ECONOMIC ASPECTS OF FORAGE PRODUCTION AND UTILIZATION ON IRISH FARMS WITH SPECIAL EMPHASIS ON BEEF PRODUCTION

by

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CHAPTER 1

INTRODUCTION

Agriculture in the Irish Economy

At a time when the pace of technological and general economic change is rapid, agriculture in most countries is still struggling to lift itself out of a state of relative backwardness. If agriculture is to contribute to economic progress as an equal partner and if those engaged in farming are to enjoy their fair share of the rising standard of living, far-reaching changes need to take place in farming structures and practices. These changes require above all the initiative of the farming community itself [1].

Irish agriculture has been subject to considerable change, both from the technical as well as from the economic viewpoint, during the past century. During this time, we have seen a big increase in agricultural output, a rise in per capita income, and a gradual migration of labor out of agriculture. There is still scope for considerable improvement in the returns from farming in Ireland. According to the 1966-67 Farm Management Survey [2] the average family farm income was £465.

This ranged from £155 for farms where mountain sheep and cattle were the main part of the enterprise to £1330 for farms primarily engaged in the liquid milk business. In recent years, the industrial sector has partly masked the expansion in the agricultural sector. As can be seen from Table 1, agriculture's contribution to gross national product has fallen from 24.4 percent of the total in 1958 to 18.6 percent in 1966. It must, however, be emphasized that these figures are in relative terms. The picture is somewhat similar as far as Irish exports are concerned. Agricultural produce has been consistently in the forefront on the list of export items. Over 50 percent of the total exports are agricultural goods and if industrial products manufactured from agricultural raw materials are included, this figure could be raised to about 70 percent.

There has been considerable bilateral trade between Ireland and Great Britain for a long time. This has occurred for a number of reasons including (1) the proximity of the two countries, (2) historical connections, and (3) the nature of the economies of these two regions. The latter reason is probably the most important. Great Britain is essentially a heavily industrialized region with a comparatively high population to feed and clothe. It derives most of its national income from industrial goods. Ireland, on the other hand, relies on agricultural products for the greater part of its national income. In this respect, the two economies are complimentary and this has been even more evident in the past.

TABLE 1: G.N.P. of the Irish agricultural and industrial sectors.
(£ million-1958 prices)

	1958	1959	1960	1961	1962	1963	1964	1965	1966
Agriculture, forestry, fishing	126.3	137.7	144.1	145.5	146.6	144.2	150.4	145.0	145.0
Industry	141.1	152.1	162.0	175.4	187.7	199.1	215.2	225.3	231.0
Agriculture, etc. as % of G.N.P.	24.4	24.8	23.7	23.0	22.0	20.5	21.1	20.1	18.6
Industry as % of G.N.P.	27.2	27.3	28.1	29.0	30.2	31.0	30.2	30.9	31.5

Source: Fennell, Rosemary, "The Agricultural Sector, 1926-1967," Ir. J. Agric. Econ. Rur. Sociol., 1:322, 1968.

Ireland exports a big portion of its agricultural products to Great Britain and imports considerable quantities of industrial items. In 1967, Great Britain's total exports to Ireland were in the region of £186 million, while Irish exports to Great Britain amounted to £224 million. Beef cattle exported on the hoof (mainly as unfinished stores) or as carcass beef constitute Ireland's greatest single export item with an annual value of about £70 million.

At the present time, Ireland and Great Britain are both striving to gain entry into the European Economic Community. If and when these two countries become members of the Community, there will be a general change in their reciprocal trade. The Anglo-Irish Free Trade Area Agreement which became effective on July 1, 1966 is the basis on which trade between the two countries will be regulated until such time as both join the European Common Market. Under this Agreement, Ireland is phasing out over a ten-year period any import tariffs which still remain on British import goods. In return, Great Britain has granted improved access for Irish agricultural goods as well as certain Irish industrial goods to the British market. Special arrangements are in the livestock area. [illegible] G.N.P. [illegible] British market for Irish store (feeder) cattle and sheep is guaranteed. The waiting period for these livestock to qualify for guarantee payments under the British Fatstock Guarantee Scheme has been reduced from three to two months. In addition,

the British Fatstock Guarantee applies to 25,000 tons of Irish carcass beef and to 5,500 tons of Irish carcass lamb imported annually into Great Britain [3]. The cattle industry plays a very important role in the Irish economy. Its relative importance as far as agricultural output as well as export earnings are concerned is illustrated in Table 2.

TABLE 2: Average annual output and export figures for Ireland in the period 1965-1967 (£'000)

Value of total agricultural output (including value of changes in livestock numbers)	.....	255,700
Value of cattle output (including value of changes in numbers of cattle)	.....	82,200
Value of total exports	.....	230,900
Value of total agricultural exports	.....	127,300
Value of cattle exports: stores	.....	33,100
live fats	.....	9,800
carcass beef	.....	25,100

Source: Report of the Store Cattle Study Group, The Stationery Office, Dublin, 1968, p. 17.

During this period, the value of cattle output constituted about one-third of the value of total agricultural output. The value of cattle exports represented more than half of the value of total agricultural exports and almost one-third of the value of total exports. At the present time, only about half of the total number of exported cattle are finished on Irish farms. The remainder are purchased by British farmers who have the facilities to finish more cattle than they can rear themselves.

Land Use

Ireland has a total land area of 17.02 million acres. In 1966, 8.46 million acres were under pasture, 2.08 million acres under hay, and 1.26 million under crops and fruit. The remainder consisted of woods, grazed and barren mountains, bogs, water, towns and roads. One outstanding feature of this land-use breakdown is the relatively high proportion of the total country which is devoted to hay and pasture. This is not only true for the 1966 season, but the pattern has been consistently similar since the middle of the last century. Each year (with the possible exception of the two World War periods when compulsory tillage programs were enforced) pasture and hay have accounted for approximately 90 percent of the total arable land in the country (Table 3).

In this paper it is not proposed to give a detailed breakdown of the area devoted to tillage crops. Fennell [4] has made a rather comprehensive study of the changes which have occurred in the entire agricultural sector during the years 1926-1967, and the main trends are worth noting. Some of the most outstanding features of the period according to this author have been the considerable decline in root and green crops (Figure 1); the increase in cattle and sheep numbers (Figures 2 and 3); and the emergence of barley as the main cereal crop (Figure 4). The decline in total acreage under tillage crops has been partly offset by a gradual increase in the yields of these crops (Table 4).

TABLE 3. Land distribution (acres) in Ireland, decennially 1851-1951, and annually 1961-1966.

Year	Total Crops Other Than Hay & Pasture	Hay	Pasture	Total Crops, including Hay & Pasture	Other Land	Total Area
1861	3,227,032	1,281,099	8,220,085	12,728,216	4,248,891	16,977,107
1871	2,772,430	1,499,057	8,673,997	12,945,484	4,007,824	16,953,308
1881	2,287,752	1,646,084	8,652,098	12,585,934	4,396,584	16,982,518
1891	1,975,145	1,661,858	8,814,787	12,451,790	4,535,319	16,987,109
1901	1,750,803	1,757,884	9,011,168	12,519,855	4,467,254	16,987,109
1911	1,697,338	2,045,579	8,447,391	12,190,308	4,813,983	17,004,291
1921	1,807,843	1,983,241	8,090,375	11,881,459	5,137,696	17,019,155
1931	1,425,021	2,313,189	7,988,824	11,727,034	5,297,447	17,024,481
1941	2,236,413	2,004,214	7,336,107	11,576,734	5,447,751	17,024,485
1951	1,717,283	1,936,263	7,934,698	11,588,244	5,435,848	17,024,092
1961	1,598,700	1,889,200	7,779,900	11,267,800	5,755,900	17,023,700
1962	1,587,500	1,853,100	7,963,600	11,404,200	5,619,500	17,023,700
1963	1,512,500	1,917,800	7,982,400	11,412,700	5,611,000	17,023,700
1964	1,438,000	1,931,600	8,147,400	11,517,000	5,506,700	17,023,700
1965	1,394,813	1,971,447	8,270,130	11,636,390	5,387,307	17,023,697
1966	1,261,900	2,020,100	8,464,700	11,746,700	5,276,900	17,023,700

Source: Derived from Statistical Abstract of Ireland, 1967, p. 69.

TABLE 4. Estimated annual average yield (pounds of starch per acre) of the main crops in Ireland, decennially 1900-1959 and annually 1961-1966.

Year	Total Cereal Crops (including rye)	Total Root and Green Crops	Total Cereal, Root and Green Crops and Hay
1900-1909	1180	2087	1398
1910-1919	1268	2376	1403
1920-1929	1169	2324	1302
1930-1939	1363	2972	1511
1940-1949	1265	2872	1489
1950-1959	1542	2098	1605
1961	1899	3363	1710
1962	2007	3418	1704
1963	1868	3266	1694
1964	1755	3119	1620
1965	1856	3258	1638
1966	1950	3473	1647

Source: Derived from Statistical Abstract of Ireland, 1967, p. 69.

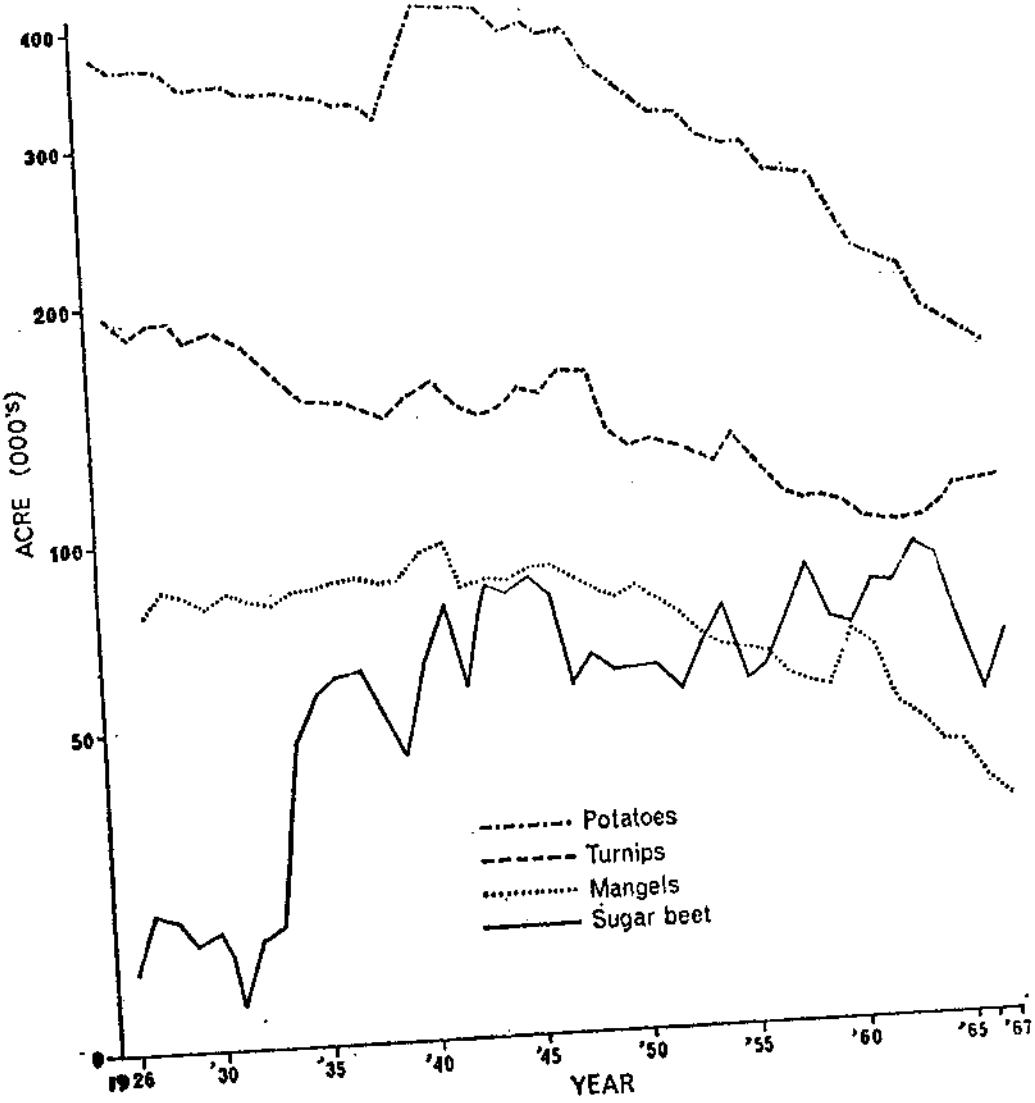

FIGURE 1. Area under root and green crops in Ireland, 1926-1967

Source: Fennell, Rosemary, "The Agricultural Sector, 1926-1967," Ir. J. Agric. Econ. Rur. Sociol., 1:329, 1968.

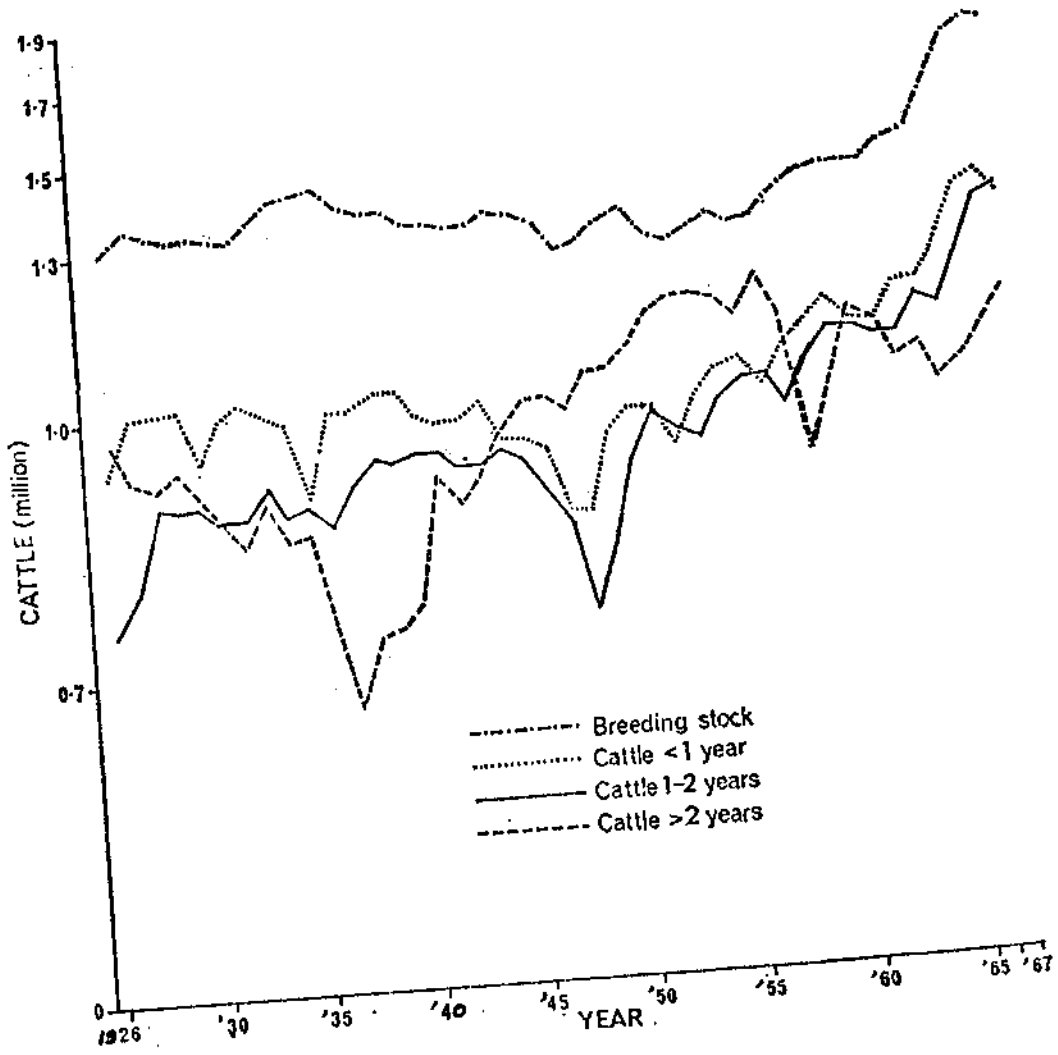

FIGURE 2. Numbers of cattle in Ireland, 1926-1967

Source: Fennell, Rosemary, "The Agricultural Sector, 1926-1967," Ir. J. Agric. Econ. Rur. Sociol., 1:330, 1968.

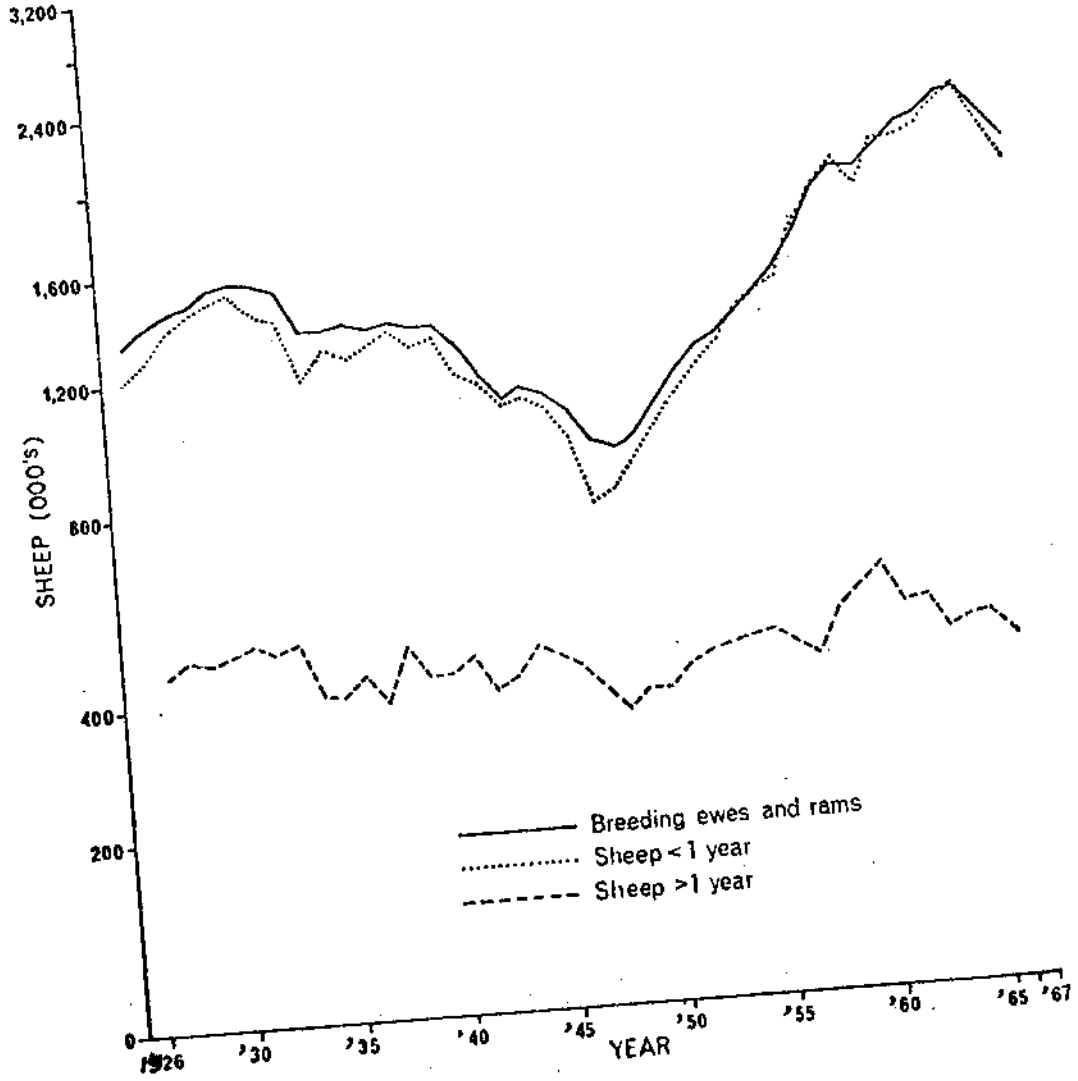

FIGURE 3. Numbers of sheep in Ireland, 1926-1967

Source: Fennell, Rosemary, "The Agricultural Sector, 1926-1967," Ir. J. Agric. Econ. Rur. Sociol., 1:331, 1968.

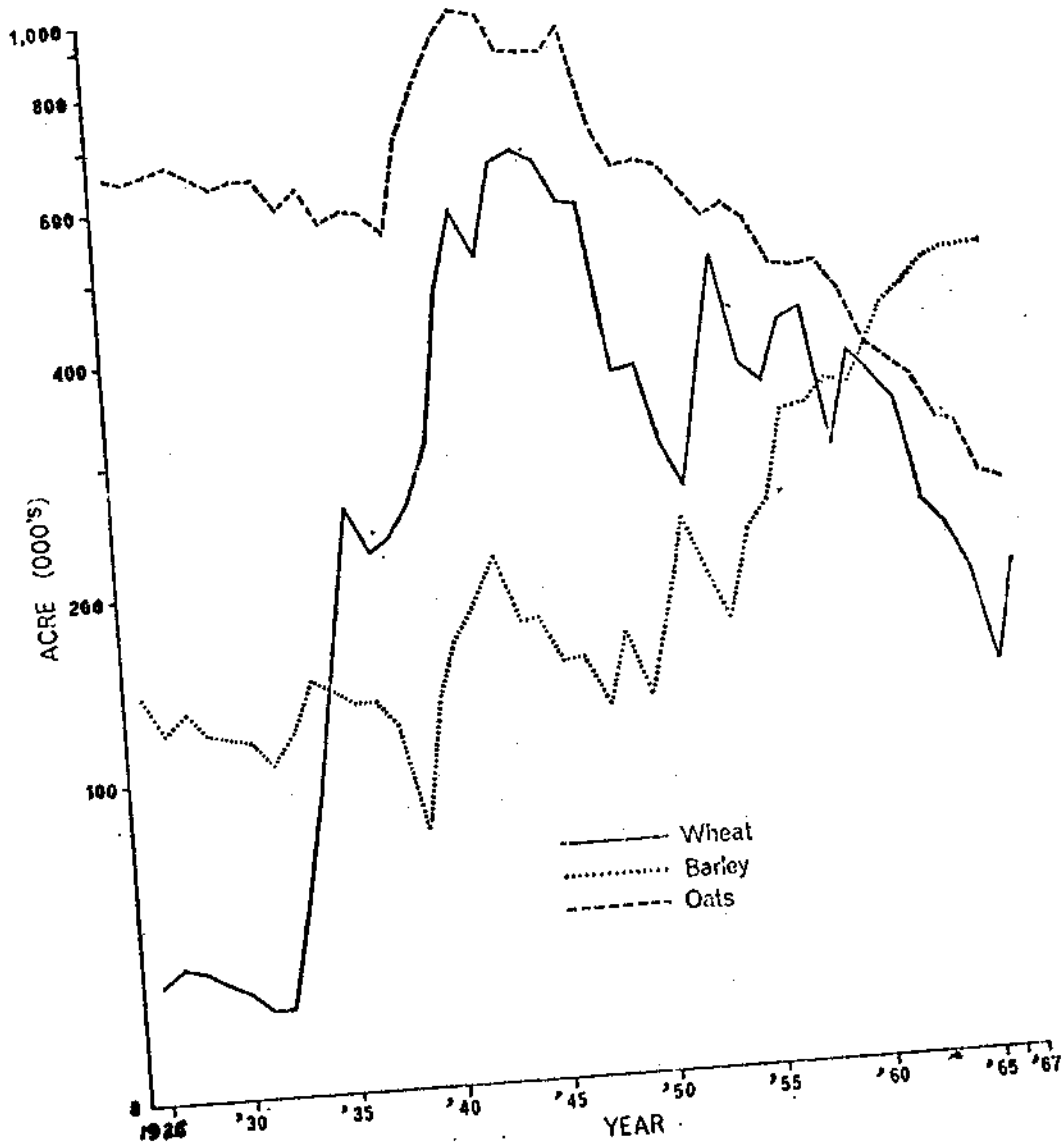

FIGURE 4. Area under main cereal crops in Ireland, 1926-1967

Source: Fennell, Rosemary, "The Agricultural Sector, 1926-1967," Ir. J. Agric. Econ. Rur. Sociol., 1:328. 1968.

The changes in the cropping pattern may have been partly due to Irish agricultural policy. The Irish Government published its first systematic development program for the Irish economy in 1958. The main aim of the agricultural section of this program was to obtain an increase in beef cattle numbers (as opposed to dairy animals) since beef was the only agricultural product which did not require an export subsidy [5]. The program laid special emphasis on subsidizing fertilizers and ground limestone in an effort to improve the quantity and quality of grass produced. Livestock improvement schemes were also developed. Two further expansion programs have been published since then, in 1964 and 1969. While the original targets listed in the two earlier programs have not been achieved, these development plans have met with some success. Cattle numbers increased steadily up to 1966 when they reached a peak figure of 5.6 million. The total number of cattle recorded each year since then just fell short of this figure. However, there was also a substantial increase in milk production. The total number of sheep increased annually up to 1965, but there has been a gradual decline in numbers each year since then.

The Grass Crop

From the foregoing paragraphs the importance of livestock (especially those of the ruminant type) to the Irish economy should be obvious. Grass is a relatively cheap source of food for this class of animal. According to Lush [6]

"mixed immature pasture vegetation growing rapidly in a fertile soil is usually superior to the highest quality of alfalfa hay as a feed for livestock except that it contains several times as much water. Pasture has been often referred to as a concentrate feed high in protein." Ireland is fortunate in so far as it can produce abundant grass over quite a long growing season. Being an island in the North Atlantic (Latitude 51 1/2° N - 55 1/2° N) and being subject to the influence of the North Atlantic Drift, it has an abundance of rainfall right through the year and does not suffer from extremes in either heat or cold.

While the soil and climate are very favorable for grass production, application of improved pasture management practices in many parts of Ireland has been at a low level up to recently. Farmers have been slow to adopt modern technology and one of the major shortcomings has been the reluctance to use fertilizer on grassland. A glance at the results of the fertilizer-use survey carried out in 1967 by Murphy and Heavey [7] will help to clarify this statement. Although farmers had no hesitation in using abundant fertilizer on crops like sugar beets and potatoes, this survey showed that whole areas of pasture had never received any fertilizer. In recent years, however, partly due to greater liaison between farmers and extension workers fertilizer use is increasing. Government programs -- subsidizing potassic and phosphatic fertilizers have also helped. The results of

research work are gradually being passed on to the farmer, and the younger farmers are particularly enthusiastic in applying the new techniques.

Purpose of the Study

At present Ireland is a keen applicant for admission to the European Economic Community. Sheehy [8] has stated that if Ireland becomes a full member of this Community it will have a comparative advantage in the production of grass products. This will be particularly true in the case of beef production.

With this in mind the main objective of this research paper was to investigate how the grass crop has fitted into the Irish farming scene up to now and what recommendations should be made in order to maximize net returns from this forage crop in the future.

Chapter 2 concentrates mainly on the conservation of surplus summer grass for winter feed. The main aim of this section was to examine the principal weaknesses which currently exist in this area. Haymaking has been the traditional method of grass conservation in Ireland. The main causes for the poor quality hay commonly found on Irish farms are investigated, and suggestions are made as to how this situation could be improved. An account is included of the various machines which are currently used in Ireland for harvesting and conditioning the hay crop. The relative

importance of silage as a method of conserving grass under Irish conditions is also discussed.

During the past decade, a considerable amount of research work dealing with various aspects of grassland has been carried out by Irish research workers. Special emphasis has been placed on (1) improving the quality as well as the quantity of grass that can be produced per acre; (2) utilizing the grass more efficiently by adopting better grazing and conservation practices; and (3) feeding the conserved forage in an economical way during the winter months. Housing livestock over the winter period can add considerably to the total cost of milk or beef production. With this in mind, research workers in Ireland have recently been investigating the possibility of out-wintering cattle completely. If this proves successful, it would have the two-fold advantage of (a) cutting down on heavy overhead costs as well as (b) helping the operator to maintain a greater flexibility in his enterprise. Currently there is need for a comprehensive economic analysis of the different methods of growing, harvesting, conditioning, and feeding the grass crop under Irish conditions. This, however, would be a major exercise and is beyond the scope of this research paper.

Beef cattle in the past have consistently played a key role in the Irish economy. This trend is likely to continue and if Ireland becomes a full member of the European Economic Community the Irish beef animal will become even a more

important earner of foreign exchange. Chapter 3 deals with various aspects of the systems of raising beef cattle that are currently in operation in Ireland. The importance of proper utilization of the grass crop in the beef enterprise is emphasized. Suggestions are made as to techniques which could be adopted to improve the earnings from beef production both at the farm as well as the national level.

CHAPTER 2

FORAGE CONSERVATION

Generally speaking the kinds and quality of forage crops grown in any country are not homogeneous. They vary according to soil conditions, climatic factors, indigenous as well as sown species, and finally and probably the most important- overall management. There is a wide variation in the types of pasture found in Ireland. No strict geographical dividing line exists between different types, and it is usual to find pockets of rough grazing in all counties. However, if one studies the general pattern of farming in Ireland, it can be seen that the midland counties together with certain parts of the south constitute the greater portion of the good quality grazing land.

Unlike the U.S. forage program, Ireland does not enjoy the benefit of high yielding forage crops such as alfalfa and corn silage. Indeed, these two high yielding crops constitute the greater part of the entire American forage feed. Ireland relies on some of the more common grasses and clovers found in temperate areas. Various strains of ryegrass, coupled with timothy, the fescues, red and white clovers are normally found in the better pastures. Grasses like brome, Yorkshire fog, crested dogstail, and bent are found in the less productive areas.

The utilization of grass on Irish farms is pretty well tied in with the growing season. When it comes to obtaining the greatest possible return from an acre of grass, the limit seems to be the amount of surplus feed that can be conserved for the winter months. Probably the least expensive method of grass utilization is to graze the crop *in situ*. The animal harvests and uses the grass where it grows thus cutting down considerably on heavy capital and labor expenditures. This method is commonly used on Irish farms where the aim is to keep livestock on pasture for the maximum length of time during the year. The length of the grazing period is, however, limited by two factors: (1) time period during which there is active grass growth, and (2) soil conditions which allow animals to graze without causing soil structure damage. The typical cattle grazing season in Ireland runs from early April to the end of October. Sheep, of course, are grazed all year around. This means that there is a gap of five months which has to be catered for with conserved surplus summer grass. In some areas this surplus grass is not harvested but is allowed to remain where it grows and is grazed during the winter. This, however, usually leads to poaching of the land as well as wastage of considerable quantities of forage. Mechanical grazing or green chopping is at the other extreme. The system involves harvesting the grass crop each day with some type of flail chopper and carting the material to a feedlot where it is mechanically fed. This method of forage utilization is practically non-existent in Ireland. Its main

shortcomings, as postulated by Hundloft and Guest [9] for New York State are also applicable under Irish conditions. The crop must be harvested every day regardless of weather conditions. This is time-consuming. Secondly, a decline in feed consumption occurs as the crop passes its peak stage of feeding value into maturity. Also, high producing cows just cannot consume enough of this high moisture forage to meet their daily requirements.

Conservations Systems

Surplus grass is usually conserved either in the form of hay or silage. There are various modifications of each system but generally speaking whichever approach is taken the overall aim is to obtain the greatest amount of digestible nutrients possible from a given tract of land with the minimum amount of cost.

Traditionally, hay has provided a major part of the winter food supply for ruminants in Ireland. Each year approximately 90 percent of the surplus summer grass is conserved in this form. In 1968, two million acres or 17.6 percent of the country's total arable land were devoted to this crop [10]. Silage, on the other hand, is relatively new on the Irish conservation scene. However, this method of grass conservation is increasing in importance. In 1963, approximately one farmer in every fifty made silage. This year (1970) it is likely that this ratio will be somewhere in the region of one in twenty. Despite this gradual swing towards silage it is felt that hay will be <u>the</u> main conservation system in Ireland in the foreseeable future.

Various experiments have been conducted to determine the quality of Irish hay. In 1939, Senior and Sheehy [11] found that hays which had been field-cured in the East of Ireland had a mean dry matter digestibility of 56.5 percent, crude protein content of 6.4 percent, and crude fibre content of 34.9 percent. In a similar study of hays from the Munster area, Ryan [12] obtained the following figures--dry matter digestibility, 57.3 percent; crude protein, 7.6 percent; and crude fibre, 33.4 percent. Rutledge and Common [13] found that samples of hay from the Ulster region had a mean dry matter digestibility of 52 percent, crude protein content of 9 percent, and crude fibre content of 30.5 percent. More recently Sheehan et al. [14] carried out a survey of the quality of field-cured hay in the West of Ireland, and Wilson et al. [15] studied samples of hay from randomly selected farms in County Meath during the harvest years 1965 and 1966. Except for the percentage crude protein which was 30 percent to 50 percent higher, there was no appreciable difference in composition of these hays and those already mentioned. It is suggested that this rather substantial increase in crude protein content may have been due to the increased use of fertilizers on grassland in recent years. According to the Evans [16] method of classification, the average hay examined (which the authors believe is representative of the entire country) was of poor to medium quality. They calculated that this hay was just about able to supply the daily digestible

dry matter requirement of a ruminant for maintenance. There seems to be general agreement that the low digestibility of the hays examined in the various experiments was mainly due to the advanced stage of maturity at which the meadows were cut as well as the losses in the field and in storage from this time up to the time the forage was actually fed.

Hundtoft [17] has indicated that the requirements for obtaining the maximum quantity of the highest quality hay possible are: (1) adequate soil fertility (for maximum yields); (2) cutting at the proper stage of maturity (for high nutrient content, palatability and digestibility); (3) curing as rapidly as possible (to reduce the threat of rain damage as well as enzyme activity of field fermentation); (4) minimum handling (to reduce leaf loss); (5) minimum exposure to elements (to reduce bleaching and leaching losses); and (6) storage at safe moisture levels (to reduce mold fermentation).

Adequate Soil Fertility

The need for proper soil fertility as an essential part of grass production is generally accepted, and this is even more important if the grass is being harvested and hauled away as opposed to being grazed where it grows. It has been calculated that an average hay crop removes about 70 lb N, 15 lb P, and 90 lb K per acre from the soil. If this grass is grazed *in situ*, a considerable amount of these nutrients would be returned to the soil in the faeces and urine of the grazing animal.

A fertilizer-use survey carried out in Ireland recently [7] shows that the Irish grass crop in general is still inadequately fertilized. About 90 percent of the grass grown for silage received fertilizer, but only 66 percent of the hay crop and 35 percent of the grazing land was fertilized. In some of the western counties the portion of grassland fertilized was as low as 20 percent. Such is the story despite the fact that there has been a steady increase in the total quantity of fertilizer and ground limestone that has been used in Ireland in recent years (Figure 5). There is an urgent need for a more intensive approach to grassland management, and, above all, this calls for proper fertilization of the grass crop.

Proper Stage of Maturity

Unlike the typical U.S. forage crop which usually consists of a single plant species (alfalfa or corn) Irish forage crops normally contain a number of grass species. Different species and different strains within species reach maturity at different times. Most of the meadows in Ireland are not harvested until the July/August period when the bulk of the grasses within the crop are likely to be at an advanced stage of maturity. According to Waite [18], digestibility is the greatest single factor determining the nutritive value of grass or grass products. Various experiments have been conducted dealing with herbage digestibility as related to time of harvest. As far back as 1928, Jones [19] has shown that

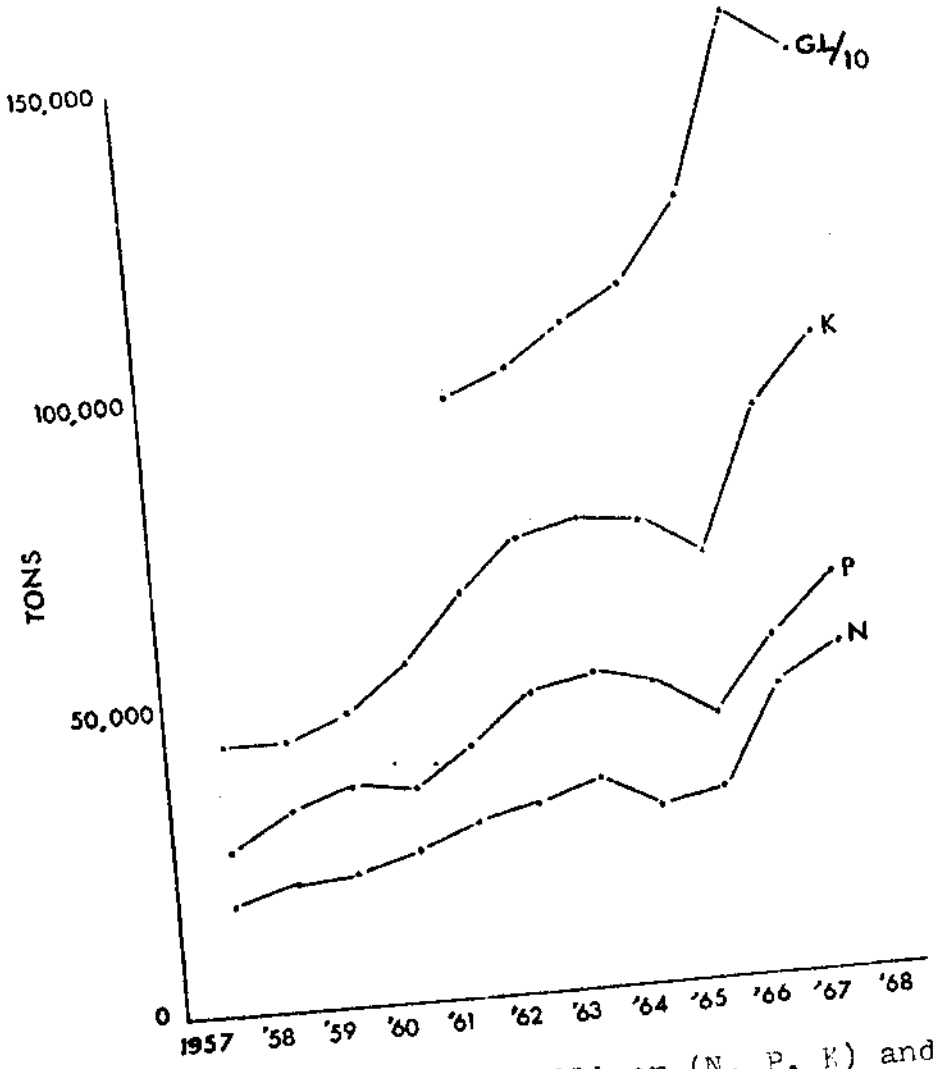

FIGURE 5. Annual use of fertilizer (N, P, K) and ground limestone (GL/10)[a] in Ireland during the period 1957-1968

[a] Note the figures for ground limestone must be multiplied by 10.

Source: Murphy, W. E., and J. F. Heavey, "Fertilizer-Use Survey," An Foras Taluntais, Dublin, p. 3, 1969.

in the case of mixed permanent pasture harvested at three progressive stages of growth there was a marked fall in the percentage protein, increase in the percentage fibre, and a decrease in the percentage ether extract with maturity. In recent years, the National Institute of Agricultural Botany have conducted a number of trials at different centers in England in order to investigate the interrelationships between heading date, yield, chemical composition, and digestibility in varieties of cocksfoot, timothy, meadow fescue, and perennial ryegrass. A total of 70 varieties were tested under two systems of management, one with monthly cuts simulating grazing and the other for hay and aftermath. Results of those trials have been given by Dent and Aldrich [20]. In the hay management, differences in digestibility and in composition between varieties cut at the same stage of growth were much greater than in the monthly cut management. The authors were of the opinion that yield, chemical composition, and digestibility probably form a complex pattern of interrelationships and for any particular variety, the changes in this pattern throughout the season are greatly influenced by the date of heading. All species showed the lowest value for digestibility in August.

During 1966 and 1967, the writer of this paper conducted a number of experiments dealing with six grass varieties commonly found in Irish meadows [21]. The object of the

research work was to investigate the possible differences in yield, chemical composition, and digestibility which may exist between these grasses if first harvested in the mid-May/ mid-June period. Results revealed that there is a definite place for early harvesting of meadows in Ireland. Thus, meadows with a high proportion of ryegrass could be harvested in early June. Bourke [22] has pointed out that there is a greater chance of obtaining good haymaking weather in June than in July or August under average Irish conditions.

Rapid Curing

Hundtoft [23] states that whether a hay-crop is to be stored in a mow or in a silo some field-curing is recommended. According to this author, "the field-curing rate is influenced by both the weather and the ground conditions. Faster drying is promoted by a low relative humidity, good air movement through the cut forage, and high temperatures. Wet or damp ground impeded drying. When the moisture content of the forage comes to equilibrium with the moisture in the air, no further drying takes place. The higher the relative humidity the higher will be this equilibrium moisture content. As the moisture content in the hay drops toward the equilibrium point, the drying rate decreases." He also indicates that the relative humidity in the vicinity of the windrow or swath will generally be higher than that indicated by the weather bureau because of moisture evaporation from the ground. The drying of the forage itself raises the relative humidity of

the air surrounding the cut hay. A light wind speeds up the drying rate of forage by replacing the saturated air with air that is drier and hence more capable of absorbing moisture.

Rainfall, relative humidity, air movement, and total amount of sunshine during curing all play a very important role in the Irish haymaking program. The former is by far the greatest enemy of the haymaker. Figures 6 and 7 give some idea of the total annual pattern of rainfall in different locations within the country for 1966. Generally the western half of the country has a higher annual total precipitation than the Eastern half.

Haymaking Losses

From the standpoint of haymaking, weather conditions during the months of June through July are of main interest. The daily precipitation for those two months during the 10-year period 1959-68 is shown in Appendix Tables 1 and 2. Valentia Island is situated on the West Coast and is typical of a region of high rainfall. Dublin Airport which is situated on the East Coast is representative of a relatively low precipitation region (Figure 7). The daily rainfall pattern in these two locations for June and July each year during the period 1959-1963 is shown in Figures 8 and 9. It will be noted from these diagrams that the difference in precipitation between these locations is not as pronounced as one might expect. One important point which emerges from these data is that the number of times during the entire 10-year period that two or

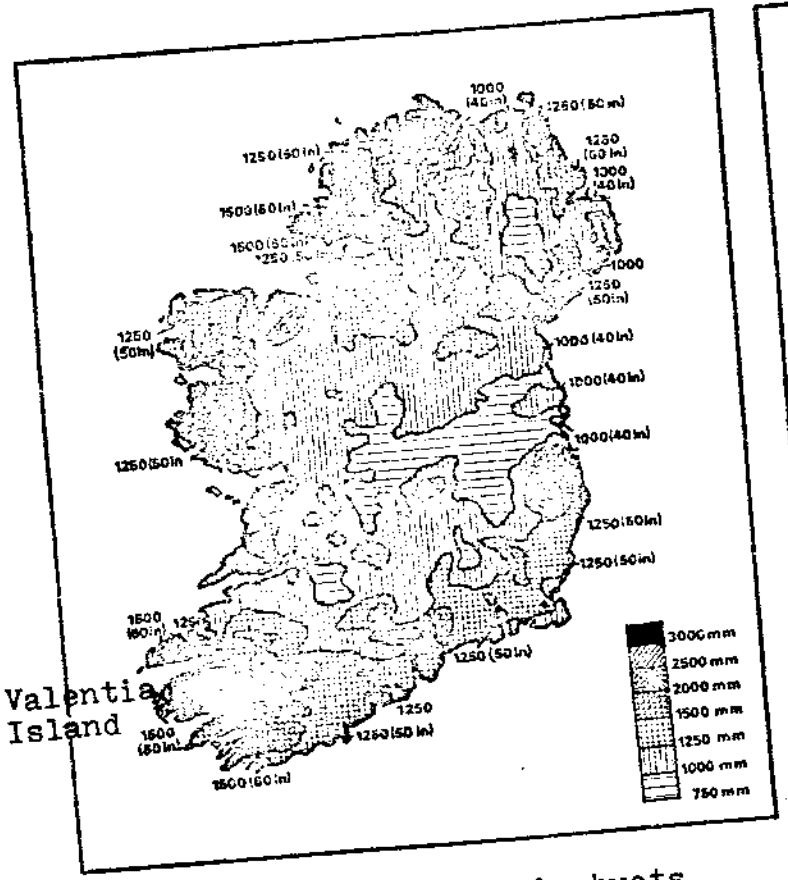

FIGURE 6: Rainfall isohyets (Millimetres) for year 1966

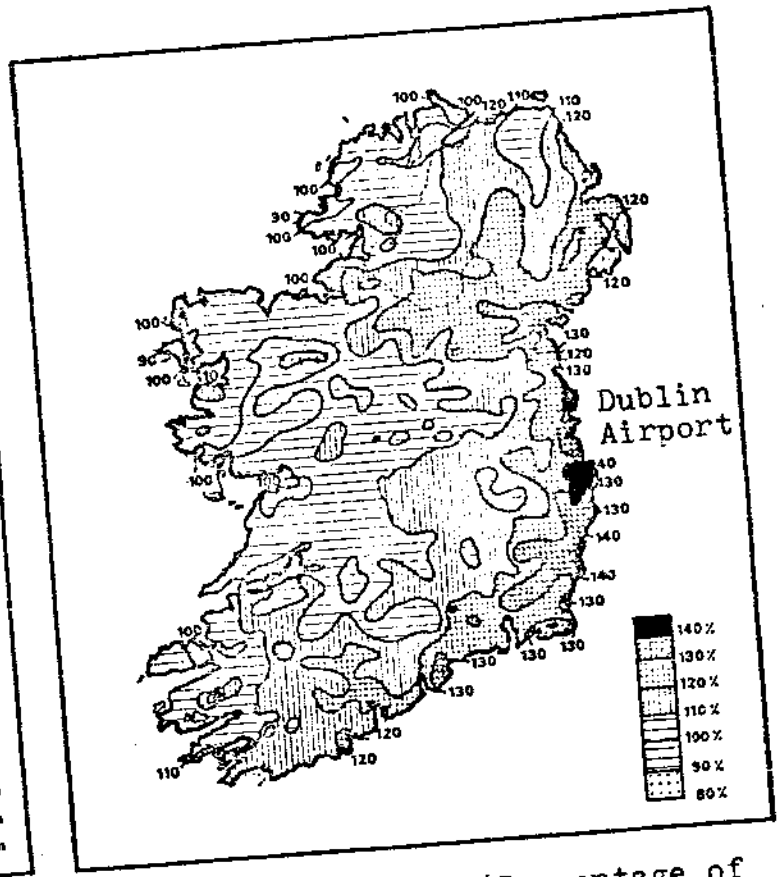

FIGURE 7. Rainfall (Percentage of average 1931-1960) for year 1966

Source: Statistical Abstract of Ireland, 1967, p. 6.

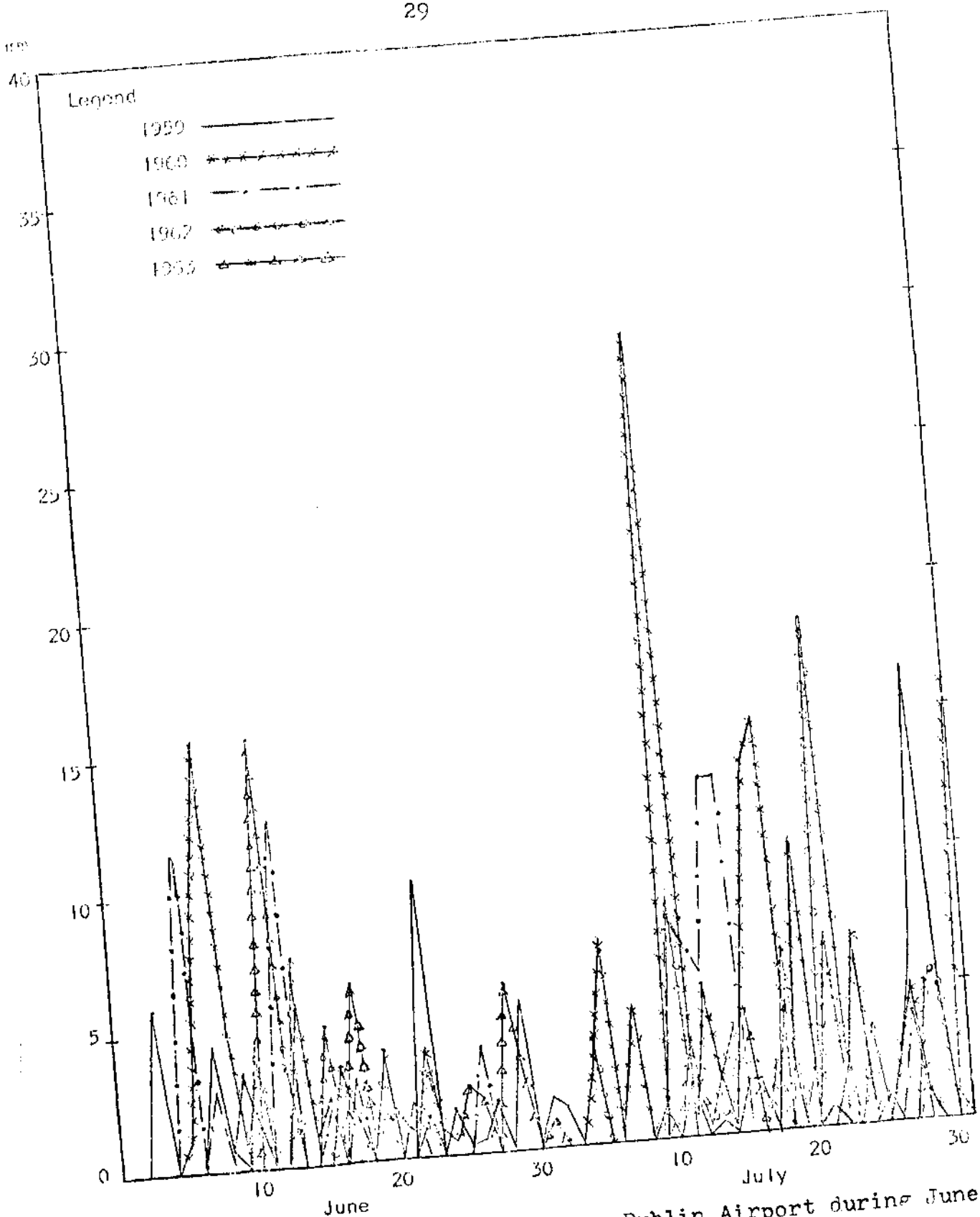

FIGURE 8. Daily rainfall (mm) for Dublin Airport during June and July for each year 1959-1963

Source: "Monthly Weather Reports", Meteorological Service, Department of Transport and Power, Dublin, June and July 1959-63.

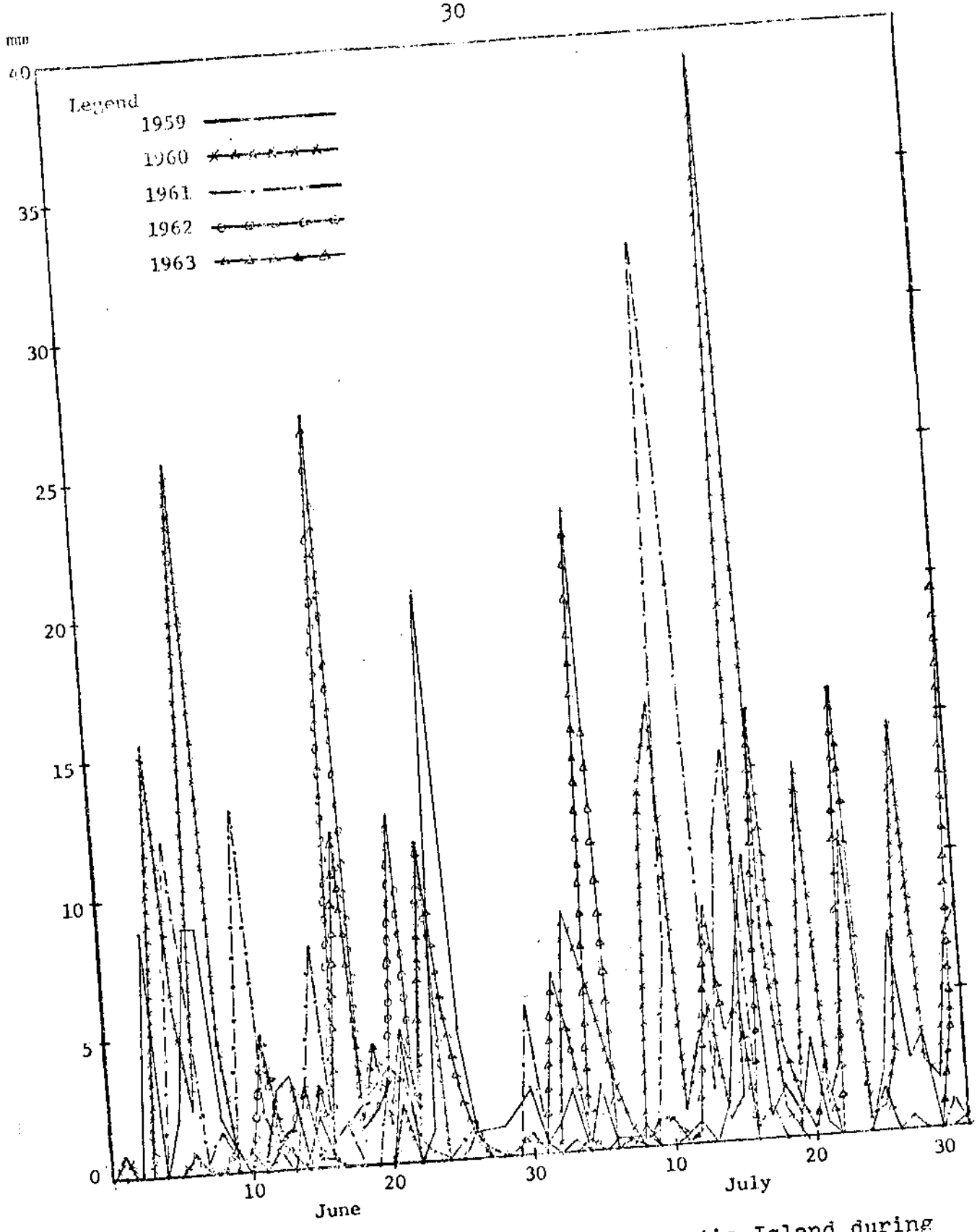

FIGURE 9. Daily rainfall (mm) for Valentia Island during June and July for each year 1959-1963

Source: "Monthly Weather Reports", Meteorological Service, Department of Transport and Power, Dublin, June and July 1959-63.

more consecutive dry days were recorded at either station were greater for the month of June than for July. This would tend to back up the earlier recommendation of having an earlier Irish haymaking season. With the exception of the 1959 and 1968 seasons which were unusually dry, the overall picture emerging indicates that the Irish climate is not particularly suitable for successful haymaking. Weather uncertainty is by far the greatest single uncontrollable factor facing the Irish farmer who attempts to make hay by conventional methods. This is the main reason for the poor quality hay reported in various studies mentioned earlier in this chapter. A brief summary of the main types of haymaking losses which can commonly be incurred from time of cutting through time of storing the hay-crop appears in Table 5. These losses may be reduced considerably by earlier harvesting, use of improved harvesting and conditioning machinery, and reduction of total time between harvesting and final storage.

Traditionally, haymaking on Irish farms has been a labor intensive process with farm family labor carrying most of the burden. A reciprocating type mower and a simple rake or swath turner were the sum total of haymaking machinery on most farms up to about 10 years ago. Since then, a number of factors both social and technological as well as economic have led to a complete new approach towards forage conservation. Agriculture has not been able to compete with other sectors

TABLE 5. Forage harvesting and storage losses.

Origin	Type of Loss	Factors Influencing Size of Loss
(1) Delayed Harvest	Reduction in palatability & digestibility of 1% per day after June 1.	Capacity of harvesting system.
(2) Cutting Losses	Stubble or complete plants.	High stubble. Lodging (influenced by system capacity). Run-over forage. Skips in field due to poor operator skill.
(3) Clipping Losses	Leaf clusters & chopped stems.	Inherent in certain cutting machines, especially impact-type. All conditioning machines cause some leaf-stem separation (influenced by adjustment).
(4) Field Fermentation	Nutrients.	Commence as soon as plant cells cease functioning (2-3 hours after cutting). How drying rate increases fermentation losses.
(5) Leaching & Bleaching	Color, flavor & palatability	Slow drying rate such that forage is exposed to excessive rain, dew and sun. Rain leaches most easily digestible nutrients from forage.
(6) Shattering Losses	Leaves.	Primarily associated with handling of forage while leaves are over-dry. Rain increases shatter losses.
(7) Storage Losses	Dry matter and nutrients.	Storage losses persist regardless of storage method. Reduction of moisture content to safe storage level is most important.

Source: Hundtoft, E.B., Agric. Eng. Ext. Bull. 363, P.9, Dept. of Agric. Eng., Cornell University, Ithaca, New York.

in paying wages. As in the U.S. the number of family farms has been on the decline. With a continuous increase in the cost of living there has been a big flight from the land. This migration of labor into other sectors has been accompanied by pronounced capital-labor substitution. Those remaining on the farm have been forced into adopting new technology mainly in the form of better and more modern machinery.

Harvesting Machines

The conventional reciprocating mower has dominated the scene for a long time. There have been various modifications, but the same cutting principle still stands. Its main advantages lie in its relatively low initial cost and low power requirements when compared with more modern inventions.

Irish research workers have been conscious of the urgent need for work in this area. During the past decade, comprehensive tests have been carried out by An Foras Taluntais (The Agricultural Institute) on mowers and other haymaking machinery commonly used in Ireland. Mowers tested included five conventional reciprocating type, one double-knife, one single rotor, one four-rotor rotary mower, and two flail mowers. The factors studied were (a) rate of work, (b) power requirement, (c) quality of work, (d) ease of operation and maintenance, and (e) durability. The following is a brief summary of the main results --

"Apart from small differences in rate of work and durability, there was little variation in the performance of the five conventional mowers tested. All suffered from the same disadvantages, cutter-bar blockages and long stubble in lodged crops, bent fingers and broken sections in stony ground, and time lost in changing and sharpening knives.

The Busatis double-knife mower had a rate of work about 50 percent higher than conventional mowers. It achieved this by faster mowing and fewer blockages. The knives were harder to sharpen but retained their edge longer, and stones did not break sections. The mid-mounted model (the one tested) was, like all mid-mounted mowers, hard to mount and could not be readily changed from one make of tractor to another.

The Hayter Rotamower, a single-rotor rotary mower, had a similar rate of work to conventional machines. It could cut lodged meadows, but needed smooth ground to leave a short stubble. It also needed a big tractor, due to its weight and power requirement. It required little maintenance.

The four-rotor PZ Cyclomower had a rate of work 60 to 100 percent higher than conventional mowers. It required a 30 to 35 hp tractor in most crops, but to maintain a high rate of work in all meadows a bigger tractor would be needed. It usually left a short stubble, even in lodged crops. Some minor parts suffered damage from stones. Though not recommended by the makers for topping it could do this without damage if it was used carefully.

The flail mowers had a high power requirement, so their rate of work depended largely on the size of tractor. With a 45 hp tractor their rate of work was up to 50 percent faster than conventional mowers. They left a short stubble, rarely got blocked and required very little maintenance. They lacerated the grass, which dried very quickly if it was turned often. The laceration did not unduly affect the quality of the hay, and the increasing drying rate improved the chance of avoiding wet weather. The hay could be baled without difficulty, but it was often very hard to collect it into cocks." [24]

The most striking feature of these results is the high performance of both the flail type and rotary mowers. At the

present time, their main disadvantage seems to be their relatively high power requirement. However, this could very well be outweighed by their faster and more trouble-free rate of output. The flail-type mower, with its crop-conditioning features seems to have a bright future in Ireland, where speed in drying is of such vital importance.

This high output machine could be particularly useful to the bigger farmer or the agricultural contractor. Indeed it is likely that as more mechanization is demanded in all sectors of Irish farming there will be more and more emphasis on the agricultural contractor or in some cases machinery pools. Such pools allow the individual farmer to have more flexibility in his enterprise and to use what limited capital he may have in more productive areas. Machinery syndicates of this nature have proved very successful in Germany in recent years. The German machinery syndicates or "rings" operate on a different basis to the ordinary cooperative system where joint ownership is a common feature. Members of each ring decide jointly from time to time what machinery is required for the entire syndicate. Each farmer buys, owns, and operates a certain piece of machinery and charges the other members for any services rendered. In this manner, each machine is operated and maintained in a proper manner. Timeliness of operation is also taken care of as there is ample machinery in the pool to ensure that critical jobs like saving hay are done as quickly as possible. But the big advantage of such a

system is the fact that members can avail of machinery which they cannot afford to purchase. Farmers sometimes make the mistake of buying big pieces of equipment and find within a short time that this becomes a fixed asset. Its marginal value product in production is much less than acquisition price, but is higher than its salvage price. In order to minimize his losses a farmer is forced to continue to make use of this machine in production.

Conditioning Machines

There is a wide variety of machines which may be used for conditioning the hay crop. These machines range from simple rakes, tedders, and turners to more sophisticated types like crimpers and crushers. In all cases, their main function is to speed up drying the harvested crop; and a few comments in this connection may be in order.

(1) Cut-hay dries faster when it is loose, such that good air movement between the individual plants is permitted.

(2) Hay left in a swath will absorb more moisture overnight than hay in a windrow; however, it will usually dry more rapidly the following day.

(3) Hay initially dries at comparable rates whether conditioned or not. But hay which is not conditioned will dry more uniformly during the first few hours. Conditioned hay will dry more uniformly after the moisture content has fallen to 60 percent.

(4) Lacerating the stems lengthwise while cutting increases the fluffiness of the resulting swath (or windrow), and improves drying.

(5) Short hay, or chopped stems and leaves, in a swath or windrow will impede air flow through it. This condition promotes a more compact mass, which decreases the drying rate.

(6) Drying hay in a windrow, rather than in a swath, will preserve more of the hay quality, providing the hay is not rained on.

(7) The leaves and leaf clusters that are stripped from the stems during cutting and conditioning will dry more rapidly than the longer material [25].

The most desirable features of any haymaking machine are: (1) It minimizes the time of drying in the field; (2) it dries the hay uniformly; (3) it has a high per/hour output; and (4) it should not be so severe as to result in high leaf loss.

Modern equipment for turning, tedding, and raking hay consists of power-driven tedders and finger wheel rakes. The power-driven equipment may be divided into the following groups: (1) horizontal side-delivery machines, (2) over-the-top tedders, (3) undershot single purpose tedders, (4) undershot universal machines (in addition to tedding, this may be adjusted for windrowing as well), and (5) reciprocating time-bar machines. These machines have been tested in Ireland by An Foras Taluntais and the results of the tests have been

published [26]. Comparisons were based on the following factors: (1) rate of drying of crop, (2) evenness of drying, (3) dry matter losses, (4) rate of work, and (5) ability to make and scatter windrows (in the case of universal machines). Briefly, the results are as follows: The fastest and most even drying was obtained with transverse chain side-delivery and over-the-top machines. The finger wheel rakes tended to give very slow and uneven drying especially in heavy, leafy crops and in this respect were inferior to power-driven machines. Windrows could be made satisfactorily with a finger-wheel rake, transverse chain machine, or universal undershot tedder. Of these machines, only the transverse-chain machine could scatter windrows. Weather was shown to have a much more serious effect on losses of hay than mechanical treatment by any of the machines tested.

Results of research work carried out on tedders in England are also referred to in the above publication [26]. The main features of these results are as follows:

(1) Early tedding, preferably immediately after cutting, resulted in a considerable increase in the rate of drying.

(2) While the frequency of tedding depended to a great extent on the weather and crop conditions, it appeared that there was very little advantage in tedding more than two or three times per day.

(3) In light, mature crops there was little difference in drying rates no matter what treatment was carried out.

In heavy leafy crops, cutting with a forage harvester was found to reduce the drying time by up to four days, when compared with conventional tedding; using a forage harvester or conditioner to ted a mower-cut swath gave a reduction in drying time of up to two days. When cutting with a forage harvester, several precautions had to be taken to ensure that losses due to chopping were not too high.

When a farmer is deciding on a particular haymaking system, this decision must be made in the context of his total farming enterprise. However, the following general recommendations can be gleaned from the tests already mentioned:

(1) For a farmer requiring to make up to six acres of hay at a time, a transverse chain side-delivery machine would be suitable. As this is a universal machine, no other machine is normally necessary.

(2) If it is required to save up to 10 acres at a time, a machine with a higher rate of work would be required. For baling, an over-the-top tedder with windrowing tines would be suitable; for cocking, the ability of the universal undershot machine to make bigger windrows would be an advantage, although its effectiveness as a tedder is less.

(3) For larger acreages, if two tractors are available, a two-swath single purpose machine plus a gearless rake would be a suitable combination [26]

Two types of haymaking machines commonly used in the U.S. are crushers and crimpers. As yet, these machines have not

been tested under Irish conditions. The crusher breaks the stem over its entire length while the crimper tends merely to bruise the stem at intervals a few inches apart. Hundtoft [27] quotes a summary statement made by West Virginia researchers on the effectiveness of crushers and crimpers relative to increasing drying rates of forages.

> "All tests have shown that both crushers and crimpers will increase the drying rate, and most tests have also shown that the crusher holds some advantage over the crimper. Conditioned stems will dry nearly as fast as leaves. The effectiveness of both the crusher and crimper are more pronounced in legumes than in grasses. Conditioned hay will pick up more moisture during the night than unconditioned hay, but it will lose it faster the following day."

The same research worker goes on to say that crushed hay may be removed from the field one day earlier than hay that has not been conditioned. In the event of rain, conditioned hay will absorb more moisture, but this one day advantage will still hold true if the matted-down, rained-on hay is again refluffed by using the conditioner the second time--this time without any pressure on the rolls.

Before any firm recommendations could be made concerning the usefulness of crushers or crimpers under Irish conditions, it would be necessary to test these machines side by side with those already mentioned.

Haymaking Methods

Probably the simplest and most direct approach to saving and storing hay is practised in some of the western states of

America. This is possible because of the ideal haymaking weather which prevails in those regions. In such cases, it is a mere matter of harvesting the crop, baling the dried forage, and storing it. An excellent product is obtained with the minimum amount of time and cost. Such is also the aim of farmers who operate with less favorable conditions. Before hay is suitable for storage in Ireland it usually has to pass through a number of intermediate stages. Typically the aim is to dry the forage down to 30 percent moisture content as soon as possible and then build it into small cocks, each containing about 5 cwt. of forage. These cocks are made weather-proof and are left in the field for about three weeks. By this time the hay is usually suitable for storage and may be baled or stored loose. In some cases, where a farmer has an exceptionally heavy hay crop containing a high proportion of legumes, he may build the forage on tripods. This can be done while the grass still contains as much as 50 percent moisture. This method is time-consuming, laborious, and expensive and in an era where main emphasis is towards mechanization its future is indeed very doubtful.

The pick-up baler has but limited application in the Irish haymaking process. While this machine cuts down considerably on the labor associated with handling loose hay one major difficulty arises in getting the forage dried to an adequately low moisture level. Under Irish conditions this may take a considerable length of time, thus increasing the risk of heavy

losses due to rain damage.

The obvious suggestion that should be forthcoming at this point is that the only positive method for ensuring a reasonable end product under such unfavorable conditions would seem to be (1) some type of artificial drying technique, or (2) silage-making. The latter will be dealt with at a later point in this chapter. As regards artificial drying, various techniques have been investigated in Ireland. Some involved the use of cold air; others involved the use of artificially heated air. The high relative humidity in Ireland during June and July rules out the feasibility of using cold air to dry hay. Heated air has met with somewhat greater success. The fuel normally used to heat the air is either low-grade fuel-oil or electricity. The writer of this paper has had some experience with barn-drying hay with heated air on the farm of University College, Dublin. This technique has a number of definite advantages: (1) It cuts to a minimum the time during which the cut grass is exposed to weather conditions; (2) It is possible to bale the forage as soon as moisture content has fallen to about 45 percent; (3) The bales can then be dried in a number of ways e.g. in a rick, in a barn or on wagons; and (4) With this approach an excellent product is guaranteed, field losses are cut to a minimum and the uncertainty associated with other techniques is almost completely eliminated. Unfortunately, there is one very big

tendency, especially among the smaller farmers, is towards hiring contractors to carry out the entire operation. The machinery rings referred to earlier should add considerably to this method. There is one other big advantage associated with this approach; i.e., it lends itself to a very simple self-feeding system with scarcely any mechanization necessary.

It is not proposed to deal in length with the various steps involved in the silage-making process. However, six basic rules for makinggood quality silage are worthy of mention. (1) Harvest the grass crop at the proper stage of growth. (2) Wilt in order to reduce loss of nutrients by seepage. (3) Chop the grass to help consolidation in the silo and to make self-feeding easier. (4) Fill the silo quickly, in order to minimize losses by respiration. (5) Cover the silo properly. (6) Have a good drainage system from the silo to ensure that effluent has no problem in getting away. A tight structure is also essential in minimizing losses during storage.

Types of silage commonly made fall into three broad categories -- (1) high-moisture, (2) medium-moisture, and (3) low-moisture silage. Low-moisture silage involves wilting the grass to 50 percent or less moisture content in the field and storing it until needed in tower silos. The need for such a drastic reduction in moisture content gives this approach very little advantage over haymaking, and it generally has little or no practical importance in countries with high rainfall.

High-moisture grass silage is the type commonly made in Ireland. Wilting is not practised, and the material is stored at about 70-75 percent moisture content. The main disadvantages of this system are: (1) It involves a big amount of seepage which leaches away a considerable amount of nutrients, has an unpleasant odor, and poses a problem from the standpoint of disposal. (2) Due to certain factors associated with this high-moisture content it is impossible for high producing animals to ingest enough dry matter to meet their daily requirements. This point is illustrated in Table 6. It is also worth noting that while dry matter intake decreased with increasing moisture content efficiency in terms of dry matter utilization actually increased. It is generally accepted that this inverse relationship between dry matter intake and moisture content is not due to the water in the forage per se but rather is due to the undesirable fermentation associated with this high moisture level.

Medium-moisture grass silage (50-70 percent moisture content) has none of the problems associated with high-moisture silage. It would seem to be the ideal solution to the problem of dry matter intake referred to above. This method would definitely call for some wilting of the grass in the field prior to ensiling. In this respect, it may give rise to some of the haymaking difficulties already mentioned.

TABLE 6. Relative value of hay crop silages compared with barn-dried hay for daily milk yield per cow.

Moisture Content of Silage	TDN	DM Intake	Milk Prod.	Efficiency[1]
	(Percent of Value for Barn-Dried Hay)			
70% Moisture & higher	100	83	100	110[2]
60 to 70% Moisture	100	86	100	108[2]
35 to 60% Moisture	100	102	104	101

[1]Efficiency = Relative milk yield per unit of DM compared with barn-dried hay.

$$\text{Efficiency} = \frac{\text{Milk prod. rel. to hay}}{\text{DM intake rel. to hay}} \times 100$$

[2]$$\frac{\text{Efficiency} - 100}{2} + 100$$

Source: Merrill, W. G., and S. T. Slack, An. Sci. Mimeo. Series, No. 3, March 1965, Dept. of An. Sci., New York State, College of Agriculture, Ithaca, New York.

As a final comment on the question of silage-making in Ireland, it seems reasonable to suggest that with existing machinery it should be possible to reach a compromise between medium-moisture and high-moisture silage. If the common rules for proper silage-making are adhered to, an end-product with 68-72 percent moisture content could be achieved without great difficulty. The grass should be adequately chopped before being ensiled. This has the two-fold effect of (1) aiding proper consolidation as well as (2) ensuring easier self-feeding and greater ease in mechanical handling when the cured forage is being fed.

With the gradual swing towards more grass together with the more intensive approach to grassland management, it is likely that the current increase in the amount of silage made annually will continue for some time. Hay will continue to be an important part of the conservation program. There is still a big need for more mechanization in both hay and silage. This is called for in making as well as in feeding the forage. Greater emphasis will be placed on hiring rather than individual ownership of the necessary machinery. Buildings will play a relatively small role in the Irish forage utilization system of the future. Recent research work in Ireland reported by McCarrick [28] has indicated that there is very little advantage in having a roof over beef animals which are being outwintered on silage. Roofless cubicles are just as effective as much more elaborate housing. These trends,

coupled with making silage in the open, should cut down considerably on heavy capital investment.

CHAPTER 3

FORAGE UTILIZATION BY BEEF ANIMALS

At this point in time, Ireland's prospects of gaining entry into the European Economic Community seem to be gradually approaching reality. Becoming a member of this Community will have a marked impact on the whole structure of the Irish economy, especially the agricultural sector. Such an international agreement has the effect of favoring the production of certain products while discouraging or eliminating completely the production of others. When such a common market is formed, each area tends to produce those products for which it has the greatest ratio of advantage or the least ratio of disadvantage when compared with other areas. This concept is referred to as the "principle of comparative advantage". It makes much more sense for areas to concentrate on the production of these products for which they have a natural or economic advantage and to trade their surplus of these products for goods they need that can best be produced in other areas. By permitting and encouraging land areas to specialize in those types of production for which they have a high comparative advantage, man has been able to increase his total supply of goods and with it his average standard of life [297].

As far as Ireland is concerned, joining the European Economic Community would tend to favor grass production as opposed to other crops. While Ireland would not be able to compete with certain member countries in growing grains and sugar beets it would command a comparatively advantageous position in producing grass products. Beef is likely to be the most important of these products. The relative importance of the beef industry in the Irish economy up to now was discussed earlier in this paper. If present trends continue - and it looks as if they will - the beef animal should play even a more important role in Irish agriculture under conditions of an expanded Community.

As standards of living rise, there is a gradual decline in the demand for starchy foods like potatoes and bread and a swing towards protein-rich foods such as beef, pork, and poultry. Indeed, at the present time, good quality beef is by far the most expensive of these three foods; and it is likely to become more and more a luxury food. The American case is a good example. Income level has been gradually increasing in the U.S. over the past twenty years. So has been the demand for high-protein foods like meat. This is evident from Table 7. Between 1948 and 1968 there has been a substantial increase in the annual consumption of red meat in general, and in the case of beef alone per capita consumption increased from 65.5 pounds in 1947-49 to 109.4 pounds

TABLE 7. Trends in meat consumption per capita, United States, selected years (pounds)[a]

Meat Commodity	Average 1947-49	Average 1957-59	1966	1967	1968[b]
Red Meat	148.5	156.6	170.5	177.5	182.7
Beef	65.5	82.1	104.0	105.9	109.4
Pork (excluding lard)	68.4	63.0	58.0	63.9	66.0
Poultry (chicken & turkey)	22.0	33.5	43.8	45.7	45.0

[a] Carcass weight (excludes edible offals).

[b] Preliminary.

Sources: U.S. Food Consumption, U.S. Dept. of Agr., Stat. Bul. No. 364, 1965, pp. 22 and 25.
National Food Situation, U.S. Dept. of Agr., May 1969, p. 21 (derived from the 1965 Household Food Consumption Survey).

in 1968. A somewhat similar picture would be expected in the case of Western Europe.

At present the European Economic Community is a relatively big importer of beef; and if Denmark, Norway, Ireland, and Great Britain gain entry, there should be a marked increase in the demand for beef within this enlarged Common Market. Provided that income will continue to grow, and that there will be a reasonable distribution of any changes in income, the demand for beef is almost certain to continue to expand in this area.

Beef Production Systems

Beef can be produced by a number of different methods; and for this reason, according to Bradford and Johnson [30], it has been difficult for research workers to estimate useful input-output relationships or production functions for beef production. These authors also mention that the particular method adopted by a farmer for producing beef will depend on such factors as: resources available, other enterprises in operation on the farm, knowledge concerning levels and variations in livestock prices, feed supplies, and production practices.

Traditionally beef cattle raised on Irish farms have been disposed of in either of the following ways: (1) used for home consumption, or (2) exported as carcass beef, as finished animals, or as unfinished store animals. For a particular period, the number of animals fitting into each

of these categories is affected by various factors--most of which are outside the farmer's direct control. Costs of production, coupled with the price of the finished product, probably have the greatest influence on the overall beef production pattern.

During the past century, the total number of cattle raised on Irish farms has been steadily increasing each year (with a few exceptions) and reached a record 5.6 million in 1966. About 1.5 million calves are born each year on Irish farms. Some of these calves are raised on the farms where they are born and are later sold either as unfinished or fat cattle. However, the typical dairy farmer of the southern counties tends to specialize in the milk part of the enterprise and sells all new-born calves beyond those required for replacements. In the past, there has been a very typical pattern in the movement of cattle of different ages. These are illustrated in Figures 10, 11, and 12. The dairy farms of the south sold their surplus calves to farmers from the western counties where most of the rearing was carried out; and these animals were later sold to the midland farmers. Here they were finished to a weight suitable for slaughter. However, in recent years, dairying has become important in almost all counties and there has been a gradual breakdown in the traditional pattern. Consequently, it is common to find farmers in different areas engaged in various stages of the

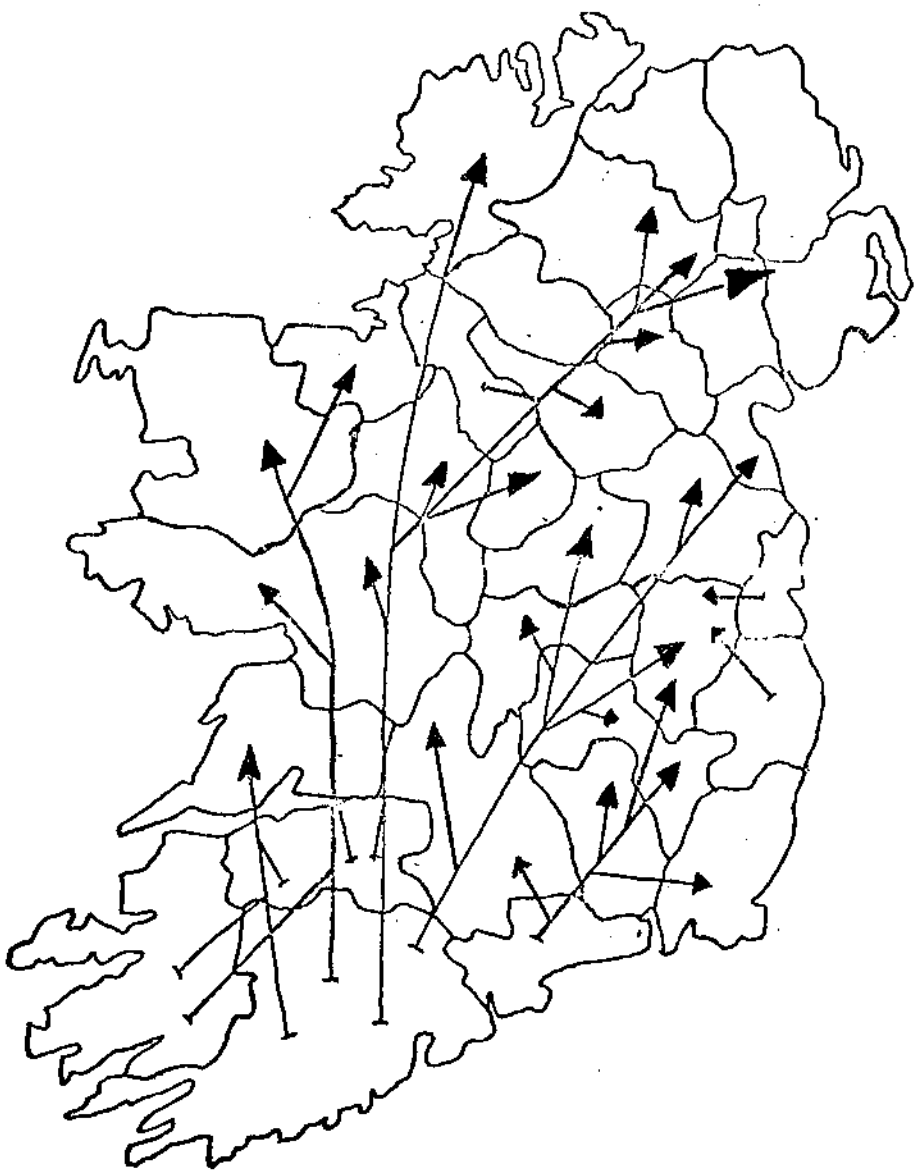

FIGURE 10 Map of Ireland showing the principal calf movements from the main dairying areas to other parts of the country

Source: Report of the Store Cattle Study Group, p. 13, The Stationery Office, Dublin, 1968.

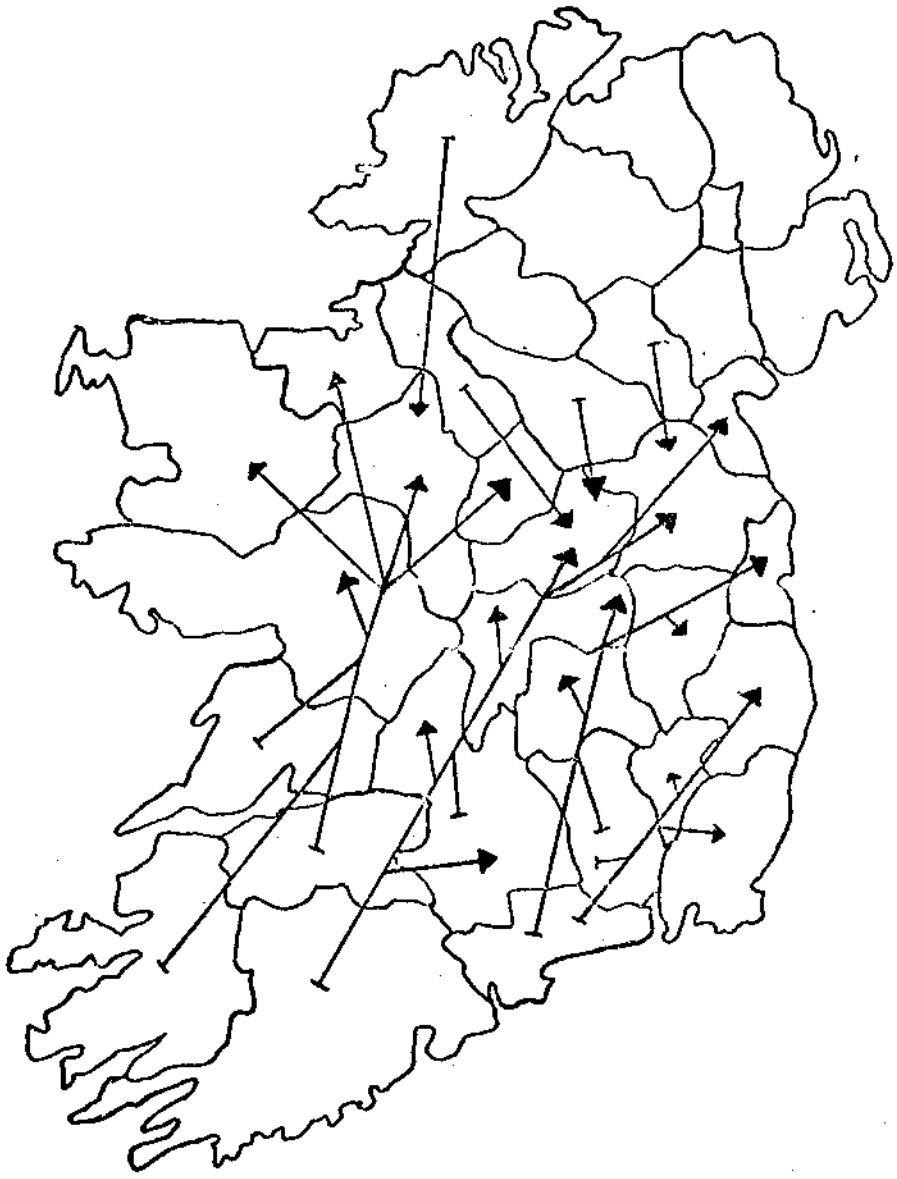

FIGURE 11. Map of Ireland showing the principal movements of yearling cattle within the country

Source: Report of the Store Cattle Study Group, p. 14, The Stationery Office, Dublin, 1968.

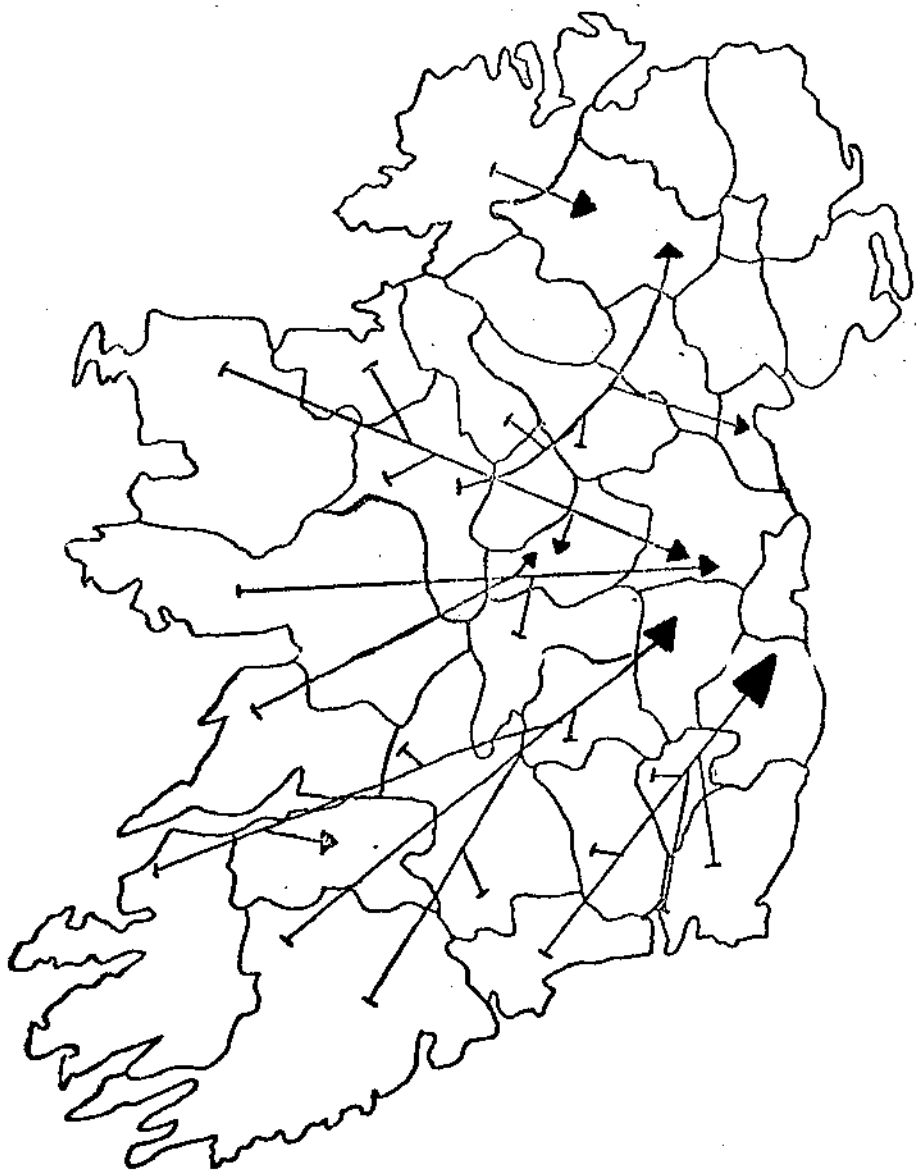

FIGURE 12 Map of Ireland showing the principal movements of 1-2 year old cattle within the country

Source: Report of the Store Cattle Study Group, p. 15, The Stationery Office, Dublin, 1968.

beef-raising enterprise. From the economic standpoint it would be much more desirable if a farmer could rear his own calves and raise these animals to a finished weight. This approach would tend to eliminate a considerable amount of transportation costs as well as inefficiency in production.

The actual numbers of cattle raised for different purposes on Irish farms fluctuate from year to year, and Table 8 gives some idea of the relative numbers which fit into each category for the period 1962-1966.

TABLE 8. Average numbers of cattle produced for different purposes in Ireland, 1962-1966

Bullocks:	Fattened in Ireland	222,300
	Exported as stores	360,100
Heifers:	Fattened in Ireland	178,200
	Used for breeding in Ireland	279,900
	Exported as stores	127,600

Source: Report of the Store Cattle Study Group, The Stationery Office, Dublin, 1968, p. 16.

During this five-year period, which is somewhat typical, 38 percent of the bullocks were fattened in Ireland and the remainder were exported to be finished in Great Britain. About 30 percent of the heifers were fattened in Ireland, 48 percent were held in Ireland for breeding purposes, mainly in dairy herds, and 22 percent were exported to Great Britain to be used either for fattening or for breeding /317.

Technical Performance

Two typical growth curves for a spring-born heifer and bullock raised under average Irish conditions are shown in Figure 13. It might be mentioned at this point that about two-thirds of the annual Irish calf crop are born in spring and early summer. Normally these animals consume a considerable quantity of grass during their first summer and early fall, and an average bullock would enter his first winter weighing about 400 pounds. Young cattle of this type are usually housed during their first winter, and their feed normally consists of hay, roots, and some grain. Mainly because of the poor quality of the hay which is fed, a ration of this nature is just about sufficient to maintain the animal's weight over this period. Such a bullock gains considerable weight when he is put onto grass during the following summer months and would weigh about 750-800 pounds at the beginning of his second winter. This type of animal is usually outwintered during which time he gains very little weight. Over the following grazing season, weight gain is fast and by late September or early October this bullock should weigh about 10 cwt. He can now be labelled a forward store which means that it is possible to finish him to a point where he is suitable for slaughter, within a relatively short period. With this part of the cycle complete, the remainder consists of either fattening this animal in Ireland or in Great Britain.

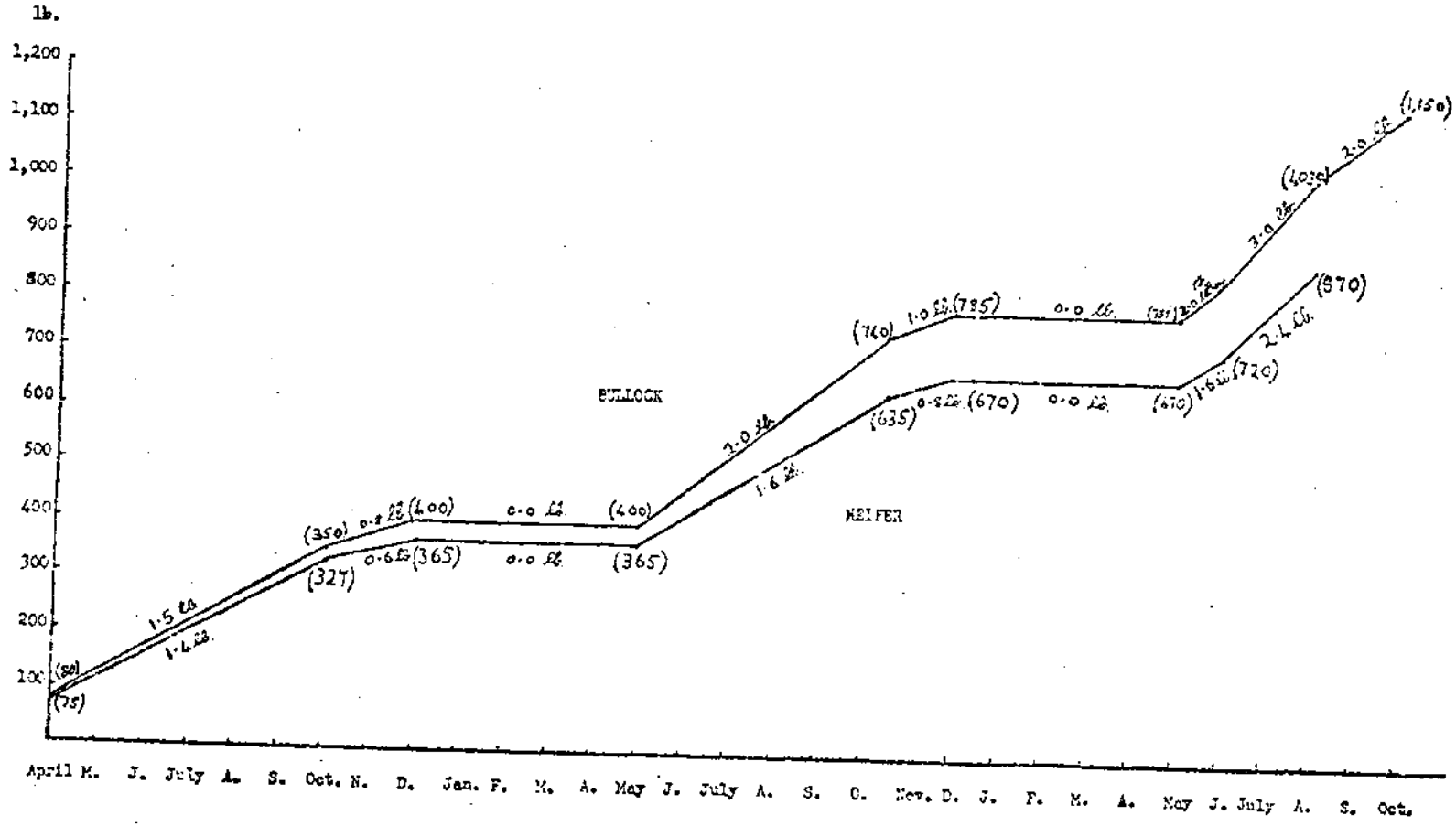

FIGURE 13. Growth curves for a typical 30 month old store bullock and a 28 month old store heifer under Irish conditions

Source: Report of the Store Cattle Study Group, The Stationery Office, Dublin, 1968, p. 65.

Currently there is room for considerable improvement in the beef production system just described. This is true both from the technical as well as from the economic standpoint. Stocking rates are much lower than is technically feasible. With current practices, it takes two to three acres to produce the 10 cwt. beef animal already mentioned. Such a weakness is even of more concern in a country like Ireland where the demand for land is far exceeding the supply.

Other weaknesses include a general low level of management and nutrition, an inadequate winter feed supply as well as keeping cattle on grass during the winter months. These shortcomings are indirectly related to the low stocking rates discussed earlier. The winter feed problem is the most serious. Table 9 indicates that the gap between the annual amount of winter feed required and the total quantity available actually widened between 1963 and 1966.

TABLE 9. Availability of winter feed and maintenance requirements of cattle, 1960, 1963, and 1966[a]

	1960	1963	1966
Winter feed available ('000 tons starch equivalent)	1611	1593	1679
Maintenance requirements of cattle wintered ('000 tons starch equivalent)	1578	1640	1920

[a] Winter feed available consists of hay, silage, turnips, mangels, fodder beets, and kale.

Source: Report of the Store Cattle Study Group, The Stationery Office, Dublin, 1968, p. 68.

There is an urgent need to bridge this gap, and the simplest and most economic method of achieving this would be to increase the amount of high quality hay and silage made each year. A general improvement in the overall management and nutrition of beef cattle would also help. It should be possible to have bullocks of the type described earlier reach the same weight (10 cwt.) six months earlier than indicated. It has been pointed out that it should be technically feasible to have a bullock averaging 1.5 pounds daily gain throughout his life reach this weight in a finished condition at two years of age on grass and grass products alone [32]. However, it has also been indicated that such a system would no longer produce store cattle of the present type, but it would raise good quality beef cattle. From the standpoint of the Irish economy, such beef cattle are likely to become more and more important in the market of the future. If Ireland becomes a full member of EEC, its policy will have to be towards producing finished beef animals rather than stores. It will be more profitable to sell these finished animals directly to continental buyers either on the hoof or as carcass beef.

Outwintering cattle on grass in a climate of relatively high rainfall such as Ireland is not recommended. Heavy cattle tend to damage the soil structure. This in turn delays grass growth in the following spring. Considerable quantities of grass are also trampled into the ground. But it may be

argued that housing beef cattle over the winter months calls for considerable quantities of capital. However, the necessity for housing such cattle in elaborate buildings is in doubt. As mentioned earlier, recent research work in Ireland has indicated that very simple roofless cubicles with lateral shelter were just as effective as elaborate structures. Findings of this nature could be of great national importance; and if it is possible to winter cattle satisfactorily by such cheap methods, this would eliminate the capital barrier to taking cattle off grazing land in the winter [33].

Economic Performance

Probably the most striking economic feature of cattle production in Ireland is its relatively low returns per acre as compared with other enterprises. This is evident from the results of a number of surveys including the 1966-67 Farm Management Survey [2]. Data from this latter survey comparing gross output, direct costs and gross margin per acre for seven systems of farming are presented in Table 10. Gross margin per acre is defined as the value of total output per acre less direct costs. This is the amount left to the farmer to cover fixed costs. The two systems showing the lowest gross margin per acre were those based primarily on drystock i.e. beef cattle and sheep.

Behan [34] calculated the total returns, direct costs, and gross margins for three different systems of cattle production. Using 1968 adjusted prices he found that a bullock

TABLE 10. Economics of different farming systems in Ireland on a per acre basis, 1966-67

System of farming	Mainly creamery milk	Creamery milk & tillage	Creamery milk & pigs	Liquid milk	Drystock	Drystock and tillage	Mountain sheep and cattle
Total gross output (£)	19.1	29.0	30.9	31.4	12.8	21.7	7.1
Total direct costs (£)	4.8	8.1	11.2	9.2	3.5	5.9	2.0
Total gross margin (£)	14.3	20.9	19.7	22.2	9.3	15.8	5.1

Source: Gaughan, Joan, J.F. Heavey, and B.C. Hickey, "Farm Management Survey 1966-67", An Foras Taluntais, Dublin, 1969, p. 21.

raised by the traditional method as indicated in Figure 13 would leave the farmer £14.5 gross margin per acre. If a more intensive approach to feeding this animal was adopted so that he would be finished on silage and barley during the winter and reach the same weight in 2 as opposed to 2 1/2 years, the calculated gross margin would be £18. Behan also mentioned that it is feasible to produce a younger, lighter store animal from an early spring calf. The animal he had in mind would enter his first winter weighing about 4 cwt.; he would gain about 0.75 cwt. during this winter on a ration of silage and some barley. By the following October, this lighter type forward store bullock would be 1 1/2 years old and would weigh about 7.5 cwt. The farmer would have about £16 per acre gross margin from such a system. Further details are given in Appendix Table 3. This author goes a step further and shows that if the weight gains obtained in the case of the intensively raised bullock could be achieved from silage alone the gross margin would be increased from £18 to £23.5. Such a performance from silage is technically feasible according to research findings in Ireland [35]. This is one definite method open to the farmer to increase his returns from cattle production.

Higher Returns From Cattle

There are four main methods of increasing returns to the farmer from cattle production: (a) lowering unit variable costs of production, (b) lowering unit overhead costs of

production, (c) raising cattle prices to the producer, and (d) raising the general level of management and nutrition [367].

It is generally accepted that a relatively large portion of the variable costs of raising a beef animal is involved in rearing the calf. The traditional method of calf rearing in Ireland, which involved considerable quantities of both whole and skim milk, is now being replaced by the relatively cheaper early weaning systems. According to the above report [367], the future of these systems will depend largely on the price of whole and skim milk, compared with the price of milk substitutes and concentrates.

Land, labor, machinery, and buildings involved in raising beef cattle constitute the main overhead costs in this enterprise. In order to minimize costs of this nature, the aim should be to spread the cost of the fixed factor over as many animal units as possible. As regards the land factor this could be achieved by increased stocking rates. The suggested approach to curtailing heavy overhead housing expenses would be to use simpler and less expensive structures. In most phases of the beef cattle enterprise, the two factors, labor and machinery, are interrelated. As in all other farming enterprises, the present tendency is towards more capital labor substitution. This is probably most evident in the case of feeding and watering cattle where labor is being gradually replaced by automated systems. In all cases, it must be borne in mind that a larger output from a plant (or farm)

of a given size causes declining average costs only as long as the decline in per unit fixed cost is greater than the increase in per unit variable cost [32].

There is a need to develop complete forage systems which fit the individual's farm and which are at the same time economically efficient. This presents a major problem in keeping a balance in investments between land and livestock, and the buildings, feed storage and machinery for harvesting and storing the feed crops [38]. In such circumstances, the ability of the individual farm manager to make the correct decisions is of vital importance.

The returns from cattle production may also be increased by improving the general level of management and nutrition. This is a further aspect of the business over which the individual farmer has a considerable amount of control and its relative importance from the Irish standpoint was discussed earlier in this chapter.

Raising cattle prices to the producer has also been suggested as a method of increasing returns from the cattle enterprise. This is almost completely outside the control of the individual Irish farmer. The British beef market plays a key role in determining the price of Irish cattle and Ireland has only a very limited amount of influence on this market.

Price Instability

Livestock and livestock product prices have long been noted for their seasonal highs and lows [39]. The main price fluctuations in the Irish cattle trade are of a seasonal

nature. Variation also occurs by year, age, breed, and sex but it is not proposed to discuss these factors in this paper. A general picture of the type of year to year variation in cattle prices which occurs in Ireland is shown in Figure 14. These prices refer to fat cattle but the same general pattern holds for store cattle as well. O'Connor [40] mentions that those who gain most when cattle prices are high are the dairy farmers who sell their surplus calves irrespective of price. Calf prices usually move in the same direction as those of finished cattle (Figure 15). The same author found the coefficient of correlation between the prices of these types of cattle and between percentage price changes for the 1951-1967 period to be .83 and .72, respectively. These coefficients were highly significant.

There is a very definite pattern in the seasonal prices of cattle in Ireland. Typically cattle prices are at their peak in the spring and are lowest in the fall of each year (Figure 16). The spring peak reflects the strong demand which prevails at this time for cattle for summer grazing. The low fall prices are partly due to the relatively low demand as well as the increased supply of cattle coming off grass at that time.

Returns from different systems of cattle production were compared in an earlier section. What was not compared, however, were the returns that could be obtained by having finished cattle suitable for sale at different times of the year.

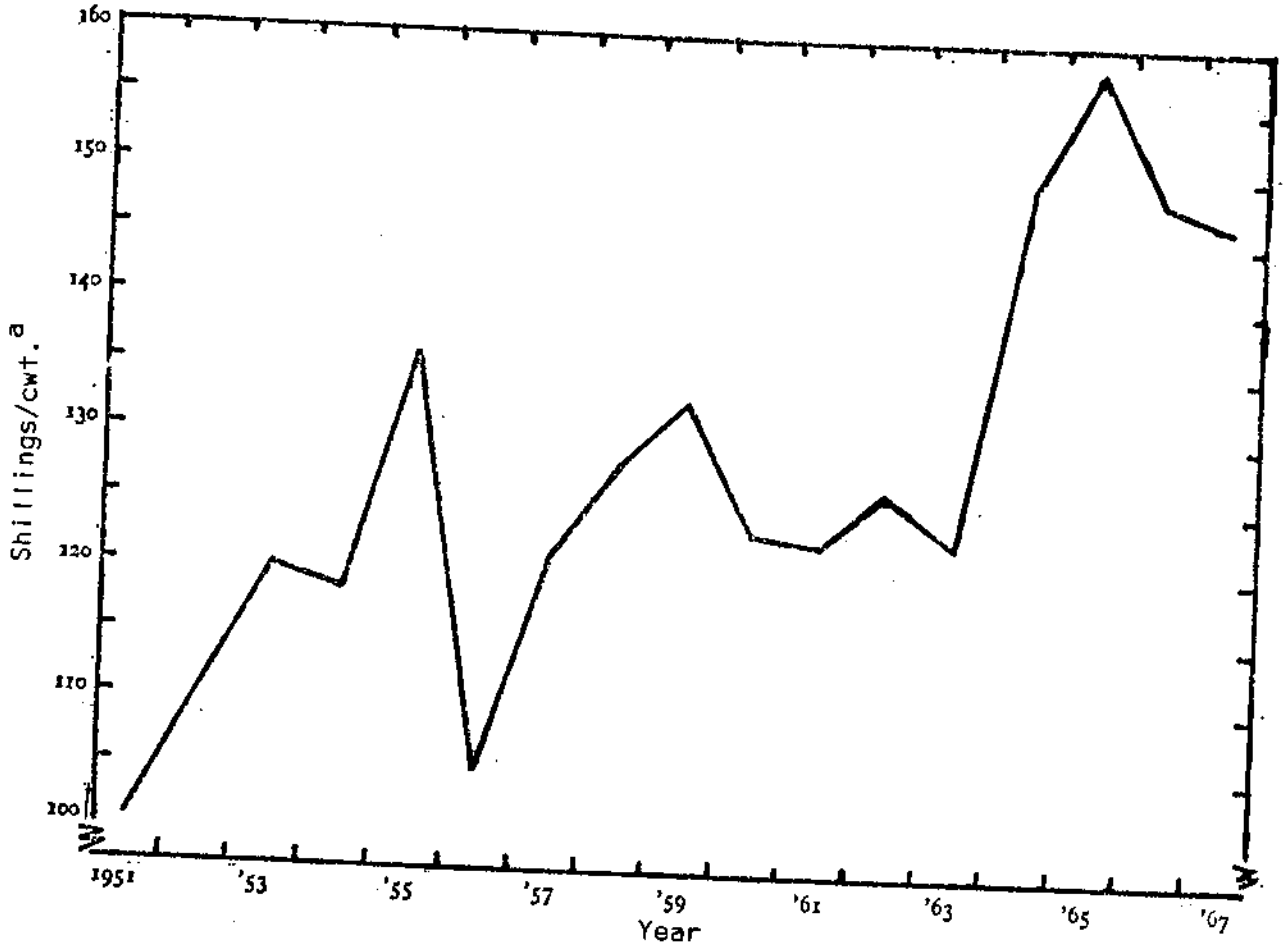

FIGURE 14. Average annual price per cwt. of fat cattle in Dublin, 1951-1967

[a] Twenty shillings = 1 pound sterling; 1 cwt. = 112 lb.

Source: O'Connor, R., "The Implications for Cattle Producers of Seasonal Price Fluctuations," Econ. and Soc. Res. Inst., Paper 46, January 1969, p. 3.

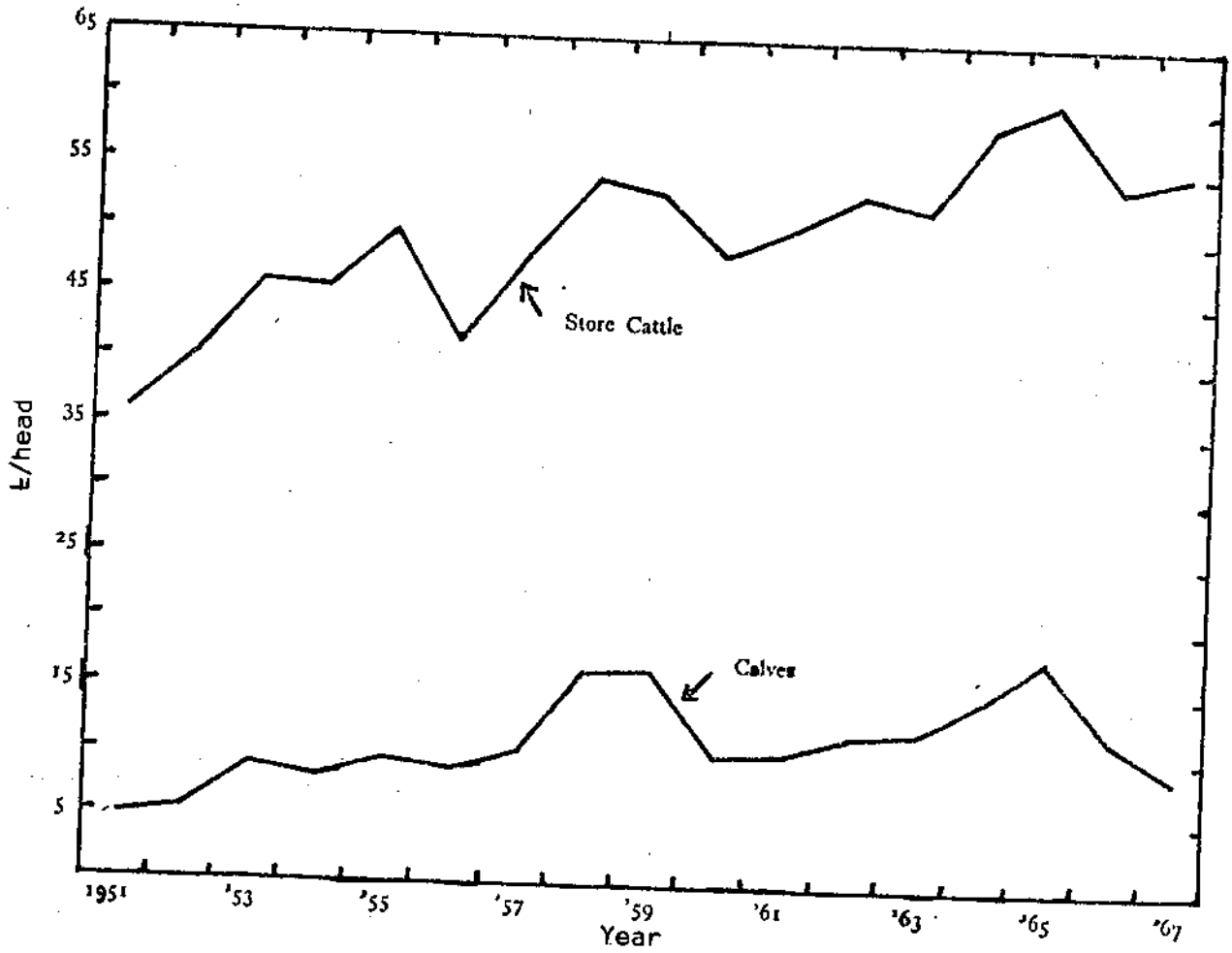

FIGURE 15. Average annual price per head of 2-3 year old store cattle and calves (<1 month old) in Ireland, 1951-1967

Source: O'Connor, R., "The Implications for Cattle Producers of Seasonal Price Fluctuations," Econ. and Soc. Res. Inst., Paper 46, January 1969, p. 5.

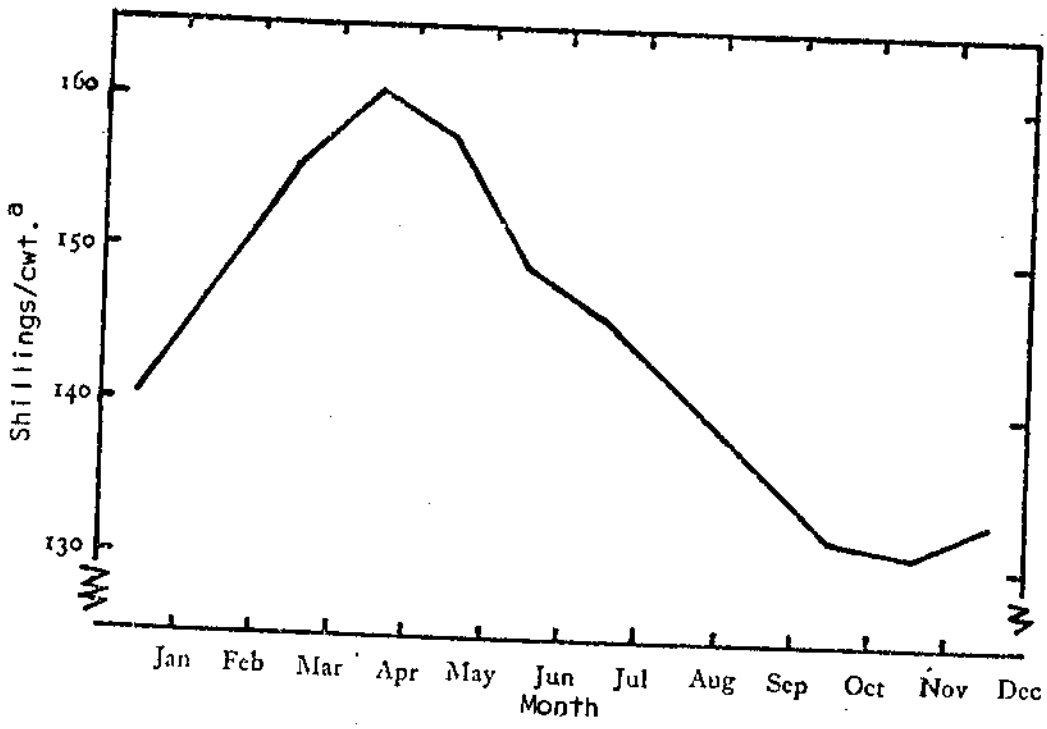

FIGURE 16. Average monthly prices per cwt. of store bullocks in Dublin, 1956-1967

[a]Twenty shillings = 1 pound sterling; 1 cwt. = 112 lb.

Source: O'Connor, R., "The Implications for Cattle Producers of Seasonal Price Fluctuations," Econ. and Soc. Res. Inst., Paper 46, January 1969, p. 6.

In Ireland it is possible to finish cattle either on relatively cheap summer grass over the grazing season or on conserved grass with possible grain supplementation during the winter period. Summer grazing is the less expensive of the two, but the low expenses incurred by this method are partly (and in some years more than) offset by the drop in prices between spring and fall. O'Connor's calculations show that there is little to be gained by keeping salable cattle on pasture beyond the end of July if these cattle are not to be overwintered. It is usually more profitable to harvest the late summer grass for silage and feed it during the winter months.

There are two choices open to the farmer who wishes to overwinter animals of the type already described. He can aim to have these animals finished by April or he may turn them onto early summer grass at this time and sell them in June. The choice a particular farmer will adopt will depend mainly on his expectations regarding weight gains over the winter as well as over the April-June grazing period and on the size of the expected fall in price between April and June. While it is not possible to make any definite recommendation in this connection, O'Connor's conclusions are worth noting: If weight gain between April and June is 1.6 cwt. or more, considerable price declines during this period would have to occur before a grazing program would not be justified. This is particularly applicable if the quality of the silage is poor thus resulting

in low weight gains during the winter. Thus, in the case of the farmer who makes poor quality silage and gets low winter weight gains, June selling is likely to be the most economical. Conversely, if the gain over the April-June period is less than 1.5 cwt., a different picture develops. In such circumstances, unless wintering costs are very high and winter price rises very low, a small price decline between April and June causes spring grazing of well wintered cattle to be uneconomic relative to April selling.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Summary

It has been postulated that, if Ireland becomes a member of the European Economic Community this should favor grass production as opposed to other crops. The main objective of this research paper was to investigate how the grass crop has fitted into Irish agriculture up to now and what recommendations should be made in order to maximize returns from this crop in the future.

Ireland has a total area of approximately 17 million acres and about 60% of this total or 90% of the entire arable land is devoted to grass each year. This general pattern is likely to continue. Typically the grass crop is grazed *in situ* during the summer months and the surplus growth is conserved either as hay or silage, to be fed over the winter period. At present there is an urgent need for considerable improvement in grassland management in general. Farmers have been slow in adopting modern technology and one outstanding example in this respect has been their reluctance to properly fertilize the grass crop. Research findings indicate that while farmers have no hesitation in using abundant fertilizer

on other crops, considerable areas of grassland have been neglected.

One of the most important aspects of the grassland enterprise is the conservation of the surplus summer grass for winter feed. Quality as well as quantity must be borne in mind. The typical cattle grazing season in Ireland runs from April through October. Sheep are grazed all year around. During the five winter months it is desirable to take all cattle off grazing land and feed them elsewhere. Otherwise considerable damage may be caused to the soil structure and animals usually trample sizable amounts of forage into the ground. The surplus summer grass may be conserved either as hay or silage. In Ireland the traditional method has been haymaking and this approach still accounts for about 90% of the grass conserved annually. However, silage is increasing in importance.

Irish research workers have found that an average sample of fieldcured Irish hay is just about able to supply the daily digestible dry matter requirement of a ruminant for maintenance. This low quality is due mainly to the advanced stage at which the grass crop is harvested as well as the losses which occur during saving and storage. Weather uncertainty is the greatest single uncontrollable factor facing the Irish farmer who makes hay by conventional methods. Recorded rainfall data however indicate that there is a better chance of obtaining good haymaking weather in June

rather than in July. At present the bulk of the Irish hay crop is saved during July. A slightly earlier haymaking season seems to be more desirable.

Use of better harvesting and conditioning machinery could also help to improve the hay quality. Irish research workers have examined a wide range of harvesting and conditioning machines. The flail-type mower with its crop conditioning features gave very favorable results. Recommendations on suitable hay conditioning machines have also been made and these recommendations varied with size of farming operation. Crushers and crimpers have not been tested in Ireland as yet.

Drying hay artificially, by means of either hot or cold air has been investigated in Ireland. Because of the high relative humidity during the Irish haymaking season it is not possible to use cold air successfully. At the present time the cost of drying hay with artificially heated air, on a commercial basis, is prohibitive.

High-moisture grass silage, with a dry matter content of about 25-30 percent, is the type commonly made in Ireland. This is not likely to be replaced by low moisture or medium moisture silage because of the general difficulty in wilting grass to a desirable level. However an effort should be made to increase the dry matter content above 30% if possible.

Grass is a relatively cheap source of feed for certain types of livestock including beef cattle. The beef cattle

industry plays a very important role in the Irish economy and accounts for about one-third of the total annual agricultural output. Ireland has a good market for this produce in Great Britain. Most of the animals exported are unfinished stores but considerable quantities of finished animals (either live or in carcass form) are also exported.

Some studies have been carried out comparing technical and economic aspects of different beef cattle systems in Ireland. In general it was learned that the technical performance was low, mainly due to low stocking rates as well as inadequate supplies of winter feed These are closely associated with the poor fertilizer practices already mentioned.

Low returns per acre and instability in these returns are two common features of Irish cattle production. The main avenue open to the individual farmer to increase his returns per acre is by an overall improvement in his management practices. This could be achieved by reducing high overhead costs on buildings, increasing the number of animal units that can be carried per acre, conserving larger quantities of good quality hay and silage and keeping cattle off grazing land during the winter months. Hence it should be possible to reduce the time it takes to raise a 10 cwt bullock from the present 2 1/2 to 2 years.

The main price fluctuations in the Irish cattle trade are of a seasonal nature. Prices typically reach a peak in

spring and are lowest in late fall. It is less costly to finish a beef animal on summer grass than to have him ready for sale in the spring which involves overwintering. The big drop in prices between spring and fall usually outweighs the advantage of this comparatively cheap summer feed. A farmer also has the choice of selling his salable cattle in April or in June. Selling in June would involve a further 3-month grazing period and whether or not a farmer will sell in April depends on his expectations regarding weight gains over the winter and April-June periods as well as the size of the expected fall in price between April and June.

Conclusions

Irish farms tend to get fewer in number and larger in size each year. Coupled with this increase in size is the need for adopting more modern technology in running these farm businesses. This is also true in the case of grassland farming. In Ireland at the present time there is considerable scope for a more intensive approach to this whole area. This calls for better management practices both in the growing as well as in the feeding of this forage crop.

There is room for considerable expansion in the beef industry. Irish farmers will have to stock their farms more heavily and produce a salable beef animal over a shorter period than is the current practice. It should also be possible to improve the current marketing arrangements and hence

reduce the wide price fluctuations which occur between spring and fall each year.

If Ireland becomes a full member of the European Economic Community there is likely to be an increase in the demand for the younger, well finished, intensively produced beef animal. In such circumstances it will be more profitable for Irish farmers to finish this type of animal in Ireland rather than sell him to the English farmer as an unfinished store. Such finished animals could be exported directly to the continent either live or in carcass form.

Implications for Irish Farmers

Irrespective of what type of farming he practises the Irish farmer of the future will be more specialized than his counterpart of today. It will be more difficult for the agricultural sector to compete with other sectors in paying wages. Hence the migration of labor out of agriculture is likely to continue. Accompanying this will be a greater need for increased mechanization. This will be particularly true in the case of grassland farmers. It will be necessary for such operators to have a fairly substantial size of enterprise in terms of land, livestock and machinery. Buildings are likely to play a relatively minor role.

Adequate size of enterprise however will not be sufficient to guarantee a reasonable return to farming. Operators will have to improve considerably on their current farming

practices including more use of fertilizers, better grazing practices, more conservation of grass and obtaining better quality conserved fodder - either in the form of hay or silage.

Becoming a member of the European Economic Community will not automically solve the problems of the Irish grassland farmers. There will be keen competition within this Community and while Ireland will have a comparative advantage in the production of grass products individual farmers will have to improve their efficiency standards considerably.

In Ireland at the present time there is an urgent need for greater concentration by cattle farmers on rearing their own calves and keeping them until they are finished beef animals. This would tend to eliminate considerable unnecessary expenses which occur when a beef animal spends some time on a number of different farms before he is finally suitable for slaughter.

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APPENDIX

TABLE 1. Daily rainfall (mm) for Dublin Airport during June and July each year 1959-1968

Day	1959		1960		1961		1962		1963		1964		1965		1966		1967		1968	
	Jn	Jl	Jn	Jl	Jn	Jl	Jn	Jl	Jn	Jl	Jn	Jl	Jn	Jl	Jn	Jl	Jn	Jl	Jn	Jl
1	T	1.8	T	T	T	T	T	--	--	1.2	0.2	T	T	T	--	T	T	1.1	T	4.7
2	T	1.5	0.2	T	T	T	T	T	T	T	3.4	T	T	--	T	0.3	T	2.7	T	3.0
3	6.7	T	T	0.1	T	0.5	T	--	--	0.1	5.2	1.6	T	T	T	--	0.1	1.8	T	0.9
4	T	T	T	3.1	T	--	T	3.8	T	T	2.5	T	7.4	T	1,0	T	T	1.8	T	T
5	T	0.1	1.2	7.5	11.5	T	T	T	0.2	0.1	0.8	0.3	7.9	0.2	0.4	12.7	1.9	T	T	T
6	4.3	T	9.5	0.3	0.2	T	T	--	T	0.5	5.1	T	T	5.3	0.7	0.1	0.7	T	T	--
7	0.6	T	15.6	5.0	2.9	T	T	--	T	T	2.0	0.7	T	T	--	--	2.2	0.4	T	T
8	3.3	T	5.2	--	0.9	0.2	--	--	T	T	0.2	1.7	T	T	T	T	T	T	2.1	T
9	1.4	T	0.8	0.2	T	T	T	1.4	T	0.8	6.5	T	0.1	0.6	46.6	0.1	T	T	T	1.2
10	T	T	3.8	28.6	3.8	8.1	0.4	8.3	T	0.3	9.6	2.9	T	1.7	3.9	9.6	T	T	T	--
11	T	2.1	0.1	0.5	T	6.6	4.6	0.1	15.5	3.3	1.9	1.4	4.9	0.5	2.9	T	T	0.3	T	T
12	T	0.1	0.3	5.6	12.6	6.2	0.4	T	4.2	0.6	7.2	T	0.4	9.2	3.3	0.1	T	T	T	T
13	T	0.4	5.7	1.9	T	12.8	T	1.9	T	0.4	0.1	4.4	T	11.5	4.5	0.2	T	3.6	T	T
14	T	--	1.1	T	--	12.8	0.7	4.1	T	1.2	2.4	0.8	8.2	0.6	9.2	T	T	34.8	T	0.3
15	T	2.0	2.4	6.7	1.9	0.5	7.4	0.4	4.8	4.5	T	T	3.3	T	T	T	T	0.5	T	3.3
16	T	1.9	0.1	13.5	T	0.1	T	T	T	T	T	T	7.7	T	1.0	0.9	T	3.6	T	1.9

17	--	T	T	14.9	2.7	T	0.1	T	6.4	2.3	T	5.2	5.2	T	1.0	T	T	4.3	T	T
18	--	4.7	T	T	T	T	3.3	6.3	1.6	T	T	24.2	2.8	14.1	9.7	T	T	14.4	T	T
19	--	T	T	10.7	T	T	1.5	0.6	1.7	T	T	T	0.5	2.0	12.4	T	T	1.7	2.6	0.6
20	T	0.1	T	--	T	T	T	3.2	1.4	T	0.1	3.4	T	T	9.7	T	T	T	1.9	--
21	T	0.9	T	7.0	1.8	T	4.1	18.4	1.1	T	T	T	16.9	1.9	1.1	T	1.1	0.2	0.6	T
22	10.2	T	3.8	1.7	0.3	T	0.5	3.0	2.9	1.8	0.3	T	1.5	6.4	0.6	T	2.2	T	8.0	T
23	T	--	1.3	7.0	--	T	0.4	--	1.1	6.0	1.3	T	4.1	4.6	1.1	1.0	0.1	--	7.8	--
24	1.7	--	T	0.3	--	--	1.4	3.5	0.5	0.4	T	T	1.1	5.7	1.1	2.4	3.0	2.4	1.1	T
25	0.3	T	T	0.4	T	0.8	0.1	T	2.5	T	T	0.4	0.6	2.5	0.4	T	0.1	T	6.7	--
26	0.5	2.6	T	2.4	3.8	T	T	T	1.8	T	1.9	--	T	T	3.1	0.4	T	0.2	6.1	T
27	2.0	5.9	T	5.1	T	4.0	T	T	0.1	T	0.6	--	T	2.4	5.5	T	T	0.6	10.6	T
28	0.2	16.3	T	1.0	T	--	T	5.7	6.1	T	T	0.1	0.3	4.7	T	0.2	T	T	3.9	T
29	5.3	4.6	T	0.2	T	T	T	6.3	2.3	T	T	0.1	T	0.6	T	5.2	T	5.3	T	T
30	0.0	0.2	--	T	T	T	T	1.0	--	T	T	T	T	1.9	0.3	1.2	T	1.9	T	T
31		T		15.8		T		T		T		0.2		2.8		0.1		2.1		T
Total	37.2	45.2	51.1	139.7	42.4	52.6	24.9	68.0	54.2	23.5	51.0	47.4	72.9	79.2	119.5	37.1	11.4	83.7	51.4	15.9

[a]T = trace

Source: "Monthly Weather Reports," Meteorological Service, Department of Transport and Power, Dublin, June and July, 1959-68.

TABLE 2. Daily rainfall (mm) for Valentia Island during June and July each year 1959-1968

Day	1959		1960		1961		1962		1963		1964		1965		1966		1967		1968	
	Jn	Jl	Jn	Jl	Jn	Jl	Jn	Jl	Jn	Jl	Jn	Jl	Jn	Jl	Jn	Jl	Jn	Jl	Jn	Jl
1	0.1	0.5	0.9	T	T	0.3	T	T	0.1	0.1	11.0	T	T	T	T	T	7.5	0.8	3.2	T
2	T	1.1	0.2	T	T	T	T	T	T	6.5	3.6	T	T	T	T	0.6	0.3	1.1	T	0.8
3	8.8	2.3	T	8.6	T	0.3	T	T	T	3.9	4.9	T	T	--	T	0.7	0.9	0.4	4.5	2.8
4	T	T	15.5	6.6	0.2	--	T	0.3	T	0.3	8.3	T	8.9	T	18.5	T	1.3	0.2	T	T
5	2.1	2.4	5.7	1.3	12.0	--	--	T	T	22.8	4.5	0.1	T	0.6	0.9	T	0.7	T	0.3	T
6	8.9	T	2.4	2.4	0.5	0.4	T	T	0.7	T	1.8	0.4	4.8	1.2	7.4	0.2	0.9	8.1	2.2	2.0
7	8.8	T	26.1	0.8	1.4	0.2	T	0.3	0.2	T	1.0	18.3	6.9	T	1.0	T	T	12.9	2.5	1.3
8	2.2	0.9	5.0	T	0.6	0.3	T	T	T	T	4.1	2.5	T	0.3	3.0	0.7	T	0.1	0.2	T
9	0.9	0.1	--	12.6	13.1	0.1	T	11.2	1.5	1.1	13.3	1.9	T	0.1	1.3	T	T	--	T	0.2
10	T	T	0.8	16.1	1.0	7.3	T	2.1	T	1.0	16.8	6.6	13.4	4.8	T	18.9	T	T	T	T
11	0.2	0.3	0.1	1.3	2.2	32.4	4.8	3.1	T	0.1	8.9	11.5	9.2	0.6	2.8	0.7	T	T	T	--
12	T	0.8	2.9	3.6	0.8	20.1	1.1	T	0.9	0.5	15.1	T	9.3	2.5	5.1	0.4	T	T	T	T
13	T	T	3.4	4.9	T	2.2	1.6	3.7	0.5	8.6	12.5	24.0	T	1.9	2.6	T	T	1.1	T	16.1
14	T	1.4	0.4	0.9	2.6	10.9	3.0	0.8	T	4.0	1.0	2.3	27.9	0.1	0.6	1.5	T	1.7	T	7.5
15	T	6.6	2.9	1.6	7.9	14.2	0.4	T	2.8	5.0	T	1.0	3.4	T	7.8	1.0	T	16.2	T	0.3
16	T	10.1	0.2	39.2	0.9	0.5	0.2	T	0.3	T	T	2.9	T	T	4.6	0.1	T	13.2	T	0.4