imports. Big fluctuations in the home supply of carrots to a large extent follow changes in the acreage from season to season (table 1). This applies to all seasons from 1960-1 to 1969-70 except 1961-2 and 1962-3. Increases in the acreage grown in a given season often follow a good price in the previous year, for example, 1966 and 1968, and decreases in the acreage grown, as in 1965, often follow a poor price in the previous years. The severe winter of 1962-3 led to an unusually large volume of imports, which normally runs at twentyfive to thirty thousand tons each year. In recent years some twenty thousand tons come from Cyprus and five thousand tons from the Netherlands, with smaller deliveries from the United States and Israel.

Figure 5. Home and imported supplies of carrots 1960-61 to 1969-70



Source: MAFF Statistics and Commonwealth Secretariat

PROCESSING

The processing of fruit and vegetables was first known in Britain as early as 1894, but not until the 1930's did the industry make rapid growth. At this time the Fruit and Vegetable Preservation Research Association at Chipping Campden was established to serve the needs of this development. Competition in the 1930's led to the elimination of many small firms, and today a few large ones remain.

In 1924 Britain processed 53,000 tons of canned food and 250,000 in 1935. By 1964 production had increased tenfold and now over one and a half million tons of canned food are produced, rather more than half being fruit and vegetables. In 1924 only one thousand tons of canned vegetables were produced, and in 1935 canned vegetables had reached sixty thousand tons. Over the past twenty years, canned vegetables have increased at the same rate as total canned foods, and today canned vegetables account for three quarters of a million tons. The production of canned carrots now runs at a hundred thousand tons having trebled since 1961. In the world picture, Britain is second only to the United States in the production of canned food and France follows her lead in Europe. The increase in processed carrots and vegetables has taken place despite great expansion of quick frozen vegetables since the war. This is due not only to the intrinsically good quality of vegetables grown in this country but also to the care taken in selecting produce for quality and freshness. There is little doubt that the basis of the vegetable canning industry in Britain is sound, and the structure of our arable farming is such

that there are numerous efficient growers farming large enough acreages to assure the industry of good supplies at the proper time.

Contracts with processors for carrots are generally on a tonnage basis, though some firms contract for an acreage. Processors have no difficulty in finding farmers with whom to make contracts and they emphasise that mutual trust and good relations with their farmer suppliers are of great importance to their business. The contract, usually drawn up for each season in February, states the drilling programme, the variety, and planting system, as well as the delivery programme to the factory. Factories supply the seed, so important it is to them to get carrots of the right quality and size. Size grades for processing are $\frac{3}{4}$ " to $1\frac{1}{4}$ " for canning whole, $1\frac{1}{4}$ " to $1\frac{3}{4}$ " for canning sliced, and 2" and more for canning diced, solo or mixed with other vegetables. Carrots for canning whole is the most popular pack and the one that processors have most difficulty in finding.

The factories follow fruit canning (at the end of August) with carrots, and this continues until January when the quality falls with the onset of severe frosts, or when the quota of the factory for the season is finished. Plant and equipment are versatile in use, not only for the processing of other root crops but for the processing of other foods too. One of the greatest problems for the factories is that of effluent. For this reason there is much to be said for topping and washing on the farms. Some farmers with a good supply of casual workers do this as off stations of the factory. From five to fifteen percent of the intake is rejected at the factory and with other losses only forty to fifty percent of the field weight may go into the cans. The process comprises, topping and washing, then peeling and immersion in lye with abrasive treatment, then grading, and finally filling the cans and packing.

Contract prices for the current season are negotiated with farmers on the basis of the previous year's contract price. The quality-price balance is a very fine one. The price the processor can afford to pay is calculated by working back from the price of his product, and all processors are in competition with each other. Farmers are paid weekly or monthly in the season. Some irregularities of flow into the factories do arise but these are largely evened out by purchase of carrots from different soil types. Again there is some scope for the factory to vary its pack, and to use various sizes of carrots. Carrots in the middle size, $1\frac{1}{4}$ " to $1\frac{3}{4}$ ", are the general size in demand for the fresh market. The processors need contracts for only a limited quantity of these, because they can get them on the open market. They normally contract in advance for rather more than half of their requirements, and buy the rest during the season. Their requirements in any season depend not only on the processors estimate of demand but on the stocks they hold, as carrots in cans keep for at least two years.

CHAPTER 2

Carrots in the Farm Economy

THE ECONOMIC SURVEY

THE SAMPLE

The National survey of maincrop carrots described in this report was carried out for the 1968-9 crop, which followed a pilot survey for 1966-7 in the Eastern counties. Early carrots which account for only three percent of the acreage, were omitted. Figure 1, page 10, gives the distribution of the carrot crop in England in 1968 based on the June 4th returns.

The regional and county distribution to which the sample refers is given in table 4. A region in this context being the group of counties served by one University agricultural economics department. The four University regions that co-operated together cover ninetyseven percent of the carrot area in England and Wales or rather more than ninety percent of the acreage in Britain. The other counties in the University regions with a small acreage were excluded.

Table 4. National carrot survey, regional and county weighting in 1968

<i>University and County</i>	<i>Thousand Acres</i>	<i>Thousand hectares</i>	<i>Percent</i>
Cambridgeshire & Isle of Ely	4.5	1.8	14.2
Huntingdonshire & Peterborough	1.5	0.6	4.7
Lincolnshire (Holland)	0.6	0.2	1.9
Norfolk	15.2	6.2	47.8
Suffolk	3.5	1.4	11.0
CAMBRIDGE REGION	25.3	10.2	79.6
Lincolnshire (Kesteven)	0.4	0.2	1.2
Lincolnshire (Lindsey)	1.3	0.5	4.1
Nottinghamshire	0.7	0.3	2.2
NOTTINGHAM REGION	2.4	1.0	7.5
East Yorkshire	0.7	0.3	2.2
West Yorkshire	0.7	0.3	2.2
LEEDS REGION	1.4	0.6	4.4
Lancashire	1.8	0.7	5.7
MANCHESTER REGION	1.8	0.7	5.7
TOTAL SURVEY AREA	30.9	12.5	97.2
TOTAL ENGLAND AND WALES	31.8	12.9	100.0

Source: MAFF Statistics

The distribution left Cambridge with by far the largest sample. A random sample drawn by the Ministry of Agriculture was based on the June 1965 Census. The weighting by numbers of records in each district and size group was in proportion to the acreage of carrots in each size group, not by the number of growers. Each acre of carrots had thus an equal chance of being drawn as part of the sample. Of the sample of one hundred records, thirtynine were recruited from farms with seventy or more acres of carrots in 1965, twentythree from farms having less than twenty acres, and thirteight from the size groups in between. The details are given in Table 5.

Great efforts were made to match the sample collected with the sample sought, but discrepancies in the numbers in three size groups arose (see Table 5). Again, there were differences between the sample collected and the actual distribution of the 1968 crop (which was not known until after the survey took place). These discrepancies are unavoidable since there is no reason for a farmer to have

the same acreage from one year to the next. They are not very important, however, as the number of records was weighted according to the acreage in each size group. The number of growers in the size groups under twenty acres in 1968 is in all cases less than those in 1965 and the number of large scale growers is higher, confirming the trend for larger scale production. Weighting was given by acreage with this in mind, so giving greater representation to large scale growers. Unfortunately completed records fell short of the hundred by one case where payment for the crop was not settled. The location of the random sample farms and the University centres are shown in Figure 6, page 20, which includes towns with carrot processing factories. Reception of the survey by farmers was good. The 1968-9 survey was preceded by a pilot survey of the 1966-7 crop of 21 farms in the Eastern Counties. The pilot survey assisted in planning the main survey for 1968-9.

Table 5. The random sample

Carrot Acreage Size Group (ha)	<10 (<4)	10 to 20 (4 to 8)	20 to 30 (8 to 12)	30 to 50 (12 to 20)	50 to 70 (20 to 28)	70 and over (28 and over)	Total
UNIVERSITY & COUNTY							
Cambridgeshire & Isle of Ely ..	1	2	2	2	3	4	14
Huntingdonshire & Peterborough ..	1	1	2	1	—	2	7
Lincolnshire (Holland)	—	—	—	—	—	1	1
Norfolk	2	3	4	7	5	22	41
Suffolk	1	1	1	1	1	6	11
CAMBRIDGE REGION							
	5	7	9	11	9	35	76
Lincolnshire (Kesteven)							
	—	—	—	1	—	1	2
Lincolnshire (Lindsey)							
	2	1	—	1	1	—	5
Nottinghamshire							
	—	1	—	1	—	1	3
NOTTINGHAM REGION							
	2	2	—	3	1	2	10
East Yorkshire							
	1	1	1	—	—	—	3
West Yorkshire							
	1	—	1	—	—	1	3
LEEDS REGION							
	2	1	2	—	—	1	6
Lancashire							
	2	2	1	1	1	1	8
MANCHESTER REGION							
	2	2	1	1	1	1	8
RANDOM SAMPLE							
	11	12	12	15	11	39	100
COLLECTED SAMPLE							
	11	9	10	19	11	39	99
1968 DISTRIBUTION							
	6	11	10	15	12	46	100

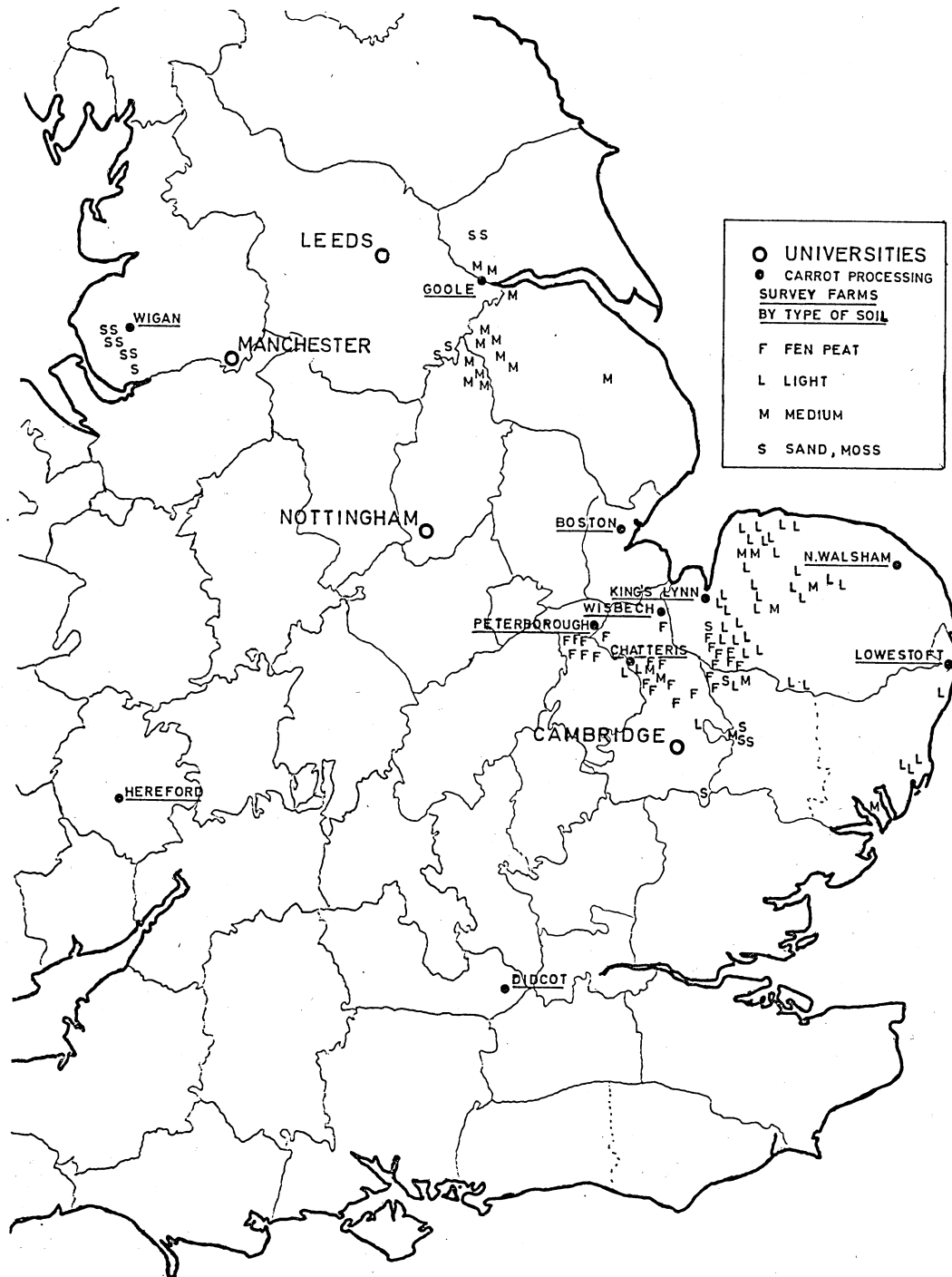
It proved difficult to achieve the one hundred completed records, especially the last ten or so. This experience suggests that in future a five to ten percent excess sample total should be carried to fill such gaps. Difficulties arose because eighteen months elapses between seed-bed cultivation and the final sales receipt, and because many farmers do not market the crop themselves. Of the one hundred in the sample, fifty-nine were recruited from the first sample list (fifty-three in Cambridge). Other centres relied heavily on the second and third lists. Fifteen co-operators in the pilot sample of twenty-one came up in the national sample.

THE FARMS GROWING CARROTS

When completed, it was found that the survey covered a quarter of the acreage in England and Wales. While two thirds of the area is *grown and marketed* by the farmers interviewed, one third is managed by carrot merchants, usually farmers themselves and growers of carrots. The latter are all located in the Cambridge region.

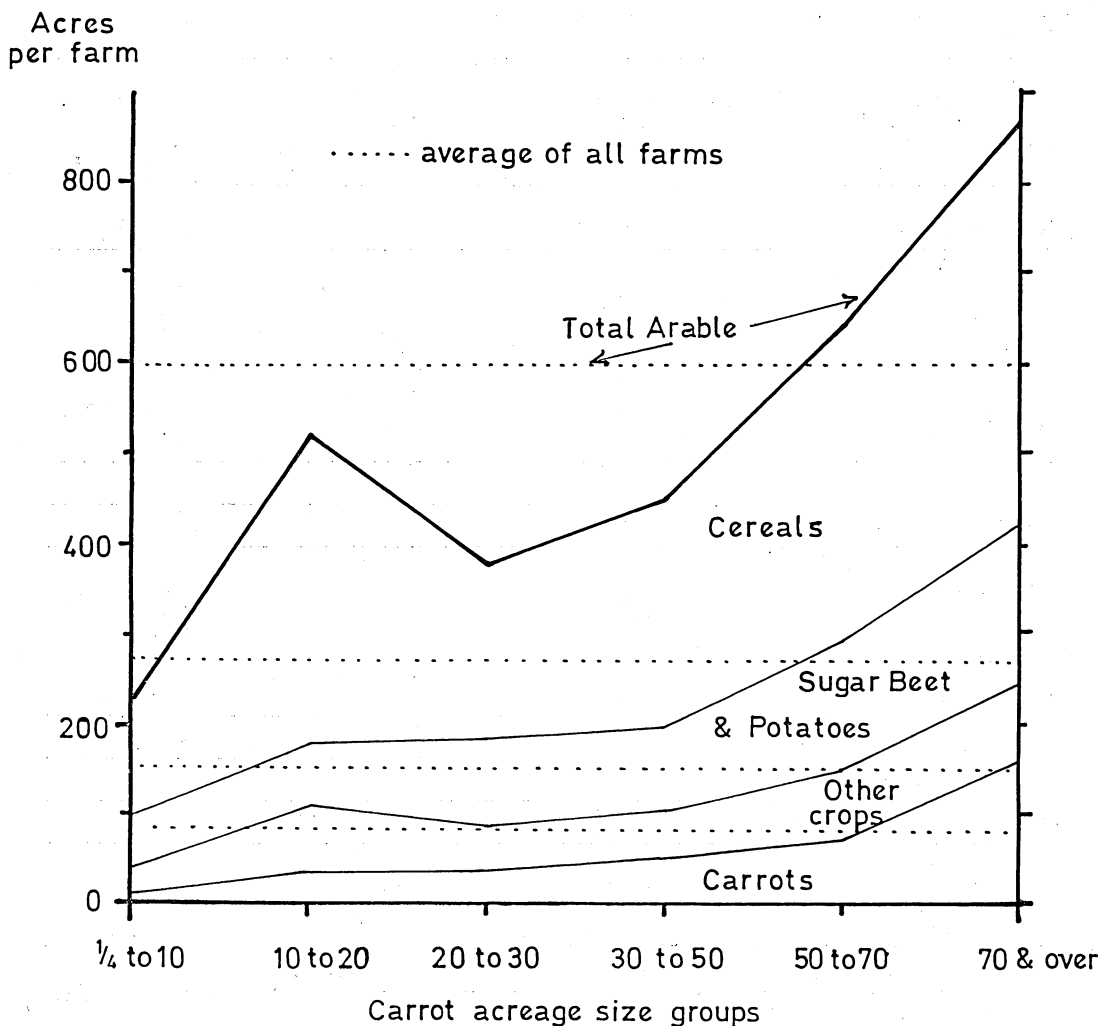
Cropping details of from eighty-eight of the ninety-nine farms are shown by carrot acreage size group in Figure 7.

Figure 6. The sample



Farms in the smallest category averaged 275 acres in size and in the largest, over a thousand. All farms together averaged nearly 700 acres with ninety percent of the land in arable cultivation and fifty percent in cereals. Figure 7 shows the prominence of cereals, for which carrots are an important break crop. Carrots together with 'other' crops (including other vegetables) are the only commodities with no price support. Cereals, sugar beet, and potatoes which enjoy price support, comprise three-quarters or more of the arable cropping. This greatly modifies the risk associated with the free market crops such as carrots.

Figure 7. Arable Cropping by carrot acreage size groups. All farms (88)



THE SURVEY RESULTS

Costs and returns by system of production

Carrots are grown under three systems. These correspond to the degree of interest which the farmer has in the crop. System A farmers grow and market their crops (at least to the first point of sale) on their own account and the profit (or loss) is their own. These crops represent two-thirds of the whole sample. The remainder share the crop with a merchant. In system B, the farmer and the merchant share the proceeds equally. In system C, the farmer lets the land for an agreed rent which may include some services (e.g. ploughing) performed by the farmer.

In other words, farmers on system A accept the entire responsibility for the crop. System B is a partnership and the responsibility and risk is shared with the merchant. In system C, the responsibility and risk is shifted entirely on to the shoulders of the merchant in return for a fixed fee. The merchant does the harvesting and the marketing and some, at least, of the cultivation. The farmer who is skilled at growing carrots will choose A. The farmer who is not or who wishes to devote his attention to other enterprises will choose C. The farmer who has some interest in the crop but would like to hedge his risks to some extent will choose B. Costs and returns for carrots grown under each system are given in Table 6 below.

Table 6. Costs and returns by system of production

<i>System of Production</i>	<i>A</i>	<i>B</i>	<i>C</i>
Number of Farms	65	13	21
Average Carrot Acreage (ha) ..	79½(32)	44½(18)	110½(45)
Acres (ha) covered by survey ..	5167½(2091)	578½(234)	2318(938)
Yield—tons per acre (tonnes per hectare)	10·8(27)	10·7(27)	na
RETURNS PER ACRE (Per ha)	£ 164·79 (407)	£ 150·01 (371)	£ 29·88 (74)
<i>Variable Costs per acre</i>			
Seed	3·63	1·59	0·72
Fertiliser	8·42	5·40	1·47
Spray materials	7·27	2·83	1·50
Nets	6·62	6·14	
Contract haulage	5·17	9·30	
Other contract	4·69	41·45	0·22
Casual labour	7·43	8·51	
Regular piecework	5·86		
Total Variable Costs per acre ..	49·09	75·22	3·91
GROSS MARGIN PER ACRE ..	115·70	74·79	25·97
<i>Fixed Costs per acre</i>			
Regular labour	13·67	2·43	1·02
Tractors	6·87	2·37	1·15
Machinery	5·21	1·39	0·65
Miscellaneous	0·37		
Rent and rates	9·34	8·32	7·53
Overheads	12·46	3·90	2·14
Total Fixed Costs per acre ..	47·92	18·41	12·49
TOTAL COSTS PER ACRE (Per ha) ..	97·01(240)	93·63(231)	16·40(41)
NET PROFIT PER ACRE (Per ha) ..	67·78(168)	56·38(139)*	13·48(33)
Return per ton	£ 15·26	£ 14·02	£ na
Total costs per ton	8·99	8·75	na
Net profit per ton	6·27	5·27*	na

A Crops grown and marketed by Farmer (all centres). Two were not lifted.

B Crops grown and marketed jointly by Farmer and Merchant (Cambridge only). Two were not lifted.

C Crops grown on Farmer's land let to Merchants (Cambridge only).

na Not available.

* Farmer's share; £28·19 per acre (£69·6 per ha), £2·63 per ton.

Farms under the three systems have a similar pattern of cropping, with some variations. System A growers grow more carrots (especially in the middle size range) while system C growers have larger farms with more cereals.

Average yields, nearly eleven tons per acre, are identical in systems A and B (Note these are yields sold; they compare closely with the Ministry of Agriculture estimates for the national crop, 12·1 tons per acre Table 8). Yields on land let to merchants were not available as they were not known to the co-operating farmer. The difference in returns per acre (A and B) has little significance as the lower return of B is explained by the merchant's commitment in marketing; he seldom abandons a crop.

Return, costs and profitability, are given on a per acre basis for all items and per ton for some. Overheads are imputed at fifteen percent of recorded costs. Profit per acre to the nearest pound for system A is £68, for system B, £56, and for system C, £13. These are profits from growing the crop. In A and C they accrue to the farmer, but in B they are shared equally between the farmer and the merchant (farmer's share £28). A comparison of profitability between these systems can be misleading, not only because accounting profit may bear little relationship to actual contribution to farm profit, but also because the farmer's resource commitment varies considerably in the three systems. Investment in equipment and other resources is heaviest in A (highest profit), much less in B (medium profit) and negligible or nil in C (lowest profit). Also the sixtyfive (System A) farm results (which by regions comprise fortyone in Cambridge, six in Leeds, seven in Manchester and eleven in Nottingham), conceal marked regional differences which are referred to later.

Costs and returns by region

Table 7 shows the results of the sixtyfive farms (system A), on a regional basis. This illustrates the wide range about the average which not only exists between regions but between farms. The scale of production is largest in the Cambridge region, and smallest in the Manchester region. In Cambridge yield is exceptionally low, two crops were not harvested and many others suffered from extremes of dry and

Table 7. Costs and returns by region
Crops Grown and Marketed by Farmer. System A

University Region	CAMBRIDGE*	LEEDS	MANCHESTER	NOTTINGHAM†
Number of Farms	41	6	7	11
Average Carrot Acreage (ha) ..	102½(42)	59½(24)	19½(8)	42½(17)
Acres (ha) covered by survey ..	4213 (1705)	357 (144)	138½(56)	467½(189)
Yield—tons per acre (tonnes per ha)	8·5(21·3)	15·9(39·9)	15·4(38·7)	13·6(34·2)
RETURNS PER ACRE (ha)	£ 126·35(312)	£ 271·92(672)	£ 213·18(527)	£ 218·86(541)
<i>Variable Costs per acre</i>				
Seed	3·79	3·55	3·36	3·27
Fertiliser	6·31	11·63	10·56	13·18
Spray materials	6·57	4·82	11·60	8·50
Nets	5·11	4·51	8·43	12·24
Contract haulage	5·25	6·64		7·41
Other contract	6·25	7·58	0·41	
Casual labour	3·47	14·39	8·41	17·75
Regular piecework	8·72			2·16
Total Variable Costs per acre ..	45·47	53·12	42·77	64·51
GROSS MARGIN PER ACRE	80·88	218·80	170·41	154·35
<i>Fixed Costs per acre</i>				
Regular labour	13·93	19·69	9·56	12·04
Tractors	7·19	7·62	4·06	7·05
Machinery	5·05	3·96	3·76	7·39
Miscellaneous	0·34	0·10	1·35	
Rent and rates	10·00	8·89	8·71	7·51
Overheads	11·99	14·01	10·23	14·77
Total Fixed Costs per acre ..	48·50	54·27	37·67	48·76
TOTAL COSTS PER ACRE (ha) ..	93·97(232)	107·39(265)	80·44(199)	113·27(280)
NET PROFIT PER ACRE (Per ha) ..	32·38(80)	164·53(407)	132·74(328)	105·59(261)
Returns per ton	£ 14·87	£ 17·10	£ 13·84	£ 16·09
Total Costs per ton	11·06	6·76	5·22	8·33
Net Profit per ton	3·81	10·34	8·62	7·76

*Fen Carrots incurred losses of yield due to waterlogged ground. Four crops were not lifted.

†One crop a partial failure.

wet periods. Returns between regions show considerable range. Yields are highest in Leeds and Manchester where weather conditions were better than in the East. Also there was a good deal of variation in price per ton, suggesting differences in the quality of the sample marketed and a range in price at different markets. Costs per acre are lowest in Manchester and highest in Nottingham. Profits in the minor carrot areas (Leeds and Manchester) are much higher, and Nottingham profits are three times as great as those in adjacent Cambridge.

As so often is the case, weather is a key factor, and the Cambridge region with by much the most potential for profitability in carrots (in soil, scale, and marketing organisation) fared worst in this particular season. This season shows the lowest net yield in recent years (see Table 8). Rainfall was below average in the early spring, and the East in April too had less than normal rainfall. Cold continued into May and there were some night frosts. Rainfall in June and July was above average with flooding in July. In August the Cambridge region had twice the average rainfall for the month and temperatures were below normal. Autumn was the dullest on record for the East, and September brought widespread flooding with adverse field conditions for harvesting. Many fields were flooded, especially in the Fens.

A good idea of a normal yield and the range in yield between regions is obtained by reference to Horticultural Crop Intelligence data. This gives gross or estimated seasonal yield and net or estimated yield harvested. These values are shown for the regions and for England and Wales in Table 8.

Table 8. Gross and Net Yields of Carrots—tons per acre Regions and England and Wales (net yields shown in parenthesis)

	<i>England & Wales</i>	<i>Cambridge</i>	<i>Leeds</i>	<i>Manchester</i>	<i>Nottingham</i>
1966 ..	16.9(14.4)	16.4(14.1)	23.0(18.9)	20.2(18.7)	19.5(14.2)
1967 ..	16.3(13.1)	16.0(12.8)	22.5(18.6)	18.8(18.0)	18.2(12.0)
1968 ..	16.1(12.1)	15.7(11.1)	19.8(17.8)	19.3(19.3)	18.5(16.0)
1969 ..	16.2(12.5)	16.6(12.2)	17.9(16.1)	19.6(19.2)	15.3(12.4)
1970 ..	14.1(n a)	13.4(11.3)	15.2(12.4)	16.2(16.1)	13.9(12.5)
1966-70 ..	15.9(13.0*)	15.6(12.3)	19.7(16.8)	18.8(18.3)	17.1(13.4)
1968-9 sample (yield sold)	10.8	8.5	15.8	15.6	15.4

*four year average

Source: MAFF Statistics England and Wales

Net yield approximates to eighty percent of gross yield. The yield in the different regions and the average yield for the 1968-9 sample (yield actually sold) is shown at the foot of the table. The 1966 to 1970 average may be taken as the 'normal' yield for the country and for the regions. Overall, with the exception of the unusually low yields of the Cambridge sample, the sample yields reflect the HCIC estimates.

FACTORS AFFECTING PROFITABILITY

Size of the carrot enterprise and profitability

Table 9 shows the same sixtyfive farms (system A) analysed into three crop size groups, under 20 acres, 20 to 70 acres, and 70 acres and over. These groups have 4.7 percent, 25.3 percent, and 70.0 percent of the total acreage surveyed in system A. Returns per acre are substantially higher in the small size range, but price per ton is similar throughout. Yields per acre are significantly better as might be expected in the smaller enterprise and lower with increase in scale. It should however be mentioned that all but one of the twentyfive crops of seventy acres or more are in the Cambridge region where low yields were general in that year. Average costs per acre for each size group decrease with increasing scale from £103 per acre in the small scale crops to £93 per acre in the large scale crops but it is likely that better yields in the Cambridge region would have brought up the costs. Variable costs declined with scale while fixed costs varied little, especially when adjusted for differences in rent.

Table 9. Costs and returns by size of carrot enterprise
Crops Grown and Marketed by Farmer. System A

<i>Carrot Acreage Size Group (hectares)</i>	<i>Under 20 (8)</i>	<i>20 to 70 (8 to 28)</i>	<i>70 and over (28 and over)</i>
Number of Farms	17	23	25
Average Carrot acreage (ha)	14½(5.9)	58(23.5)	148(60.0)
Acres (ha) covered by survey	246½(100)	1334(540)	3700(1497)
Yield—tons/acre (tonnes/ha)	14.4(36.2)	11.1(27.9)	8.2*(20.6)
RETURNS PER ACRE (per ha)	£ 217.51(537)	£ 164.98(408)	£ 128.79(318)
<i>Variable Costs per acre</i>			
Seed	3.82	3.34	3.77
Fertiliser	9.63	9.38	6.72
Spray materials	7.28	8.32	6.30
Nets	7.28	8.49	4.46
Contract haulage	6.54	4.45	4.93
Other contract	8.03	4.37	2.70
Casual labour	10.93	9.02	3.57
Regular piecework	0.88	3.74	11.21
Total Variable Costs per acre	54.39	51.11	43.66
GROSS MARGIN PER ACRE	163.12	113.87	85.13
<i>Fixed Costs per acre</i>			
Regular labour	15.45	10.93	14.98
Tractors	6.61	6.33	7.55
Machinery	5.32	5.69	4.69
Miscellaneous	0.59	0.60	†
Rent and rates	7.40	9.94	10.11
Overheads	13.35	12.13	12.15
Total Fixed Costs per acre	48.72	45.62	49.48
TOTAL COSTS PER ACRE (per ha)	103.11(255)	96.73(239)	93.14(230)
NET PROFIT PER ACRE (per ha)	114.40(282)	68.25(169)	35.65(88)
Return per ton	£ 15.08	£ 14.92	£ 15.67
Total Costs per ton	£ 7.15	£ 8.74	£ 11.33
Net Profit per ton	£ 7.93	£ 6.18	£ 4.34

*All farms but one are of fen peat. †Negligible

Yield by scale of enterprise

Since returns per ton in Table 9 are nearly the same in each size group, it is the yield per acre that determines the profit. The range in yield for the sample and the size groups is given in Table 10.

Table 10. Yield distribution by size of enterprise
Seventy-eight farms. Systems A and B

	<i>All Farms</i>	<i>Carrot Acreage Size Group (ha)</i>		
		<i>Less than 20 (8)</i>	<i>20 to 70 (8 to 28)</i>	<i>70 & over (28 & over)</i>
Number of Farms	78	22	27	29
Average Carrot Acreage (ha)	73½(30)	15½(6)	54½(22)	139½(57)
Yield tons per acre (tonnes per ha)	(10.8(27))	13.0(33)	11.8(30)	8.3(21)
Yield per acre:				
Less than 5 tons	12	2	5	5
5 to 7½	12	3	2	7
7½ to 10	9	2	1	6
10 to 12½	12	1	4	7
12½ to 15	16	6	8	2
15 to 17½	9	3	5	1
17½ to 20	2	1	—	1
20 or more	6	4	2	—

In each case, yield per acre is the tonnage sold, which can be less than the amount grown if the crop is not all sold. Of the seventy-eight farms, twenty-four have yields under $7\frac{1}{2}$ tons per acre and sixty-one under 15 tons. The breakdown of yields by size group shows that larger enterprises more commonly have lower yields and the smaller enterprises, higher yields.

Soil type and profitability

Yield distribution by soil type is shown in Table 11.

Table 11. Yield distribution by soil type
Seventy-eight farms. Systems A and B

Soil Type	Sand and Moss	Medium (Sandy Loam and Loam)	Light (Very Light Light and Skirt)	Fen Peat
No. of farms	19	19	24	16
Average Carrot Acreage (ha)	$71\frac{3}{4}$ (29)	$48\frac{1}{2}$ (20)	$94\frac{3}{4}$ (38)	$80\frac{1}{4}$ (33)
Average Yield tons/acre (ha)	12.7(32)	12.1(30)	10.55(26)	7.6(19)
Yield per acre:				
Less than 5	1	2	2	7
5 to $7\frac{1}{2}$	5	1	4	2
$7\frac{1}{2}$ to 10	2	1	5	1
10 to $12\frac{1}{2}$	1	3	6	2
$12\frac{1}{2}$ to 15	4	7	3	2
15 to $17\frac{1}{2}$	3	3	2	1
$17\frac{1}{2}$ to 20	—	1	1	—
20 or more	3	1	1	1

Soil types are as described by the farmer as sand and moss, medium (sandy loam and loam), light (very light, light and skirt), and fen. (For the distribution of the sample farms by soil type, see Figure 6, page 20). Cambridge has soils of all types and Leeds, sand and medium soils. All the Manchester farms are on sand (and moss), and Nottingham farms are mostly on mainly medium soils. Carrots on the fen peat have the lowest yields of any soil type but those on the lighter land are higher. As mentioned before, one should not associate lower yields with large scale production and with soil types. The large growers are mainly on fen land, where crops suffered in this particular season.

Costs and returns by soil type are shown for system A in Appendix Table 1. Of the four soil types returns are highest for the sand, and much the lowest for the peat. Costs per acre vary little for each soil type, but they are lower on the sand and on the peat.

Profits per acre are:—

Sand and Moss	£108	Light and Skirt	£52
Medium	£ 82	Fen Peat	£ 5

Carrots from Fen peat obtain a higher price, suggesting superior quality and that given a normal yield their profitability would have been greater.

Profit per acre between farms is comparable for systems A and B only. The distribution of profits according to size of crop and soil type is given in Appendix Table 2. This emphasises their widely scattered distribution both in total and *within* each size group soil type.

FARM ORGANISATION

Operational costs

There is undoubtedly scope for increasing profitability within the farm organisation. All farm operations should be geared to the production of a high yield of a marketable sample at the least cost. Cultivation, the choice of seed and the planting system are of particular concern here, together with the type mechanisation which follows.

Sixty of the sixty-five growers in system A supplied records suitable for analysis by cost of operation. These results are shown in Table 12. Operational costs per ton are given for the group average in parenthesis.

Table 12. Operational costs per acre by scale of enterprise

	All Farms per acre (per ton)		Carrot Acreage Size Groups (ha)		
			Less than 20 (8)	20 to 70 (8 to 28)	70 & over (28 & over)
Number of Farms	60		17	21	22
	£	£	£	£	£
(a) Preparation of seedbed	12.29(1.14)		14.17	12.76	10.39
(b) Drilling	4.47(0.41)		4.76	4.20	4.49
(c) Growing	10.32(0.96)		9.84	12.77	8.36
Pre-harvest Total		27.08(2.51)	28.77	29.73	23.24
(d) Harvesting	24.31(2.26)		30.34	19.13	24.60
(e) Marketing	27.85(2.58)		30.40	26.77	26.91
Total Harvesting & Marketing Costs		52.16(4.84)	60.74	45.90	51.51
Overheads and rent		22.29(2.07)	20.76	23.02	22.78
Total Costs	101.53(9.42)		110.27	98.65	97.53
Yield—tons per acre	10.78		13.9	10.29	8.85
Return—£'s per ton	15.60		15.65	15.16	15.97

- (a) Stubble cultivations, ploughing, cultivating, rolling, fertiliser and its application.
- (b) Includes cost of seed.
- (c) All operations between drilling and harvesting and cost of sprays.
- (d) Removal of tops, lifting, loading and carting from field.
- (e) Washing, grading, loading and hauling to market and cost of nets.

Operational costs account for the same factors as given in Table 6 but they are presented on the basis of each operation. (For example, drilling includes man and tractor hours, depreciation on machinery, and seed, i.e. all the items for the operation). Overall, overheads and rent account for 22 percent, and operations 78 percent. Pre-harvest work is 34 percent, harvesting 31 percent, and marketing 35 percent. Operational costs which diminish with scale are seedbed preparation, drilling and (for the largest crop size only) growing, and the cost of the pre-harvest operations as a whole. Harvest and marketing costs diminish with scale but this may be due to the poor yield on the large farms. Table 13 shows operational costs by soil type, the lighter soils on the left. On the sand and loam soils, preharvest costs are highest. Field harvesting and marketing costs are significantly lower on sand (and moss) soil, and on the fen soil.

Table 13. Operational costs per acre by soil type. Sixty farms

	Sand and Moss	Sandy Loam and Loam	Light Very Light & Skirt	Fen Peat
Number of Farms	17	16	16	11
	£	£	£	£
(a) Preparation of seedbed	13.34	15.56	10.22	8.91
(b) Drilling	4.39	4.47	5.33	3.33
(c) Growing	11.43	10.45	7.19	12.99
Pre-harvest Total	29.16	30.48	22.74	25.23
(d) Harvesting	19.05	24.70	31.08	19.23
(e) Marketing	20.71	28.99	25.37	25.23
Total	39.76	53.69	56.45	44.46
Overheads and rent	19.94	21.31	20.97	29.26
Total Costs	88.86	105.48	100.16	98.95
Yield—tons per acre	12.4	12.8	10.6	6.4

Only four growers adopted the bed system, there were great variations in planting pattern, and more than a dozen makes of drill were in use. Most farmers follow a system which aims at the highest canning percentage, putting what they cannot sell for this purpose on the ware market, and some specialise in this market. The proportion in each size grade depends on many factors including the date of harvesting

and the weather before harvest. The saleable sample is also affected by the type of soil and by mechanical damage. Most farmers grow more than one variety resulting in the following yields per acre and prices per ton:—

Yield and price by variety

	Farms having entire acreage planted with:		
	Chantenay	Autumn King	Other varieties
Proportion of growers*	25	14	31
Yield, tons per acre	11.6	15.2	8.4
Price £ per ton	11.6	17.5	18.1

*Thirty percent grew varieties in two or more of the above groups

Seed rate which varies greatly, averaged 3.8 lbs per acre. More is sown for a smaller carrot and less for the larger one. Chantenay was grown on half the acreage, Autumn King on one eighth, and three eighths of the acreage was cropped by other varieties.

Four farmers harvested entirely by hand and a few more used a potato hoover to lift the carrots for picking up by hand. The majority have specialised carrot harvesters either of the share lifting or top gripping type, and some growers have more than one machine. Top grippers can only be used before the winter frost when the tops weaken, but share lifters and potato hoovers may be used throughout the season. Top grippers are especially useful in the light land of Norfolk and Suffolk where the soil is stony. Share lifter machines may harvest one hundred acres in a season, and top-grippers rather more. These machines cost upwards of £1,000, but hoovers are much cheaper.

The comparative cost of harvesting for each system per acre is as follows:—

	Share Lifter	Top Gripper	Potato Hoover	Hand Lifting
	£	£	£	£
Depreciation and repairs	2.96	2.28	1.02	—
Tractors and trailers	5.25	5.26	3.57	1.53
Labour	7.28	12.57	32.54	54.91
Total	15.49	20.11	37.13	56.44
Cost of machine new	£1,200-£1,500	£750-£1,000	£350-£500	—

Harvesting by hand is the most expensive, but the paper cost may not reflect the real cost of resources in the context of management on a particular farm. With the same qualification, share lifters have the lowest cost, top lifters a higher cost, and potato hoovers the highest of the mechanical systems. Much depends on the acreage of carrots and other root crops for which the harvester is used. Work study results on thirteen specialised harvesters suggest equal performance from the two types:—

	All harvesters	Share lifters	Top grippers
Row length	328	259	353
Centre width, inches	17.4	23.3	14.6
Distance to washer, yards	1679	2741	1280
Gang size	4.2	5.3	3.9
Man hours per acre	1.39	1.37	1.39
Miles per hour in row	2.5	1.8	2.7

A similar study on washing and grading indicates the following norms:—

Potential output per hour	6 tons	Gang size	7.2
Percent of time grading	73	Man hours per ton	2.0
Actual output per hour	4.5 tons	Number bagging off	3.6

Labour requirements

Cost figures alone are of little value in *planning* for profitability. In truth too, records of costs only serve to put a value on the resources used. What determines the real cost to the farm business is the given resources on the farm and, for a particular enterprise, the use to which these are put. The com-

bination of resources, of which labour is among the most important, and the efficiency of their use for the range of enterprises on the farm determines farm profit. Labour requirements per acre by operation and period of operation are given in Table 14.

Table 14. Labour requirements. Hours per acre—sixty farms

Operation	Number Reporting*	Average Hours per acre	Time of Year
Stubble Clearing	29	0.95	Sep to Dec
Ploughing	60	1.25	Nov to Mar
Cultivating	41	1.02	Feb to Apr
Harrowing	49	0.75	Feb to Apr
Rolling	35	0.38	Feb to Apr
Fertiliser Application	41	0.74	Feb to May
Drilling	55	0.98	Apr to May
Top Dressing	7	0.93	June
Spraying	57	0.95	Apr to Aug
Tractor Hoeing	33	1.88	May to July
Hand Hoeing	8	17.96	June to Aug
Ridging	12	0.72	Aug to Oct
Forage Harvesting	12	1.62	Sep to Oct
Machine Harvesting	36	32.42	Sep to May
Hand Harvesting	1	151.60	Sep to Nov
Washing and Grading	27	37.80	Sep to May

*Where less than sixty, the operations are either on contract or they were not carried out

Similar data by size of enterprise shows economies of scale for most operations, especially harvesting and marketing.

Table 15. Labour requirements by size of enterprise—hours per acre

Carrot acreage size group	under 10	10 to 20	20 to 30	30 to 50	50 to 70	70 and over
Operation:—						
Stubble Clearing	1.1	1.3	0.7	0.5	0.8	1.0
Ploughing	1.4	1.3	1.4	1.2	1.5	1.0
Cultivations	1.8	2.1	1.9	1.4	1.3	1.2
Fertiliser Application	2.6	1.1	0.4	0.8	0.4	0.4
Drilling	1.3	1.2	0.7	1.1	1.2	0.8
Rolling	0.6	0.6	0.3	—	—	(0.3)
Top Dressing	0.8	0.9	(2.6)	(0.3)	(0.3)	—
Spraying	1.6	1.2	0.5	1.1	0.9	0.8
Tractor Hoeing	3.9	2.5	2.1	1.4	1.4	1.6
Hand Hoeing	14.0	(2.1)	(27.3)	—	(47.9)	(5.5)
Ridging	(1.0)	0.4	(1.4)	(0.7)	(0.5)	(0.5)
Forage Harvesting	(1.2)	1.2	(2.7)	2.0	(1.5)	—
Machine Harvesting	48.5	45.4	44.9	17.8	24.5	26.4
Hand Harvesting	—	(151.6)	—	—	—	—
Washing and Grading	97.3	35.8	76.2	28.7	18.4	28.0

() few reporting

THE INTERPRETATION OF PROFIT

The value of the carrot crop

Profit per acre varies considerably even between farms on the same soil type and operating on the same scale. The paper profit resulting from enterprise studies can however be misleading. The real contribution to profit on a given farm may be greater or less than this, because no enterprise except that of a single commodity business (for example a glasshouse tomato nursery) is alone in contributing to the profit of the farm and in offsetting its overheads. Allocation of resource costs on an enterprise basis in part necessitates some arbitrary estimates and profit planning on the farm in question is of course better done by a complete linear programme, but this is seldom possible. Even so, programme results for one farm are *different* from those for another. Moreover the importance of carrots as a break crop

to enable cereals to perform their major role in farm income in successive years is an important motive for most carrot growers, especially when they are restricted from growing potatoes and sugar beet by eel worm infestation. Indeed, the contribution of carrots to farm profit in this way may well exceed the direct assessment of their profit as a separate enterprise.

Carrots as a break crop

As a break crop, carrots have a high gross margin per acre (£116 in system A, Table 6) exceeding sugar beet and potatoes (each £80 to £95) and for farmers in the carrot areas they offer a good alternative. If the farm is already geared to root crops, the extension to carrots may not require much outlay. The situation is even more flexible when growing and marketing arrangements with a merchant are possible, and much more so when the land can be let to a merchant for carrots, when gross margins (in this case all profit), compare well with others from extensive break crops. Fixed costs run at £48 per acre, one third of which is regular labour. For many farmers, carrots give better gross margins and better profit than the less intensive break crops such as field beans and oilseed rape. The opportunity in carrot production for the individual farmer very much depends on the structure of his fixed resources, his cropping, and farming in a carrot growing area where the market arrangements are present. Most farmers, however, are either in carrots continuously or they do not grow them. They may change their acreage from year to year but once having geared up to the crop and arranged their marketing, they usually stay in production.

Table 16. Imputed costs and returns per acre for 1970-71
Values per ton in parentheses

System of Production	A	B
Yield (1970-1) tons per acre	13.0	13.0
Return per ton	£ 14.9	£ 13.7
RETURN PER ACRE	193.2	177.5
<i>Variable Costs per acre</i>		
Seed	3.6	1.6
Fertiliser	8.4	5.4
Spray materials	7.3	2.8
Nets	7.9	7.4
Contract haulage	6.9	12.4
Other contract	5.2	45.6
Casual labour	8.9	10.2
Regular piecework	7.0	—
Total Variable Costs per acre	55.2 (4.2)	85.4(6.6)
GROSS MARGIN PER ACRE	138.0(10.7)	92.1(7.1)
<i>Fixed Costs per acre</i>		
Regular labour	16.4	2.9
Tractors	7.6	2.6
Machinery	5.7	1.5
Miscellaneous	0.4	—
Rent and rates	9.3	8.3
Overheads	14.2	4.9
Total Fixed Costs per acre	53.6(4.1)	20.2(1.6)
TOTAL COSTS PER ACRE	108.8(8.3)	105.6(8.2)
NET PROFIT PER ACRE	84.4(6.7)	71.9(5.5)

A crop grown and marketed by farmer.

B crop grown with merchant in partnership.

*To the farmer £36.00.

Regular and Casual labour increased by twenty percent over the 1968-9 level.
Machinery, tractors, and contract charges increased by ten percent.

The market for carrots, with changes in both supply and demand from year to year, gives the commodity fluctuating prices per ton, and fluctuating returns and profits per acre. The carrot grower accepts this and he expects the poor profit years as well as the good. To the arable farmer, with threequarters of his income from price supported crops, an occasional paper loss on the crop is of little consequence. When carrots fit the farm system, they have a value irrespective of their assessed profitability and many a grower makes good profits from the crop whichever way it is assessed.

The merit of profitability worked out on an enterprise study basis is that it presents in a comparable way the financial performance of the enterprise on different farms both within and between regions, and provides a well understood and interpreted schedule of costs and returns and other management data where the various factors and elements are clearly identified. This enables the farmers outside an economic survey to compare their position and the Advisory Service to give well documented advice on the enterprise and its fit in the farm business. Because of the structure of the data, adjustments are readily made either for a particular farm situation or for the enterprise survey as a whole.

The 1968-9 survey results are raised to the 1970-1 crop level in Table 16 for systems A and B. The results are given on the basis of a normal yield of 13 tons per acre (see Table 8) and the farm sale price of 1968-9 is adjusted according to MAFF price changes for carrots between the two seasons. (At the time of publication the net yield was not known but it should fall close to 13 tons per acre). This gives a per acre profit of £84 for system A and £36 (to the farmer) for system B.

The facility which the enterprise study method affords for adjusting existing economic survey data to meet current needs gives much value to the 'enterprise cost' in the administration of agricultural policy. This has more obvious application for the price supported commodity than for the non price supported one. For carrots and similar crops however it has importance at present in the negotiation of contracts with processors and prepackers. Enterprise data on carrots and other crops will have great significance when Britain joins the Common Market. On this sort of data depends the successful administration of Common Market policy and the fair treatment of British farmers.

The results of the pilot study (1966-7 crop) and the labour and machinery rates used in the main survey (1968-9 crop) are given on Tables 3 to 5 of the appendix.

The Carrot Merchants

THE ROLE OF THE MERCHANTS

A merchant for the purpose of this report, is a person (or firm) specialising in the marketing of carrots and organising production of the crop on farms other than his own. He is usually, though not necessarily also a grower of carrots on his own land. Of the seventyfive growers in the Cambridge region sample, ten are carrot merchants (four in the middle size group and six in the biggest size group). Thirtyfour produce carrots in partnership with merchants and others sell to merchants.

Today merchants grow and market half the carrots in Britain, and about threequarters of those in the Cambridge region. This represents a threefold increase in the last twenty years. As their role is important a survey of merchants was included in this study. Fifteen were visited, including six already in the sample as growers. It is believed that their total number is between forty and fifty and they operate almost entirely in the Cambridge region. The survey of these fifteen revealed the following situation. Between them, they control the production and marketing of over ten thousand acres. The systems they use (1969-70) are as follows:—

Acreage (ha) Managed by Merchants and Systems of Organisation
(15 merchants of a possible 50)

	<i>Acres</i>	<i>Percent</i>
Grown on merchant's own land	2510 (1016)	24.7
Grown in partnership with farmer	4980 (2015)	49.1
Grown on land rented from farmer	1380 (558)	13.6
Grown by farmer on contract	1280 (518)	12.6
	10150 (4107)	100.0

Chatteris, in the Isle of Ely, is the focal point for these firms. Seven of the fifteen have offices there, and most of the others are located in the carrot area to the north and east within twenty miles. Most of the merchants operate within a radius of twenty miles of their washing and grading plants (some have several plants), but two of the largest firms operate over distances of up to seventy to eighty miles. The larger merchants have offices and market stands in the wholesale markets and some deal in other produce too. Four merchants prepack carrots, an expanding business which benefits from the selection from bulk which merchants can exercise. The merchant business varies considerably in size. The smaller ones control less than two hundred acres, one over two thousand, and another some twelve hundred acres. Most have from two to five hundred acres each.

The development of these specialised dealers sprang from an expanding market in Britain both for fresh carrots and for carrots for processing; indeed, merchants have done much to expand this market. Some of the firms originated fifty years ago among farmers who then acquired a special knowledge of the crop and they have continued to hold the confidence of their farmer clients. To serve the needs of both the fresh market and the processors bulk deliveries are necessary. In the case of the processors these are regulated to factory needs. Bulk supply and disposal of fresh carrots (the ware trade) makes for effective marketing and price setting. The reason for market specialisation stems from the market characteristics of the carrot crop. It has two aspects, one is bulk and the other is quality for different uses.

For instance, however well a farmer tries to produce a good sample for processing, only some seventy percent (usually much less over the whole crop) will comply with the size and quality standards required. (See appendix table 6). Moreover, there is a regular demand for carrots for the fresh trade (of certain sizes), often at a premium price. Carrots of different sizes generally go to specific outlets and grading and washing plants supply both markets. The merchant business (like that of the larger

grower who is not a merchant), provides an assured and continuous supply over the long marketing season which starts in June or July and lasts until May of the following year. This supply function for both markets has established the merchant business. Carrots for processing are sold at a contract price usually uniform throughout the locality for specified grades in one season. On the other hand, the market for fresh carrots has considerable price fluctuations over the season, mainly due to weather which affects supply or demand (or both). Supply varies over time, not only in the amount lifted at any time within the season but also in the proportion in each size grade. This mostly depends on how the harvest weather during any season brings crops to maturity.

There is of course no one month for harvesting and lifting depends partly on pressure to keep up with harvesting and partly on changes in the market price. There is a delicate balance in the market, and at the extreme, demand is most keen when the ground is frozen and lifting is restricted. Demand also depends on the variety and price of other vegetables available at a given time. There are occasions when the fresh market price will attract processing grades which it does not usually take, or market demand may be slack, and more carrots intended for the fresh market are offered for processing or kept back for later harvesting and marketing.

Adding to the variable demand supply situation is overall crop quality which depends on the season. Certain seasons give poor quality, carrots intended for processing are rejected, and put on the ware market. On occasions the processors may be obliged to adjust their size requirements when the season's crop gives insufficient carrots for their packs at the regular sizes. Thus both markets continually react on each other despite advance contracts for rather more than half of the requirements for processing. These requirements too vary from year to year according to the stocks of cans held over from one to another.

Many farmers perform all the marketing functions of the merchant, and many of these operate on a larger scale than the smaller merchants. These farmers and merchants have advantages in throughput and in market knowledge. The interest of the merchant however goes beyond this in his relationship with farmers who supply him.

Two thirds of the merchants grow a proportion of their carrots on their own land, a quarter of the acreage in the merchant sample. A carrot crop owned by a merchant gives him a useful reserve and can complement the supplies of his farmer clients. Indeed his own fields often have an unusual programme of drilling to balance up his supplies. Most merchants have their own washing plant and transport, but a few hire them. Larger merchants may have a dozen lorries for field transport and another dozen larger ones for delivery to market. Two merchants in Norfolk choose to lift with hand labour (and Hoover machine), on piece work payments of £3 to £4 a ton for lifting and 75p to £1.50 for washing and grading. So far as fertiliser application is concerned, the soil is commonly analysed by specialist firms and fertiliser applied by them. With the crop following carrots in mind, this is much appreciated by the farmer.

Grants for harvesting and grading equipment are made to growers of carrots under the Horticultural Improvement Scheme and merchants not growing carrots on their own land complained that they did not qualify despite their important part in production and marketing.

PRODUCTION AND MARKETING IN PARTNERSHIP

Thirteen farmers with seven percent of the acreage in the national sample grow carrots in partnership (system B). Seven of the fifteen in the merchant sample grow in partnership covering one half of their carrot business. In the national sample of growers, partnership arrangements are not as common as System C, where land is simply rented by the merchant. To make partnership schemes work a strong element of mutual confidence is required. Business is done on this basis only with a few farmers with large acreages. Especially if carrots are grown in partnership, some merchants grow cabbages, parsnips, turnips and swedes, with farmers on a similar system. Merchant preference for either system varies; some are developing partnerships and others are expanding on rented land.

In partnership arrangements the merchant always markets, harvests the crop, prepares it for sale and markets, though the farmer may supply men and equipment. Pre-harvest work may be carried out

by either partner but the farmer usually ploughs the land and prepares the seed bed. A farmer with other root crops may well do more of the work on carrots than one with none. Much depends on what suits either, having in mind pressure of field work at the time. For all operations, charges are agreed in advance. Rates charged are shown in table 17.

Table 17. Charges for operations per acre under partnership

Operation	£ per acre	Operation	£ per ton
Ploughing	2.0 to 2.25	Harvesting labour	3.5
Harrowing	0.3 to 0.5	Transport to washer	0.75
Rolling	0.35 to 0.5	Wash and grade	1.25 to 1.5
Drilling	0.75 to 1.25	Topping, large carrots	5.0
Spraying	1.00 to 1.5	Topping, small carrots	7.0
Hoeing	0.6 to 1.0		
Fertiliser Application	0.75		

From the farmer's standpoint, carrots fit easily with labour requirements on his other crops, while a share of the profit gives an incentive to both to do their best. The local name for the arrangement, *Joint Venture*, aptly describes it, the outcome is unknown, and the risk and responsibility is taken jointly. Many farmers have practised this form of partnership for twenty years. The merchant usually selects the field and stipulates the seed variety and the planting system, having in mind his contracts with processors or his interests in the fresh market. The period the crop will occupy the land is agreed, because the farmer needs access to prepare for the succeeding crop in the following spring. The merchant's expenses for marketing, such as commission and transport to market, are deducted from the market return. Sales less these market charges are the proceeds of the venture. Agreement on rent charged by the farmer for the field chosen is made in advance. At the end of the season the merchant presents a complete statement of account of which the following is an example:

Table 18. Partnership (Joint venture) account

INCOME												
45 Acres												
583.9 tons Carrots (£15.35 per ton)										£		
										8967.12		
EXPENDITURE												
<i>Farmer</i>												
Growing Cultivations										£		
Rent @ £10 per acre										£		
										£		
										872.34		
<i>Merchant</i>												
Seed										78.66		
Drilling										44.40		
Cultivations										251.17		
Fertiliser										56.76		
Sprays and spraying										249.33		
Labour for lifting @ £3.50 per ton										2043.65		
Transport to washer. 133.3 tons @ 75p per ton (450.6 tons loaded direct from field)										97.75		
Grading and washing. 133.3 tons @ £1.50 per ton										199.95		
Topping 42.5 tons large carrots @ £5 per ton										212.50		
Provision of empties												
7027 x 28 lb nets and ties @ £2.40 per ton (88 tons for market)										210.81		
19842 half bags @ 2½p each (496 tons for processing)										496.05		
Haulage to customers. £1 per ton										869.63		
Administration costs, telephone, postages, etc.										448.36		
										5259.02		
Excess of Income over Expenditure, Profit (£63.02 per acre)										2835.76		
										8967.12		
APPROPRIATION ACCOUNT												
<i>Farmer</i>												
By Costs										872.34		
Half share of profit										1417.88		
										2290.22		
<i>Merchant</i>												
By Costs										5259.02		
Half share of profit										1417.88		
										6676.90		
										8967.12		

The statement is in two parts, income and expenditure for each partner and an appropriation account which summarises the expenses of each and allocates the profit.

Farmers who have developed this arrangement may benefit considerably in cash terms, as well as from the way the crop fits in with the other enterprises and the use of labour on the farm. Joint management must raise the level of crop and market performance on the farms, many of which have a small acreage of carrots. Merchants do not lightly operate on this basis and once partnership is established, the farmer is keen to keep it going. Agreements between the farmer and the merchant are mainly verbal and built on mutual trust.

CARROTS ON RENTED LAND

Twentyone farmers with 30 percent of the acreage in the national sample let land to merchants. Here the merchant owns the crop and is responsible for growing it from the date of entry to the land. The farmer receives a straight rent that varies with the time the crop occupies the land and the type of soil. Some merchants will rent no less than fifty acres on one farm, and, for some crops taken at harvest, the merchant stipulates a minimum yield for a given rent. Most commonly the merchant takes over the land after ploughing or when it is ready for drilling. Half the rent is paid when the crop is drilled and half after harvesting. Fen land, because of good yields, typically attracts a higher rent than sand land. The range of rents paid under different arrangements and on different types of soil is given below.

Range of rents received by farmers for land let

	<i>All Farms</i> £ per acre	<i>Light Land</i> £ per acre	<i>Fen Land</i> £ per acre
Ploughed land	17 to 30	18 to 20	29 to 30
Land ready to drill ..	17 to 40	17 to 30	32 to 40
Crop ready to harvest ..	50 to 65	50 to 60	65

Letting again requires close understanding and mutual trust, and again there is the opportunity for the farmer to suit his own management inclinations, and, as in partnerships the merchant harvests and markets the crop. Crops taken by the merchant at point of harvest are normally for a much larger acreage when in addition the farmer is more involved and he expects to get from £45 to £65 per acre. The economic results of letting arrangements are shown in table 19.

Table 19. Land let to merchants at different stages. Gross margins per acre
Twentyone Farms. National Sample

<i>Point at which land is taken over</i>	<i>After ploughing</i>	<i>Ready for drilling</i>	<i>Ready for harvest</i>	<i>All farms</i>
Number of Farms	9	8	4	21
Carrot acres per farm	85	73	242½	110½
Acres (ha) covered by survey	765 (310)	584 (236)	969 (392)	2318 (938)
	£ per acre	£ per acre	£ per acre	£ per acre
RENTS RECEIVED	22.71	27.13	51.51	29.88
FARMERS COSTS PER ACRE				
Seed	—	—	3.77	0.72
Fertiliser	—	0.94*	5.86	1.47
Spray materials	—	—	7.86	1.50
Contract	—	—	1.17	0.22
Total variable costs	—	0.94	18.66	3.91
GROSS MARGIN	22.71	26.19	32.85	25.97
Regular labour	0.68	1.14	1.54	1.02
Tractors	0.80	1.34	1.57	1.15
Machinery	0.36	0.61	1.36	0.65
Rent and rates	6.86	8.41	7.27	7.53
Overheads	1.30	1.87	4.56	2.14
Total Fixed Costs	10.00	13.37	16.30	12.49
Total Costs	10.00	14.31	34.96	16.40
NET PROFIT	12.71	12.82	16.55	13.48

*One farm only.

In table 19, rents received and results per acre are the average of so many crops taken at each stage of letting. Land ploughed or ready for drilling does not normally incur the farmer in variable costs, and a higher rent applies when it does. On crops taken over at harvest the farmer generally follows a drilling programme and carries out all operations under merchant supervision. Gross margins per acre from land let (table 19) are more or less in proportion to the farmer's contribution. Agreements are generally informal, about a third are written, but however constituted they are seldom broken. Crops grown on contract (p. 32) include those rented for taking over at the point of harvest and those purchased by the merchant at this stage. The former agreement is always supported by a written contract. The difference is that in the first case the merchant is committed to the crop before harvest, before the season's current market trend is known. In the second he buys according to the market situation. In the latter case the farmer grows the crop on speculation and finds a merchant to take it. There were fewer cases of a merchant buying lifted carrots, though this is done especially on the smaller farms. Some merchants make special arrangements for crops which they agree in advance to take at harvest. In one case, on a crop with a rent of £60 per acre, £10 is paid in August, £25 when harvest starts, and £25 on completion. On crops of less than fifteen tons per acre, £4 per ton is paid. If the farmer fails to produce a crop of fifteen tons per acre, he receives less than £60 per acre, in proportion to the tonnage realised. This protects the merchant against poor yields and encourages the farmers to attain good yields.

The development and success of arrangements between the farmer and the merchant, who has every advantage in marketing (both in recruiting supply and satisfying demand) and expert organisation to support this, gives little scope for farmer group co-operatives. Despite generous grants their growth in carrot production has been slight. If co-operation (which is present government policy) is to increase in the marketing of many farm commodities *the marketing strength of the trade must be recognised*. Marketing is better left to the trade if competitive efficiency is the main consideration; if not, co-operation should where possible include the trade. Perhaps the recently established inquiry on contract farming will consider this, but, as shown by Dr. L. G. Bennett, they will need to look beyond formal contracts.

MARKETING

As an example, the marketing operations of a merchant specialising in carrots for the fresh market (with some five hundred acres) are now given in more detail. Most of his carrots are on rented land, some fifteen percent are taken at harvest, and one hundred acres are owned. To ensure a flow of the right type of carrot at the time required, land is rented on different soils and the seed is drilled at different dates. Fen land gives higher yields and affords natural storage as the rows are earthed up for the winter. The sand land of West Norfolk produces a high quality carrot early in the season. Investment in equipment in the merchant business runs at £6,000 and harvesting is mechanised with two share lifters and two top grippers to meet the various lifting conditions. These machines lift about two acres a day. Contracts are placed for processing carrots in February but over ninety percent go to the fresh market.

Records for a recent season, with a throughput of six thousand tons show trading in market carrots throughout the country to thirty seven wholesalers (many of whom are secondary wholesalers), four local merchants, and for processing carrots, another local merchant and a processor. The proportions for each destination over the country is given in table 20. London and Northern markets take a third each, while Southampton and the Midlands account for the remainder. Merchants and growers of course have a different pattern of outlets, a natural development of marketing practise which is of benefit to both the producer and consumer. In this way total demand and supply are well matched.

Carrots are washed depending on the type of soil on which they are grown, and certain markets prefer them washed. It is important that carrots are washed within fortyeight hours of lifting and that they are marketed straight away.

Market carrots are delivered by eight or ten-ton lorries in 28 lb nets (nearly half a million) and those for canning in 56 lb bags. Market deliveries to each wholesaler take place several times a week and loading continues every working day for eleven months. Lorries leave the washing plant for the wholesale markets by 3.00 p.m. (the normal end of the early working day in the Fens) to arrive in time for market dealings by the early hours of the following day. The carrots arrive in the retail shops early

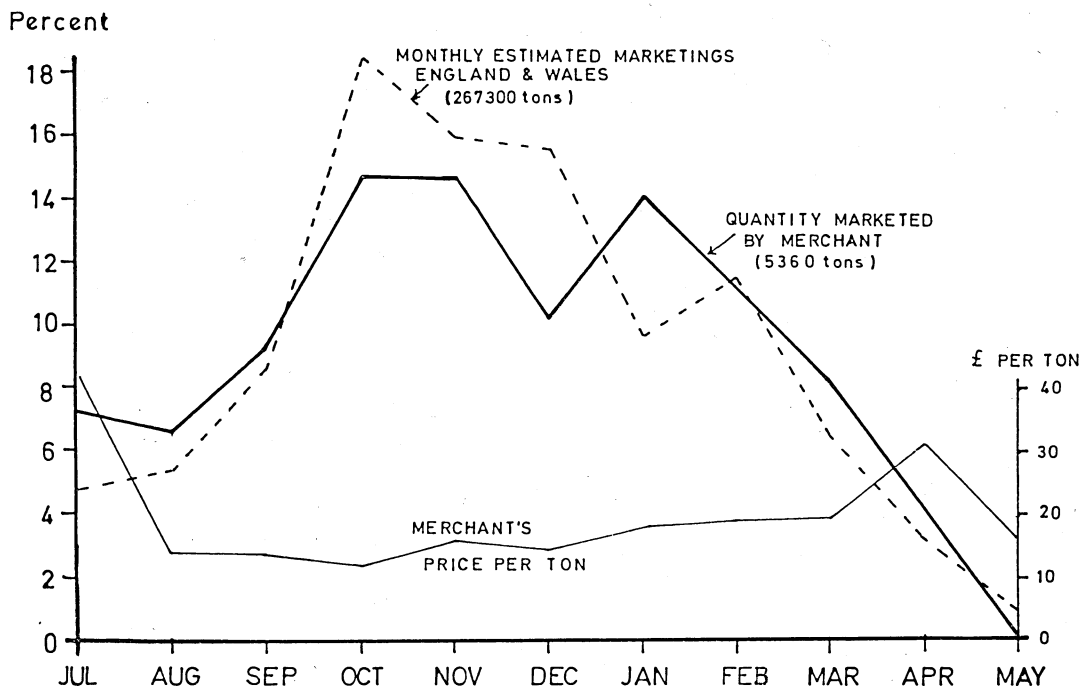
the same day. Carrots are sold on commission by wholesalers at seven-and-a-half (now ten) percent and the market charges are £1 per ton for handling.

Table 20. Market sales—one merchant

Market	Number of Wholesalers	Percent of Throughput (6036 tons)
London—Covent Garden	3	11.2
Brentford	5	9.9
Other (three markets)	10	10.6
Leeds and Bradford	5	8.3
Manchester and Liverpool	6	12.9
Newcastle	4	12.0
Birmingham and Coventry	3	4.0
Southampton	1	14.3
Local merchants	4*	10.1
Processing carrots	2†	6.7
	43	100.0

*Includes a secondary wholesaler. †Local merchant mainly, and processor direct.

Figure 8. Monthly market sales over the season
Proportion marketed in each month and price per ton



Monthly marketings (two percent of UK) by the merchant over 1965-6 season are shown in Figure 8, against the price received. At the beginning of the season in particular, and at the end, prices are high because supplies are short. There is a good demand for new carrots in July and a much poorer demand towards the end of the year when they have been available for many months. In the new year demand increases as other vegetables become scarce. Prices vary from £40 per ton in July when seven percent of the supply is marketed to £14 per ton in December when ten percent is marketed, and over £30 a ton in April when four percent is marketed. The dotted line in Figure 8 shows the proportion of the crop in England and Wales (ninety four percent of the UK crop) marketed in each month. For a single merchant some variation from the national pattern of marketing is expected because of differences in ground conditions for lifting and in maturity of the crop. This particular merchant emphasises early

carrots and the post Christmas late carrot. The proportion marketed in different periods of the season is as follows:

	<i>Merchant percent</i>	<i>England & Wales percent</i>
July to September	23.0	18.6
October to December	39.5	50.0
January to March	33.3	27.4
April to May	4.2	4.0
	<u>100.0</u>	<u>100.0</u>

Such a range in the pattern of deliveries from merchants and growers, with alternative varieties grown in different localities on various soil types, permits a nearly continuous supply to the retail shops which only slackens when the ground is frozen or when the season comes to an end. The fresh market for carrots, with its numerous suppliers in the production areas and a large number of wholesalers widely distributed over the country to channel supplies to retailers in the consumption areas, is an example of truly competitive marketing now less common in Britain. Because of the great number of buyers and sellers, efficiency of transport, homogeneity of supply and the durable yet perishable nature of the commodity, carrots have a perfect market throughout from the first sale to purchase by the housewife.

Carrots fetch markedly different prices in different markets (prices have been weighted for the quantity sold in each market for the whole season shown in the table below). With the average price in all markets as 100 (£17.77 a ton) prices in the different markets for the season are shown below.

<i>Market</i>	<i>Price Index</i>
London Covent Garden	107
Brentford	103
Other	100
Leeds and Bradford	91
Newcastle	87
Manchester and Liverpool	101
Birmingham and Coventry	88
Southampton	123
Local Merchants	86
All Markets	100

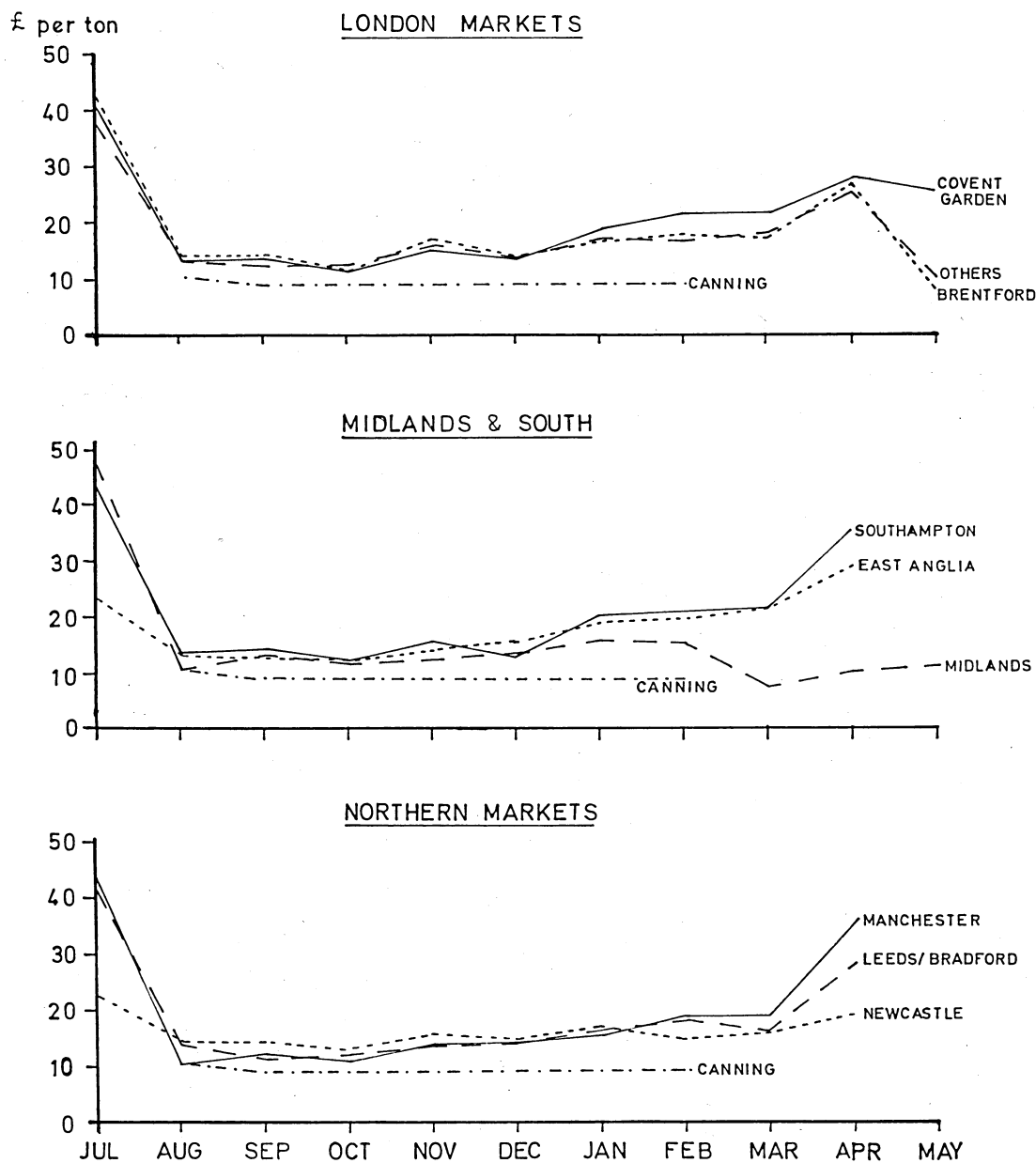
Again prices in different markets vary with the particular market interest of the merchant or grower but so far as the above figures are concerned London markets are as good or better than average, while the North other than Liverpool and Manchester, and the Midlands are relatively poor, and Southampton is outstandingly good. This situation is shown for the monthly price in different markets in Figure 9.

The price of canning carrots which falls from £10.59 per ton in August to £8.85 in February, is put in all three sections as a guide. Price differences between markets are most marked at the beginning and end of the season suggesting that the market is most perfect at the time of full supply. London markets are relatively close in price, but Brentford is best before Christmas and Covent Garden after. For much of the season local sales are similar in price to Southampton sales but a much larger quantity goes on the Southampton market. Midlands prices are noticeably poor over the whole season, particularly towards the end. Among Northern markets, Newcastle prices are the highest in the full season but lowest at the end. Manchester prices are the lowest during the peak season and those for Leeds and Bradford are close to Manchester over most of the season.

Merchants do much to reduce the risk in carrot marketing, especially for the smaller grower who has neither the experience nor the opportunities in the marketing field. For many farmers carrots provide a break crop and co-operation with a merchant can raise standards of production. Naturally a merchant is in carrots to make money too, but there is always ample competition between the merchants themselves and the farmers who market to keep the merchant business itself competitive. In general, the biggest part of the merchants business is in market carrots. Merchants are not only necessary to handle the large quantities of carrots in Britain, but their role continues to develop with the changing market. Some merchants now specialise in a particular type of carrot for the trade or for the processors and they lead the field in the development of carrots for pre-packing. Without their unique experience

and knowledge of the market, it is inconceivable that the five hundred thousand tons (which represent our annual supply), would find outlets in Britain. Without the services of the merchants the market for fresh and processing carrots would have been restricted in its growth.

Figure 9. Prices in different markets over the season



Marketing and Outlook

THE FARMER'S MARKET

Sales data for the 1968-9 season for sixtyfive farms (system A), growing nearly two thirds the acreage in the sample, greatly adds to understanding of how carrots are marketed in this country. Six of the seven Manchester farms sell their entire output to the fresh market trade to satisfy the big local demand. Farmers mainly send to wholesalers (one under contract) in Manchester and Liverpool, and in the industrial towns in Lancashire and Cheshire. Some carrots go to wholesalers in the potteries and in Shrewsbury. One farm sells only to the local canning factory, and a third of the output goes to local markets. The Leeds region shows a similar situation, that of local supply mainly fulfilling local needs. One farm grows a wide range of vegetable crops and the farmer has stands on the wholesale markets in Yorkshire. The other five growers distribute carrots to wholesalers principally in the Yorkshire and Lancashire regions, but also to towns in Sheffield and Newcastle. Two of these growers send to local canning factories. The eleven farms in the Nottingham region, some on the fringe of the big concentration of carrot production in the Fens, also show considerable local specialisation in marketing but in this area the specialist carrot merchants take part. Merchants buy the entire crop on three farms and a part of the crop on three more. Eight farms sell at least part of their output (one its entire output) to processors, mainly in Sheffield. Carrots go to local markets principally in Scunthorpe, Sheffield, Doncaster and Hull, but some go to Manchester, Liverpool and Glasgow.

The fortyone Cambridge region growers and the merchants who support them dominate the national market for carrots. Ten of the growers are themselves carrot merchants and five growers sell their entire crop to merchants. The whole crop on another five farms goes to processors (one through a merchant) in the locality. All the other farms supply both the market and the processors, though some specialise in market carrots and some in carrots for processing. Most growers supply a large number of wholesale markets all over the country and they may do business with merchants as well. All growers are interested in marketing as they rightly see it as the principle way in which the profit is made on the crop. Many are involved in marketing and the following case is typical. Carrots for processing amount to 630 tons, and for market to 830 tons. Market carrots are sent to three main markets, Southampton, Covent Garden and Leeds, and smaller amounts go to the other markets.

Scotland, where nearly two thousand acres are grown, shows some differences compared with England. Here the emphasis is on carrots for processing and overthreequarters of the crop has been sold to processors in recent years. Fresh carrots come mainly from England. An economic survey by the East of Scotland College of Agriculture for the 1969-70 crop of 24 farms covering 40 percent of the acreage, shows that all the farms have contracts with processors. Fourteen percent of the harvested production is fed to livestock. (In the 1968-9 sample in England only one or two farmers reported livestock use and most of the unsold carrots are dumped). Eightynine percent of the sales of Scottish carrots go to processors as compared with an estimated 30 per cent for Britain in the same year, ten percent is marketed fresh and the remainder is sold for stock feed. In Northern Ireland where some five to six hundred acres are grown, the fresh market is the main outlet and processors take only two percent of the output. Carrots are imported into Northern Ireland from England, the Republic of Ireland, and from Cyprus in varying quantities each year.

The sixtyfive growers in the sample marketed 54,000 tons of carrots, or an eighth of the crop in Britain. Thirtysix percent were market carrots and fortyseven percent carrots for processing. The remaining 9,000 tons went to merchants for disposal on both markets, and most of these would be sold as market carrots. In the random sample merchants directly control nearly 40 percent (systems B and C) and through trade a further ten percent. The marketing of crops in system A is shown in table 21.

Crops of seventy acres and over that account for most of the carrot output produce the biggest proportion of carrots for processing and these farms rely least on carrot merchants. Crops in the

middle size group go mainly to market and the merchant plays only a small part in their disposal. Farms with a smaller carrot enterprise sell over half their output to merchants, and in consequence, their own sales of market carrots are low. Four percent of market carrots are known to go for prepacking, all selected from fields grown on farms with seventy or more acres of carrots.

Table 21. Market outlets: sixtyfive farms in system A. 54,046 tons

	<i>All Farms</i>		<i>Under 20 acres</i>		<i>20 to 70 acres</i>		<i>70 acres and over</i>	
<i>Number of Farms</i>	65		17		23		25	
	<i>tons</i>	<i>percent</i>	<i>tons</i>	<i>percent</i>	<i>tons</i>	<i>percent</i>	<i>tons</i>	<i>percent</i>
Market	(43.0)	19,343 (35.8)	432 (11.3)	6,892 (50.4)	12,019 (32.9)			
Processors	(57.0)	25,597 (47.4)	1,308 (34.2)	4,809 (35.2)	19,490 (53.3)			
Merchants	—	9,106 (16.8)	2,083 (54.5)	1,962 (14.4)	5,061 (13.8)			
		100		100		100		100
Total tons.. .. .	54,046		3,823 (7.1)		13,663 (25.3)		36,560 (67.6)	

Thirtyseven records had information to show the disposal of their crop of 27,000 tons over the season. These compare with Ministry estimates for 1968-9 for 433,000 tons, as follows:

Table 22. Disposal of the carrot crop. 1968-9 season

	<i>Survey Farms</i>		<i>MAFF estimates (UK)</i>	
	<i>percent</i>		<i>percent</i>	
July		0.8		3.3
August		4.3		7.7
September		6.1		8.6
October		13.1		16.8
November		19.4		16.3
December		15.7		13.1
January		16.7		11.7
February		8.9		11.1
March		9.3		8.0
April		4.5		2.9
May		1.2		0.5
		100.0		100.0

The survey figures which are based on a representative sample appear to confirm the validity of the Ministry estimates of the movement of the carrot crop off farms, though in the survey loadings bulk more slowly. In the last three months of the year 48 percent of the crop is lifted in the first case and 46 percent in the second, and in the first three months of the new year the proportions are 35 and 31 percent. This emphasises how much the carrot is a winter harvested crop with all the seasonal weather difficulties which arise from this.

Farmers respond to the national market demand by planting so many acres each year. On a given acreage in a mild winter carrots grow more, production is greater and prices are low because more carrots are available than the market requires. Moreover, in a mild winter there are quantities of other vegetables available and the demand for carrots is less because of this. In a severe winter, however, growers have a struggle to lift a smaller crop. There are few alternative vegetables on offer, and the price of carrots is high. This is one of the reasons most farmers stay in carrots from year to year. Over the years there is a steady decline in the total number of farms growing carrots and those who give up remain out of production.

The prices received by the survey farmers showed a fairly wide distribution about the average, some of which must be attributed to quality and some to the marketing skill, particularly for market carrots. The distribution of price is shown in table 23.

Table 23. Price distribution by type of outlet. Thirtyseven growers

Average price £'s per ton	All Outlets	Market	Processors	Merchants
.. .. .	15.0	17.4	13.2	13.3
Less than £10	10	5	2	3
£10 to £12	12	2	9	1
£12 to £14	21	3	14	4
£14 to £16	19	8	8	3
£16 to £18	7	5	—	2
£18 to £20	6	4	1	1
£20 and over	15	12	2	1

For the market price the grower incurs costs of delivery and nets, some three to five pounds a ton. The price for processing carrots usually includes delivery to the factory. The range in price in table 23 is widest for market carrots, and for those sold to merchants (which mainly comprise market carrots). As one might expect, there is little range in the price of processing carrots. The monthly prices too are interesting. These come from ten growers of market carrots and two of processing carrots only. They are shown against the Ministry estimate of monthly prices on the wholesale market (from nine markets) and the retail prices expressed in pounds per ton.

Table 24. Monthly prices per ton 1968-9

	Survey Processing Carrots	Survey Market Carrots	Wholesale Markets*	Retail Shops†
	£	£	£	£
July	—	25.36	31.25	124.1
August	12.44	13.36	16.58	69.1
September	12.87	14.04	19.92	60.7
October	12.60	14.08	18.33	58.8
November	12.96	14.31	20.92	59.7
December	13.19	14.03	26.08	59.7
January	13.52	16.52	23.25	68.1
February	19.31	22.96	42.17	81.2
March	18.48	24.48	32.83	80.3
April	—	26.63	34.33	93.3
May	—	22.14	26.42	103.6
Monthly average	14.42	18.90	26.61	78.05

*MAFF Market Reports nine markets. †Department of Employment Gazette.

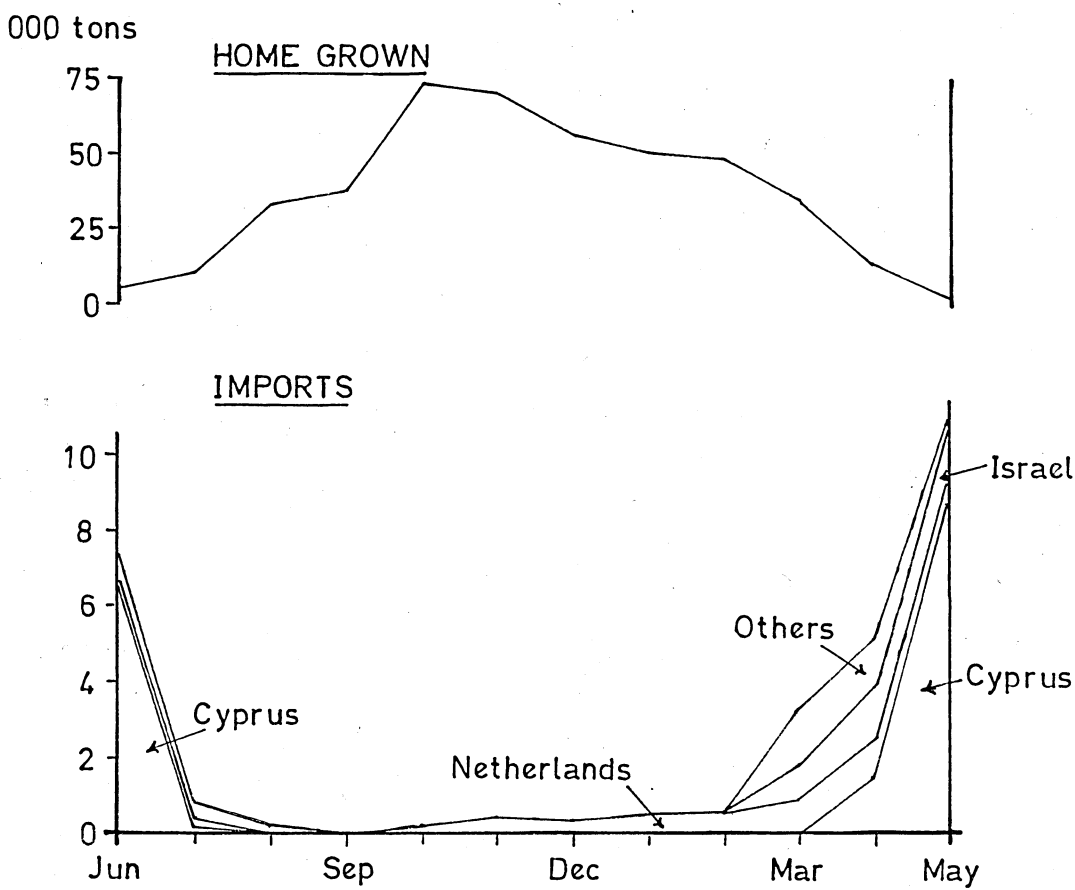
On average, processing carrots are threequarters the price of market carrots, and though there are quite substantial premiums for late delivery to the factory, the gap widens in the late season. The wholesale market price is higher than the grower's price (price at the farm) by 40 percent, rather more in December and February, and less in the early and later parts of the season. Retail prices are four times as high as the grower's price, a rather larger increase on grower's price than one would expect even allowing for wastage. This compares with a two to threefold increase in price from grower to retail level for potatoes. Smaller amounts of carrots than potatoes are purchased in the retail shop but the big mark up from grower's price to the retail price for carrots does suggest the need for research on this topic.

For processing carrots the best prices are given for small ones for canning whole. The range in price for these is slight, most commonly it is £13 per ton delivered to the factory but it may be within £1 of this up or down. As the season advances (when fewer carrots comply with the factory requirements) the price increases. Larger carrots for processing fetch £9 a ton, and again there is little variation in price.

Market supplies over the months of the 1968-9 season are shown in figure 10. The top part of figure 10 shows the monthly liftings of home grown carrots and the lower part (on a larger scale) the imports of carrots.

May and June are the only months with imports in any quantity, ten thousand tons in May and eight thousand tons in June. From July to February inclusive only a few thousand tons are imported each month and these come from Holland.

Figure 10. Monthly supplies of carrots in Britain 1968-9



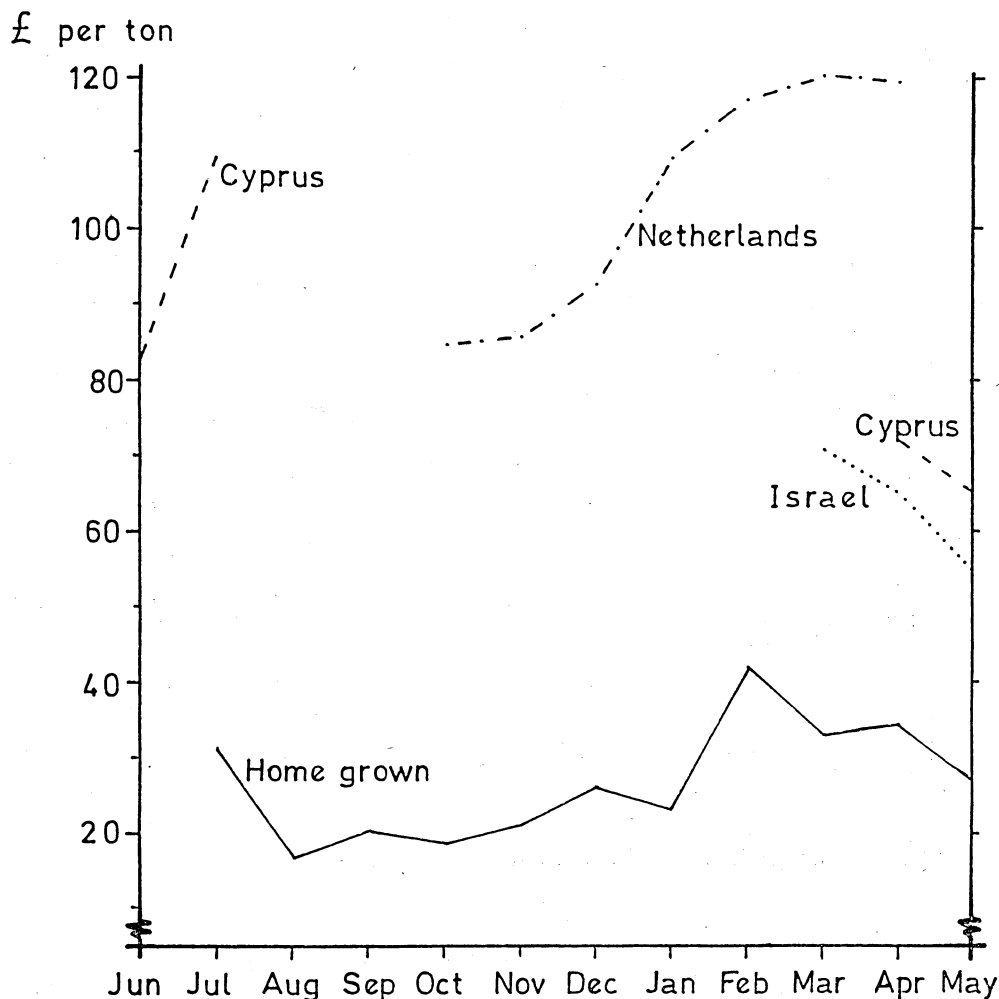
Source: MAFF Statistics and Commonwealth Secretariat

The current UK tariff on non Commonwealth imports is ten percent *ad valorem* for April, and July to October inclusive, six percent for November to March inclusive, and £1 per cwt in May. The latter is a very high rate, adding £20 a ton to the price of all imported carrots in May (except those from Cyprus). For this reason Cyprus supplies some eighty percent of the May imports and she also dominates the imports in June when other countries pay the ten percent tariff. Cyprus imports (1968-9) are twenty thousand tons and all other imports together, thirteen thousand tons. Netherlands carrots amount to nearly five thousand tons and they compete through their quality; see the price of Dutch carrots in figure 11. Four thousand tons come from Israel and two thousand from the United States. Another two thousand tons come from various countries including Denmark, Algeria, Morocco and the Lebanon, Italy and France. Imports are attracted by the high price which a quality produce can attract in Britain. The market for imports of some twentyfive to thirty thousand tons per year is very small compared with the home grown carrot market for some four to five hundred thousand tons per year, and in a sense it is a different market as the prices in figure 11 indicate.

Figure 11 shows the big changes in the price of home grown carrots (wholesale to retail prices, MAFF) over the season. Prices are at a peak at the beginning and they rise gradually from August to another peak at the time of the most difficult winter harvest conditions from February to the end of the season. Dutch prices rise markedly with the onset of winter, while carrots from Cyprus and Israel come a little later

and have a lower price. The graph splits up the Cyprus season into two parts (Imports in April and May meet one British season and those in June and July, another).

Figure 11. Monthly prices of carrots in Britain 1968-9



Source: MAFF Statistics and Commonwealth Secretariat

DEMAND AND SUPPLY

Statistical relationships between supply and demand for carrots in Britain were examined on twenty years data on production and price in the wholesale market. The mathematical procedure is given in appendix table 7, the results following in the text.

Acreage and price

The response of acreage grown in Britain to price was measured on both semi log and double log functions (appendix table 7A). In the former, prices in the preceding year were plotted against the acreage grown in the current year, as it was expected that the acreage grown in any particular year might be influenced by price in the previous year. The semi log function shows that thirty percent of the variation in the acreage planted in a given year is attributable to price in the previous year. The double log function gives another estimate of the price elasticity of carrots in relation to acreage grown, and shows that a ten percent rise in price is followed by a 2.6 percent rise in the acreage drilled in the following year.

While these results are positive, it is evident that the acreage grown responds to other factors other than price. Among these are the weather and the price of other farm crops, especially cereals, sugar beet and potatoes. One most important factor however is the contract price for processing carrots (which is known before sowing) and is set having regard to the expected price of market carrots in any season. The acreage drilled each year will depend on supplying the demand from both markets, having in mind both the normal yield and the likely fluctuations from it. The fact that farmers tend to profit from a scarcity of fresh carrots, induces them to grow an acreage from year to year which roughly corresponds to the amount the market will take. Individually the acreage planted depends on many factors especially on the farmer's experience in production and marketing to date. Because there are some 2,000 growers, competition is likely to be more perfect on the supply than on the demand side.

Acreage and consumption per head

In this case, demand is not measured by price but by consumption per head to avoid complications of seasonal price variations. The calculations rely on a number of functions (appendix table 7B). Given current technical conditions in production, a ten percent rise in consumption per head gives rise to a 4.2 percent increase in the acreage grown. Technical innovations and plant breeding could achieve higher yields and this would lead to a smaller acreage response for a given demand increase.

Forecast of future consumption

People in Britain like carrots, so much so that we have the highest consumption in Western Europe, except France (present consumption in Britain is 8 Kg per head). Estimates of future demand are based on existing consumption habits. The economic growth rate and disposable income for the United Kingdom are included on the twenty year trend, and official population forecasts are used. The estimating function is shown in appendix Table 7C. On this basis the expected future consumption of carrots (in lbs per head) is as follows:—

1970	18.1
1975	18.6
1980	20.2
1985	21.1
1990	23.2
2000	26.2

This shows an increasing demand (estimates beyond 1980 have less confidence than estimates to 1980) but future demand will be more sophisticated in choice. Demand for fresh carrots will not rise so fast if Britain becomes appreciably more affluent when normal season raw carrots will become an inferior food, but will be greater if we make slow progress on the economic front. The trend of increasing demand for carrots for processing is rather more than twice that for fresh carrots. Future consumption in Britain is not expected to be affected directly by our joining EEC, only indirectly by the effect on our economic growth.

Retail and wholesale price

Wholesale carrot prices are available for a number of years but retail prices only since 1968. The average retail price in recent years exceeds the wholesale price by 268 percent. Variability of wholesale prices is almost four times as great as for retail prices. Wholesalers of course work in perfect or near perfect competition and prices respond readily to demand and supply. At the retail level, other considerations enter the picture. The retailer looks for a certain "mark up" to cover his overheads and puts a price on carrots to justify their presence in his shop among many products competing for a place. Initially too, he is paying rather more than the wholesale price as he buys in small lots through the trade which also has to make a profit after the wholesale stage. The equation shown in appendix Table 7D enables prediction of the retail price, when the wholesale price is given. If the average wholesale price rises by one percent, the retail price rises by 2.2 percent.

Imported and home-grown supplies

Carrots grown in Britain account for over ninety percent of the supply. Imported carrots are much more expensive and from the demand point of view constitute a different commodity. Calculations confirm this statement, but some increase in imports does take place when home production is significantly below average. This is clear from figure 5 (page 16) which shows a big shortfall in the 1962-3 crop, but in normal years imports change little. There is some correlation between imports and home supply when they are lagged two years against home production. Even so, only sixteen percent of the variation in carrot imports can be attributed to changes in home production.

Over the past twenty years, the average price of home grown carrots at wholesale is $\pounds 13 \pm 3.8$ against $\pounds 53.5 \pm 9.1$ (per ton) for imported carrots. The price variation of home grown carrots is much greater than that of imported carrots (Coefficient of variation twenty-nine percent for home grown, and seventeen percent for imports). This is substantially because the imported carrot has reached a different point in trade than the home grown carrot (wholesale market price) and because imported carrots are sold firm. Moreover, home supplies are large and the price in any one year is subject to changes in seasonal yield. Also production costs make up a lesser proportion of the price of imported carrots but with marketing and preparation costs they are a relatively high cost commodity. They are specially produced and with the exception of Cyprus which has an exclusive British market, they have alternative markets in different countries.

Year to year changes in the amount of carrots imported is only weakly related to consumer spending, but the elasticity of demand is greater than zero, between .2 and .3. A ten percent increase in income is associated with a .3 percent increase in carrot imports. From this it appears that the quantity of carrots imported in normal seasons depends more on the purchasing power of the housewife than on the level of production in Britain.

CARROTS IN THE COMMON MARKET

Little change in restrictions on the trade in carrots is foreshadowed by negotiations under the Kennedy Round. For example, Britain will relax the November to March tariff from six to five percent with effect from January 1st, 1972 but no other change is anticipated. (In this period less than one sixth of the total imports come in). A quota on imports to Britain applies to the Eastern Area (Bulgaria, Hungary, Rumania and Poland) but in fact no imports from these countries have arisen in the last ten years. The external tariff of the EEC is seventeen percent *ad valorem* throughout the year.

Trade within the EEC in carrots is important and it has increased greatly since the Market was established. This takes place chiefly because of a deficiency in domestic supplies (Western Germany) or to supplement supplies in the season when home production is waning (France and Germany). The chief exporter both within the EEC and elsewhere is Holland, followed by Italy. Israel is also an important source for EEC countries, but unlike citrus fruit she has no trade concession for carrot exports. Holland is the market garden of Europe, while Italy and France produce the fruit. Twentyfive percent of Dutch exports are farm products and over a quarter of these are horticultural. The production of carrots, one of the most important crops in Holland, runs at 138,000 tons per year (1969-70). Fifty-three thousand tons go for export and 24 thousand for processing. Her principal export markets are Belgium-Luxembourg (52 percent), Western Germany (34 percent) and Britain 9 percent. Smaller quantities are exported to Scandinavia, Austria, Eastern Germany, and even to Italy and the United States. Of the three thousand acres grown, half are finger carrots for the luxury trade, grown on light sandy soils. For this trade, the crop is protected with straw and polythene and labour costs are high. However, yields per acre reach 28 tons when the crop is worth more than a thousand pounds per acre. Washing and grading is done co-operatively and marketing for export is centred on the Katwijk clock auction to which come crops from all over Holland. Grading and inspection takes place here for a levy of five percent. This charge supports the basic price for crops which fall below the reserve price for the day and surplus carrots are fed to stock or destroyed. Consumption of carrots in Holland is among the lowest of the six (some 4 Kg per head), partly because of its high value as an export crop. It is unlikely

that the acreage will increase, so great are the pressures on the land in Holland, but it is likely that production will continue to increase in the next decade as it has in the last, through technical improvements.

Western Germany has a rising consumption of carrots (3.4 Kg per head) and produces 170,000 tons (1969-70). Germany imports 67 thousand, and exports three and a half thousand tons. Almost all her imports come from other members of the six; 23 percent from France, 41 percent from Italy, and 31 percent from Holland. Germany imports carrots from all the countries she borders as well as Poland, Hungary and Israel, and exports small quantities to Italy, Sweden, Denmark, Switzerland and Austria. Frontier trade is associated with the proximity of carrot land in one country with urban centres in another.

France with 628,000 tons (1970) produces more carrots than any other West European country and has the highest consumption (11.5 Kg per head). In 1969, 4,000 tons were processed and in 1970 9,000 tons, much less than Britain where it is estimated that 106,000 tons of the 1968-9 crop and 175,000 tons of the 1969-70 crop were processed. France exports 21,000 tons and imports 32,000 tons. Like Britain, she imports only some 5 to 7 percent of her consumption, mainly from Italy (58 percent) and Belgium-Luxembourg (27 percent). In Italy production of carrots is now some 165,000 tons of which 15 percent is exported, mainly to other members of the EEC. Home consumption is rising and a decrease in exports is expected.

In the EEC Britain would import carrots from Holland tariff-free but no dramatic increase from Holland can be expected. These are luxury carrots for which we would be competing with Belgium-Luxembourg and Western Germany. Should Britain's growth rate in future, as is unlikely, approach or even exceed that of these countries, most of the Dutch exports will still go to our competitors on her border. Furthermore, expansion of the Dutch carrot production is limited by the scarcity of land. The effect for the Cyprus carrot trade of Britain joining the EEC could be serious. In Cyprus, carrots are an important export—they all come to Britain under the shelter of heavy protection. This may be replaced by the Common External Tariff against Cyprus of seventeen percent. If supplies from Cyprus decline, we could have a shortage in May and June and we must develop storage techniques in Britain to meet this need. Advances in storage would make British carrots more competitive with imports at the end of the season. Production in Israel on the other hand is rising steeply and imports to Britain are increasing. Israel already faces the Common external tariff and half her exports go to France and Germany. With Britain as a member of the Community and competition from Cyprus reduced, more supplies from Israel might come here. There is little immediate prospect for Britain to export fresh carrots to the EEC countries but there is no reason why a certain quantity of finger carrots should not be produced in time for this purpose and to save imports. There are good prospects for trade in processed carrots because our production costs are so low compared with the EEC. Higher prices for cereals (if we join the EEC) might however reduce the acreage available for carrots in Britain, resulting in a lower output and higher prices.

OUTLOOK

Holland apart, carrot production in Britain is the most highly organised, and we produce carrots more cheaply than any country in Europe. We have made great strides in the production of carrots for processing but the trade in fresh carrots has remained far too traditional, not keeping up for instance with developments in Holland. To some extent it is because of the imports of luxury finger carrots that production of prepacked finger carrots for supermarkets has been slow to develop in Britain. The potential is there, but it has yet to be realised. From over four thousand farmers growing carrots in 1962, the number has now dropped to less than two thousand. Production in Britain is now more concentrated on good soils, is on a larger scale, and is more mechanised than in any country in Western Europe, and these advantages will increase in future. Furthermore, most of the production is more and more in the hands of large and businesslike arable farmers who respond to changing conditions. As a breakcrop, carrots commend themselves by fitting in well with seasonal work loads, offering scope for mechanisation, and they give a high gross margin.

Supporting the carrot industry is the Agricultural Development and Advisory Service of the Ministry of Agriculture and other bodies such as the National Vegetable Research Station, the National

Institute of Agricultural Botany, the Scottish Horticultural Research Institute, the National Institute of Agricultural Engineering, and the Fruit and Vegetable Preservation Research Association. A few years ago the Ministry of Agriculture decided that research on carrots lagged behind other vegetables. Processors were becoming more interested in the crop and prepacking was becoming more important. The demand for a more precise product suggested more precision in production techniques. Consequently a comprehensive research programme is underway which should have an impact in the next decade. It includes all factors affecting quality, yield, and continuity of production. The various bodies mentioned are co-operating in this research with the principal object of precision growing of carrots for the new market outlets. Developments are going ahead with different types of pack. Experiments are being made with a flexible (plastic) package in which clean carrots ready for cooking are vacuum packed at a cost little more than the canned pack. Dehydration, which removes ninetythree percent of the weight, will increase, and provide another outlet for the large carrot. At present we receive dehydrated carrots from Israel and we must now look to Israel for technical advance and continue to note the progress of the Dutch in this field.

While attention is being given to technical aspects of carrot production in Britain, too little attention is being given to marketing. It is fair to ask why we import so many carrots even though the total value is small. Lack of progress is largely the result of concern with the traditional market carrot. Competition among growers must intensify as demand becomes more sophisticated. The carrot, so long a British favourite, needs a modern image in the modern market, or as affluence increases it will become an inferior food. Furthermore if it is true that finger carrots are not successful on existing carrot soils, then we should grow them in new areas such as the sand lands of Cornwall. Then we could share the rich Dutch market for luxury carrots in Europe. We only need to develop it ourselves.

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Appendix

Table 1. Costs and returns by soil type
Crops grown and marketed by farmer system A. Sixtyfive farms

<i>Soil Type</i>	<i>Sand and Moss</i>	<i>Medium (Sandy Loam and Loam)</i>	<i>Light (V. Light, Light and skirt)</i>	<i>Fen Peat</i>
No. of Farms	18	19	16	12
Average carrot acreage (hectares) ..	75½ (30)	48½ (20)	118 (48)	91½ (37)
Acres (ha) covered by survey	1359 (550)	921½(373)	1888 (764)	1101 (446)
Yield-tons per acre (tonnes per ha) ..	13.1 (33)	12.1 (30)	10.6 (27)	5.8 (15)
RETURNS PER ACRE (Hectare)	£ 198.89 (491)	£ 183.75 (454)	£ 152.04 (376)	£ 99.50 (246)
<i>Variable Costs per acre</i>				
Seed	3.45	3.72	4.53	2.57
Fertilizer	9.67	10.66	6.99	4.90
Spray materials	8.03	7.74	5.30	8.04
Nets	6.35	9.95	2.68	7.01
Contract haulage	5.10	4.20	5.82	6.00
Other contracts	2.95	4.21	0.38	13.79
Casual labour	9.58	10.92	5.56	1.15
Regular piecework	1.93	3.09	17.52	0.63
Total variable costs per acre	47.06	54.49	48.78	44.09
Gross Margin per acre	151.83	129.26	103.26	55.41
<i>Fixed Costs per acre</i>				
Regular labour	12.87	13.59	15.63	12.38
Tractors	5.34	7.76	8.36	5.78
Machinery	4.86	5.53	6.42	3.59
Miscellaneous	0.52	0.03	*	1.15
Rent and Rates	8.52	7.81	7.91	14.92
Overheads	11.76	12.82	13.06	12.12
Total fixed costs per acre	43.87	47.54	51.38	49.94
TOTAL COSTS PER ACRE (Hectare)	90.93 (225)	102.03 (252)	100.16 (247)	94.03 (232)
NET PROFIT PER ACRE (Hectare)	107.96 (267)	81.72 (202)	51.88 (128)	5.47 (14)
Returns per ton	15.21	15.21	14.30	17.07
Total costs per ton	6.95	8.45	9.42	16.13
Net profit per ton	8.26	6.76	4.88	0.94

*Negligible

Table 2. Distribution of profit per acre all farms, crop size and soil type.
Seventyeight farms, systems A and B.

	By crop size			
	All Farms	Carrot Acreage Size Group (acres)		
		Less than 20	20 to 70	70 & over
No. of farms	78	22	27	29
Average carrot acreage (ha)	73½ (30)	15½ (6)	54½ (22)	139½ (57)
Average Profit £ per acre (per ha)	65.88 (163)	106.25 (263)	67.79 (167)	33.48 (83)
Loss	15	2	4	9
£0 to £25 per acre	12	2	3	7
£25 to £50 per acre	12	4	4	4
£50 to £100 per acre	16	1	10	5
£100 to £150 per acre	12	8	2	2
£150 to £200 per acre	6	2	3	1
£200 or more per acre	5	3	1	1

Soil Type	By Soil Type			
	Sand and Moss	Sandy Loam and Loam	Very Light, Light and skirt	Fen Peat
No. of farms	19	19	24	16
Average acreage (ha)	71½ (29)	48½ (20)	94½ (38)	80½ (33)
Average profit—£ per acre (per ha)	102.84 (254)	81.72 (242)	54.82 (135)	11.28 (28)
Loss	2	2	3	8
£0 to £25 per acre	3	3	4	2
£25 to £50 per acre	2	1	8	1
£50 to £100 per acre	3	6	5	2
£100 to £150 per acre	3	4	2	3
£150 to £200 per acre	3	3	—	—
£200 or more per acre	3	—	2	—

Table 3. 1966-7 Pilot survey results. Costs and returns per acre

	All farms	Fen soil	Light soil
Number of farms	21	7	14
Average carrot acreage (ha.)	100 (40)	106½ (43)	97 (39)
Acres (ha) covered by survey	2100 (850)	743½ (301)	1358 (550)
Yield—tons per acre (tonnes per ha)	12.1 (30)	10.7 (27)	12.8 (32)
RETURNS PER ACRE (per hectare)	£ 126.0 (311)	£ 121.7 (301)	£ 128.2 (317)
<i>Variable costs per acre</i>			
Seed	3.3	2.2	3.8
Fertilizer	5.4	5.8	5.2
Spray materials	6.5	8.6	5.4
Nets	6.6	6.6	6.7
Contract haulage	2.6	5.3	1.2
Other contracts	4.2	0.3	6.1
Casual labour	12.8	15.1	11.6
Regular piecework	7.3	9.4	6.2
Total variable costs per acre	48.7	53.3	46.2
GROSS MARGIN PER ACRE	77.3	68.4	82.0
<i>Fixed costs per acre</i>			
Regular labour	12.0	11.3	12.4
Tractors	6.7	5.7	7.2
Machinery	7.5	7.8	7.4
Miscellaneous	*	*	*
Rent and Rates	9.1	13.3	7.0
Overheads	12.6	13.7	12.0
Total fixed costs per acre	47.9	51.8	46.0
TOTAL COSTS PER ACRE (per ha)	96.6 (239)	105.1 (260)	92.2 (228)
NET PROFIT PER ACRE (per ha)	29.4 (73)	16.6 (41)	36.0 (89)
Returns per ton	10.4	11.4	10.0
Total costs per ton	8.0	9.8	7.2
Net profit per ton	2.4	1.6	2.8

* negligible

Table 4. Distribution of yields and profits, 1966-7 survey

Tons per acre	Number of Farms		
	All Farms	Fen Soil	Light Soil
0 to 4	1	—	1
5 to 9	5	2	3
10 to 12½	5	2	3
12½ to 15	4	1	3
15 to 20	3	1	2
20 and over	2	—	2
Net Profit £ per acre			
Loss	8	4	4
0 to 25	3	1	2
25 to 50	2	—	2
50 to 75	3	1	2
75 to 100	3	1	2
100 & over	2	—	2
Total farms	21	7	14

Table 5. Labour and machinery rates 1968-9 survey

Wages per hour

Calculated on 39 weeks at the 1968 level (man per week £11.55) plus 13 weeks at the 1969 level (£12.40). In the year, three weeks are allowed for paid holidays. The employers National Insurance contribution and graduated pension is added. The standard week is 44 hours.

The effective hourly rate is: men 30p, women 24p and youths 20p. Rates paid per week are often above the basic wage and this is taken into account.

Tractors and lorries per hour

Rates vary with tractor capacity: small vehicles 27½p, large 35p, and four wheel drive tractors 81½p. Small crawlers 56½p, and large £1.25. Lorries 5p per mile.

A wide range of standard rates per acre apply to general implements and machinery used for the various operations. Depreciation is charged at twentyfive percent on the written down value of specialised equipment and machinery.

Table 6. Specifications for carrots for processing

For all types of packs, good quality raw material is an essential prerequisite to a high quality final product. The carrots should possess a bright deep colour and a good flavour which should penetrate the root, that is, the core should be indistinguishable from the flesh. The raw material should not show any woody characteristics, be irregularly shaped or coarse in texture.

- Canning (whole)*. For the whole carrot pack roots should be within the size range ¾ to 1½ inches shoulder diameter and not longer than 4 inches. Smaller sizes are required for the baby carrot packs with lengths of 1½ to 2½ inches and ¾ inch at the shoulder. Stump shaped or conical roots are required for this pack and the Red Cored Chantenay stocks are the most widely used.
- Canning (sliced)*. For slicing, carrot sizes are more variable, ranging from about 3½ to 6 inches in length. The diameter should be a minimum of 1½ inches. It is important that the core colour is very similar to the flesh.
- Canning (diced)*. The sizes of carrots required for this pack appear to be unlimited with a minimum diameter of 1½ inches.
- Quick frozen*. Quick frozen carrots are usually sliced or diced and the same specifications apply as for canned carrots.
- Dehydration*. A carrot with a deep orange to red colour and a high dry matter content is required for this process. Larger carrots are sought as the wastage loss is far less than with smaller roots.
- Soups*. A minimum size is specified for carrots for soup products. Again the colour of the carrot is most important.

Defects—The following defects occur in raw material delivered to the factory: carrot fly damage, frost damage, mechanical damage, splitting, greening, cavity spot, clayburn, souring, five o'clock shadow, woody cores, poor shape, wire worm, violet root rot and other fungal defects, soil and internal darkening. The average figure above which a load may be rejected at the factory is about 10 percent total defects. This figure varies from factory to factory but is usually within the range of 5 to 15 percent.

Table 7. Summary of the statistical analysis

A. ACREAGE RESPONSE TO PRICE

The algebraic equations developed take the following form:

(1) $\text{Log } Y_t = \text{Log } a + b \text{ Log } X_{t-1}$

(2) $Y_t = a + b \text{ Log } X_{t-1}$

(See empirical results below)

where Y_t = acreage planted in year t

and X_{t-1} = price in year t - 1

Results

(1) $\text{Log } Y_t = \text{Log } 4.5721 + .2593 \text{ Log } X_{t-1}$
 SE = (.3649) (.0830)
 Ratio = 12.53 3.13
 $R^2 = 36.4877 \quad \bar{R}^2 = 32.7517 \quad \text{F Ratio } 9.8 \quad N=19$

Means St. Dev.

$Y_t = 3.4347 \quad .382$

$X_{t-1} = -4.3870 \quad .3321 \quad r = .604$ (significantly different from zero at the 5 percent level)

r = simple correlation coefficient

(2) $Y_t = 67.1081 + 8.1599 \text{ Log } X_{t-1}$
 SE = (11.9768) (2.7231)
 Ratio = 5.60 3.00
 $R^2 = 34.5632 \quad \bar{R}^2 = 30.7140 \quad \text{F Ratio } 8.98 \quad N=19$

Means St. Dev.

$Y_t = 31.3105 \quad 4.4706$

$X_{t-1} = 4.3870 \quad .3221 \quad r = .588$ (significantly different from zero at the 5 percent level)

r = simple correlation coefficient

B. ACREAGE RESPONSE AND CONSUMPTION PER HEAD

Summary of Results

Means St. Dev.
 $Y = 31.6444 \quad 4.3496$
 $X_1 = 6.2152 \times 10^{-3} \quad 1.4692 \times 10^{-3}$

Where Y is acreage

X_1 is consumption

r = .726 Simple correlation coefficient

Regression Equations

The linear function takes the form:— $Y = a + bX$

$Y = 17.4098 + 2.2593 X_1$

SE = (3.0564) (.4834)

Ratio = 5.70 4.67

$R^2 = 54.8240 \quad \bar{R}^2 = 52.3143 \quad N=20$

The log-log function takes the form:—

$\text{Log } Y = \text{Log } a + b \text{ Log } X_1$

$\text{Log } Y = \text{Log } 2.6855 + .4183 \text{ Log } X_1$

SE = (.1827) (.1010)

Ratio = 14.70 4.14

$R^2 = 48.7853 \quad \bar{R}^2 = 45.9400 \quad \text{F Ratio} = 17.17$

C. CONSUMPTION FORECAST

Extrapolation from time series-consumption function

The consumption of home grown carrots per head of the population over the last 20 years may be expressed in the form of the following algebraic equations:—

where Y = consumption per head

X_t = time trend

1. $Y = a + bX_t$

2. $\text{Log } Y = a + bX_t$

3. $Y = a + b \text{Log } X_t$

The following functional relationships were established:—

1.	$Y = -255.9237$	+	$.1338 X_t$			
	SE = (92.7026)		(.0473)			
	Ratio = 2.76		2.82			
	$R^2 = 30.7514$	$\bar{R}^2 = 26.9042$	F Ratio = 7.99		N=20	
2.	$\text{Log } Y = -36.9750$	+	$.0198 X_t$			
	SE = (15.0011)		(.0077)			
	Ratio = 2.40		2.58			
	$R^2 = 27.0652$	$\bar{R}^2 = 23.0132$	F Ratio = 8.67		N=20	
3.	$Y = -1978.8625$	+	$261.8621 \text{Log } X_t$			
	SE = (703.0157)		(92.7481)			
	Ratio = 2.81		2.82			
	$R^2 = 30.6928$	$\bar{R}^2 = 26.8424$	F Ratio = 7.97		N=20	

D. RETAIL AND WHOLESALE PRICE

Y	=	54.4655	+	.8212X	where Y = retail price
SE		(5.6016)		(.1893)	where X = wholesale price
R^2	=	94.95	$\bar{R}^2 = 89.9062$	F Ratio = 19.00	

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