SCOTTISH EXPERIENCES IN THE IMPACT OF FARM MECHANISATION ON THE EMPLOYMENT AND USE OF MAN LABOUR WITH OBSERVATIONS ON POSSIBLE INDIAN PROBLEMS IN THIS FIELD.

by

Kalyan Kumar Sarkar, B.Sc., M.Sc.

Thesis submitted for the Degree of Doctor of Philosophy to the University of Edinburgh, March, 1962.

CONTENT

LIST OF TABLES

APPENDIX TABLES

INTRODUCTION

One might rightly ask at the outset why a comparative study such as this has been undertaken, when socio-economic conditions of the two countries are so different that the nature of the problems confronting them hardly show any resemblance, and, therefore, a study of the approach involved in tackling the problems of the one is unlikely to be of much use in solving the problems of the other. In Scotland, for example, the necessity of introducing mechanisation to farm practices arose mainly from the problem of shortage of farm labour and increasing level of wages, while in contrast, such conditions are almost absent in India. In India, on the contrary, surplus agricultural labour itself constitutes a serious unemployment problem and mechanisation alone in this context is therefore likely to aggravate the problem further.

Sharp contrast also emerges when the economic conditions of the two countries are taken into consideration. The net income of an average Indian farmer, for example, hardly exceeds £25 or £30 annually whereas the net

yearly income of a backward Scottish stock-rearing farmer is above £400. This feature is significant, and reflects the meagre financial capacity of an Indian farmer, a capacity which is too low to offer him any great possibility of mechanising his farm himself. Similarly, on the criterion of average size of holding, India stands very low (average size seldom exceeds 5 or 6 acres) in comparison with Scotland where the average size of holding is as high as 66 acres, which is obviously a significant factor in the application of mechanisation.

These highlight the sharp contrasts that exist between the two countries leading to possible doubts concerning the usefulness of this study.

The study has, however, been undertaken with two main objectives in view. In the first place, there is a pressing need to increase agricultural productivity in India in order to solve her own food problem and to cope with the developmental pace of Western countries. To reach the same goal, it is a matter of urgency to develop and apply modern technology

to the processes of production and thereby to promote agriculture from a"depressed industry" to an industry of prosperity. Mechanisation can perhaps play a vital role in this respect.

In the second place, a country like India which happens to start her economic development late has some advantages in taking over and applying techniques that have been worked successfully in a more advanced country. Scotland, in this respect , deserves attention by her record of spectacular achievement in this field. She started mechanising her agriculture from the middle of the nineteenth century and development has gone on almost unchecked since then. Today, Scotland has one of the most highly mechanised mixed agricultures in the world.

It is therefore likely that one who feels the necessity of modernising agriculture in his own home country will be interested to study the Scottish approaches to modernising farm practices, the economic background that stimulates the growth of mechanisation, the effect of farm mechanisation on employment of labour, skill of labour, type of farming and farm costs and incomes.

This study is also significant in the sense of assessing the chain reaction that mechanisation initiates. The purchase of a tractor, for example, makes necessary the adding of new tillage and harvesting machines to replace those formerly used with animal power; it initiates a significant change in structure of farm costs. As agriculture becomes more highly commercialized, farm credit, land tenure and farm science assume new significances.

The reaction to a change over to tractor power does not stop with economic consequenes only. The social consequences are of equal significance. When the economies of power farming permit the operation of larger acreages by fewer farm people, opportunities for the employment of displaced labour in the non-agricultural part of the economy become more important. Mechanisation needs to be appreciated not only from an economic point of view but from the point of view of leisure and physical comforts as well.

It is, therefore, of vital concern that the mechanisation process in Scotland be carefully assessed and analysed in order to be

aware of its implications for the future development of Indian agricultural industry. This does not imply that Scottish experiences will be all applicable to India but such a study is worthwhile, at least in the sense of a critical appraisal in the light of Indian conditions with a view to framing future developmental programmes.

Such programmes, needless to add, must be drawn out within the framework of Indian conditions. A society in which labour is plentiful in relation to capital has to develop the art and technique of modernising the processes of production in such a way that the economic advantages of modernisation may not be offset by the social cost of unemployment. The problem of unemployment which confronts India at the present moment is not so acute in the countries in which productivity is high because of the use of machinery and new techniques, but even so, large scale introduction of such labour displacing and capital intensive methods are perhaps less appropriate to existing Indian conditions. It is therefore obvious that what applies to Scotland or any other advanced

country, may not necessarily be suitable to present day India. But it is none-the-less true that labour saving mechanical devices in particular lines are often a necessary condition for increasing employment opportunities in the economic system as a whole, which is evidently the objective of every nation. A co-ordinated and systematic plan for mechanisation therefore needs to be applied in India, befitting her own condition.

Chapter I deals with the history and development of improved machinery and mechanical power in Scottish agriculture from the middle of the eighteenth century, and assesses the growth of mechanisation in terms of economic incentive during various periods, with special reference to World War II and Post-war period. It critically examines the extent of the growth of mechanisation in different regions in Scotland and explains the trend in the light of type and size of farms.

Chapter II starts with a discussion on the mobility aspect of farm labour. It analyses the nature of different forces that cause drift of labour from land and how far mechanisation plays a part in this respect. It attempts to assess the impact of mechanisation on the number of workers, nature of employment pattern, emergence of skilled labour, age groups and wage levels, including a critical analysis of the relationship between mechanisation and the reduction in labour in different regions and counties in Scotland.

Chapter III deals with capital investment, farm costs and income, and farm credit needs. It also presents an analysis of the social effects of mechanisation.

Chapter IV outlines the unemployment problem, capital resources and technological considerations in India as a background to the possibility of introducing mechanisation to Indian agriculture and its consequences.

Against this background, Chapter V presents a plan of farm mechanisation befitting to Indian conditions. It contains an assessment on scope of mechanisation in India and the progress that has already been made in this direction. It also projects future mechanisation trends and points to additional avenues of mechanisation.

Chapter VI contains Summary and Conclusion.

CHAPTER I

TRENDS IN MECHANISATION OF SCOTTISH FARMS

Introduction

The modern era of farm mechanisation in Britain appears to have begun with the invention of the steam tractor in the middle of the nineteenth century, followed by the evolution of other improved implements and machines such as reapers, binders, drill sowing machines etc., although improved horse-drawn implements such as the swing plough, double mould board plough, iron teeth harrows etc. were developed and introduced to Scottish agriculture from the middle of the eighteenth century.

The invention of internal combustion engines and tractors after the opening of this century was perhaps the second stage of development leading to the present form of highly developed and mechanised agriculture where specialised machines such as combine harvesters, forage harvesters, potato planters and harvesters, fertiliser distributorsetc. which were largely introduced during the period of World War II and post-war period, are playing a vital role.

Progress in mechanisation, however, does not appear to have been uniform throughout the entire period. Although internal-combustion tractors and other specialised machinery were introduced before the outbreak of World War II their uses were limited until they were found economic in the face of a shortage of farm labour and increasing rates of wages of labour during World War II period. Since the War, the progress of mechanisation has been spectacular

This chapter deals with a brief account of the evolution of different improved implements and machinery in Scotland from the middle of the eighteenth century. An attempt has also been made to explain the trend of progress in mechanisation throughout the entire period and an investigation has been carried out to assess the impact of Government policy related to the progress of mechanisation in different periods including the period of vigorous growth of mechanisation since the outbreak of World War II.

A critical assessment has been made of the growth of mechanisation in terms of number of tractors, combine harvesters and other specialised machinery in Scotland from 1942 to 1959.

An attempt has also been made to measure the growth in terms of number of tractors per unit of labour, horses and acreage of crops and grass.

CENTURY 1750 - 1849

To start with, Symon (66) remarks "The century 1750 - 1849 was one of striking progress in the invention and use of improved farm implements, and much of the credit belongs to Scotland".

The improved plough which was known as Small's chain or swing plough was designed and introduced by James Small in 1763. These ploughs were evidently a great improvement on the old Scots plough. Sinclair (59) described that it had a feathered share and a curved instead of a straight mould board. Wood was replaced by iron in the vital parts, the mould board, the sheath and the head. Spring balances were used to measure the draught. Small himself claimed, as Symon (66) wrote, that the plough was made according to basic mechanical principles. Small's plough became so popular that by 1790 there were well over a hundred ploughs, all of Small's design.

Later, other different types of ploughs came into use. Double mould board ploughs were introduced for setting up and splitting ridges. According to a report of Fussel (20) the drainage plough drawn by twelve horses was

designed by McEwan of Stirling. Later, with the introduction of the American plough, the Scottish swing plough was remodeled to short board plough.

Tillage tools were also improved. Iron teeth replaced the effective wooden teeth of the harrow. By the middle of the nineteenth century Scottish farms were well equipped with horse-drawn implements.

From 1850 Onwards

Introduction of steam power to agriculture was, however, the starting point from whence the modern era of farm mechanisation actually began. Watson & Moore (69) reported that a tractor with steam engine was first found working on British farms about 1850. In Scotland particularly, Macdonald (41) reported that the most spectacular efforts at steam cultivation were observed in land reclamation work in 1872. Only a few years later, steam was applied to drive the threshing mill and to do other stationary work successfully.

This was a period of continuous inventions and introduction of new machinery. A new threshing machine with a straw binder was introduced in 1883. A reaper was designed and it replaced the scythe or sickle in 1852, although attempts at designing a suitable reaper were being made from the beginning of the nineteenth century. The invention of the mower was followed by that of a binder which was introduced to British agriculture in 1879. An improved type of drill sowing machine was also designed and introduced. The great

revolutions in farm mechanisation, however, only came with harvesting machines after the American Civil War and with the internal combustion engines and tractors after the opening of this century.

Progress of Farm Mechanisation

Although inventions of different improved agricultural implements and machinery proceeded well, their uses remained limited until the outbreak of World War I. The common unit of steam tackle - a pair of heavy engines chaining a plough, etc. - proved too costly and was not sufficiently adaptable to the variety of tillage operations. Steam power also was not of much use for transportation. Later, the introduction of efficient internal combustion tractors replaced the steam tractors, but they themselves were not popularly used by Scottish farmers. On the whole the progress of mechanisation was slow in Scotland until the outbreak of the first World War, as also was the progress of the whole agricultural industry. Allan (2) while describing the farming conditions in Scotland wrote that from 1851 the prosperity of farmers started to decline. By 1878 the farmers' glory came to an end. Throughout the 80's and 90's the tide of agricultural prosperity was ebbing and it continued until 1914.

At the outbreak of the First World War when home food production required to be stimulated due to the irregularities and uncertainties in supply of imported foods, tractors with internal combustion engines were introduced in farming to accelerate wartime production. But the number declined strikingly soon after the war. Reasons for this, Symon(66) remarked: "The tractors introduced during the First World War were imperfect, and since both farmers and tractor drivers had had little or no experience in handling them, breakdowns were frequent. These reasons, coupled with the depression in agriculture, the lack of money, and the low prices of horse feed which ruled after 1921, explain the temporary setback in the use of tractors after the 1914-18 war".

Since 1930 there was a relatively rapid development of mechanical tillage, with a continuously growing population of tractors of various types. Better tractors were manufactured and became increasingly popular. Another feature of the period was the development of the combine harvester. In Scotland

the combine harvester was first introduced in the middle thirties, but made little progress before 1939. Symon (66) reported that the first combine harvesters imported were unsuitable for British conditions. In addition to that, higher initial cost at first hindered development: with improvements in the machines and altered circumstances enforced by war conditions, they became widely used.

Economic Conditions of Agricultural Industry prior to Outbreak of World War II

From the point of view of the economic conditions, the agricultural industry was in a depressed condition; adversely affected by the great depression of 1931. Farm incomes were so low that farmers sometimes found no means even to maintain and replace the existing implements. There was little inducement to introduce new techniques into the industry at this time.

Since the outbreak of World War II conditions of farming began to change. The farming industry in Scotland started to prosper and the progress of mechanisation on Scottish farms accelerated. On the basis of the arable acreage per tractor, Scotland is now perhaps one of the most highly mechanised regions in the world. Until the outbreak of the World War II, much of the farm equipment was imported from North America and the Continent of Europe but now all Britain's farm machinery is being manufactured in Britain and, furthermore, exports of farm machinery have gone up steadily. The progress of farm mechanisation during the war II and post-war periods will be discussed in the last section of this chapter.

Necessity of Mechanisation

(War II and Post-War Period:)

Economic Inducement

War Period:

At the outbreak of war in 1939, the immediate objects of agriculture were to reduce Britain's dependence on food imports by expanding home production and to economise on shipping space. This, along with the scarcity of labour followed by high wage rate, necessitated the rapid development of mechanisation on Scottish farms. Mechanisation played a notable role in the process of agricultural expansion. Agricultural industry was guaranteed by Governmental price supports and subsidies. The farming industry prospered. Farmers found it profitable to invest the necessary capital in machinery, in the face of higher wage rates for labour. In brief, the war-time emergency for food, Government policy, prosperity of farmers along with the shortage of labour were the conditions which favoured the vigorous growth of mechanisation.

Post-War Period

When the World War was over there was a considerable change in the international

situation and that made it necessary to maintain agricultural production at the wartime level. In the two World Wars, foreign investments were lost to a great extent. The whole national economy was embarrassed by a series of crises. The terms of trade deteriorated seriously (70). A major reason for this latter development was the high level of effective demand for foodstuffs in producing countries like India and other Asiatic countries due to industrialisation and increasing growth of population. Other countries like Argentina and Australia who were formerly almost entirely primary producers, exporting food in exchange for industrial products, were becoming gradually industrialised. The increasing industrial capacity of countries like West Germany and Japan intensified the competition for foreign markets. It therefore became certain that the policy of importing cheap food in exchange for exporting industrial products had to be revised. It is important to note here that Britain developed a profitable finished industrial export in exchange for importing cheap food from the middle of the nineteenth century. From the economic point of view it paid better to Britain since the

country had the special facilities and aptitude for manufacturing industries. This policy of "Free Trade" was followed up to 1931 when the great economic depression forced Britain to abandon the policy. Prices of certain agricultural commodities at that time dropped to levels so low that the whole agricultural industry seemed doomed. The Government measures through payment and subsidies recovered the situation partially and protected British farmers from foreign imports. But still British farmers had to face keen competition from the Empire. The policy of importing cheap food in exchange for exporting industrial goods to Colonies, protected territories and Common Wealth countries was still followed. This continued until the outbreak of World War II.

Post-war agricultural policy, based on newly developed situation, faced greater self-sufficiency in home grown food production. The Agriculture Act of 1947 offered farmers the security of tenure and opportunity of a reasonable income. This served to the farmers as an incentive to expand the agricultural industry which, in turn, accelerated the growth of

mechanisation on Scottish farms during the post-war period. The scarcity of labour and high wage levels for agricultural workers were also at the same time predominant factors which made the process of mechanisation so rapid.

Development of Farm Mechanisation (War II and Post-War Period)

Introduction

It has already been mentioned that mechanisation in Scottish farming has been proceeding very rapidly since the outbreak of the World War in 1939. In 1939, according to the basis of calculation 5 horses = 1 tractor as assumed by Witney (71) only 24 per cent. of the total requirement of motive power was furnished by tractors. In 1959 it rose to 96 per cent. The change from horse to tractor power has been a remarkable feature in the history of farm mechanisation in Scotland. Furthermore, there has been a significant development and change in the designs and models of tractors and other machinery in recent years. Diesel tractors have replaced the old parafin and petrol tractors. There has been a shift from binder and thresher to swathers and combines for harvesting purposes. The change in tillage implements has also been marked. Other important and pronounced trends have occured in the farm dairy enterprises. In addition, the use of electric power is an important change. McEwan (44) narrated: "Around the steading the use of the internal combustion engine has declined while that of the electric motor has

increased markedly and larger numbers of electric refrigerating and sterilising installations also illustrate the trend towards a greater use of electricity".

The study of the trend of these changes will probably reflect the degree of progress of farm mechanisation and with which this section deals.

Number of Tractors and Other Machines

The Censuses of Agricultural Machinery, which have been taken by the Department of Agriculture since 1942, present some useful information, illustrating a significant change from horses to tractors as the source of draught power and an increase in the number of other specialised machinery over the period 1942 to 1959.

Tractors:

The number of wheeled tractors, for example, rose from 14,910 in 1942 to 54,852 in 1959 (Table 1), with a comparatively heavier rise in track layers from 420 to 2,337 during the same period. It is to be noted, however, that the rate of increase of tractor force was not the same throughout the entire period.

TABLE 1

NUMBER OF CERTAIN IMPORTANT MACHINES AND EXTENT OF MECHANISATION - SCOTLAND

	1942	1944	1946	1948	1950	1952	1954	1956	1959
Tractors: Wheeled	14,910	19,780	22,539	28,578	35,319	40,243	43,600	48,618	54,852
Tracklayers	420	730	1,037	1,319	1,626	1,896	2,579	2,787	2,337
Electric Motors	3,800	4,500	6,346	8,036	10,843	13,841	17,134	21,545	28,607
Petrol and Oil Engines	23,520	23,800	23,851	26,013	28,065	29,124	26,352	24,766	24,042
Combined Harvester - Threshers	60	100	211	256	422	785	1,245	1,876	3,365
Binders	6,090 (Tractor) 23,540 (Horse)	8,990 (Tractor) 20,380 (Horse)	-	-	13,429 (Horse) 16,785 (Tractor)	10,879 (Horse) 18,789 (Tractor)	8,126 (Horse) 20,586 (Tractor)	6,378 (Horse) 22,229 (Tractor)	- 26,993
Hay and Straw Balers	590	520	184	159	262	577	1,031	2,015	4,737
Pick-up	(b)	(b)	(c)						
Grain Driers	(a)	(a)	50	55	60	135	188	370	1,026
Loaders, Tractor - Mounted	(a)	(a)	(a)	(a)	354	1,334	3,018	5,671	7,819
Milking Machines	5,650	7,230	7,927	10,078	9,582	10,203	10,879	11,919	12,295
Farmyard Manure Spreaders	(a)	(a)	(a)	(a)	(a)	(a)	4,184	6,077	8,688
Sprayers, Ground Crop, Wheeled and Tractor Mounted	410	570	586	642	597	973	1,927	3,664	5,492
Horses used for Agricultural Purposes	121,097	110,367	101,581	86,201	66,340	49,135	34,143	19,106	10,281
Tractors per 100 Regular Workers	15.4	20.3	26.2	33.4	42	49.8	54.3	64	76
Tractors per 100 Horses	12.7	18.6	23.2	34.7	55.7	85.8	135	269	556
Tractors per 1,000 acres crops and grass	3.5	4.6	5.3	6.8	8.4	9.6	10.5	11.7	13.1

(a) Not Return

(b) All Types

(c) Pick-up Only

Source: Machinery Censuses
Agricultural Returns

TABLE 2

INCREASE IN AGRICULTURAL TRACTORS

Period	Tractors Added Numbers	
	Between Censuses	Yearly Average
1944 - 46	3,060	1,530
1946 - 48	6,320	3,160
1948 - 50	7,050	3,525
1950 - 52	5,190	2,595
1952 - 54	4,040	2,020
1954 - 56	5,230	2,615
1956 - 59	5,780	1,925

Source: Scottish Agricultural Economics, Vol. X. 1960

From the Table 2 it appears that although the rate of increase was remarkably high up to 1950, thereafter it fell gradually. The development of specialised machinery, such as combine harvesters, pick-up balers and grain driers, rather than the growth of tractor force, appears to be a dominant feature from 1950 and

onwards. As regards the type of tractors, there has been a major shift from vaporizing oil engined tractors to diesel engined tractors in recent years. The proportion of diesel engined tractors increased from 19.3 per cent. in 1954 to 57.0 per cent. in 1959 (Table 3).

TABLE 3

TRACTORS, 10 H.P. AND OVER, BY TYPE OF FUEL USED

Fuel Type	Number			Percentage		
	1954	1956	1959	1954	1956	1959
Diesel	8,433	17,441	31,100	19.3	35.9	57.0
Paraffin	32,144	28,666	21,444	73.5	59.1	39.3
Petrol	3,157	2,411	1,983	7.2	5.0	3.7
Total	43,734	48,518	54,527	100.0	100.0	100.0

Source: Scottish Agricultural Economics.
Vol. X, 1960

In terms of actual number, the number of diesel engined tractors rose from 8,433 in 1954 to 31,100 in 1959. This trend is likely to be continuous as reflected by the increasing rate of purchase of diesel engined tractors in recent years. The new tractors bought in 1958 happened to be all diesel engined (Table 4).

TABLE 4

FUEL TYPE OF TRACTORS PURCHASED IN RECENT YEARS. PER CENT.

Engine Type	1948	1950	1952	1954	1956	1958
Diesel	6	14	74	88	96	100
Paraffin	84	80	26	12	4	-
Petrol	10	6	Nil	Nil	-	-
Total	100	100	100	100	100	100

Source: Scottish Agricultural Economics. Vol. III, V, VII, X.

Old paraffin and petrol engines have been gradually disappearing. The popularity of diesel engine over other types is perhaps due to cheap fuel cost.

Other Specialised Machines

There has been a considerable increase in the number of specialised machines such as sprayers, manure spreaders, loaders, pick-up balers, etc. (Table 1) from 1950. The need for these machines was felt some time back in order to mechanise other agricultural processes. This also gave an opportunity to utilise the tractors more efficiently. It has already been mentioned that the rate of growth of the tractor force ceased to be so vigorous after 1950 owing to the fact that the requirement for tractors was largely fulfilled by that time. In 1955, Hendry (27) wrote "The most significant feature of these figures lies not so much in the further stages of the change-over from horse to tractor machinery as in the developing use of more specialised machines". He further pointed out: "The application of power to particular tasks which otherwise make heavy demands on manual labour is shown in the rapid increase of the number of pick-up balers and loaders".

Combine-Harvesters and Binders

In the progress of farm mechanisation in Scotland, combine harvesters played an important part. They reduced the labour requirement and simplified many laborious and repetitive processes into a single operation. The number of combine harvesters rose from only 60 in 1942 to 3,365 in 1959, with an unproportionate fall in the number of binders from 29,630 to 26,993. The actual decrease in the number of binders (e.g. from 23,540 to 6,378*) happened to be only in case of horse-drawn binders where as the number of tractor-drawn binders (e.g. from 6,090 to 22,229*) went up considerably. It is worthwhile to mention here that there has been a considerable switch over from horse-drawn implements to tractor drawn implements as revealed by Machinery Census Statistics.

---

* These figures are for the year 1956. No information available on the number of horse-drawn binders and tractor-drawn binders separately for the year 1959.

Electricity

The discussion on the growth of mechanisation will remain incomplete if no reference is made to the impact of electricity on the farms. Extension of electricity to the farms generally facilitates the application of machinery to farms more extensively. In Scotland, as it was reported by the Department of Agriculture, the number of electric motors rose from 3,800 in 1942 to 28,607 in 1959.

The use of electricity in the operation of milking machines has been presumably increased substantially, although no recent statistical information is available at the moment. Today, electricity is utilised for the working of such machines as feed grinders, ensilage cutters and seed cleaning machinery and also furnish lights and power in the farm households and in farm buildings. It is now reported that nearly half of the total farm houses and crofts in Scotland have had electricity installed. It is expected that the extension of electricity would cover all farms and crofts in the near future.

Degree of Mechanisation

In the last section, it has been pointed out that the number of tractors and machinery increased tremendously since 1942. While those figures broadly reflect the vigorous growth of mechanisation in Scotland, they do not really indicate the degree of mechanisation. The discussion on the growth of mechanisation will perhaps be more meaningful if that growth can be measured to show the extent or the degree of mechanisation. But such measurement is unlikely to be very simple and accurate since there is practically no single indicator to measure it. The number of tractors is, however, taken as a useful indicator (which may not necessarily be very accurate) of machine power against the land, labour and horse numbers. On this basis, it has been estimated that the number of tractors per 1,000 acres crops and grass rose from 3.5 in 1942 to 13.1 in 1959 (Table 1). Similarly, the increase in the number of tractors per 100 horses from 12.7 in 1942 to 556 in 1959 appears to indicate the high rate of progress, although some reservation should be kept here due to the fact that the

total number of horses itself dropped strikingly from 121,097 in 1942 to 10,281 in 1959. This latter development appears to have a considerable effect in reflecting the number of tractors per 100 horses so high in recent years.

Like the two previous cases, the number of tractors per 100 workers increased from 15.4 in 1942 to 76 in 1959. It is again a positive indication of rapid progress in mechanisation. Unlike the number of horses, the total number of workers did not fall so drastically. This probably suggests that the tractors have been introduced and used on existing labour force and without displacing them proportionately.

On the basis of these three factors, it appears that Scottish farms are highly mechanised today.

Degree of Mechanisation - on Regional* Basis

Data on the number of farms reporting machines of various types illustrate the detailed account of increase in the number of tractors, combines, milking machines and electric motors on regional basis.

For the measurement of degree of mechanisation if the above procedure is followed, i.e. if the number of tractors is related to the number of horses and of regular workers and to the acreage of crops and grass, the mechanisation appears to have reached the highest degree of progress in the Eastern parts of Scotland in general and in the North East and East Central regions in particular (Table 5).

---

* The Counties under each Region

Region	Counties
Highland:	Argyll, Inverness, Ross and Cromarty, Sutherland, Zetland.
North East:	Aberdeen, Banff, Caithness, Moray, Nairn, Orkney, Kincardine
East Central:	Angus, Clackmannan, Fife, Kinross, Perth.
South East:	Berwick, East Lothian, Midlothian, Roxburgh, Selkirk, West Lothian.
South West:	Ayr, Bute, Dumfries, Dumbarton, Kirkcudbright, Lanark, Renfrew, Stirling, Wigtown.

Graph No. I

EXTENT OF MECHANISATION IN SCOTLAND, BY REGIONS.

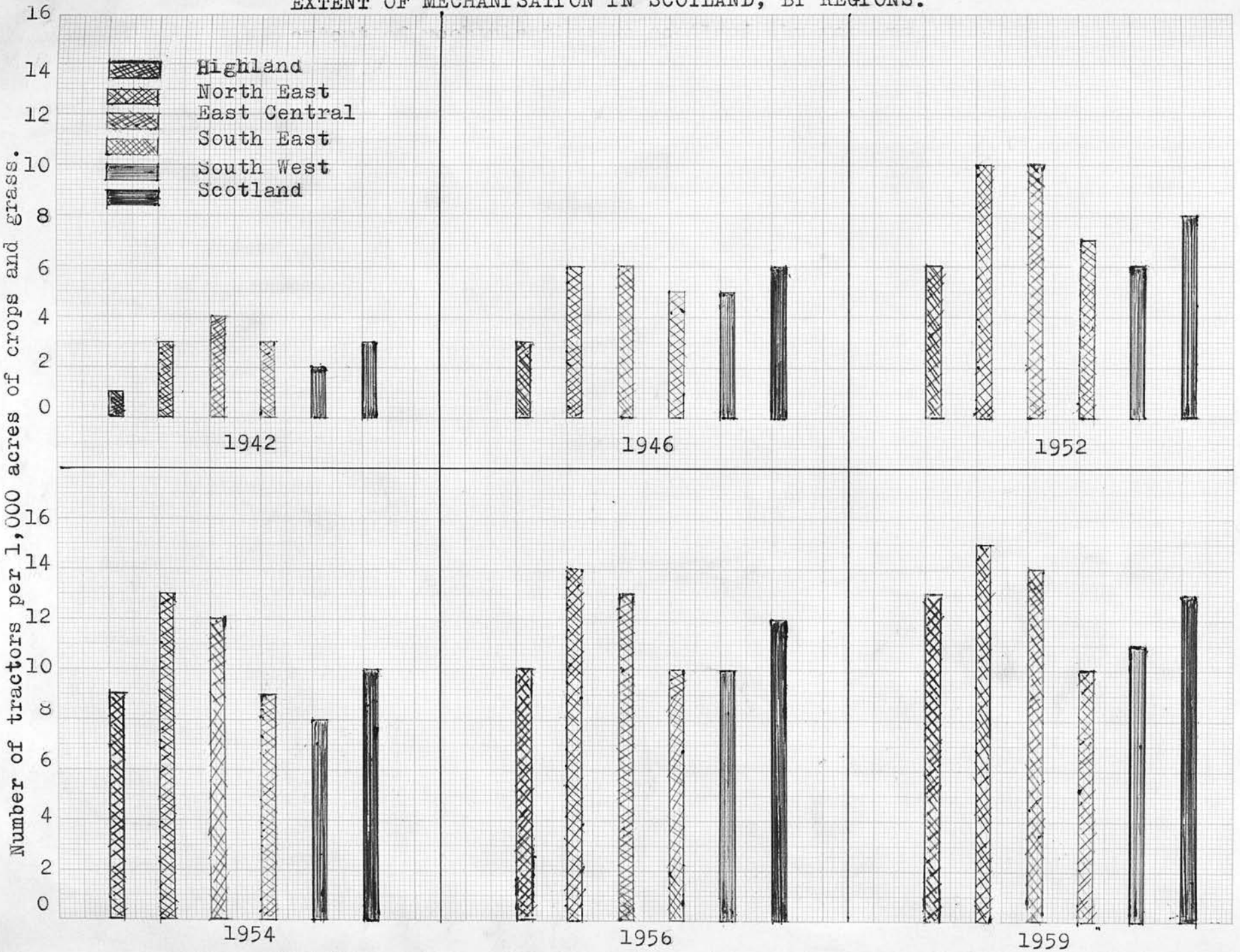


TABLE 5

EXTENT OF MECHANISATION IN SCOTLAND, BY REGIONS

	Tractors per 100 Regular Workers						Tractors per 100 Horses					
	1942	1946	1952	1954	1956	1959	1942	1946	1952	1954	1956	1959
ghlands	4	10	31	46	56	82	4	10	37	69	116	227
rth East	15	32	64	76	88	104	12	27	120	210	400	763
st Central	18	29	46	55	64	71	17	34	112	206	405	706
uth East	16	27	38	45	54	59	22	46	121	214	387	635
uth West	11	25	34	41	51	63	11	27	59	102	181	321
otland	13	31	43.8	53	63	75	13	33	85	148	266	471

(Calculation based on the number of tractors owned only by occupier of agricultural holdings).

Tractors per 1000 Acres of Crops & Grass						Combine Harvesters per 1000 Acres of Crops & Grass			
1942	1946	1952	1954	1956	1959	1942	1946	1952	1959
1	3	6	9	10	13	0.014	0.042	0.04	0.33
3	6	10	13	14	15	0.016	0.018	0.093	0.45
4	6	10	12	13	14	0.01	0.036	0.28	1.26
3	5	7	9	10	10	0.011	0.16	0.51	1.52
2	5	6	8	10	11	0.006	0.006	0.02	0.72
3	6	8	10	12	13	0.011	0.026	0.16	0.83

In terms of number of tractors per 1,000 acres of crops and grass, the North East and East Central regions have 15 tractors and 14 tractors each, respectively, and thus lead over other regions. Similarly, in terms of number of tractors per 100 horses, the Eastern part of Scotland leads over other parts. The North East region particularly exceeds the others in this respect with 763 tractors for every 100 horses, followed by East Central with 706 and South East with 635. The counties like Kincardine and Nairn in the North East region and Berwick in the South East region stand highest in the ratio of tractors to horses. Machinery Statistics for 1959 show that Kincardine has 1,481 tractors for every 100 horses followed by Nairn with 1,276 and Berwick with 1,092.

At the other end of the scale comes the Highland region with only 227 tractors for every 100 horses. It possibly tends to reflect that in the Highland region mechanisation has not yet proceeded far enough to replace horses appreciably. The reason for this

McEwan (44) stated: "In the Highlands there are still more horses per tractor than any other region, due to the nature of the terrain, the isolation and the size of farms in this region, the rate of disappearance of horses is much slower, giving a smaller increase in the number of tractors per 100 horses". But from the Table 5 it appears, however, that the Highlands has made up that handicap in recent years. A vigorous growth of mechanisation has taken place in the Highlands as reflected by a considerable increase in the number of tractors (i.e. 82) per 100 regular workers and 13 tractors per 1000 acres of crops and grass.

On the basis of regular workers, the number of tractors, however, appears to be the highest in the Eastern part of Scotland. The North East region of the Eastern part is leading in this respect with 104 tractors for every 100 regular workers. The existence of a large number of tractors in the North East region is perhaps mainly due to a large proportion of small and part-time (Table 6) farms, each one requires to maintain at least one tractor whether or not it can be efficiently utilised.

TABLE 6

THE NUMBER AND SIZE OF FARMS AND ANALYSIS OF NUMBER OF TRACTORS BY SIZE OF FARMS REGIONAL BASIS (Scotland)

	Small Farms		Medium and Large Farms		Part-time Farms		All Farms		Acreage of Crops and Grass per Farm	(1959) No. of Tractors per Farm	(1959) Acreage of crops & grass per Tractor per Farm
	'000	p.c.	'000	p.c.	'000	p.c.	'000	p.c.			
Highlands	2.0	11	1.7	9	15.2	80	18.9	100	2.2	0.29	8.0
North East	5.8	35	5.5	33	5.4	32	16.7	100	72.1	1.1	65.5
East Central	1.4	22	3.6	56	1.4	22	6.4	100	127.3	1.7	74.7
South East	0.7	18	2.3	59	0.9	23	3.9	100	173.8	1.7	102.2
South West	2.9	24	6.3	52	2.9	24	12.1	100	104.1	1.1	94.6
Scotland	12.8	22	19.4	33	25.8	45	58.0	100	75.4	0.97	77.7

It is to be noted that these farms are predominantly operated by family workers and they are less likely to be replaced by mechanisation abruptly. The number of tractors per 100 workers would perhaps go much higher if the substitution of labour by machinery takes place proportionately. This also applies to the East Central region where fall in number of labour (Table 16) appears to be rather low in spite of tremendous advancement of mechanisation. The number of tractors, for example, increased from 5,033 in 1946 by 127 per cent. to 11,435 in 1959 (Table 7) against only 12.7 per cent. displacement of labour (Table 16).

Presumably, change in land use pattern in some of the counties of East Central region has made it hardly possible to reduce workers proportionately, although East Central region is predominantly an arable farming area where the area under crops and fallow covers nearly half* of the total acreage under crops and grass.

---

* Area under crops and fallow amounts to 392,712 out of the total acreage of 815,076 under crops and grass.

TABLE 7

NUMBER* OF TRACTORS AND COMBINE-HARVESTERS
BY REGIONS - SCOTLAND

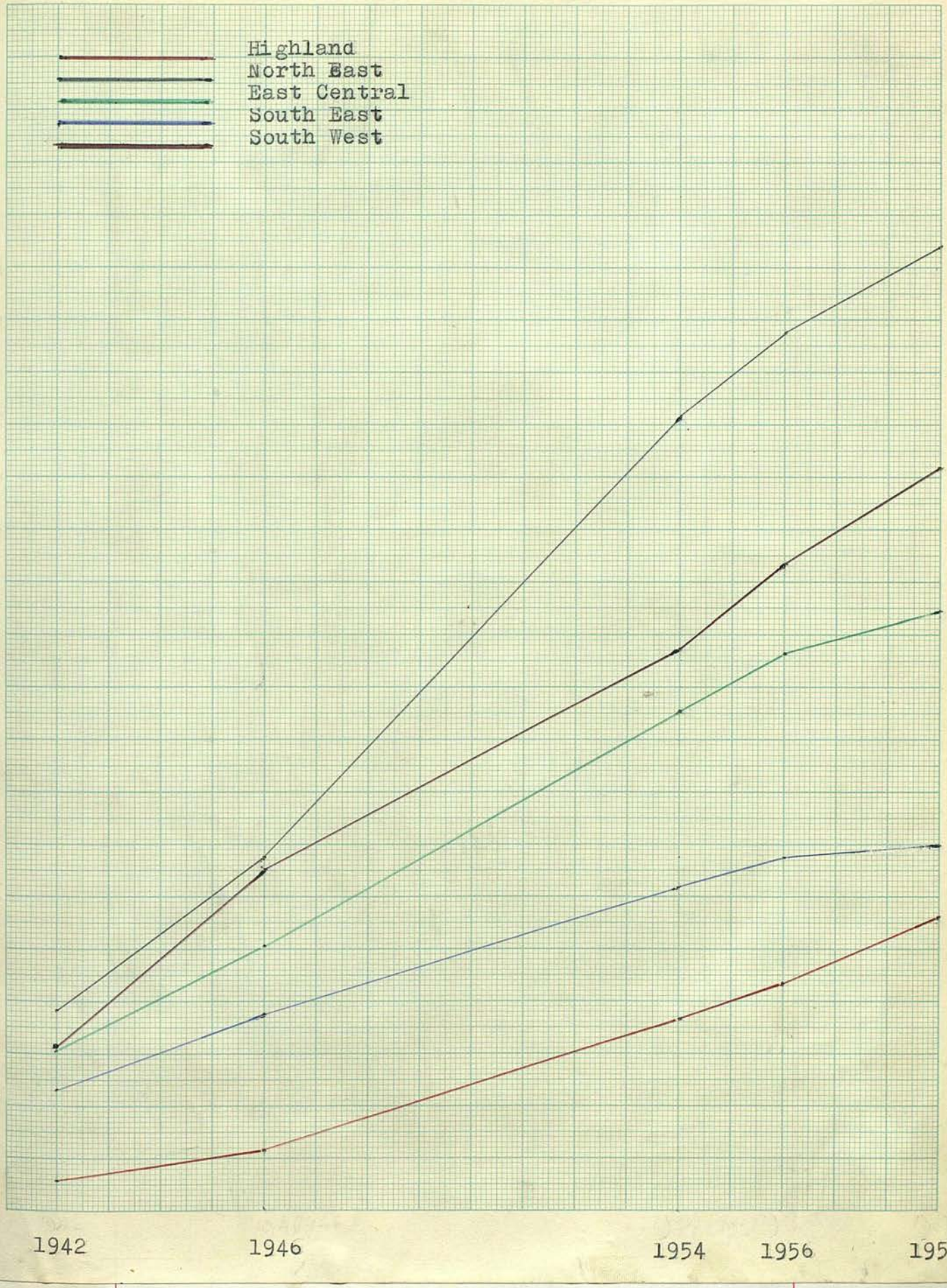
	Tractors					Combine-Harvesters				
	1942	1946	1954	1956	1959	1942	1946	1954	1956	1959
Highland	580	1184	3664	4351	5604	6	18	16	43	130
North East	3834	6763	15162	16734	18407	20	22	163	237	543
East Central	3043	5033	9533	10625	11435	9	30	387	596	1033
South East	2309	3768	6191	6781	6995	8	113	533	753	1032
South West	3152	6504	10731	12324	14188	9	8	85	201	913
Scotland	12918	23252	45281	50815	56629	52	191	1184	1830	3651

* Owned by the Occupier of Agricultural Holdings only.

Source: Machinery Censuses.

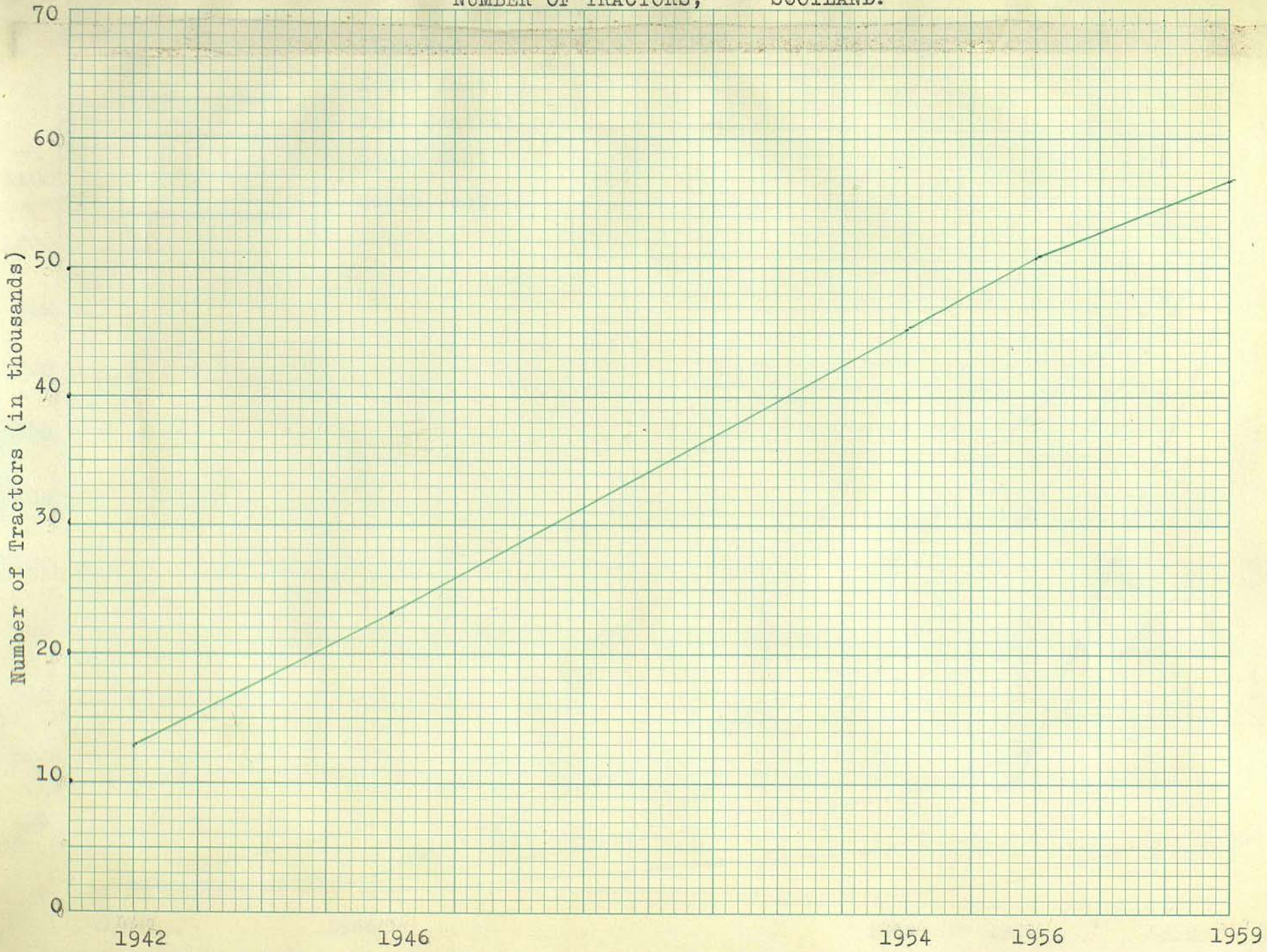
Graph No. II

NUMBER OF TRACTORS BY REGIONS, (SCOTLAND), 1942 - 1959



Graph No. III.

NUMBER OF TRACTORS, SCOTLAND.



The degree of mechanisation measured in terms of number of tractors per 100 workers and per 1,000 acres of crops and grass appears to be strikingly low in the South East region thus, contrasting to the real situation. The South East region is, in fact, a highly mechanised arable farming area where the number of workers has fallen by 27 per cent*, with significant increase in number of other specialised machinery, and this is not truly reflected by statistical figures as calculated and presented in the Table. A number of other factors, such as size of farms and use of other specialised machinery, needs to be considered in assessing the extent of mechanisation in different regions.

---

* Table 16.

On the whole, mechanisation has, however, progressed markedly in the eastern part of Scotland, significance of which suggests that mechanisation is more effective in arable farming than in livestock farming.

Sizes of Farms

It is evident from Table 6 that in the East Central region and South Eastern region, medium and large farms preponderate over small and part-time farms but the reverse is the case in the North Eastern and Highland regions. The pattern of progress of mechanisation in different regions appears to have significant co-relation with the sizes of farms in respective regions.

In the East Central and South East regions, there are less tractors per unit acre of land (e.g. only 1 tractor for every 74.7 and 102.2 acres of crops and grass respectively) although these areas have greater proportion of medium and large farms, the significance of which suggests that requirement of tractors per unit area is low owing to the better utilisation of tractors offered by the large size of farms. It therefore appears to be evident that less number of tractors for every 1,000 acres of crops and

grass, or for every 100 workers in these regions is not likely to be a very accurate indication of a low degree of mechanisation. Mechanisation has, in fact, reached a high degree of efficiency in these regions.

The East Central region, however, draws special attention. Here the medium and large farms constitute as high as 56 per cent. of total farms but the area that a tractor covers is comparatively low (only 74.7 acres of crops and grass). It is difficult to explain this trend and a number of factors such as land use pattern etc. is likely to be involved in it.

It has already been mentioned that in the North East and Highland regions, comparatively large number of tractors for every 1,000 crops and grass or for every 100 workers, does not really tend to indicate that mechanisation has reached a high degree of efficiency there. On the contrary, the feature of less area under crops and grass for every tractor in these regions, as evident from the Table, suggests that the tractors are not efficiently utilised due to the small size of farms and thus due to less scope.

Specialised Machinery

It has been shown that the number of tractors per unit of area and labour is not always a very accurate indicator to gauge the extent of mechanisation since other factors such as size of farms, types of farming, have a significant effect on the necessity of maintaining certain number of tractors which may or may not be utilised efficiently throughout the year. In addition to that, the introduction of specialised machinery, such as self-propelled combine harvesters, reduces and simplifies the works which are usually performed by tractors and thereby minimizes the requirement of tractors. But this development does not in any case imply less advancement of mechanisation. On the contrary, it is a clear indication of advanced stage of mechanisation when the requirement of tractor is reduced. Following the same basis (i.e. number of combined harvesters) it will be worthwhile to analyse the extent of mechanisation in different regions.

Measurement of Extent of Mechanisation by Other Indicator

On regional basis, the South East region draws special attention because of its two contrasting features. Per 1,000 acres of crops and grass and per 100 regular workers, it has a high ratio of combined harvesters but a low retio of tractors (Table 5). It is likely, at least on the assumption mentioned earlier, that this signifies the highest level of mechanisation. In the North East region the conditions are the reverse. Here the high ratio of tractors, coupled with the low ratio of combined harvesters, might well mean that mechanisation is not yet in the advanced stage, although it has been progressing rapidly.

The conditions are entirely different in the South West region. The low ratio of combined harvesters, coupled with the low ratio of tractors to the acreage of crops and grass, and to the workers, probably indicate the low degree of mechanisation in this region. The type of farming is important here in explaining why the progress is slow. The South West region is a predominantly dairy farming area

where, as a matter of general experience, specialised machinery or engines, such as combined harvesters, are of no use in growing the grass or of little use for raising the fodder crops, although uses of tractors for the preparation of soil are prevalent. The Highland region, on the other hand, is characterised by the small sizes of holdings, crofts,and there is really less scope to introduce specialised machinery there.

Increase in Number of Tractors and Machinery - Regional Basis

Along with the measurement of degree of mechanisation, a study on the growth of mechanisation is perhaps worthwhile to trace out the trend of growth of mechanisation in different regions in recent years and its relationship with the degree.

Some interesting and striking points emerge when the increase in number of tractors and combined harvesters in different regions is interpreted in terms of percentage of increase on the basis of 1942 as the base period. The most striking feature as revealed in Table 8, is that the highest increase (i.e. 866 per cent) in the growth of tractor force has occured in the Highland region between the years 1942 and 1959 whereas, the same increase

is only 380 per cent. in the North East region, 275 per cent. in the East Central region, 202 per cent. in the South East region and 350 per cent. in the South West region, during the same period. It might tend to suggest at first glance that the Highland region is the most highly mechanised area, but a critical analysis relating to the extent of mechanisation in different areas, as discussed earlier,* does not appear to confirm this assumption. What is really reflected by the figures is that mechanisation has been proceeding in the Highland region at a very rapid rate but they do not indicate that the Highland region has already attained a very advanced stage of mechanisation.

---

* Page 38, 45 and 48.

TABLE 8

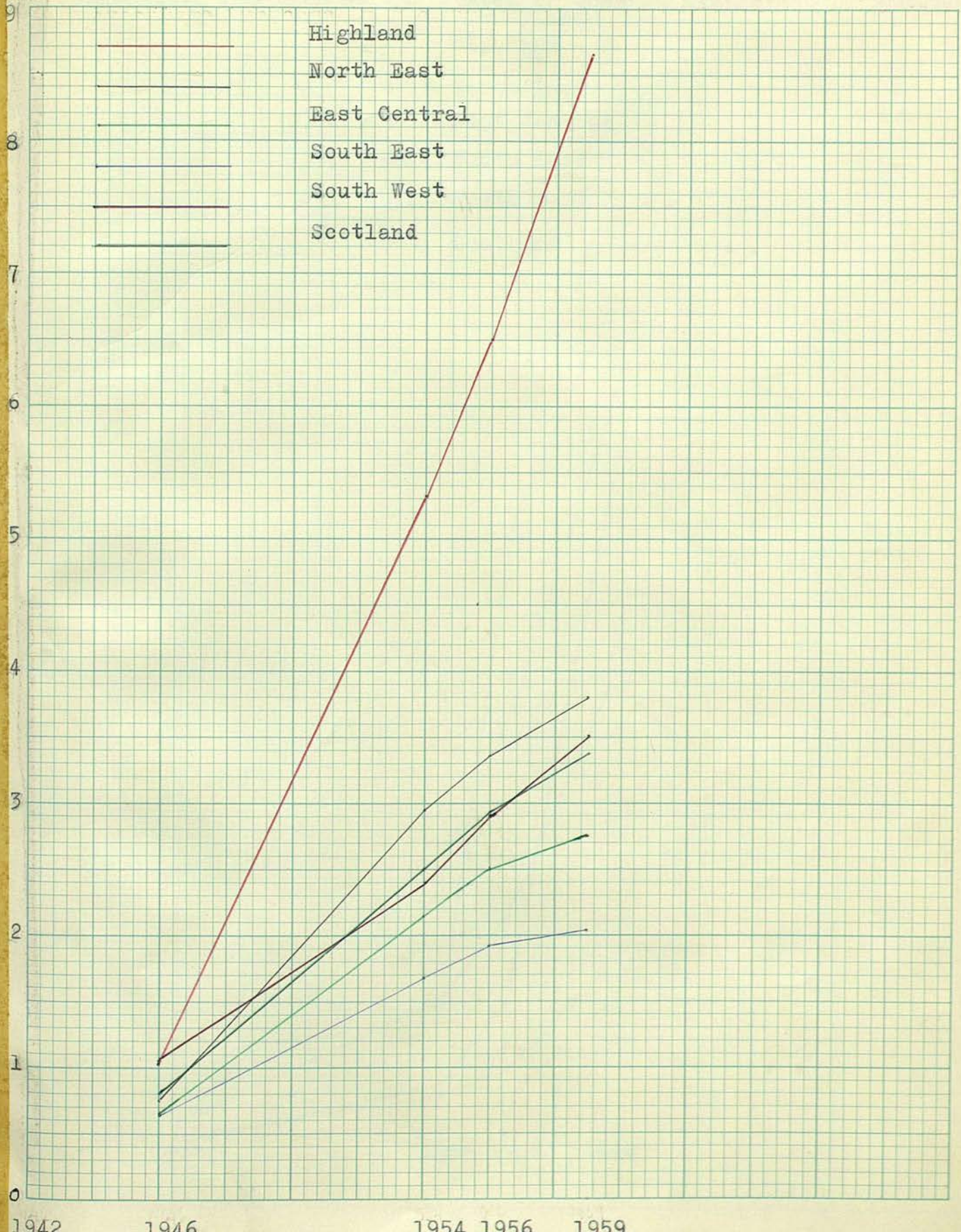
PERCENTAGE INCREASE IN THE NUMBER OF TRACTORS AND COMBINE HARVESTERS BY REGIONS - SCOTLAND

(Base Period 1942)

Base Period 1942 (1942 = 0)	Scotland		Highland		North East		East Central		South East		South West	
	Tractors	Combine Harvesters	Tractors	Combine Harvesters	Tractors	Combine Harvesters	Tractors	Combine Harvesters	Tractors	Combine Harvesters	Tractors	Combine Harvesters
1946	80	267	104	200	76	10	65	233	63	1312	106	-12
1954	250	2176	531	166	295	715	213	4200	168	1816	240	844
1956	293	3419	650	617	336	1085	250	6522	193	9313	290	2156
1959	338	6922	866	2067	380	2615	275	11378	202	12801	350	10045

Graph No. VI.

PERCENTAGE INCREASE IN THE NUMBER OF TRACTORS BY REGIONS, SCOTLAND.



It is evident from Machinery Census Statistics (Table 7) that the tractors were introduced and mechanisation progressed fairly well in other regions even before 1942 when there were only a few tractors in the Highland region. In the North East region, for example, there were already 3,834 tractors in 1942 and the number went up to 18,407 in 1959, although in terms of percentage it is a rise of only 380 per cent. Similarly, there were 3,043 tractors in the East Central region in 1942 and the number rose to 11,435 in 1959; 2,309 tractors in the South East region in 1942 and the number rose to 6,995 in 1959; 3,152 tractors in the South West region and the number went up to 14,188 in 1959. In comparison with these, the Highland region had only 580 tractors in 1942 and the number rose rapidly to 5,604 in 1959. The Highland region appears to be still backward in mechanised farming.

The increase in the number of combined harvesters and the same increase expressed in terms of percentage, appears to be remarkable in the South East and East Central regions. The number of combined harvesters (Table 7) climbed

up from 8 in 1942 to 1,032 in 1959 and from 9 in 1942 to 1,033 in 1959 in the South East and East Central regions respectively. In terms of percentage (Table 8) it is a tremendous rise of 11,378 in the case of the East Central region and 12,801 in the case of the South East region. These particular features perhaps signify a spectacular advancement of mechanisation in the East Central and South East regions of Scotland. At the other extreme end of the scale stands the Highland region. In 1942 there were only 6 combined harvesters and the number went up very slowly to 130 in 1959. It presents a rise of 2,076 per cent. which happens to be the lowest in comparison with that of other regions. The numbers relating to the North East and South West regions do not appear to be dissimilar although the South West region happens to have more combined harvesters in 1959 than the North East region whereas the situation was just the reverse in 1942.

Milking Machines

The South West region has already been mentioned as a predominantly dairy farming area and is reflected by the largest number of milking machines (Table 9) now in operation in that region. There is also a substantial increase in the number of milking machines in the North East region. The number of milking machines, for example, rose from 502 in 1942 by 468 per cent. (Table 9) to 2,853 in 1959. The development in the North East region tends to reflect a growing emphasis on dairy farming. There appears to be an emphasis on dairy farming at varying degree in all regions as indicated by the increase in the number of milking machines.

TABLE 9

THE NUMBER OF MILKING MACHINES AND INDICES* OF INCREASE

	1942		1946		1954		1956		1959	
	Number	Base Year	Number	p.c.of Increase	Number	p.c. of Increase	Number	p.c. of Increase	Number	p.c. of Increase
Highland	244	100	514	210	598	245	681	279	795	326
North East	502	100	775	154	1998	398	2571	512	2853	568
East Central	478	100	804	168	1494	312	1795	375	1623	340
South East	330	100	533	161	938	284	987	299	977	297
South West	4094	100	5201	127	5850	142	5885	143	6111	149
Scotland	5648	100	7821	138	10878	192	11919	211	12359	218

* 1942 = 100

Source: Machinery Census.

Summary

Although the modern era of farm mechanisation started with the introduction of steam power to farming in the middle of the nineteenth century, it accelerated only since the outbreak of World War II. The number of tractors increased from 15,330 in 1942 by 273 per cent. to 57,189 in 1959. Horses have almost been replaced by tractors. In 1939 only 24 per cent. of the total requirement of motive power was furnished by tractors. In 1959 it rose to 96 per cent. The number of combine harvesters rose from 60 in 1942 by 4,608 per cent. to 3365 in 1959. The number of other specialised machinery, such as pick-up balers, sprayers, loaders etc. also increased considerably.

Today, Scotland has one of the most highly mechanised mixed agricultures in the world. In terms of number of tractors per unit area of land and per unit of worker, she possesses 13 tractors for 1,000 acres of crops and grass and 76 tractors for 100 regular workers.

It is, however, striking that the progress of mechanisation was slow until the outbreak of World War II, although the tractors existed

even before World War I and combine harvesters were introduced in the middle of the thirties. This was mainly due to the fact that their use proved to be uneconomic, especially when labour was adequate and cheap and farm incomes were low.

During the period of World War II, the shortage of labour in agriculture, as compared with the requirement for maintaining necessary home grown agricultural production was felt for the first time and farmers found it economic and within their means since farm incomes also increased reasonably, to mechanise their farms in the face of increasing rate of farm wages.

In the advancement of mechanisation in different regions in Scotland, the Eastern regions lead over the others. In the North East, for example, the number of tractors for every 1,000 acres crops and grass rose from 3 in 1942 to 15 in 1959. Similarly, the number of tractors and other specialised machinery increased considerably in the East Central and South East regions. The South East region is, however, the most highly mechanised area. The existence of high proportion of large and medium farms has offered an opportunity to utilise

tractors and other machinery more productively, leading to a substantial increase in efficiency of mechanisation in this region.

At the other end of the scale come the South West and Highland regions where progress of mechanisation has been comparatively slow, due to less scope for mechanisation in these regions.

On the whole, in the progress of mechanisation, the lead of the Eastern part of Scotland, where crop farming is predominant over other parts, suggests that mechanisation has been more effective in crop farming than any other type of farming.

CHAPTER II

MECHANISATION AND FARM LABOUR

Since the outbreak of World War II, Scotland has moved forward at a very rapid rate of expansion in the agricultural industry. Farm mechanisation, for example, proceeded remarkably as already discussed in the last chapter. Gross farm output increased by about 31 per cent. between the years 1939 and 1959. Similarly, employment in Scotland as a whole rose from 14.5 million in 1939 to 21.45 million in 1959, as shown in Table 10.

TABLE 10

NUMBER OF EMPLOYEES - SCOTLAND

Employment	Million 1939	Million 1959	Rise or Fall in Terms of Percentage (Between the Year 1939 and 1959)
Non-Agriculture	14.395	21.366	+ 48
Agriculture	0.104	0.084	- 19
Total	14.5	21.45	+47.9

Source: Labour Gazette

These figures, of course, cover up the manpower trend in agriculture. But a further analysis of the figures on employment reveals contrastingly that while the number of non-agricultural employees climbed up from 14.396 million in 1939 to 21.366 million in 1959, the number of agricultural employees fell from 0.104 million in 1939 to 0.084 million in 1959. In other words, while the non-agricultural employment rose by 48 per cent. from 1939 to 1959, the number of agricultural employees fell by 19 per cent. during the same period. This latter development appears to be striking and the different forces, such as farm mechanisation, appear to be involved in it. It is, however, important to note here that the downward trend in the number of labour must have continued in this country for over 600 years, from a time when agricultural practices were perhaps far less advanced and thus remained labour consuming. Although there are no adequate statistical figures to illustrate this trend there were occurences such as enclosure systems in the middle of the eighteenth century which pushed agricultural workers out of agriculture.

Simultaneously, there was an increasing demand for labour in manufacturing industries to cope with the developmental pace, and this exerted an effective force to pull labour from the land. Symon (66) stated that the movement out of agriculture, and rural depopulation, perhaps started much earlier than the eighteenth century but received a new impetus and proceeded at an accelerated pace through the 'great enclosures' from the middle of the eighteenth century. There is, however, no reliable statistical proof of it, as has already been mentioned, but this declining trend can be traced with certainty back to 1871 (28) It, therefore appears to be worthwhile to make a critical study on the mobility aspect of farm labour in order to assess the conditions which cause and accelerate the movement of farm labour in the first instance and latterly to investigate the effect of farm mechanisation involved in it and with which this particular chapter is concerned.

Movement of Farm Labour

(Reasons: Pulling force and pushing pressure)

The reasons for the movement of farm labour out of farms are manyfold and complex.

On one side there has been a "pulling" force and on the other side there has been a "pushing" pressure. Their combined effect is the eventual 'drift from the land'. It is, however, a controversial point whether "pulling" force starts operating first followed by "pushing" pressure or the reverse. Pedderson (52) while discussing the impact of technical change on employment stressed the importance of the pulling force, at least in the context of British conditions. He stated that during the free trade era of the nineteenth and twentieth centuries, Britain required labour for a profitable export trade in finished industrial goods with which domestic agriculture could not compete. The industry thus started pulling labour from the land. This pulling force became very effective in drawing the labour from agriculture since industry was able to offer them better pay, promotion and other amenities. Workers left the land and joined industry. It appears that this force is

operating even today*. He further argued that agricultural machinery together with other technical improvements in agriculture might serve to explain some of the smooth reduction in labour force but not the structural change taking place during and after the Second World War. British experience thus, Pedderson inferred does not support the view that mechanisation has been the cuase of fall in the agricultural labour force. Mechanisation in an economically developed country follows the reduction in the supply of farm labour caused by the pull from industry.

This view is, however, subject to contradiction by others who hold different views. Hirch (31) for example, does not place so much

---

* With the exception of the emergency period during wartime, outstanding among the causes of the movement of workers from agriculture, seems to be the level of wages. From the Report of an Enquiry into reasons for the 'Drift' from the land by Cowie and Giles (14) in 1959, it revealed that the "reasons for workers to leave the land are low wages, general conditions and both the system and state of tied cottages..... Within the group of reasons, low wages alone accounts for almost 50 per cent. of the total and is undoubtedly the most important single contributing cause of the drift from agriculture"

stress on the importance of the pulling force. He is of the opinion that the reasons for drift from the land are not only due to the pull from industries but to the equally powerful push from agriculture which has been at work since the middle of the fifteenth century. He stated "These causes have to be distinguished which occasioned a lower demand for labour. Amongst the causes of reduced demand was the change in the pattern of production, i.e. the change from arable to grass farming.....

Even more effective in this respect was the extended use of labour saving machinery such as drill, horse hoe, mowers and other hay making machinery, reapers, self binders, elevators, fertiliser distributors and the altered methods of farming adopted with a view to economising on labour. The better education of farmers over the last seventy years created the necessary condition for them to be able to economise in labour and to be willing to use labour saving machinery. It has been rightly stated that the reduced demand for farm workers may be attributed more to mechanisation and more efficient use of labour than any other single cause".

The opinions of Pedderson and Hirch differ from each other so widely that they are worth considering in more detail.

To start with Hirch, it appears to be less convincing to accept the view that the pushing pressure generated by the introduction of machinery and change in land use pattern was equally as powerful as that of pulling force from manufacturing industries in Britain in drifting the labour from the land. The economic condition of agricultural industry and other non-agricultural industries and the country as a whole, in fact, play the most vital role in it. The tractors, for example, were introduced at the time of World War I and the combined harvesters in the thirties, but their uses remained extremely limited until the outbreak of World War II in 1939 when their uses were found to be economic in the face of the shortage of labour and the rising wage rate of farm labour. The progress of mechanisation was strikingly slow throughout the entire period, although the drift of labour from the land continued during the whole period. Agricultural workers fell from 0.126 million in 1921 to 0.104 million in 1939. More prosperous non-agricultural

industries must have evidently attracted them and offered them better and prospective employment. If there were no adequate alternative employment opportunities, agriculture would have been over-crowded like India or any other industrially under-developed country. These features appear to support what Pedderson found out that the pulling force is the primary cause for the movement of farm labour.

The statistical information relating to wage ratio between agricultural and industrial workers that are available from 1850 appear to support the same line of thought. The figures on wage ratio in U.K. (Table 11) quoted from Bellerby's work (7) reveals that wage rate of agricultural workers was sufficiently low in comparison with that of industrial workers from the middle of the nineteenth century up to the middle of the last World War, although some improvement in favour of agricultural workers appears to have occured at the later part of this period. The implication of this feature suggests that the drift of workers from the land was inevitable when agricultural wage rate was as low as half of non-agricultural wage rate.

TABLE 11

WAGE RATIO OF AGRICULTURAL WORKER TO INDUSTRIAL WORKER - U.K.

Year	Per cent.
1850-4	43
1855-9	45
1860-4	47
1865-9	46
1870-4	48
1875-9	50
1880-4	50
1885-9	51
1890-4	48
1895-9	48
1900-4	47
1905-9	49
1910-14	49
1915-18	48-50
1919-23	49
1924-28	50
1929-33	52
1934-38	53
1939-43	65
1944-47	75

Source: "The relative incidence on agriculturists and on other groups of the benefits resulting from technical change in agriculture" by J. R. Bellerby, published in the "Proceedings of the International Conference of Agricultural Economists, 1955.

Even today the force is strikingly powerful despite the marked improvement* in agricultural wage rates in recent years. This is because still the difference in the wage rates and other opportunities between agricultural and manufacturing industries is so wide that the net outflow of workers from agriculture to manufacturing industries is natural. In this connection Hughes (34) presented some of his estimates relating to the number of male agricultural workers in Great Britain where he has shown (Table 12) that in the course of 20 years the number if expected to fall by 198,000 from 563,000 in 1955 to 365,000 in 1975.

---

* Sturrock (63) estimated in 1956 that the wage rates in farming have increased to three and a half times the pre-war figures, those in industry have risen only two and a half times.

TABLE 12

ESTIMATE OF THE MALE EMPLOYEES IN AGRICULTURE, 1965 AND 1975. GREAT BRITAIN
(in thousands)

Age Group	Under 20	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65 and over	Total	Age 20-64
1955 (Actual)	74	70	65	56	46	51	53	51	54	28	35	563	454
1965 (Estimates)	75	64	47	38	37	34	28	33	35	34	25	450	350
1975 (Estimates)	60	57	48	35	27	23	23	22	19	22	27	365	278

Source: "A note on the decline in number of farm workers in Great Britain" By J. D. Hughes. Published in "The Farm Economist", Vol. VIII, No. 9, 1957, Page 34.

Sturrock (64) also appears to hold the same type of view. He predicted that over the next twenty or thirty years there would be undoubtedly a marked reduction in the number of labour force, including farmers. The 'pulls' from other industries would be so powerful he asserted, that such reduction is inevitable.

The information that is available from all reliable sources appears to support the view that the mobility of farm workers is more due to the increasingly stronger 'pulls' from non-agricultural industries than to the pushing pressure exerted by farm mechanisation.

In a process of long time duration of migration, there is, however, both pushing and pulling, the pushing coming from the pressure created in the farm, and the pulling coming from relatively better opportunities in non-farm employment.

Economic Implication in Fall of Workers

Hendry (29) states: "Though a declining farm labour force may raise a number of social problems in rural areas, there is no doubt that long-term trend in labour use should be downwards if the agricultural industry is to derive the full economic benefit from the application of new techniques and machinery to farming". Ashby (4) went further. Apart from the benefit of agricultural industry, he stated, the release of manpower from the land is necessary in order to produce non-food commodities and services, and to produce even luxury goods, thereby raising the level of living of the country. The most important general interest at the moment perhaps, he emphasised, is the urgent national need for economy in the use of labour power with all other of its productive resources. And thus, 'the drift from the land' and the reduction in the proportion of agricultural population are the necessary conditions for the material improvement of the people.

It is therefore evident that reduction in the number of workers is of economic advantage to the nation at large, to those who are left to

the land and presumably to those who make the move. The role of farm mechanisation in this connection is therefore neither meagre nor insignificant.

The Conditions that favour Mechanisation

The progress of mechanisation as has been pointed out, was strikingly slow before the World War II. The reason for this obviously was there were less favourable conditions for the growth of mechanisation as mentioned earlier. An adequacy of agricultural workers, for example, is one outstanding factor which has always some retarding effect on the growth and process of farm mechanisation. Substitution of labour by machinery, in that case, becomes less profitable.

In Scotland it appears that there was never shortage of labour before World War II. Duncan (18) wrote: "There was nothing to indicate that the supply was short of the demand and the trend of wages over the whole period would indicate that the supply was generally adequate". The war changed these conditions. The bargaining power of farm workers for the first time appeared to increase enormously not only because of the greater demand for labour

created by the expansion of agriculture, but also because of the competition from other industries on the labour market. The rate of wages of the agricultural worker increased strikingly. The gap between farm wages and industrial wages was narrowed down. Adoption of machinery for agriculture became necessary to substitute costly human labour. A similar situation arose in the late 1920's when maintenance of farm wage rates by statutory regulations, in face of the falling price level of agricultural products, was made costly in terms of farm output and forced farmers to curtail labour requirements by mechanisation, although the progress of mechanisation did not proceed appreciably later on, due to, perhaps, general depressed conditions of agriculture. During the period of World War II and Post-war period, however, reasonable incomes of farmers were assured and granted through the Governmental supports in the form of price support and other subsidies. This has made the farming business profitable and enabled the farmers to afford heavy capital investments in machinery.

Coming back to the point that progress of mechanisation is slow during depression when wages fall and is fast after the rise in wages sets in, it follows some economic laws. The price of machinery is mainly determined by industrial wages and rises relatively with the fall in agricultural wages. The substitution of machinery for labour then becomes less economical. It is therefore obvious that there appears to be no favourable point in mechanising farm operations if no reduction in the number of labour force takes place.

But strikingly the labour situation in Scotland during war time reveals a distinct deviation from the above hypothesis. The number of labour went up from 104,133 in 1939 to 123,896 in 1943 and then came down to 117,004 in 1945, despite the rapid growth of mechanisation during the same period.

Paddeerson (52) remarked "Mechanisation was speeded up right from the outbreak of the war. This should have made it possible to pay higher price for labour or to reduce the labour force drastically. The latter alternative has not been followed. On the contrary, the desire to

increase production has called for an increase in the labour force". The reason for this appears to be primarily the abnormal situation which arose from war conditions when self-sufficiency in food production was so much needed that free market of demand and supply of labour was controlled by Governmental orders* and thus such a market disappeared. The normal and free movement of labour out of agriculture to manufacturing industries, was artifically restricted and therefore substitution of labour by mechanisation was retarded.

---

* 1. Restriction of Engagement Order: "An employer should not seek to engage any male worker whose normal employment in agriculture.....except for working in agriculture".

2. Essential work (Agriculture) (Scotland) Order which reads that such workers engaged by week or longer could not terminate their engagement, nor could their engagement be terminated without the consent of a National Service Officer unless of serious misconduct.

The outflow of labour from agriculture, however, again began after the end of the war when conditions gradually came back to normal. Farmers now find it again necessary to substitute the labour in face of high wage rates which are effected or influenced by the loss of labour to industry.

The conclusion therefore emerges that the progress of mechanisation of agriculture in Scotland has been influenced, among other factors by the supply of labour and the level of wages. Shortage of labour, due to the unattractiveness of agricultural wages in comparison with the industrial wages, has influenced to a great extent, the rapid advancement of agricultural mechanisation in Scotland during the war and post-war period.

Composition of Labour Force: Impact of Mechanisation on them - Farmers and Family Workers

Scotland has always had a much higher proportion of hired wage paid labour than of family labour. The labour of members of farmers' family constitutes smaller portion of total working force. It has been estimated by Hendry (28) that such

family workers make up a little over one-fifth of the farm worker force.

TABLE 13

NUMBER OF FARMERS - SCOTLAND
(in thousands)

Census	Male	Female	Total
1901	48.0	7.9	55.9
1911	46.0	6.8	53.6
1921	50.1	5.0	55.1
1931	45.9	4.0	49.9
1951 (1 p.c. Sample)	47.2	4.4	51.6

Source: "Labour in Scottish Agriculture" by G. F. Hendry, Journal of Agricultural Economics of Agricultural Economic Society, Vol. XI, No. 4. January, 1956.

Scottish population census figures for various (Table 13) dates back to 1901, show that the number of farmers recorded in Scotland in the Census of 1951 differed by only 4,300. In terms of percentage it is a decrease by only 7 per cent. and the crofters constituted a

major portion of it. These figures suggest the stability of Scottish farmers to their farming occupation, even in the face of powerful pulling force. Causes of such stability as Nash (49) investigated, are much more deep rooted than to be easily affected by Governmental policy or any other pressures or forces. Agriculture to many of them is a way of life more than a business. Many of them especially stock rearing farmers, are on subsistence level but neither pulling force nor pushing pressure has been so far effective in drifting them from the land.

As regards family labour, Hendry (28) traced a downward trend in the numbers from 1941 to 1952, but if that trend at all existed, there is no reliable information to prove its further continuity. It therefore seems to be unfair to infer that family workers have been moving out of farms drastically, although Duncan (18) in 1957 wrote, from his general impression, that sons of farmers do not seem to be any more inclined to farm as their life occupation.

In contrast to the above two cases, hired labour appears to be much more mobile and is easily susceptible to the forces that influence the movement of labour from agriculture to non-agricultural industry.

Total Agricultural Workers -

Scotland

Although it is difficult to get statistical figures relating to family labour* and hired labour separately, a drop in the number of labour force, which include both family and hired labour, by 19 per cent. (Table 14) between the years 1939 and 1959, is important and the implication of which proves the existence of powerful forces and pressures that cause mobilisation of labour out of agriculture.

---

* Family labour constitutes nearly one-fifth of the total labour force.

TABLE 14

INDICES OF LABOUR FORCE - SCOTLAND

1939 = 100

1921	1931		1939	1943	1946	1950	1954	1959
115.8	108.7	Full-time Regular Workers (Total)	100	113.7	100.3	98.8	87.0	76.5
159.2	103.9	Casual Workers (Total)	100	151.4	99.0	114.0	84.9	65.5
121.1	107.9	All Workers (Total)	100	119.0	111.0	101.0	93.4	81.3

Regular and Casual Workers

Table 14 presents the indices of labour force and it appears from the Table that the degree of reduction of casual workers is higher than that of regular workers. While index of the casual workers fell by 34.5 per cent. between the years 1939 and 1959, regular workers fell by 23.5 per cent. during the same period. In terms of actual numbers, (Table 15) the number of regular workers declined from 89,670 in 1939 to 68,624 in 1959, whereas the number of casual workers went down more drastically from 14,463 in 1939 to 9,477 in 1959. This suggests that the mechanisation is perhaps more effectively associated with casual workers than permanent workers. In other words, mechanisation appears to be more effective in reducing the requirement of casual workers than that of regular workers. This feature needs to be studied analytically with special reference to the agricultural industry.

TABLE 15

NUMBER OF FARM WORKERS - SCOTLAND

	1939		1943		1946		1950		1954		1959	
Full-time Regular Workers	No.	p.c.	No.	p.c.	No.	p.c.	No.	p.c.	No.	p.c.	No.	p.c.
Males 21 & over	56,674	54.4	56,234	45.3	57,316	49.7	60,970	58.0	56,064	57.6	51,234	60.3
Under 21	18,617	17.8	18,500	14.9	16,126	14.0	13,564	13.0	11,860	12.1	10,235	13.0
Women & Girls	14,379	13.8	27,261	22.2	16,526	14.3	14,100	13.4	10,105	10.4	7,155	8.2
Total	89,670	86.0	101,995	82.2	89,968	78.0	88,634	84.4	78,029	80.1	68,624	81.5
Casual Workers												
Males 21 & over	6,712	6.5	9,072	8.0	7,238	6.3	9,854	9.3)	7,531	7.7	5,364	6.3
Under 21	1,916	1.9	2,409	1.9	1,346	1.1	1,146	1.0)				
Women & Girls	5,835	5.6	10,420	7.5	5,747	4.9	5,493	5.3	4,750	4.9	4,113	4.6
Total	14,463	14.0	21,901	17.4	14,331	12.3	16,493	15.6	12,281	12.6	9,477	10.9
Others	-	-	-	-	1,092	9.7	-	-	7,150	7.3	6,578	7.6
Total - All Workers	104,133	100.0	123,896	100.0	115,228	100.0	105,127	100.0	97,360	100.0	84,679	100.0

Source: Agricultural Statistics (Scotland)

Casual Workers: Seasonality.

In agriculture, as it is known, the requirement of labour fluctuates from season to season depending on the nature of different seasonal agricultural operations. There is a peak period, such as the period of harvesting of cereals, thinning of root crops, when requirements of labour is highest. Similarly, there is a slack period when there is practically no work to do and thus labour requirement is low. Thus seasonal labour requirements, in fact, vary in intensity and timing with physical conditions of the farm, and the pattern of enterprise. The variations as Lloyd and Rowley (39) stated might be as high as 30 - 60 per cent. from season to season of the same year. This very nature of farming business makes it extremely difficult to make a proper adjustment of labour to the actual requirement if the labour is employed productively throughout the year. Farmers very often maintain more labour (just to meet the requirements of the peak period) than would have been required if the work could have been distributed throughout the year. Although the casual labour in this condition is evidently

more useful and, in fact, a substantial portion of seasonal labour requirement was fulfilled by them in the past years but the availability of such casual labour, as is reported today, is very uncertain and unreliable.

It is likely that these conditions, along with others, have induced farmers to go for more specialised machinery, such as potato lifters, combined harvesters, sugar-beet harvesters and binders etc. with a view to coping with the seasonal labour requirement, although this machinery is costly and its use is extremely limited to a particular period in a year.

Regular Workers:

A comparatively low degree of reduction of regular labour might be due, on the other hand, to two reasons. In the first place, as has already been mentioned, farmers employ larger numbers of regular workers than is actually required. This is because, unlike the manufacturing industry, in agriculture as Jones (37) studied, the use of machinery hardly enables the farmers to reduce the labour force drastically without ill effects, even if such a reduction is of economic necessity to adjust the labour force with the exact requirement. In the

second place, there are a number of operations which are still predominantly performed by hand, especially in live-stock farms. In this context, the preponderence of livestock farms over other types of farms in Scotland is noteworthy and it tends to explain partly why the reduction in labour force was not very high between the years 1939 and 1959, in spite of speedy progress of mechanisation. In course of time, however, as is expected, a substantial reduction of labour force will take place along with the re-organisation and planning of farms, in order to take full advantage of machinery available. This exactly happened in America where Sturrock (62) noted that the first effect of mechanisation was to make the work easier and to reduce the drudgery of work, but not to reduce the workers. Mechanisation proceeded further and eventually a stage came when it was possible to reduce labour throughout the year or to use the time saved to increase production. This is the second phase of mechanisation as he remarked, in contrast to the first phase, when machines lighten the work but cannot reduce the requirement of farm labour considerably. "British farming" he inferred, is still in the first phase, but there are now signs that we are moving into the second phase".

Trend of Labour Force:

By Regions - Scotland

Mechanisation, as has been pointed out, is less effective on labour problems associated with livestock production than those with crop production. The implication of this means that reduction of labour is less in the area of low proportion of crops and vice-versa. An analysis on fall of labour force in different regions will be interesting in assessing how mechanisation is related to the degree of fall of labour force and the proportion of area under crops and fallow.

TABLE 16

RELATIONSHIP BETWEEN THE PROPORTION OF AREA UNDER CROPS AND FALLOW AND PERCENTAGE OF FALL OF LABOUR FORCE BY REGIONS - SCOTLAND.

	Area (acreage) under crops and grass	Area (acreage) under crops and fallow	p.c. of area under crops & fallow to the total area under crops & grass	Labour Force				Tractors per 100 Regular Workers		Tractors per 1000 Acres of Crops & gr	
	1958	1958		1946	1958	1946-1958	p.c. of fall	1946	1959*	1946	1959*
Highland	417,632	120,745	28.9	14,498	8,712	5,786	39.9	10	82	3	13
North East	1,205,654	530,583	44.0	24,852	20,322	4,530	18.2	32	104	6	15
East Central	815,076	392,712	48.1	22,028	19,225	2,803	12.7	29	71	6	14
South East	678,230	265,409	39.1	18,732	13,629	5,103	27.2	27	59	5	10
South West	1,259,654	270,410	21.4	35,118	26,533	8,585	24.4	25	63	5	11
Scotland	4,376,246	1,579,859	36.1	115,228	88,421	26,807	23.2	31	75	6	13

* Since no machinery census was taken for the year 1958, the calculation is based on the machinery census figures of 1959.

Table 16 reveals that the Eastern part of Scotland is predominantly arable farming area where the proportion of area under crops and fallow varies from 39.1 per cent. in South East region to 48.1 per cent. in East Central region, and correspondingly the percentage of fall in the numbers of workers between 1946 and 1958 varies from 27.2 in the South East region to 12.7 in the East Central region. By contrast, the heaviest loss of workers (i.e. 39.9 per cent) has occured in the Highland region where the area under crops and fallow constitutes only 28.9 per cent. of the total area under crops and grass. The South West region showed a similar trend where the drop of workers by 24.4 per cent. occured against only 21.4 per cent. of the total area under crops and fallow.

These trends appear to be very irregular and inconsistent. The reasons for this are manyfold and complex. In the South East region, for example, a high rate of fall in the number of workers appears to be associated with the high proportion of area under crops and fallow but, in contrast, the relationship between the rate of fall in the number of workers and the rate of increase in the number of

tractors, appears to be less significant. The number of tractors rose very slowly from 5 in 1946 to 10.0 in 1959 for every 1,000 acres of crops and grass and from 27 in 1946 to 59 in 1959 for every 100 regular workers respectively. The South East region is, however, the most highly mechanised arable farming area and such a high percentage of fall in number of workers appears to be a clear indication of an effective substitution of labour by mechanisation.

In the Highland region, on the other hand, such a high percentage of fall in number of workers appears to be less proportional to the percentage of area under crops and fallows, although the number of tractors increased tremendously from 3 in 1946 to 13 in 1959 for every 1,000 acres and from 10 in 1946 to 82 in 1959 for every 100 regular workers. Such a drastic fall (39.9 per cent) in the number of workers in this region is perhaps not solely due to the effect of progress of mechanisation: the remoteness of the locality and the inadequate employment opportunity for the whole year are probably more important factors in drifting the workers from the land to other occupations.

The increase in the number of tractors, however, reflects that farmers have been trying to make up for the loss of workers by increasing tractor force.

Similarly, in the North East region, the proportion of area under crops and fallow, the percentage of fall in the number of workers and the number of tractors per unit of area or workers, do not seem to be related as revealed in Table 16. The area under crops and fallow is as high as 44 per cent. and the number of tractors increased as speedily as 6 in 1946 to 15 in 1959 for every 1,000 acres of crops and grass and 32 in 1946 to 104 in 1959 for every 100 regular workers, but in comparison with these, the fall in the number of workers is rather low - only 18.2 per cent. The reason for this development is perhaps that since family workers are less susceptible to the pushing pressure generated by mechanisation, substitution of labour by mechanisation has not taken place proportionately in the predominant family farming North East region where the proportion of family workers to total workers is

considerably high.

The East Central region shows the same type of trend so far as the relationship between the area under crops and fallow, increase in the number of tractors per unit area or per unit of worker and percentage of fall in the number of workers, is concerned. The reason for this less reduction in the number of workers is, however, different. The change in land use pattern such as switch over from arable farming to livestock farming and shift from cereal growing to fruit growing in certain counties in the East Central region, have probably made it necessary to retain a large number of workers.

Unlike the above two regions, in the South West region the low proportion of area under crops and fallow, and less increase in the number of tractors per unit of land or per unit of workers, are associated with comparatively high percentage of fall in the number of workers. The fall in the number of labour force is as high as 24.4 in this region where the area under crops and fallow constitutes only 21.4 per cent. to the total area and the number of tractors is only 11 for every 1,000

acres of crops and grass and 63 for every 100 regular workers. The reason for this development is again quite different. The industrial expansion that has been taking place in counties like Dumbarton, Renfrew and Lanark of the South West region has probably drawn the workers from surrounding farms considerably. Along with this, extensive mechanisation of different dairying processes such as milking etc. has probably had a substantial effect in reducing labour requirement and it is to be noted that this reduction by mechanisation cannot be related to the proportion of area under crops or to the degree of mechanisation in terms of number of tractor per unit area of land.

On the whole, the relationship between the area under crops and fallow, increase in the number of tractor per unit area of land and per unit of worker, and the percentage fall of workers, appear to be so irregular and inconsistent for one reason or another, as discussed before, that they sometimes hardly follow the hypothesis that mechanisation is more effectively associated with arable farms in reducing labour requirement than any other type of farms.

It will, however, be misleading to assume that mechanisation has no effect in reducing labour requirements at all. The impact of mechanisation on labour is, in fact, of considerable dimension and to trace that a critical study on the trend of labour force in each county appears to be useful and of much significance.

On County Basis:

An analysis has been made and represented in a tabular form showing the percentage of fall of labour force against the proportion of area under crops and fallow in each county. The figures are represented in Table 17 and in the graph.

Nearly half of the total number of counties fall in between the two lines drawn on the graph implying that the percentage of fall of labour force and the proportion of area under crops and fallow have some co-relation in these counties. In other words, it signifies that the degree of fall of labour force corresponds with the proportion of arable land.

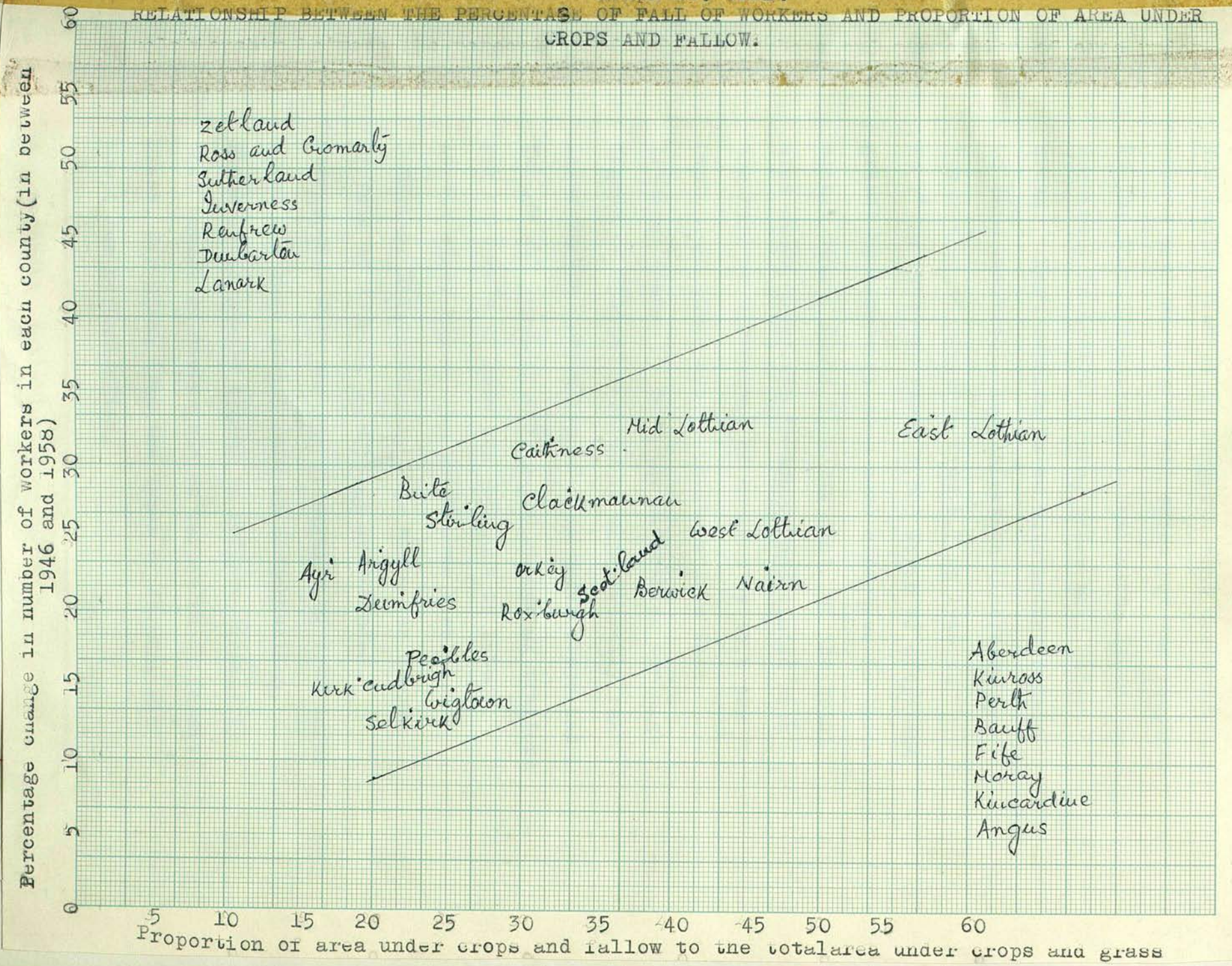
TABLE 17

RELATIONSHIP BETWEEN THE PROPORTION OF AREA UNDER CROPS AND FALLOW AND PERCENTAGE OF FALL OF LABOUR FORCE - BY SCOTTISH COUNTIES

	Crops and Grass Acreage in 1958	Crops and Fallow Acreage in 1958	p.c. of crops and fallow to total crops & grass	Labour Force			
				Number in 1946	Number in 1958	1946-1958	Per cent. of Fall
Aberdeen	614,311	277,675	45.2	12,568	10,330	2,238	17.8
Angus	239,246	135,978	56.8	6,601	6,132	469	7.1
Argyll	99,277	20,117	20.3	3,535	2,677	858	24.2
Ayr	284,592	49,226	17.3	8,331	6,375	1,956	23.5
Banff	154,429	70,163	45.4	2,991	2,547	444	14.8
Berwick	182,217	73,338	40.2	3,790	2,933	857	22.6
Bute	25,499	6,022	23.6	653	465	188	28.8
Caithness	93,956	30,537	32.5	1,838	1,248	590	32.1
Clackmannan	14,043	4,659	33.2	371	265	106	28.6
Dumfries	228,916	51,147	22.3	5,272	4,152	1,120	21.6
Dumbarton	37,658	8,754	23.2	1,361	919	442	32.5
East Lothian	104,765	60,543	57.8	4,712	3,130	1,582	33.6
Fife	221,095	108,144	48.9	6,469	5,317	1,152	17.8
Inverness	135,005	37,210	27.6	3,816	2,397	1,419	37.2
Kincardine	117,346	59,829	51.0	2,593	2,239	354	13.6
Kinross	30,846	11,670	37.8	651	571	80	12.3
Kirkcudbright	161,555	30,598	18.9	3,298	2,788	510	15.5
Lanark	215,025	49,382	23.0	7,675	5,315	2,360	30.7
Midlothian	100,952	40,240	39.9	4,102	2,719	1,383	33.7
Moray	91,630	45,747	49.9	2,200	1,922	278	12.6
Nairn	24,626	11,481	46.6	522	402	120	23.0
Orkney	109,356	35,153	32.1	2,140	1,634	506	23.6
Peebles	41,930	10,090	24.1	874	723	151	17.3
Perth	309,848	132,261	42.7	7,936	6,940	996	12.5
Renfrew	63,850	12,413	19.4	2,199	1,448	751	34.1
Ross & Cromarty	133,105	50,226	37.7	4,333	2,243	2,090	48.2
Roxburgh	170,382	52,809	31.0	3,252	2,577	675	20.7
Selkirk	28,233	6,329	22.4	548	474	74	13.5
Stirling	99,704	26,418	26.5	2,644	1,925	719	27.2
Sutherland	29,407	7,637	26.0	800	513	287	35.9
West Lothian	49,751	22,060	44.3	1,454	1,073	381	26.2
Wigtown	142,852	36,450	25.5	3,685	3,146	539	14.6
Zetland	20,834	5,555	26.7	2,014	882	1,132	56.2
Scotland	4,376,246	1,579,861	36.1	115,228	88,421	26,837	23.2

Graph No. VIII.

RELATIONSHIP BETWEEN THE PERCENTAGE OF FALL OF WORKERS AND PROPORTION OF AREA UNDER CROPS AND FALLOW.



The implication of it suggests that mechanisation reacts with workers in all cases but the reaction is far more effective in substituting labour by machinery in arable farming areas than other areas. East Lothian is an outstanding county in this respect. Mechanisation (increase in the number of tractors from 6.7 in 1946 to 13.1* in 1959 for every 1,000 acres of crops and grass) appears very much more effective in this arable county where 57.8 per cent. of the total area under crops and fallow is associated with the fall in the number of workers by 33.6 per cent. In other arable counties like West Lothian, Nairn, Berwick and Midlothian the high degree of fall of workers is significantly related to the proportion of area under crops and fallow and the increase in the number of tractors per unit area of land and per unit of labour. At the other end of the scale come Peebles, Dumfries, Kirkcudbright, etc. where low degree of fall of workers as already apprehended, corresponds with the low proportion of area under crops and less advancement in mechanisation. These developments appear to reflect distinctly that impact of mechanisation varies in different areas, depending upon the types of farming and scope for mechanisation.

---

* Appendix Table 1.

Strikingly, however, the counties like Ross and Cromarty, Zetland, Inverness of the Highland region and Renfrew, Dumbarton and Lanark of the South West region, shown in the upper end of the graph, such a heavy fall of workers does not seem to be in accordance with the proportion of area under crops. Although there has been a considerable increase in the number of tractors in Zetland, for example, the area under crops and fallow, constitutes only 26.7 per cent. of total area but the fall of workers is as high as 56.2 per cent. and the increase in the number of tractors* is rapid as the number rose from 1.7 in 1946 to 21.9 in 1959 for every 1,000 acres of crops and grass. Such a trend is observed in other Highland counties. While the explanation for this inconsistent trend is likely to be that in the case of Highland counties the remoteness of area and subsistence type of farming, have necessitated the workers to leave agriculture and to migrate to other areas with a view to securing better employment, in the case of other Lowland counties such as Dumbarton,

---

* Appendix Table 1.

Renfrew, Lanark of South West region on the other hand, the 'pulls' from manufacturing industries appear to have effectively drifted the workers from the land in order to cope with the expansion programme of manufacturing industries in these areas. Mechanisation in dairy farming has had presumably the same substantial effect in reducing labour requirements in these counties. At the lower end of the graph, come Aberdeen, Banff, Kincardine and Moray of the North East region and Angus, Fife, Kinross and Perth of the East Central region where, in contrast to previous case, the degree of displacement of labour is strikingly low in comparison with the area under crops and fallow and level of mechanisation.

There might be different reasons for this development in different counties. Changes in land use pattern, for example, might be the reason for less degree of reduction of workers in Angus. There has been a considerable change from cereal growing to fruit growing

(to Raspberry)* in Angus and this has probably made it necessary to retain large number of workers. Similarly an increase in the number of livestock** appears to be the probable reason for retaining a fairly large number of workers in Fife, Perth and Kinross, in spite of such a speedy progress of mechanisation in terms of number of tractors and combine harvesters per unit area of land in these areas.

It does not, however, imply that the impact of mechanisation on employment is of no significance. Had there been no advancement of mechanisation in these counties more workers would likely have been required to maintain the present level of production.

---

* The acreage under raspberries rose from 1,747 acres in 1946 by 109 per cent. to 3,653 in 1958.

** (i) The number of cattle in Fife increased from 57,318 in 1946 by 33.5 per cent. to 76,529 in 1958. The number of sheep and pigs rose by 46.1 per cent and 16.2 per cent. from 100,022 and 11,000 in 1946 to 146,229 and 28,839 in 1959 respectively. (ii) In Perth, the number of cattle, sheep and pigs climbed up by 32.6 per cent., 14.2 per cent. and 260 per cent. from 83,782, 581,512 and 9,014 in 1946 in 111,117, 678,441 and 32,471 in 1958 respectively. (iii) In Kinross, the number of cattle, sheep and pigs increased by 53.3 per cent. 142.9 per cent. and 2,520 per cent. from 7,779, 29,195 and 514 in 1946 to 11,927, 70,919 and 13,502 in 1958 respectively.

(to Raspberry)* in Angus and this has probably made it necessary to retain large number of workers. Similarly an increase in the number of livestock** appears to be the probable reason for retaining a fairly large number of workers in Fife, Perth and Kinross, in spite of such a speedy progress of mechanisation in terms of number of tractors and combine harvesters per unit area of land in these areas.

It does not, however, imply that the impact of mechanisation on employment is of no significance. Had there been no advancement of mechanisation in these counties more workers would likely have been required to maintain the present level of production.

---

* The acreage under raspberries rose from 1,747 acres in 1946 by 109 per cent. to 3,653 in 1958.

** (i) The number of cattle in Fife increased from 57,318 in 1946 by 33.5 per cent. to 76,529 in 1958. The number of sheep and pigs rose by 46.1 per cent and 16.2 per cent. from 100,022 and 11,000 in 1946 to 146,229 and 28,839 in 1959 respectively. (ii) In Perth, the number of cattle, sheep and pigs climbed up by 32.6 per cent., 14.2 per cent. and 260 per cent. from 83,782, 581,512 and 9,014 in 1946 in 111,117, 678,441 and 32,471 in 1958 respectively. (iii) In Kinross, the number of cattle, sheep and pigs increased by 53.3 per cent. 142.9 per cent. and 2,520 per cent. from 7,779, 29,195 and 514 in 1946 to 11,927, 70,919 and 13,502 in 1958 respectively.

The conclusion, therefore, emerges that mechanisation has involved an effective substitution of labour force in more than half of the total number of counties at a varying degree, the substitution increase as the proportion of area under arable farming increases. Heavy losses of workers in four counties of the Highland region and three counties of the South West region, as already mentioned, do not seem mainly due to mechanisation but due to other force, as already discussed, although rapid adoption of machinery and mechanical power have indeed enabled the farmer to make good the losses of the workers.

Changes in Wages and Labour Employed - Types of Farms

Reduction in the number of workers as already analysed against the proportion of area under crops and the extent of mechanisation in different counties in order to assess the impact of mechanisation on employment of labour, also needs to be studied against the background of different types of farms in order to find out precisely how the opportunities for mechanisation have varied according to the type of farming carried on and how farmers of different types have fared in reducing their labour requirement.

While this appears to be an important study, statistical information relating to it is inadequate. Only Shemitt (58) provided some information covering the space of only five years.

TABLE 18.

CHANGES IN WAGES AND LABOUR EMPLOYED

		Hill Sheep	Stock Rearing	Stock Rearing and Feeding	Arable	Dairy
Average Wage Bill per farm						
in 1951/52 - 1952/53	£	701	403	889	1,345	1,227
in 1956/57 - 1957/58	£	939	445	1,040	1,426	1,434
Index of Wage Bill per farm in 1956/57 - 1957/58 *		134	110	117	106	117
Index of Wages per Worker in 1956/57 - 1957/58 *		136	137	137	135	136
Index of Labour Employed in 1956/57 - 1957/58 *		99	80	85	79	86

* 1951/52 - 1952/53 = 100

Source: "The Financial Results of Farming in 1957/58" by H. J. Shemitt. Scottish Agricultural Economics (Vol. X, Page 18) 1960.

From Table 18 (showing the changes in labour employment on different farm types and the wage bill per farm and per worker over the period of 5 years), it appears that the greatest reduction of workers has taken place on arable farms and, correspondingly, greater economies seem to have been made on arable farms. By contrast, hill sheep farms are marked with less degree of fall of workers and consequently higher degree of rise in wage bill per farm.

These developments appear to follow the same hypothesis as is mentioned earlier that effectiveness of mechanisation in reducing labour requirement varies according to the types of farms. In arable farms, for example, wider opportunities for mechanisation exist as these are evident from the highest degree of fall of workers in these farms in comparison with hill sheep farms where mechanisation has, in fact, only a limited scope to reduce labour requirement. On stock rearing farms such a high rate of reduction of labour force appears to be, however, mainly due to more uneconomic conditions of the farms which necessitated the stock rearing farms to curtail labour requirement rather than due to mechanisation, although mechanisation might have played some part in replacing labour.

Influence of Mechanisation on the Class of Workers

The impact of mechanisation on farm labour is, of course, to reduce the labour requirement in the first instance, as has already been noted, but this is just the beginning of far reaching effect of mechanisation. A critical analysis reveals that mechanisation tends to effect the make-up of the labour force in several ways. A new type of worker with higher skill and training is being produced out of the necessities, i.e. to be able to handle different machines and engines. Similarly, a major portion of tractor drivers happens to be young people which suggests that mechanisation appeals differently to the different ages of workers. The make-up of the labour force therefore appears to be appreciably influenced by mechanisation and a study on the change in such make-up is thus likely to be of interest in assessing the extent of the influence of mechanisation on it and with which this section is concerned.

TABLE 19

CLASS OF WORKERS, ADULT MALES - EXCLUDING THOSE 65 AND OVER

	1947/48 p.c.	1953/54 p.c.	1958/59 p.c.
Grieves	7.4	6.9	7.9
Shepherds	7.1	7.8	8.6
Stockmen	15.2	19.3	23.1
Tractormen	15.9	28.8	37.6
Horsemen	22.1	7.6	1.3
All Specialists	67.7	70.4	78.5
General Workers	24.3	22.1	15.9
Others *	8.0	7.5	5.6
All Workers	100.0	100.0	100.0

* Ancillary workers, permits of exemption and partners.

Source: Department of Agriculture and Fisheries for Scotland.

Specialists and General Workers

The figures (Table 19) reveal that specialists constituted 67.7 per cent. of the total labour force in 1947/48 and the proportion went up further to 78.5 per cent. in 1958/59, with a substantial fall of 'general' and other classes of workers. Among all specialists, tractormen appear to hold a dominant position.

The proportion of tractormen rose from 15.9 per cent. in 1947/48 to 37.6 per cent. in 1958/59. Conversely, the proportion of horsemen and general workers declined from 22.1 per cent. and 24.3 per cent. in 1947/48 to 1.3 per cent. and 15.9 per cent. in 1958/59 respectively. The implication of these developments reveal a marked impact of mechanisation on the make-up of the labour force.

It is, however, necessary to note that the make-up of the labour force is also likely to be influenced by the combined effect of level of wages and the nature of requirement by farmers as well. It is worthwhile to make a further discussion on these points.

TABLE 20.

AVERAGE WEEKLY TOTAL EARNINGS, 1938/39 to 1958/59

SCOTLAND

Year	Grieves		Shepherds		Stockmen		Tractormen		Horsemen		General Workers		All Adult - Male Workers	
	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
1938/39	46	3	43	2	41	9	41	11½	39	11	37	1½	40	3
1939/40	47	11	45	1	43	9½	44	½	42	1½	39	5½	42	5
1942/43	78	3	72	9½	72	½	72	½	70	11½	67	3½	70	10
1945/46	94	10	89	2	90	4	85	9	85	5	81	4	86	0
1948/49	123	11	113	10	115	5	108	8	108	0	100	8	108	1
1951/52	145	11	138	1	138	11	127	9	126	11	119	10	130	0
1955/56	184	9	177	2	182	0	162	0	159	7	152	7	165	4
1958/59	221	9	212	5	212	6	195	0	194	7	181	8	196	10

Source: Department of Agriculture and Fisheries for Scotland.

Effect of Wage Level

The levels of wages for all specialists have all the time since 1938/39 been higher than that of general workers as revealed from Table 20. The average weekly earnings in 1938/39 for Grieves and Shepherds, for example, were 46/3d. and 43/2d. respectively, whereas that was only 37/1½d. for general workers. While in 1958/59 the level of total weekly earnings rose to 221/9d. and to 212/5d. for Grieves and Shepherds respectively, that only rose to 181/8d. for general workers. In terms of percentage the average weekly earnings of all specialists including stockmen and tractor-men, have always been 7.3 to 24.6 per cent. higher than that of general workers (Table 21).

TABLE 21.

RELATIVE AVERAGE WEEKLY TOTAL EARNINGS - SCOTLAND
(Males 21-64 Years of Age)

Year	Grieves	Shepherds	Stockmen	Tractormen	Horsemen	General Workers
1938/39	124.6	116.3	112.5	113.0	107.5	100
1947/48	123.1	114.4	114.8	110.1	107.6	100
1953/54	123.5	114.4	116.3	108.0	107.2	100
1958/59	122.0	116.9	116.9	107.3	107.2	100

Source: 1. "Labour in Scottish Agriculture" by G. F. Hendry, Published in Journal of Agricultural Economics (Vol. XI, No. 4, January, 1956)
2. Scottish Agricultural Economics

This suggests that the make-up of the labour force has been considerably influenced by the level of wages. Hendry and McEwan (29) while appraising the labour situation in Scotland appear to have come to the same conclusion: "The existence of this well defined and accepted wage structure leads to a much higher proportion of agricultural workers", they remarked, "being classfied as specialists in Scotland. In 1958/59 78 per cent. of specialists workers in Scotland compared with under 50 per cent. in England and Wales".

But to consider only level of wages without relating it to the working hours appears to present an incomplete picture. It is therefore necessary to relate this factor to level of wages for respective classes of workers in order to study the labour situation in Scotland.

TABLE 22.

AVERAGE NUMBER OF HOURS WORKED PER WEEK

FOR CERTAIN CLASSES OF REGULAR MEN 1957/59 - SCOTLAND

	Regular Hours	Garage or Stable time	Seasonal Overtime	Total Hours
Dairy Stockmen	54.7	-	1.2	55.9
Other Stockmen	51.4	-	0.9	52.3
Tractormen	47.1	0.9	1.7	49.7
Horsemen	47.0	1.8	1.3	50.1
General Workers	47.4	-	1.0	48.4

Source: "The Changing Labour Situation" by G. F. Hendry and L. V. McEwan.
Published in "Scottish Agricultural Economics" Vol. X, 1960.

The Table 22 shows that specialists work for longer hours than general workers. This signifies that higher levels of wages for specialists are always associated with longer working hours. A dairy stockman, for example, has to work for 55.9 total hours/week whereas a general worker is supposed to work for 48.4 total hours a week. This leads to a low variation in earnings in between different classes if calculated per hour basis. The spread is, Hendry and McEwan (29) described, from 3/9d. per hour for general workers to 4/- per hour for dairymen - a variation of 6 per cent, compared with the difference of nearly 25 per cent. in total earnings for these same groups of workers.

The conclusion therefore emerges that levels of wages for specialists are really not much higher than that of general workers if the working hours for respective workers are taken into account. This analysis therefore tends to suggest at first glance that the make-up of the labour force has not been influenced by level of wages. This type of inference will, however, be misleading. The influence of level of wages if unlikely to be insignificant.

The explanation of this situation appears to be that the workers prefer to get high paid specialised jobs than less paid unspecialised jobs, although high paid specialised jobs are associated with long working hours.

Along with it, a substantial increase in requirement of specialist by farmers and the impact of mechanisation on the labour force appears also to be considerable. The reduction in the proportion of general workers from 24.3 per cent. in 1947/48 to 15.9 per cent. in 1958/59 and horsemen from 22.1 per cent. in 1947/48 to 1.3 per cent. with a rise of the proportion of tractormen appear to reflect the impact of mechanisation leading to a change in composition of labour force. In discussing the labour situation in Scotland immediately after the World War II, Shemitt (56) appears to have the same view in mind. He wrote: "Farmers made up for the loss of general workers, including prisoners of war, by increasing the use of other resources particularly mechanisation and specialist labour....Farmers employed many more tractormen than were necessary to balance the fall in the number of horsemen; they were replacing not only horse labour but some of the manual labour previously performed by general workers, with tractor-driven machinery".

Influence of Mechanisation on Workers of Different Ages

It is difficult to assess the degree of response of workers of respective age groups towards mechanisation, although it is a general impression that the younger generation is more machine minded than the older. A survey conducted by Osborne on behalf of the Ministry of Labour (50) also supports this view. It reported that the younger generation is more machine minded and has the aptitude towards mechanical jobs (mechanical jobs such as tractor driving and harvesting are also referred to as the type of work which even non-agricultural workers would like to do). An investigation carried out by Mackenzie (42) on Scottish farm workers might throw some further light in this direction as revealed in Table 23. "There is a marked tendency" as he reported "for the proportion of grieves, shepherds, other stockmen and horsemen to rise with succeeding age groups and for the proportion of dairy stockmen and tractor drivers to fall".

TABLE 23

PERCENTAGE DISTRIBUTION OF FARM WORKERS BY CLASS OF WORKER IN EACH AGE GROUP - SCOTLAND

	All Ages	21-24 years	25-29 years	30-39 years	40-49 years	50-59 years	60-64 Years
All Classes	100	100	100	100	100	100	100
Grieves	8	-	3	6	11	14	12
Shepherds	9	7	4	7	12	13	12
Dairy Stockmen	7	8	9	8	6	5	4
Other Stockmen	13	11	11	12	13	17	14
Tractormen	33	45	45	42	30	17	9
Horsemen	8	5	5	7	9	11	11
General Workers	22	24	23	18	18	23	38

Source: "Variation in earnings of Scottish Farm Workers" by A. M. Mackenzie, Published in "Scottish Agricultural Economics" Vol. VII, 1956.

Although Mackenzie did not specifically point out aptitude to workers of different age groups towards mechanisation in his article, the preponderence of tractor drivers in young age groups appears to reflect more machine mindedness of the younger generation that the older generation.

Effect of Mechanisation on Age of Retirement

Although mechanisation reduces the requirement of labour of all age groups it appears from the Table 24 that old age groups are affected most. Up-to-date information is, however, not available but it is perhaps a fact that in the rising tide of mechanisation a proportion of the older, less adaptable workers, has found it increasingly difficult to adjust themselves on some farms (55). Thus, they are now forced to retire at a comparatively early age whereas previously many of these men were probably well over the usual retiring age, but had remained in the industry when labour was especially scarce.

TABLE 24

CHANGE IN NUMBER OF REGULAR FULL-TIME MALE WORKERS BY AGE GROUPS

1951 = 100

	Total	Under 18 Years	18 to 21 Years	21 to 40 Years	41 to 64 Years	65 and over
1951	100	100	100	100	100	100
1952	97	101	82	93	109	86
1953	92	98	76	88	107	72
1954	91	98	78	88	105	68

Source: "The Changing Age Structure of the Farm Labour Force" by P. M. Scola. Published in "Scottish Agricultural Economics" Vol. VI , 1955.

Summary

The movement of farm labour out of farms is usually initiated either by the 'pulling' force, i.e. the demand for labour by non-farm industries and relatively better opportunities in non-farm employment, or by the 'pushing' pressure, i.e. the reduction in the requirement of workers by the introduction and use of labour saving machinery or by both. In Britain, the pulling force was, however, the primary cause for the

out-flow of farm workers and it started operating first, followed by pushing pressure later.

Until the outbreak of World War II, such pushing pressure was not at all very strong in Scotland. This was because the uses of mechanical power and machinery for farming processes were not very common as they proved to be costly. Since the outbreak of World War II, mechanisation became progressive and started pushing the farm workers out of farms effectively.

The number of agricultural workers fell by 19 per cent. between the years 1939 and 1959. This does not appear to be a very high fall in comparison with the progress of mechanisation. The reasons for this may be that the family workers are less susceptible to any force or pressure; specialised machines, such as combine harvesters, potato harvesters, etc. are more effective in reducing only casual labour requirement than regular labour requirement as evident from a comparatively lesser fall in the proportion of regular workers than that of casual workers and Scottish farming may still be in the first phase of mechanisation where the effect of mechanisation is to lighten the work rather than to reduce labour requirement.

Mechanisation has been, however, proved to be more effective in reducing labour requirement in crop farming than in livestock farming in Scotland as evident from comparatively higher proportion of fall of workers in the crop producing counties than that of the livestock producing counties. This has been the general trend although there are certain exceptional counties which do not follow the same trend due to specific reasons.

The change in the make-up of the labour force, such as increase in the proportion of tractormen and simultaneous decrease in the proportion of horsemen and general workers has been influenced by the level of wages, the nature of requirement by farmers and by mechanisation as well.

TABLE 25

VALUE OF TENANT'S CAPITAL

	1948		1949		1950		1951		1952	
	Amount £ (Million)	p.c.	Amount £ (Million)	p.c.	Amount £ (Million)	p.c.	Amount £ (Million)	p.c.	Amount £ (Million)	p.c.
Machinery and Equipment	30.9	21.2	35.0	21.4	39.0	22.7	42.8	23.8	48.0	24.7
Livestock	86.0	58.8	96.3	58.8	101.5	58.7	105.6	58.3	112.2	57.7
Total 1 + 2	(116.9)	(80.0)	(131.3)	(80.2)	(140.5)	(81.4)	(148.4)	(82.1)	(160.2)	(82.4)
Stores, Cultivations & Improvements & Others	22.4	15.3	23.2	14.1	23.3	13.3	23.1	12.7	23.8	12.3
Crops & Produce	6.9	4.7	8.8	5.7	8.5	5.3	9.1	5.2	10.5	5.3
Total 4 + 5	(29.3)	(20.0)	(32.0)	(19.8)	(31.8)	(18.6)	(32.2)	(17.9)	(34.3)	(17.6)
al Tenant's apital	146.2	100.0	163.3	100.0	172.3	100.0	180.6	100.0	194.5	100.0

ource: (1) Scottish Agricultural Economics, Vol. VI.
(2) Department of Agriculture and Fisheries for Scotland (in private correspondence)

1953		1954		1955		1956		1957		1958	
Amount £ (Million)	p.c.	Amount £ (Million)	p.c.	Amount £ (Million)	p.c.	Amount £ (Million)	p.c.	Amount £ (Million)	p.c.	Amount £ (Million)	p.c
52.6	24.4	57.1	24.8	58.7	24.5	60.4	24.8	61.5	23.6	62.6	23.8
129.0	59.5	137.9	60.0	144.1	61.0	146.1	60.6	161.3	62.1	162.9	62.6
(181.6)	(83.9)	(195.0)	(84.8)	(202.8)	(85.5)	(206.5)	(85.4)	(222.8)	(85.7)	(222.5)	(86.4
23.6	10.5	23.3	10.0	24.8	10.7	24.7	10.3	24.9	10.1	24.9	9.7
12.0	5.6	11.5	5.2	9.4	3.8	9.7	4.3	11.6	4.2	9.9	3.9
(35.6)	(16.1)	(34.8)	(15.2)	(33.6)	(14.5)	(34.4)	(14.6)	(36.5)	(14.3)	(34.8)	(13.6
217.2	100.0	229.8	100.0	236.4	100.0	240.9	100.0	259.3	100.0	260.3	100.0

Tenant's Capital

A feature of Scottish farming in the last two decades, as revealed by Table 25, has been a tremendous increase in capital investment. It is evident from the Table that tenant's capital investment rose from 146.2 million pounds in 1948, by 78 per cent. to 260.3 million pounds in 1958. Among the various items on which capital has been invested, rate of investment on machinery and equipment appears to be most striking. While investment in machinery and equipment rose from £30.9 million in 1948 by 102.0 per cent. to £62.6 million in 1958, investment in non-machinery items rose from £115.3 million in 1948 by 71.4 per cent. to £197.7 million in 1958.

Another noteworthy feature of this capital breakdown appears to be that, despite the tremendous increase in investment in machinery and equipment, this item comprised only a slightly larger proportion (i.e. 23.8 per cent.) in 1958 than it had (i.e. 21.2 per cent) in 1948. The reason for this is, according to Ashby (5), that for machinery and equipment the increase in the volume of the investment has been caused more by volume increase than by a price increase, whereas

for the other items the opposite is true.

Justification of this heavy capital investment in recent years needs to be assessed from the point of view of turnover, an analysis of which will be made in the succeeding section.

TABLE 26

ESTIMATES OF THE MAIN OUTLAYS BY SCOTTISH FARMERS.

£m.

	1948/49		1949/50		1950/51		1951/52		1
	Amount	p.c. (a)	Amount	p.c. (a)	Amount	p.c. (a)	Amount	p.c. (a)	Amou
Labour - Salaries and Wages	27.2	33.9	27.3	30.2	28.1	28.7	30.2	28.4	30.3
Insurance	1.1	1.4	1.1	1.2	1.1	1.1	1.1	1.1	1.2
(Total)	(28.3)	(35.3)	(28.4)	(31.4)	(29.2)	(29.8)	(31.3)	(29.5)	(31.5
Rent	4.6	5.7	4.8	5.3	4.9	5.0	5.1	4.8	5.4
Interest	0.8	0.9	1.0	1.2	1.1	1.1	1.4	1.3	1.7
Machinery - Depreciation	4.8	6.1	5.4	6.0	6.2	6.3	6.8	6.4	7.4
Repairs	4.5	5.6	5.1	5.7	5.8	6.0	6.2	5.9	6.3
Fuel and Oil	2.5	3.1	2.9	3.2	3.9	4.0	4.9	4.6	5.5
Miscellaneous	0.7	0.9	0.7	1.1	0.8	0.8	0.9	0.9	0.9
Contract Service	1.9	2.4	2.1	2.3	1.8	1.9	1.2	1.1	1.4
(Total)	(14.4)	(18.1)	(16.2)	(18.1)	(18.5)	(20.0)	(20.0)	(18.9)	(21.5
Feedingstuffs	6.0	7.4	10.8	11.9	13.0	13.2	15.7	14.7	16.5
Seeds	4.0	5.0	4.1	4.5	4.4	4.5	4.4	4.2	4.5
Lime (Gross Cost)	1.7	2.1	2.0	2.2	2.1	2.2	2.1	2.0	2.
Fertilizers (Gross (Cost)	7.1	8.8	8.3	9.2	10.2	10.4	10.0	9.4	9.
Store Livestock	6.0	7.4	6.0	6.6	5.3	5.5	6.1	5.7	7.
Miscellaneous	7.5	9.3	8.6	9.6	9.1	9.3	9.9	9.5	10.
Total	80.4	10.0	90.2	100.0	97.8	100.0	106.1	100.0	110.

(a) Proportion of the cost (on respective items) out of the total costs.

Source: Department of Agriculture and Fisheries for Scotland (in private correspondence)

Estimate of Main Outlay

Operational costs on Scottish farms increased from £80.4 million in 1948/49 by 94.4 per cent. to £156.3 million in 1960/61 (Table 26). While the costs of labour rose from £28.3 million in 1948/49 by 35.5 per cent. to £38.4 million in 1960/61, operational costs of machinery concurrently climbed up from £14.4 million in 1948/49 by 115.2 per cent. to £31.0 million in 1960/61.

Other features of considerable interest are that while the proportion of costs of labour to total costs was 35.3 per cent. in 1948/49, the same dropped to 24.4 per cent. in 1960/61; the proportion of operational costs of machinery rose very slightly from 18.1 per cent. in 1948/49 to 19.8 per cent. in 1960/61.

Analysis of Input and Output Ratio

One gets the impression at first sight from the figures relating to the tenants' capital and estimates of main outlays that the capital requirement for the agricultural industry in Scotland has been increasing at a very high rate, justification of which needs to be assessed.

The value of gross output of Scottish agriculture rose from £104.931 million in 1948/49 (Table 27) by 59 per cent. to £166.841 million in 1960/61. This feature appears to suggest that highly mechanised agricultural industry in Scotland, which has involved such a heavy capital investment, is justified. But such a conclusion is misleading. This is because return in terms of net income is really the appropriate index to assess the justification of any scale of investment.

Statistical figures relating to the net farm incomes in Scotland for all the years, are however not available. The information so far available from the Department of Agriculture and Fisheries for Scotland (in private correspondence) covers the space of only seven years from 1954 onwards, and is as follows:- (Page 126).

£ (000)

TABLE 27

GROSS AND NET OUTPUT OF SCOTTISH AGRICULTURE AT CURRENT PRICES*

	1948/49	1949/50	1950/51	1951/52	1952/53	1953/54
s Output - Total	104,931	116,120	117,418	133,515	147,797	148,681
Output - Total	88,609	94,926	94,513	107,069	119,403	114,673

GROSS AND NET OUTPUT OF SCOTTISH AGRICULTURE AT CONSTANT (1945/46) PRICES*

	1948/49	1949/50	1950/51	1951/52	1952/53	1953/54
s Output - Total	80,653	96,343	85,416	86,705	93,795	93,339
Output - Total	66,833	71,710	71,183	71,895	78,523	76,769

* Incorporating revisions up to February, 1961.

Source: Department of Agriculture and Fisheries for Scotland, (in private correspondence).

Total Net Incomes* of Farmers in Scotland

Year	£m
1954-55	40.6
1955-56	40.7
1956-57	50.0
1957-58	47.8
1958-59	38.9
1959-60	38.1
1960-61 (forecast)	38.5

---

* Net income is normally calculated by subtracting costs of production from gross incomes. There are certain elements, e.g. some subsidies and grant not included in the published figures of costs and gross incomes, for Scotland, and they will have been included in the calculation of the above figures.

TABLE 28

NET AND GROSS INCOMES FOR EVERY £100 OF TOTAL COSTS

Year	Total Cost of Production	Net Incomes**	Gross* Incomes	Net Incomes per £100 of Total Cost	Gross Incomes per £100 of Total Cost	
	£m	£m	£m	£	Yearly £	5 Yrs. Aver. £
1948 - 49	80.4	-	104.9	-	137.4	
1949 - 50	90.2	-	116.1	-	123.7	
1950 - 51	97.8	-	117.4	-	114.2	126.8
1951 - 52	106.1	-	133.5	-	125.8	
1952 - 53	110.9	-	147.7	-	133.1	
1953 - 54	122.6	-	148.6	-	-	-
1954 - 55	128.7	40.6	149.0	31.5	-	-
1955 - 56	135.8	40.7	153.3	29.9	-	-
1956 - 57	141.1	50.0	165.7	35.4	117.4	-
1957 - 58	147.4	47.8	169.0	32.4	114.6	
1958 - 59	152.2	38.9	168.5	25.5	110.7	111.6
1959 - 60	154.5	38.1	168.1	24.6	108.8	
1960 - 61	156.3	38.5	166.8	24.6	106.7	

* Gross Incomes mean the value of gross output. ** Net income is normally calculated by subtracting costs of production from gross incomes. There are certain elements, e.g. some subsidies and grants not included in the published figures of costs and gross incomes, for Scotland, and they will have been included in the calculation of the above figures.

It appears from Table 28 that the total net agricultural incomes in Scotland shrunk from £40.6 million in 1954/55 to £38.5 million in 1960/61.

By contrast, as has already been mentioned, the cost of production increased during that period and the combined effect of these factors lead to the fall in net incomes for every unit of cost as revealed in Table 28.

The net incomes for every £100 of costs declined from £31.5 in 1954/55 to £24.6 in 1960/61.

Although the number of years dealt with is not large enough to infer anything definite, there appears to be an undoubted tendency for incomes to fall. Even in terms of gross incomes*, information of which is available for a longer period, the same tendency is evident from the fall in gross incomes per £100 of costs from £126.8** to £111.6*** (Table 28). In terms of gross incomes for every £100 of tenants' capital the trend of fall of incomes is also substantial (Table 29).

---

* Gross incomes mean the value of gross output.

** Relates to the average yearly incomes of five years beginning from 1948/49.

*** Relates to the average yearly incomes of five years beginning from 1956/57.

TABLE 29

RETURN ON TENANT'S CAPITALS - SCOTLAND

Year	Tenant's Capital £m	Gross Income £m	Gross Income for every £100 of Tenant's Capital
1948	146.2	104.9	71.7
1949	163.3	116.1	70.0
1950	172.3	117.4	68.1
1951	180.6	133.5	73.9
1952	194.5	147.7	75.9
1953	217.2	148.6	68.4
1954	229.8	149.0	64.8
1955	236.4	153.3	64.8
1956	240.9	165.7	68.7
1957	259.3	169.0	65.1
1958	260.3	168.5	64.7

At the same time, costs, as percentage of gross incomes, (Table 30) climbed from 76.6 per cent. in 1948 to 93.7 per cent. in 1960, which suggests that the cost of production has gone higher in comparison to the return.

TABLE 30

GROSS INCOMES AND OPERATING AND OVERHEAD COSTS - SCOTLAND

Year	Gross Incomes £m	Operating and Overhead Costs £m	Cost as percentage of Gross Incomes
1948	104.9	80.4	76.6
1949	116.1	90.2	77.6
1950	117.4	97.8	83.3
1951	133.5	106.1	79.4
1952	147.8	110.9	75.0
1953	148.6	122.6	82.5
1954	149.0	128.7	86.3
1955	153.3	135.8	88.5
1956	165.7	141.1	85.1
1957	169.0	147.4	87.2
1958	168.5	152.2	90.3
1959	168.1	154.5	91.9
1960	166.8	156.3	93.7

The reasons for these developments are presumably more complex. While variation in yield from year to year might have some effect on incomes, it would be unlikely that such effects would result in a steady downward trend. Some other factors therefore appear to be responsible for these developments. Price relationship between input and output, for example, appears to be an important indicator in assessing the price-cum-income circle. It is a matter of general experience that when prices of input rise faster than that of output, the rate

of turnover declines. The trend of declining rate of turnover in Scotland therefore suggests that prices of inputs rose faster than that of output. In other words, terms of trade* have been against farmers. It has been estimated and statistically shown by Hendry (26) (Table 31) that prices moved appreciably in favour of farmers from 1945/46 to 1948/49 but a movement in the opposite direction began thereafter.

TABLE 31

THE "TERMS OF TRADE"* FOR SCOTTISH FARMERS

Year	Hill Sheep	Stock Rearing	Stock Rearing & Feeding	Arable	Dairy	General Index
1945/46	100	100	100	100	100	100
1946/47	97	99	98	97	104	100
1947/48	110	107	103	100	105	104
1948/49	114	109	104	101	107	106
1949/50	116	107	101	98	102	103
1950/51	107	101	99	97	98	99
1951/52	137	107	99	96	93	101
1952/53	131	105	95	91	94	99

* Revenues Index ÷ Expenditure Index.

Source: "The 'Terms of Trade' for Scottish Farmers, by G. F. Hendry, Published in Scottish Agricultural Economics (Vol. IV. Page 58) 1953.

Although Hendry's calculation on "Terms of Trade" was referred up to 1952/53, it is evident that terms of trade have all the time been against the farms from 1952/53 onwards. Hendry's later report supports this view. While analysing the relative rise in prices of input and output, covering the whole period of the fifties he (30) reported in 1961 that prices of agricultural products "rose much more rapidly in the period up to 1953 - average rate of increase in prices received by farms was 6 per cent. per annum compared with the average increase of 3 per cent. per annum from 1954 onwards.

Prices of inputs also increased during the whole period, slightly more rapidly than output prices at the beginning of the period, then moved rapidly, with some levelling off between the years 1956 and 1958. Prices were thus moving against farmers during the whole period. The rises in input prices had been so adverse to farmers, Shemilt (57) commented "they would have virtually eliminated the incomes of small farms and reduced the large ones by half. But the gain in physical efficiency on small and medium sized farms more than counter-balanced the

adverse effect of price changes". Along with the increasing physical efficiency, farmers have been presumably able to adjust their production pattern according to prices as evident from the growing emphasis on production commodities of high prices such as barley, pigs, milk and eggs etc. to minimise adverse effect of rise in input prices. On the whole, increasing rate in prices of inputs appears to have reduced farm incomes appreciably in spite of adopting different measures.

Financial Position

It is therefore evident from the analysis made in the last section that capital requirements for agricultural industry have been increasing enormously, with farm incomes no longer rapidly rising; return on capital investment is being automatically reduced. With regards to the effects of these upon the financial buoyancy of farmers, the position merits a closer examination.

Farmers maintain their existing capital intact and meet expenditure from ploughed back funds out of profits and from credits as well. When incomes fall, ploughed back funds out of profits become automatically reduced, farmers depend increasingly on credit. The fall in

in income in Scottish agriculture for the last few years therefore means less ploughing back of profit and more raising of fresh capital out of credit. It is to be noted from Table 32 that bank advances to farmers increased enormously from £7.54 million in 1938 by 451. per cent. to £41.64 million* in 1960 and this therefore appears to follow closely the rising trend of capital investment (Table 25). The implication of the development suggests that the incomes of farmers were not sufficient to maintain the existing capital intact and to cope with the increasing financial requirement for farming business, farmers require to borrow enormous sums each year.

---

* In addition to this, farmers might be obtaining loan from other sources, precise information of which is not available.

TABLE 32

BANK ADVANCES TO OWNER-OCCUPIERS AND TENANTS IN SCOTLAND

Year	Owner-Occupiers £	p.c.	Tenants £	p.c.	Total (Farmers) £	p.c.	Index
At 28th. May, 1938	-		-		7,547,503		100
" 1943	-		-		5,526,357		73
" 1950	-		-		15,611,400		207
" 1953	16,797,313	76.6	5,125,801	23.4	21,923,114	100	290
" 1954	18,732,377	79.2	5,222,130	21.8	23,954,507	100	317
" 1955	21,509,275	78.0	6,065,488	22.0	27,574,763	100	365
" 1956	21,993,644	78.2	6,118,543	21.8	28,112,187	100	372
" 1957	22,972,681	78.6	6,219,018	21.4	29,191,699	100	386
" 1958	22,670,103	79.8	5,703,058	20.2	28,373,161	100	376
" 1959	27,781,556	79.2	7,255,974	20.8	35,057,530	100	464
" 1960	33,691,405	80.8	7,957,846	19.2	41,649,251	100	551

Source: Scottish Agricultural Economics (Vol. VI, VII, VIII, X and XI)

These developments lead one to infer that farming is becoming capital intensive and to cope with the capital requirement, farmers, on many occasions, are required to undertake financial strain, justification of which may not be always unquestionable. Investment in mechanisation, which is one of the main factors involving such heavy capital investment, is of much significance in this context. It appears from the analysis, Table 25 and 26, that if farm prices and profits fall, investment in machinery will not necessarily contract. The incentive to increase mechanisation which arises from labour costs and scarcity will perhaps continue. It seems there will probably be a greater need for credit to finance the level of mechanisation and the agricultural industry as a whole, although one cannot help feeling that on many farms mechanisation has already been carried further than is economically justified.

Long (40) reported a case study in East Riding of Yorkshire where he found out from the analysis of farm records that twice the expenditure (in real terms) on machinery was required in 1957 compared with 1939 for a 'performance greater by only one-sixth'.

Re-organisation of farm policies now appears to be essential in order to get economic return from capital investment. To do so, an effective substitution of labour by mechanisation will of necessity be an important step.

Characteristic Feature of Mechanisation Relating to Agriculture

Mechanisation leads to a reduction of the cost of production, where production can be broken down into a number of repetitive motions which can be fairly continuous process of conversion of raw material into finished products. This type of production is much more common in manufacturing industry than in agriculture.

Secondly, it is a matter of common experience that although the economic benefit of using machinery arises largely through the substitution of machinery for labour, such substitution is on many occasions not in proportion due to the indivisibility factor of the power unit. A tractor, for example, has to be bought whether or not the units of farming are large enough to offer optinum utilisation of the tractor. It is true, especially in the case of small farms, that the cost of tractors are relatively high in comparison with their utilities in different farming operations throughout the year. Heavy capitsl investments

in machinery in these cases is unlikely to be justified. Jones (37) commented on this: "The immediate saving in labour cost might not be very great unless the whole series of farm operations is mechanised, thereby reducing the requirements for regular labour".

Mechanisation in British agriculture, it would appear, has not come to that stage where mechanical power can be effectively applied to almost all farming processes. Farmers frequently therefore require to maintain many more workers than would be actually required if the work were distributed uniformly throughout the year. And the seasonal nature of farm work is such a characteristic feature of the farming industry that such uniform distribution of labour is less possible at the moment without re-organising farm planning completely. So also is the case with machinery. Because of the lack of uniformities both as regards materials and operating conditions, the substitution of labour by machinery is much more difficult in agriculture than in industry.

"In a factory" Sturrock (64) for example, explained, "a new process that allowed a reduction of 10 per cent. in the number of man-

hours could easily be translated into a reduction of 10 per cent. in the Labour Bill. The factory manager with 100 workers could either sack ten of them or increase the output by 10 per cent. with the same staff. If a similar improvement took place on farms it might be much more difficult to turn this saving into cash. If the farmer has two men and gets rid of one, this is a reduction of 50 per cent. and this would be too much". It is therefore evident that substitution of labour by mechanisation at a proportionate ratio is a difficult proposition in practice; it is even more difficult to re-employ them productively.

But in an age of rapid technological advance like the present, improved techniques and the re-organisation of farms, are expected to be the most effective measures in substituting labour by machinery properly, and thereby reducing the cost of production substantially. In course of time it appears that Scottish farmers should be able to favourably adjust their capital investments to their incomes. Sturrock (64) also envisaged that intensive mechanisation will eventually show some economic

return. Lastly, it must be noted that in Scotland, mechanisation has at least replaced 110,816 horses between the years 1942 and 1959 and thereby has released 221,632* to 33,048 acres of land from fodder crops to human food crops.

Scope for Economics

When considering the cost of agricultural production it is necessary to analyse the economic advantage of mechanisation not only from a national point of view but from the point of view of individual farms as well. This section deals with saving of labour by different machines, mechanisation costs and efficiency, chiefly from the point of view of individual farmers.

Tractors:

The advantage of tractors leading to a lower labour requirement per unit of work done on individual farms can be shown in figures from the reference of Barker (6). From his studies the following findings are revealed:

"1 man with 2 horses and a furrow plough might plough $\frac{3}{4}$ - 1 acre per day.

---

* Calculation is based on the assumption that 2 - 3 acres of land are needed for the fodder for each horse (Westminster Bank Review 1949).

1 man with 1 wheeled tractor and a 2 furrow plough might plough 3 acres per day.

1 man with 1 Crawler tractor and a 5 furrow plough might plough 8 acres per day.

Similarly, one man can plant by hand one acre of potatoes per day if the ridges have been opened, but 2 men, one driving a tractor and the other tending an automatic 3 row planter, can open, plant fertilize and ridge as many as 8 acres in the same time".

A similar example can be quoted to support the fact that the mechanisation of a process leads to a lower labour requirement per unit of work done and that the larger the machine the greater the output per man, from studies done by Witney (72) on an arable farm in East of Scotland. He noted that output per worker became doubled within the period of 5 years. The reasons for this, he assessed, might be many management factors but much of the higher output was attributed to farm mechanisation which had enabled the farmer to reduce the staff on his regular payroll almost by half as "in place of the 18 men and 2 women formerly employed when there were 6 pairs of horses and 1 tractor on the farm now there are 4 tractors and 5 very elderly horses, the staff consisting of only 10 men".

Use of transplanting machine

There appears to be a considerable saving of labour if machines are used instead of hands in transplanting many crops, especially vegetables such as cabbages, brussel sprouts, cauliflowers etc. An investigation (73) in the East Midlands on autumn cauliflowers planted at 11,000 per acre with a 3 row machine operated by a gang of five showed that the jobs took 11 man hours per acre compared with 22 man hours per acre for hand planting by day work.

Harvesting by Binder and Combines

The rapid increase in the use of combine harvesters in Britain has already been mentioned and there can be little doubt that this trend will continue. The chief reason for using a combine harvester is the fact that the harvesting itself can be carried out effectively with a small gang of regular workers. A substantial saving of labour in favour of the combine method also serves as an economic inducement.

The result of the study made by Sturrock (61) at Cambridge on the work of the combine harvester and binder is mentioned overleaf. It shows a considerable saving of labour in

favour of the combine method.

Cut by Binder	per acre
(a) Crop - stacked and threshed	23.6 man hour
(b) Crop - threshed from field	14.6 " "
By 12 ft. self-propelled Combine	
(c) Straw stacked	9.3 man hour
(d) Straw burnt and ploughed in	5.3 " "

These figures suggest that if a farmer who had been stacking and threshing grain bought a combine and was prepared to burn the straw he could reduce his labour requirements from 23.6 to 5.3 man hours per acre, a decrease of 78 per cent.

Similarly, Culpin (15) quoted a study on combine and binder in the Eastern counties in England where it is noted that a saving of labour in favour of the combine method has occured. He gave the detailed account as follows:-

"Total labour requirements per acre in the Eastern counties in 1945 were 23.6 man hours for the binder method, 11.7 man hours for 5 ft. and 6 ft. cut combine harvesters and 9.3 man hours for self-propelled 12 ft. cut machines, due allowance having been made for sweeping and stacking straw after the combines. In the

south west in 1954 comparable figures were 20.9 man hours for the binder method, 7.1 man hours for 5 ft. and 6 ft. cut tractor-drawn machines, and 6.8 man hours for 8 ft. and 8 ft. 6 in. cut self-propelled.

In the Eastern counties in the difficult 1956 season the binder method required 28 man hours per acre of wheat and 26.3 for barley, compared with 8.9 and 8.7 for combine harvesting and collecting the straw by pick-up baler. Thus, taking a rough average of these sets of figures, labour cost for the binder method is 25 man hours per acre, compared with about 9 man hours for combining, including collection of the straw".

Sugar-beet harvester

The mechanical harvesting of sugar beet presents an indication of a fairly advanced stage of mechanisation in Britain. Studies in the West Midlands (35) have shown that on average 48 man hours per acre are required for the operations of pulling, topping and heaping alone by hand, compared with only $8\frac{1}{2}$ man hours per acre by complete harvester.

Potato Harvester

It has been discussed in previous chapter that the number of casual workers has declined

substantially. This development suggests that mechanisation has been appreciably effective in coping with the seasonal labour requirement. As far as potatoes are concerned, mechanisation of planting has progressed favourably, but casual labour is still largely used for lifting and dressing. Complete potato harvesters are being developed, but there are not many in use at the present day.

There have been few comparative studies of the labour requirements of various methods of harvesting. Some data, obtained in a survey in the Fens as Culpin (15) quoted, give an indication of the range of differences between spinner, elevator digger, in the conditions in which the harvester operates satisfactorily.

TABLE 33

LABOUR REQUIRED FOR HARVESTING POTATOES

WITH COMPLETE HARVESTER

ELEVATOR DIGGER AND SPINNER

	Complete Harvester (Chain Type)	1 - row Elevator Digger	P.T.O. Spinner
Labour Required	Man Hours per acre	Man Hours per acre	Man Hours per acre
Lift and Pick	9.9	18.8	30.5
Carting	5.9	7.3	8.9
Clamping	3.3	6.3	6.5
Harrowings, etc.	2.8	4.3	2.2
Total	21.9	36.7	48.1

Economy in the use of labour in harvesting potatoes by harvesters is therefore quite evident from the figures.

Costs

What effect do these figures actually have on cost structure? Undoubtedly, mechanisation pays where there is such a clear and substantial saving in direct labour costs over and above the additional direct machinery costs incurred.

Tractors

In the article 'Mechanisation and Management' Barker (6) presented an estimate where he showed that the cost of ploughing by tractor is much cheaper than ploughing by horses. He calculated that while the cost of ploughing by tractor amounts to only £1-3-4d. that with horses amounts to £2. Horsburgh (33), The Edinburgh School of Agriculture, in discussing the economic aspects of tractor work showed that the fuel costs of diesel tractors are lower than those of vaporising oil tractors. He presented his findings in tabular form as follows:

TABLE 34

A COMPARISON OF FUEL COSTS ON FARMS USING DIESEL TRACTORS AND THOSE USING V. O. TRACTORS

	Farms with all Diesel Tractors	Farms with mainly V.O. Tractors	Farms with all V. O. Tractors
Number of Farms	7	7	7
Average Cropping Acreage	296	294	245
Fuel Cost per 100 Cropping Acres	£71	£139	£165
Average Fuel Cost per farm	£210	£409	£404
p.c. Diesel	100	28	-
p.c. T.V.O	-	72	100

Av. Potential Saving £68 per 100 acres or £200 per farm. Potential Saving £94 per 100 acres or £230 per farm.

He concludes: "It is not difficult to understand from the figures in the Table why the diesel tractor has come so rapidly into favour in recent years. The superior fuel economy of the diesel tractor is undisputed. On farms still using mainly vaporising oil tractors a potential saving of £68 per 100 acres or an average saving of £200 per farm is indicated. On the one farm using all vaporising oil tractors the potential saving would be £94 per 100 acres or a total reduction in the annual fuel bill of some £230." This is the main reason why there is a marked shift from vaporising oil tractors to diesel tractors in Scotland in recent years as revealed in machinery statistics.

Potato-Planters

Culpin (15) made a comparative study on cost of planting of potato by hand and by the use of a simple planter of the hand dropper type and found that while the cost of planting per acre with the simple machine amounts to £1-15-8d. that hand planting amounts to £3-1-4d.

The estimate has been made in the following ways:-

TABLE 35

COST OF PLANTING POTATOES BY HAND AND BY SIMPLE MACHINE

	Cost per Acre					
	Hand Planting			Machine Planting		
	£.	s.	d.	£.	s.	d.
Ridging ($1\frac{1}{2}$ acres per hour)		5	4		-	
Planting (Labour cost)	2	8	-	1	4	-
Planting (Tractor cost)		-		-	8	-
Planter depreciation		-		-	2	8
Interest on Capital (Planter only)		-			-	
Covering (1 acre per hour)	-	8	-		-	
Total	3	1	4	1	15	8

The calculation has been made on the basis of the following assumptions:

Rate of planting by hand $\frac{2}{3}$ acre per man per day.

Rate of planting by machine $\frac{1}{2}$ acre per hour.

(With tractor driver and two operators)

Area planted annually 20 acres.

Combine Harvesters

Combine harvester is a good example of the economies resulting from mechanisation as reported in the comparative cases per acre for the binders and combine methods in the Eastern counties in 1956, were £7.17s. and £4.19s. per acre respectively.

From the report (72) of Edinburgh and East of Scotland College of Agriculture, more detailed picture on economies in both labour costs and total costs is revealed in Table 36.

TABLE 36

BARLEY COSTS IN EAST OF SCOTLAND

Items of Costs	Combine Harvester				Binder Harvester			
	Cost per acre			per cent	Cost per acre			per cent
	£.	s.	d.		£.	s.	d.	
Labour	1	3	3	21.5	4	7	5	68.1
Horse	-	-	3	0.2	-	2	2	1.6
Tractor	-	10	3	9.7	1	1	9	17.0
Combine	3	14	3	68.6	-	-	-	-
Hire of Threshers	-	-	-	-	-	17	2	13.3
Total	5	8	3	100	6	8	6	100

It is to be noted that besides showing the higher total cost involved in the binder harvester group, difference in labour costs between the two systems of harvesting is striking. Labour cost amounts to £1.3.3d. in combine harvester group whereas the same amounts to as high as £4.7.5d. in binder thresher group.

Cost of Operating a Forage Harvester

The uses of forage harvesters have been increasing, which suggests uses of forage harvests are likely to be economic. Turner (67) calculated the average cost of silage making by different methods in Scotland and found forage harvester is the most economic. The result of his calculation is as follows:

	Cost per ton of Silage s
Silorator	7 - 10
Buckrake	8 - 12
Pick-up Baler	15 - 20
Green crop loader	15 - 18

Cost per acre of Harvesting Sugarbeet by Different Methods

A survey in Yorkshire of the comparative costs of harvesting by hand, by simple two-stage harvesters and complete harvesters, in 1955 as Culpin (15) quoted, shows a substantial saving by using harvesters.

TABLE 37

COST PER ACRE OF HARVESTING SUGARBEET BY DIFFERENT METHODS

	Hand	Farmers Machines		Contractors
		Small	Complete	Complete Harvester
	£.s.d.	£. s.d.	£. s. d.	£. s. d.
Lifting & Topping: Manual Labour	8-9 -	3-14 -	1 - 4 - 6	-
Tractor	- 8 -	1-13 -	1 - 1 -	-
Horse	-	2-6	-	-
Implement Depreciation	- 3 -	1 - -	1 - 17 - 6	-
Implement Repairs	-	- 5-6	- 18 - 6	-
Total	9-0-6	6-15-0	5 - 1 - 6	7 - 2 - 6
Acreage Harvested by Machine			23	36½

Milking Machines

The investigation carried out by Sturrock (61) in 1947/48 also showed substantial saving of labour and labour cost. He found that the use of milking machines produced an average saving of 38 man hour per cow set against the cost of machines.

On the basis of this information he calculated as follows:-

Cost of 38 man hour @ 2/6d.....£4.15s.

Cost of Machine per cow.....£1.5.6d.

Net Saving.....£3.9.6d.

In his opinion such a saving of labour would enable a farm with a large herd to reduce his labour force from six cowmen to five.

The conclusion emerges that machines are, no doubt, efficient enough to reduce labour requirement and consequently labour costs from the point of view of individual cases, but many other factors are involved in the farming industry, as discussed before, which really do not help farmers to get full benefit of these machines. Unlike manufacturing industry, it is hardly possible in agriculture to lay down machinery and labour to a definite formula in practice in order to get maximum advantages. These lead farmers to maintain more labour than would be actually required if the economic benefits of machines were to be fully obtained.

But in course of time, with proper readjustment of farm planning, it is expected that the full economic benefits of mechanisation can be achieved.

Social Aspect - Improvement in Working Conditions

Further, it is perhaps worthwhile to remember that (whether or not any economic return is obtainable from mechanisation,) the sole criterion for assessing the merit of or the need for mechanisation, on the farm, is by no means always to save labour but to eliminate the drudgery of work as well. And there is no dispute that mechanisation reduces the drudgery of work, if not cost.

The effect of mechanisation in improving working conditions, e.g. shorter working hours, more leisure etc. is immense now in comparison with that of the nineteenth century when agriculture was practically unmechanised. Alderman (1) gave an account of the conditions of workers which appears to be extremely depressing in comparison with today's condition. He wrote that wages were extremely low accompanied by long working hours. Holidays were unknown. He further states: "No pay was given when there was no work and none when there was illness or accident. The farm worker had no insurance, no pension". These are, in brief, a few indications which reflect

the condition of farm workers in the last century. Today, not only the wage rates of workers have been enormously increased but the workers have established their rights to some leisure and normal working hours have become shorter. No longer is a holiday a rarity. Bank holidays and annual holidays with pay are now a feature of agricultural employment.

Many factors have contributed to this marked improvement in rural life and work. Social legislation sometimes hastened by pressure exerted by the workers' organisation and its influence on public opinion, has also played an important part in changing the situation.

But perhaps the changes within the industry itself have been most potent in improving country life, since the foundation of rural progress lies in agricultural prosperity. There has been consolidation of holdings, better methods of land drainage, more scientific cropping and also the progress of mechanisation. It is however the mechanisation of agriculture, to which the two wars gave such a great impetus, that is likely to be the greatest single factor influencing such changes on the farms and on the working conditions of workers.

Returning to the cost aspect of farming business it is evident now that any reduction in the cost of production (either by lowering wage rates or by increasing working hours or by reducing the period for leisure) at the expense of the dis-satisfaction of a large sector of the population does not appear to be really a true gain. Jones (36) also remarked that mechanisation cannot always be considered from the point of view of economic return alone. He stated "If the machines were removed there would be ample labour on the farm to hand milk without curtailing any other productive operation. The milking machines perform a very desirable function of reducing drudgery: but in this they fall into the same economic category as domestic machines where consideration of maximum utilisation, and cost and returns, hardly apply. It is partly used just to make life more pleasant or less unpleasant. In this the farmer is being entirely rational if he can ease his burden in this way....." He concluded that in agriculture, the machines are not possibly the pace makers but remain as helping hands when labour is scarce and prices are rising.

Better Financial Position of Workers

(From the point of view of social income)

The farmer, the landlord and the agricultural worker are the main partners of farming community and their respective share of the total income (which is known as social income) indicate their relative positions in agricultural industry.

TABLE 38

DISTRIBUTION OF SOCIAL INCOME IN EACH YEAR 1939/40 - 1958/59

(in Agriculture) (Scotland)

	Rent p.c.	Wages p.c.	Net Farm Income p.c.	Social Income p.c.
1939/40	19	38	43	100
1940/41	13	34	53	100
1941/42	11	36	53	100
1942/43	10	38	52	100
1943/44	10	45	45	100
1944/45	11	52	37	100
1945/46	11	54	35	100
1946/47	10	54	36	100
1947/48	9	54	37	100
1948/49	9	50	41	100
1949/50	9	49	42	100
1950/51	9	51	40	100
1951/52	9	50	41	100
1952/53	8	45	47	100
1953/54	8	49	43	100
1954/55	9	52	39	100
1955/56	9	53	38	100
1956/57	8	47	45	100
1957/58	7	46	47	100
1958/59	8	48	44	100

Source: Department of Agriculture and Fisheries for Scotland (in private correspondence).

Table 38 reveals that the share of workers to total social incomes expanded from 38 per cent. in 1939/40 to 48 per cent. in 1958/59. These suggest that workers have been constantly enlarging their share and in 1958/59 they became the major shareholder. These tend to reflect a marked improvement in their financial position.

It is, however, necessary to mention here while describing the trends of the shares of the three partners in social incomes, that all the rise in the proportion of share of workers has not been entirely due to higher wages, but in part to an increase in the number, at least up to 1950 when the number of workers employed was more than that of 1939. From 1951 onwards there has been, however, a continuous reduction of workers and this suggests that the increase in the share of farm workers from that time was entirely due to higher wage rates.

The role of mechanisation in relation to the improvement of the financial position of workers is perhaps more indirect than direct, although that does not necessarily mean that it is of little significance. Mechanisation reduces the labour requirement and thereby it

enables farmers to afford to pay higher wages to their workers. Mechanisation is, of course, not the only single factor involved in it, there are other factors inter-related with each other, but mechanisation is obviously one of them.

Summary

Scottish Agriculture has become capital intensive mainly due to mechanisation. The investment in machinery and equipment, for example, rose from £30.9 million in 1948 by 102 per cent. to £62.6 million in 1958. Similarly, the operational cost of machinery rose from £14.4 million in 1948 by 115.2 per cent. to £31.0 million in 1960/61 with not much decrease in labour costs.

This development along with the more rapid rise in prices of other inputs has led to the fall in both gross and net farm incomes per unit of cost of production and investment respectively and ultimately lowered the total net farm incomes from £40.6 million in 1954/55 to £38.5 million in 1960/61.

In this situation, the farmers are presumably under financial strain in order to be able to cope with the increasing financial requirement for the necessary investment.

Re-organisation of farm planning now appear to be essential. To do so, an effective substitution of labour by machinery will be essentially an important step. In agriculture, it is however rather difficult to adjust the requirement of machinery and labour to a

definite formula from the point of view of full employment. But the experiences of farm mechanisation in other countries, such as U.S.A. suggests that an effective substitution of labour by machinery is always possible in the course of progress of mechanisation.

It has been experimentally proved that tractors, and other machinery, reduce the labour requirement and thereby economise on labour costs substantially from the point of view of individual farms. Barker (5) for example, states that the requirement of 8 men to plough 8 acres per day with 8 pairs of horses can be reduced to only 1 man to plough the same area per day with 1 Crawler tractor.

Combine harvesters are a good example of the economies resulting from mechanisation as reported by Witney (72) in comparative costs per acre for the binders and combine methods in the East of Scotland in 1952 were £6.8.6d. and £5.8.3d. per acre respectively.

It is, however, less possible to obtain full economic benefit as discussed above from the national point of view immediately. But there is considerable scope in this respect in future.

Mechanisation needs also to be considered from the social angle. There is no disputing that mechanisation reduces the drudgery of work and lightens work.

CHAPTER IV

INDIAN AGRICULTURE AND MECHANISATION WITH REFERENCE TO LABOUR FORCE ECONOMIC AND TECHNOLOGICAL CONSIDERATION

Introduction

Although agriculture in India is the most important branch of national economy accounting for nearly 50 per cent. of the national incomes and employing 70 per cent. of the population, it is still a "depressed" industry, characterised by low productivity and low efficiency. Das (16) remarked "Agriculture in India is only 86 per cent. as efficient as the average production in the other countries of the world, but compared with most of the European countries it would be scarcely more than 50 per cent. as efficient".

When such is the condition of an industry is it any wonder that it fails to offer a reasonable standard of living to those who depend on it? "For what the husbandman produces is barely sufficient, Jussawalla (38) reported, "for himself and his family. There is no surplus to supply the market."

Reasons for this depression are many, and among them, unproductive methods of cultivation are signficant.

The mode of cultivation is so primitive even today that the common tillage implement used is still the wooden plough which does little more than scratch the surface of the soil. Harvesting operations are predominently performed by sickles, threshing by bullocks' feet and winnowing by the sole agency of natural wind. It is of interest, in this context to compare Indian conditions with those of western countries where agriculture has reached a high degree of productive efficiency. In Scotland, for example, the wooden plough went out of use in the middle of the eighteenth century (59), with the invention and introduction of the efficient Small's chain or swing plough. The reaper was designed and replaced the sickle for harvesting operations in the middle of the nineteenth century. A threshing machine with a straw binder was introduced in the fourth quarter of the last century. Most spectacular of all was that steam power was first applied to farm practices in the middle of the nineteenth century (69), and this began to be appreciated and accepted by farmers as the source of a cheap and efficient form of easily available motive power. Since then, modernisation of agriculture has proceeded rapidly through the invention and introduction of more improved machinery.

Internal-Combustion tractors came into use on Scottish farms at the time of World War I. These gradually replaced horses. In more recent times the introduction of extremely efficient machinery such as the combine harvester has been quite unique. It simplified many complicated, laborious and repetitive processes and combined them into a single operation.

It is therefore obvious that to keep up the development pace with the western countries and to improve its own farming conditions, India needs a complete turn over from its primitive way of agriculture. The introduction of technical knowledge to Indian agriculture is really of prime importance today, and thus it is necessary to take positive steps in this direction.

But here one has to be careful that any successful implementation of a scheme of modernisation for agriculture needs some pre-requisite conditions. It is to be analysed whether or not such conditions exist in the country concerned. India, for example, is an over-populated agricultural country where surplus labour itself constitutes a serious problem along with the problems of small and scattered holdings and the meagre financial capacity of farmers. One therefore

often wonders how a scheme of mechanisation can be implemented in these conditions without creating any upset and irregularity in present socio-economic structure of the country. It is understood that colossal unemployment could be created if mechanisation were introduced in India at the present moment, since there are extremely inadequate alternative employment opportunities where the labour replaced by mechanisation could be absorbed. What is more is that holdings are so small and scattered, financial capacities and resources of farmers are so inadequate, that any introduction of mechanical power to agriculture is hardly feasible or economically justified. On this basis it is suggested that at present the scope for introducing large scale mechanisation in India is extremely limited and indeed may not even be desirable.

But opinions vary very considerably on this point. Another school of thought considers that mechanisation will not create unemployment. It is further argued that if it creates any unemployment at all, it will be of a temporary nature. Mechanisation, in fact, gives birth to a series of new employment opportunities. In the

cloth manufacturing industry, for example, as Paranjpe (51) quoted, introduction of machine reduces half of the labour requirement to maintain the same amount of production. This looks at first glance like a clear loss. But the machine itself required labour to make it, so here as one offset, are jobs that would not have otherwise existed. Here is the case of creation of further employment opportunities. He quoted a more concrete case from the British history of industrial development.

In England, Arkwright invented his cotton-spinning machinery in 1760. At that time it was estimated that there were in England 5,200 spinners using wheels and 2,700 weavers - in all 7,900 persons engaged in the production of cotton textile. The introduction of Arkwright's invention was opposed on the ground that it threatened the livelihood of workers and the opposition had to be put down by force. Yet in 1787 - only twenty-seven years after the invention appeared - a Parliamentary inquiry showed that the number of persons actually engaged in cotton spinning and weaving has risen from 7,900 to 320,000, an increase of 44,000 per cent.

The views on the issue of the introduction of mechanisation to Indian agriculture and its consequences with especial reference to employment

of labour, appear to be therefore so varied and controversial that detailed analytical study relating to the labour situation, employment opportunities, financial capacities, sizes of holdings and other considerations seem to be necessary in order to assess the scope for mechanisation under Indian conditions.

Trend of Growth of Agricultural Population and Employment

The Census figures reveal that the agricultural population in India has increased strikingly during the last few decades. It rose, for example, from 102 million in 1921 to 249 million in 1951. It is worth noting here that the agricultural population in India comprises, owner cultivators, tenant cultivators, agricultural labour and unclassified classes of workers.

It is, however, the agricultural labour which is primarily the subject of discussion here.

In 1951 out of the total agricultural population, labour represented about 49 million. This infers a large expansion in the number of workers in recent years as is evident from the corresponding figures in previous years (Table 39).

TABLE 39

AGRICULTURAL LABOUR - INDIA

Year	Number (Million)
1882	7.5
1891	18.7
1921	21.6
1931	Over 33
1951	About 49

It reveals that agricultural labour constituted only 7.5 million persons in 1882, but rose to 18.7 million in 1891, 21.6 million in 1921 and over 33 million in 1931.

The information available from other sources as follows, also indicate a steady rise in the number of agricultural labour although those figures may not be identical with census figures due to lack of uniform procedure of calculation and definition. For example, the Planning Commission of India in 1956 (24) estimated that in the course of 50 years, from 1901 to 1951,

the working force* in agriculture rose from 73 million to 98 million, while the working force in non-agricultural occupation showed no change in number, as it stood at about the same figures (i.e. 44 million) as at the beginning of the century. These features generally involve an increase in pressure of population on land.

---

* For the purpose of the population census, a cultivator was distinguished from a 'cultivating labour' as a person who took the 'responsible decisions which constitute the direction of the processes of cultivation'. Broadly, all cultivating labourers were employees of cultivators. In rural life many individuals, whether farmers or artisans or labourers, have to eke out their existence by doing work of more than one kind and a person may be both a cultivator and a labourer or both an artisan and a labourer, doing what comes his way at a given time in the year. From this respect the definition of agricultural labourer adopted in the Agricultural Labour Enquiry, although not without its difficulties (1951), is likely to reflect the actual situation more closely. According to this definition an agricultural labourer is a person who, for more than half of the total number of days on which he actually worked during the year, worked as an agricultural labourer, on this definition the Agricultural Labour Enquiry revealed that about 30.4 per cent. of rural families were agricultural labourers, half of them being without land, and the rest being in possession of some land.

Second Five-Year Plan, Government of India.

The pressure appeared to have been created by increasing rate of growth of population coupled with inadequate employment opportunities in the non-agricultural sector. The latter development has led presumably to the declining proportion of population engaged in the non-agricultural sector as reflected from Table 40.

TABLE 40

PROPORTION OF POPULATION ENGAGED IN NON-AGRICULTURAL SECTOR

Year	p.c.
1880	13.0
1940	9.3

Source: Report of Nanavati (48)

Year	p.c.
1901	18.1
1941	11.3

Source: Reports of the All India Khadi and Village Industries Board (46)

Year	p.c.
1901	37.6
1951	30.9

Source: The Planning Commission of Government of India (24)

The existence of unemployment and under-employment of agricultural labour which prevails in India today appears to bear a close relation with this development. Lack of adequate alternative employment opportunities in the non-agricultural sector appear to have exerted such a heavy pressure of population on land that it has led to a tremendous over-crowding on agriculture, resulting in under-employment and unemployment.

It is therefore necessary to assess how far the growth of industries will be effective through different development programmes which are now under operation to relieve the pressure of population on land by providing employment to the surplus agricultural labour in non-agricultural industries and thereby create the condition for farm mechanisation. Any such assessment needs to be, however, commensurate with the Survey on the magnitude of unemployment and under-employment of labour in the first instance and with which the next Section deals.

Unemployment and Under-Employment

The Indian Agricultural Labour Enquiry Committee made a very exhaustive Survey of the employment situation in 1951 and submitted its report (22). The report is very informative and useful for the study of any problem associated with agricultural labour in India. Some information is also available from other sources for this purpose.

From the report, it appears that Indian agricultural labour gets paid employment for only 7 months in a year. Of the other five months, they remain totally unemployed for more than 3 months and self-employed* for less than 2 months. As many as 85 per cent. of agricultural labour have only casual work, mostly in connection with harvesting, weeding, preparation of soil and ploughing and their total number of working days are only 100 days in a year. This high level of unemployment, as investigated, is chiefly due to the want of work. On an average want of work accounts for more than 74 per cent. of the number of days unemployed. Some 16 per cent. of agricultural labour has no wage earning employment at all during the year.

---

* (Self-employment is often considered deceptive employment in the sense that within itself, it might have an element of disguised unemployment).

In terms of actual unemployed persons, Labour Enquiry Committee assessed that 2.8 million agricultural labour might be totally unemployed in rural areas. The estimate produced by Nag (47) however, showed a much higher figure. The number of unemployed labour according to his estimate amounts to 9.8 million.

Besides unemployment, under-employment is also a significant factor which needs to be analysed. The precise statistical information on under-employment is, however, inadequate. The only information available from the report of the Planning Commission of the Government of India (24) presents some statistical figures which might serve as a rough indication. According to the report, one-fourth to one-third of the existing labour force in agriculture may be considered as surplus to its requirement. In other words, it means that the present level of production can be maintained with about 65 to 75 per cent.of the number of workers now engaged in agriculture. This gives some indication of the enormity of the problem of unemployment.

Employment Opportunities

The Planning Commission of the Government of India in 1956 (24) estimated that in spite of an ambitious plan for creating large scale employment opportunities, there is likely to be no marked improvement in the employment situation by 1961. It is expected that the employment opportunities will be expanded so as to provide employment to only 9.5 million persons (7.9 million in non-agricultural pursuit and 1.6 million in agricultural pursuit) out of a total 15.3 million unemployed persons (6.3 million in urban areas and 9.0 million in rural areas). This meant that the rest, 5.8 million persons in rural areas were going to remain unemployed by 1961, in spite of all developments.

The issue of mechanisation against this background raises controversial views. One school of thought considers that a sad consequence is inevitable if any attempt to mechanise agriculture is made abruptly. Another school of thought argues that mechanisation eventually involves large scale employment opportunities. Both views, however, need to be discussed in order to assess the impact of mechanisation on labour.

Case for Mechanisation

Bhattacharjee (10) an eminent Indian Economist is of the opinion that a severe repercussion on existing social and economic conditions of India appears to be inevitable if Indian agriculture is rationalised abruptly. Mechanisation of agriculture, according to his estimate, is likely to push out as high as 60 per cent. of the working population in agriculture and thus India would hardly be able to stand the full strain of it without attending social or economic dangers. He suggested, however, a slow policy in the matter of mechanisation and to correlate its speed with the progress of industrialisation. Another Indian economist such as Singh (60) also holds the same view. Even the views of western economists like Jones and Coolman, Williams and others who had considerable experience in under-developed economics appear to support the same line of thought.

Jones (37) remarked: "where farm labour is already under-employed such mechanisation is undesirable from most points of view..... furthermore the displacement of farm labour where there is no adequate alternative work creates a further problem of unemployment".

Continuing the same discussion he concluded: "Farm mechanisation is most likely to be profitable both to the farmers and to the economy as a whole when the demand for labour from other sectors of the economy is strong".

Laying down the criterion for the use of machines in agriculture, Agarwal (3) quotes Dauson's remarks: "in a country where machines are cheap while labour is expensive, the introduction of labour saving implements will generally result in a direct saving of outlay: even if it does not, the additional expense is so small and the need for economy in labour so great that its use is economical. If this criterion is applied to India it is noticed that machines are expensive as most of them are imported, fuel is costly, labour is cheap and unskillful in the use and care of machinery". This is, however, an economic aspect of mechanisation which will be dealt with in detail later. From the point of view of increase in production, it is agreed that production can be increased by other measures such as use of better seeds, fertilizer and assured supply of water by irrigation etc. apart from using mechanical power. In other words, as Coolman and Williams (13) remarked "in many under-

developed areas the mechanisation problem is not yet relevant. Other measures for increasing productivity will have priority in these areas. Mechanisation has no pressing urgency because of the abundant supply of labour which cannot be reduced over a short period".

The aggregate of views of experts along with substantial statistical information so far presented, tends to lead one to infer that the effects of large scale mechanisation under present Indian conditions will be more of employment reducing and which is, of course, not desirable. But such an inference does not appear to be complete unless due attention is given to the opinion of others who hold different views.

Among them Paranjpe (51) is a leading one. He argues that it is true that mechanisation is likely to create unemployment in the first instance, but such an unemployment is short lived. Eventually the displaced labour will be absorbed in other industries since mechanisation of one industry accelerates employment opportunities in other industries. As for example, mechanisation of agriculture leads to the expansion of tractor and machinery manufacturing industries.

Scope for providing employment to displaced labour from agriculture therefore appears to lie in the development of manufacturing industry, accelerated vigorously by the increasing demand for tractors and machinery for the expansion of farm mechanisation.

Although the argument appears reasonable, it would seem to be more theoretical and thus is less likely to be applicable to Indian conditions. It has already been pointed out that the expansion of manufacturing industry which includes manufacturing of farm machinery and implements, is not expected to proceed so fast as to absorb by far the major portion of natural growth of the population and backlog of unemployed. Opportunities to provide employment to additional workers if displaced by mechanisation appear to be therefore remote.

Most vital point of his argument is however still to be discussed. This is about the economic significance of full employment and full production and their relative importance to national economy. He stated: "The real objective of different activities in agriculture is to maximise production. In doing this, full employment - that is absence of involuntary idleness-

becomes a necessary by-product. But production is the end, employment is merely means. We cannot continuously have full production without full employment. But we can very easily have full employment without full production.

Although China and India are, comparatively speaking, poorer than many countries, the main trouble from which they suffer is primitive productive methods and not unemployment. Nothing is easier to achieve than full employment once it is divorced from the goal of full production and taken as an end in itself". He further argued "It would be far better if that were the choice - which it is not - to have maximum production with part of the population supported in idleness by undisguised relief, than to provide full employment by so many forms of disguised make - work that production is disordered. The progress of civilisation has meant the reduction of employment, not its increase. It is because the world is becoming increasingly wealthy as a whole that we are in a position to reduce child-labour, to remove the necessity of work for many of the aged and to make it unnecessary for millions of women to take jobs. The question is not so much

whether there would be an increase in the number of jobs, but rather whether there would be an increase in production and what in consequence would be the standard of living. The problem of distribution is more easily solved, the more there is to distribute. In contrast to this is the opposition of mechanisation".

The argument no doubt appears to contain some substantial academic thought but in practice it is a debatable point whether or not such an achievement of full production at the cost of shrinkage of employment under Indian conditions is desirable. There is perhaps good reason to apprehend that full production whatever its economic implication might be, at the cost of unplanned displacement of labour is of no use for the overall benefit of the country. From a social point of view, implementation of such a proposal of full production will probably lead to the social discontent of a serious nature. Considering all the pros and cons the Planning Commission of India in 1956 (24) came to this conclusion that "in agriculture, except under certain conditions, in the present stage of development the possible economic advantages of mechanisation may be more than offset by the social costs of unemployment that such mechanisation would involve".

Laying down the condition for mechanisation, Campbell (12) pointed out that mechanisation proceeds smoothly under such a condition of an area where industrial employment opportunities are strong enough to pool the surplus population from land.

Another Indian Economist, who like Paranjpe advocates immediate introduction of mechanisation to Indian agriculture, is Sayanna (54). He does not seem to be in agreement with those who maintain that mechanisation will create unemployment. His argument is based on the experiences of western countries. In western countries such as Britain he stated that introduction of mechanisation was never objected to or disapproved of on the ground that it would create unemployment. On the contrary, British experience showed that the adoption of machinery for agriculture made good for the loss of labour absorbed by industries and towns. Introduction of machinery has enabled the worker to produce many times more than what he can otherwise do by hand.

He critised the arguments of opposing schools of thought as a mere fallacy comparable to that of the predictions made by some people

at the beginning of the Industrial Revolution that industrial mechanisation was bound to create severe unemployment. But history of industrial revolution in Britain dis- proved this. Mechanisation, in fact, gave birth to a series of new employment opportunities. Mechanisation of one industry led to the development and expansion of more employment opportunities to other industries.

Sayanna indeed argued in a systematic and attractive way but he appeared to have overlooked two important considerations which tend to weaken his case.

In the first place it is misleading to make any comparison when the conditions of the two countries are not alike. Britain, for example, is now a highly industrialised country in the world. She started developing her manufacturing industries in the middle of the nineteenth century. To cope with this development, enormous requirement for labour became urgent and essential, and which, in turn, started drawing labour from the land by offering them better pay and amenities. The introduction of labour saving machinery to agriculture then became necessary to make up the loss of workers from land.

It is worthwhile to mention here that even in Britain before World War II, the progress of mechanisation was comparatively slow, although tractors existed even before World War I. The reason for this as Mejer (45) found was that there was never a real shortage of labour in British farming. The shortage of labour in agriculture as compared with the requirement for maintaining necessary agricultural production in Britain was really felt for the first time during the period of the Second World War. This was the main economic reason as can be broadly said behind the remarkable progress of farm mechanisation during the war and post-war period in Britain.

The significant point therefore emerges that adequacy of farm labour has always a retarding effect on the growth and progress of farm mechanisation even in a highly industrialised country. This feature is very significant, even if the issue of farm mechanisation in India is viewed in the light of British experience, although British conditions differ very considerably from those of India, as discussed before.

Starting from the very beginning, the condition of two countries - Britain and India - had and still have no close similarity. On the contrary, the difference between them is sometimes so wide that any formula or measure which applies to one country with success may fail to other countries. India, for example, unlike Britain, had no significant and developed manufacturing industries (which pulled surplus population from agriculture) in the past and even today, she is not an industrially developed country. Pressure of population on land is extremely high with no avenue for alternative employment. Adoption of machinery for agriculture which became necessary in Britain to substitute the loss of labour absorbed by expanding industries, is therefore likely to be more of an injurious employment reducing method under Indian condition. It is true that in Britain, mechanised cultivation has increased production remarkably and the same will probably prove true in India but it is unlikely that there is any economic point in mechanising farm operations if the only result is that the existing farm labour remains on the farm, but has less work to do.

Turning to the second point, Sayanna quoted the reference of industrial mechanisation which, in fact, does not seem to have any relation with

with farm mechanisation. The use of machinery in industry reduces the requirement of labour strikingly whereas use of machinery in agriculture cannot reduce the requirement of labour to that extent for one reason or another. In agriculture, for example, it is less easy to make it possible to mechanise all operations and thus a substantial number of labour is always maintained to meet the seasonal requirement, despite maintaining all necessary machinery. A large tractor plough is of little use for anything apart from plougning yet it cannot be profitably used during much more than one-third of the year. A combine harvester is equally specialized, and its period of use is even more restricted. Furthermore, such a machine can reduce labour requirements only on a specific task.

So in agriculture, unlike industry, processes can hardly be planned from the point of view of utilization of machinery. This leads to a less effective substitution of machinery for labour in agriculture than in industry.

It is also significant that mechanisation of one industry leads to the mechanisation of other industries and thereby offers more

employment opportunity. It is less likely in agriculture.

It is therefore apparent that the nature and consequences of farm mechanisation and industrial mechanisation are so different that they are hardly comparable. Example of the history of the progress of industrial mechanisation therefore hardly applies in the case of farm mechanisation. It seems that Sayanna did not place any importance on these points.

Lastly, it is perhaps not irrelevant to quote here two instances where unplanned attempts of mechanisation to agriculture were met with sad consequences.

One was in Hungary and the other was in Turkey.

In Hungary, before World War II as Warriner (68) reported, that costly mechanical ploughing was tried to agriculture when labour was surplus and cheap. This brought an effect in creating colossal unemployment. Socio-economic structure of the country was severely affected. It is significant to note here that social and economic condition of Hungary in pre-war period had a close similarity with that of India today. Warriner commented that Hungarian

example proved what was obvious, namely mechanisation of agriculture which was out of step with the progress of the non-agricultural part of the economy could not be successful.

Incidence in Turkey happened during post-war period and was a comparatively recent one. Turkish experience is an important precedent from the point of view of India, since both the countries are agricultural Asiatic countries with similar social and economic make-up.

Large scale mechanisation was introduced in Southern province of Turkey as Robinson (53) reported, with a view to stepping up the production of cotton which was an export earning commodity. But the result was that it brought discriminate advantage and profits to landlords only at the cost of share-croppers who fell to a cadre of more casual worker. Whole fabric of the village community was broken down.

Both the examples illustrate that unplanned and haphazard attempts at mechanisation are likely to be more injurious than beneficial. But it does not at the same time mean that there is any prejudice and unjustified condemnation of mechanisation; it rather highlights the necessity of a careful and cautious plan for

mechanisation before any such attempt is made. It will be discussed later that a move has been taken to intensify agricultural production by adopting different measures including mechanisation but they are all essentially designed without interrupting present socio-economic conditions to the extent of upsetting the existing balance.

ECONOMIC CONSIDERATIONS

The point has already been touched on that the financial capacity and resources of an average Indian farmer are far below the financial requirements for the introduction of farm mechanisation. Mechanisation, as has already been discussed, means a heavy capital investment, as for example, light four wheeled tractor with accessories costs at least £600 - £700 and which is obviously beyond the financial means of an average Indian farmer whose net income does not generally exceed £25 or £30 per annum. This is, however, a broad generalisation. The financial aspect of farm mechanisation needs to be studied very analytically in the light and capacity of Indian farmers and with which this particular section deals.

Information available in this field is, however, limited although enquiries on cost of

production conducted by a few agencies appear very informative and useful. Some idea of the financial capacity of the farmers and the position of capital investment on farms might therefore be obtainable from these sources. Accordingly the following figures* obtained from the result of a Cost of Production Enquiry (19) conducted by Sreniketan, Visva - Bharati University, India, in 15 villages are being taken as an approximate index.

Certain features are quite interesting, as revealed by that enquiry (Table 41).

---

* Although the figures reflect the condition of 1946 but it is not likely that the condition has changed much even today.

TABLE 41.

CAPITAL INVESTED IN FARMS IN WEST BENGAL

Class of Farmers	Average Area Acres	Value of Capital Investment				
		Land	Cattle Shed	Bullocks	Implements and Accessories	Total
Per Tenant Farm	7.53	£414.5	£10.0	£51.2	£10.5	£486.2
Per Cropper Farm	5.13	£225	£ 7.5	£20.5	£ 6.5	£259.5
Per Farm of all Classes	6.30	£319.7	£ 8.7	£35.8	£ 8.5	£372.8
Per Acre of:						
Tenant Farms	-	£ 55	£ 1.3	£ 6.7	£ 1.3	£ 63.2
Cropper Farms	-	£ 43.8	£ 1.4	£ 3.9	£1. 2	£ 49.1
Per Acre of:						
Farms of all Classes	-	£ 50.7	£1. 3	£ 5.6	£ 1.3	£ 57.7
Percentage	-	85.8	2.3	9.6	2.3	100.0

Source: "Mechanisation of Agriculture in India - its economics" By J. P. Bhattacharjee. Published in "The Indian Journal of Agricultural Economics", Vol. IV, March, 1949.

It appears that the amount of working capital("bullocks and implements") invested per farm of all classes is of the order of £44.3.0. While further breakdown on the Table shows investments on the same account amounts to £61.7 per tenant farm, the same amounts to £27.0s. per cropper farm. It is worthwhile to classify here that tenant farms are those which are cultivated by hired, permanent or contract labourers, i.e. by persons other than those who act only as managers, whereas cropper farms are those which are cultivated and managed by the same person who in some cases is also the owner. Farms operated by owners themselves mainly with family labour fall under the latter class. Any way, the tenant farms are obviously better placed than the cropper farms with regard to the supply of working capital, as evident from high value of capital investment and this is quite natural in view of the larger size of the tenant farms and the better financial position of the tenants in comparison with the croppers. But even then tenant farms look very poor against the average farm in Scotland. In Scotland, the value of working capital invested per acre of average farm of all types was £16.8.

These figures, as for Scotland, given on last page, do not, it must be remembered, accurately reflect the real situation in the matter of mechanisation in as much as the value of working capital has been averaged for farms of all types including those which do not, by their nature, stand much in need of mechanisation. If, however, figures are worked out for arable and mixed types of farms, the volume of working capital would be presumably much greater. These two types, it should be mentioned, account for almost 99 per cent. of all farms in India. Any way, it is obvious that mechanisation demands a very large amount of capital investment, an amount much larger than the present volume of investment of working capital in farms in India. The figures for West Bengal, needless to add, are here being taken as representative of India.

Turning to the point of the financial position of particular class or classes of farmers from the point of view of requirement for mechanisation, it is noticeable that where taken solely on a per acre basis, tenant farmers would seem in fact to be financially capable of mechanising their farms. This assessment emerges from the figures on investment that working capital per acre (bullocks and implements) amounts

to £8 in case of tenant farms and thus it is higher than what is required to mechanise a farm. To mechanise a farm under Indian conditions Bhattacharjee (10) calculated that it would require investments at the rate of about £7.5 to £8 per acre. But, at the same time, the size of such tenant farms needs to be at least 40 acres or more in order to make such capital investment in mechanisation economically justified. Unfortunately, the number of such farms in India is very small. It has been surveyed that in West Bengal farms above 33 acres in size form 0.2 per cent. of total farms and account for 1.7 per cent. of the total farm land. Furthermore, these farms are small, scattered and fragmented, average size of farms range from 5 to 15 acres. So, even in the case of tenant farms, the average "Tenant Farmer" cultivating his 7.53 acres of land would not be able to spend, say £600 at a time for buying a tractor and accessories. The tenant farmers are better off than the 'cropper farmers'. For the average farmer, mechanisation is thus something beyond his reach. There appears to be also less possibility that conditions of Indian farmers will be improved as much as to enable them to incur

heavy capital investment in mechanisation within any short period.

Even in Scotland, where farmers are far more resourceful and wealthy, they are undergoing financial strain in order to cope with the increasing financial requirement for the necessary investment in mechanisation. But banks and other such agencies are their available source for obtaining credit and they, in fact, meet a substantial portion of requirement. Conditions in India in this respect are so different that they are hardly comparable with that of Scotland. The income of the average farmers is too much below the economic unit to offer him any possibility of mechanising his farm. There remains nothing which can be called savings at the end of the year. The credits that are available with a high rate of interest from unscrupulous moneylenders are mostly used to meet the requirements for consumption needs. While practically no credit is obtained for productive purposes, 58 per cent. of the farmers in Hooghly district and 68 per cent. of those in 24 Parganas district of West Bengal reported by Farm Management Enquiry Committee (23) are in debt.

Against this background the scope for mechanisation of individual farms appears to be extremely limited. But it is no exaggeration to say that the most important single factor in promoting economic development is the country's readiness to develop and apply technology to processes of production. Some ways and means must therefore be found to implement any schemes of mechanisation. Different proposals and schemes have been so far offered by a number of experts: the idea of co-operative ownership of capital and co-operative investments is one of them. The idea of co-operative approach to the financial and technical aspects of mechanisation sounds sensible and effective in an economically under-developed and densely populated country like India. The Royal Commission on Agriculture in 1942 (21) also recommended that successful implementation of schemes of mechanisation lie only in co-operative efforts. In its report it stated: "The use of large scale machinery such as steam tackle and motor tractors and indeed every form of power machinery is beyond the means of a small cultivator himself in the present condition (i.e. scattered and uneconomic holdings, his poverty, etc) and the only hope of placing it within

his reach, is by co-operative efforts". The Planning Commission of the Government of India in 1956 formulated a scheme (24) of co-operation in the mechanisation of farm practices and accordingly some substantial move has been already taken in this direction. It appears to be most likely that there is considerable scope for mechanisation of farming and agriculture in India on a basis of co-operation, while such scope is extremely limited on the basis of individual efforts.

It is also worthwhile to consider that contract use of machinery on the model in use in Sweden, Noray and also in Scotland (during war time) might be useful.

TECHNOLOGICAL CONSIDERATIONS

Adoption of mechanisation helps the farmers to increase productive efficiency of agriculture. It hastens the rapidity of work, completes the different agricultural operations in time and minimizes weather hazards and thereby offers a guarantee of production. Opinion, however, differs on this point. One school of thought argues that the use of tractors or engines may not themselves necessarily lead to efficient tillage although improved implements may ultimately be responsible for it. It is

suggested that under Indian conditions, improved implements drawn by bullocks are perhaps more suitable than those drawn by tractor power. The whole issue is vital since the very usefulness of what we call mechanisation is questioned and thus it needs to be discussed further.

To start with, Bomford (11) Chairman, Tractor Users' Association of Great Britain, presented a calculation showing that a medium sized Crawler tractor can increase output about eight times greater than what a team of three horses can normally do. This calculation is derived from the assumption as he stated "the ploughman with his three horses team controlled three horse-power. When given a medium sized Crawler tractor he controlled between twenty and thirty horse power. His output therefore went up in the ratio of about eight to one". The figures may or may not be acceptable by all as very accurate but it is likely to be agreed by all that tractors are capable of drawing heavy implements which, in turn, for example, pulverize the soil and perform inter-culture operations more efficiently and thereby increase yield per unit. This view is specifically supported by Gray as Bhattacharjee (10) quoted: "The agricultural machine like the industrial,

represents a new, more rational, combination of the simple components of an operation originally performed by man. It does away with the quantitative or qualitative limitations of the human body. Efficient tillage machinery accomplishes more effective cultivation resulting in a larger product per acre". But opinion differs substantially on this point.

Wright (74) who was well known authority in agricultural engineering in Britain, for example, argued: "One might go further and question whether tractors or engines have yet accomplished anything in any branch of farming which could not, in theory at any rate, have been done simply by using larger teams of horses. Nor is it improbable that the most genuinely economical ploughing ever accomplished by any means is that done in Australia with teams of eight or more horses pulling multi-furrow ploughs". There is much truth in the argument of Wright's so far as the production side is concerned, but two other important points need to be considered at the same time and which are not referred to. In the first place, it is perhaps much easier to handle and to maintain a tractor than that of a team of eight horses. It is also less likely that maintenance of eight horses costs less than

that of a tractor. Secondly, lands devoted to the production of horse feed can be released for the production of human food when horses are replaced by the introduction of mechanisation. From the economic point of view, use of horse plough instead of mechanical plough does not therefore appear to be a very sound proposition. Moreover, from a technical point of view it is to be remembered that modern machinery like combine-harvester can never be drawn by bullocks or horses. Application of mechanical power is necessary to operate modern implements and can never be drawn by others except tractors or other engines.

India is, however, a different case. Here inadequate capital resources along with other inhibiting factors retard every attempt of mechanisation. For the time being at least, a suitable way of increasing the efficiency of cultivation is more likely to be through the introduction and uses of light machinery and improved implements such as mould board plough drawn by bullocks. As already discussed, that to buy a tractor for the purpose of drawing heavy machinery is beyond the means of an average Indian farmer. But it does not mean, in

any case, that tractors or engines have not got any advantages over the bullocks or horses in rendering an efficient cultivation. Advantages of mechanical cultivations both from technological and economical points of view are undoubtedly more obvious than that of cultivation performed by animals. Examples can be quoted from western countries where mechanical cultivation has been proved to be superior in every respect to the cultivation performed by animals. Advantages of mechanical cultivation are being realised and appreciated in India as well, although the introduction of such mechanical cultivation to Indian agriculture needs to be well planned and co-ordinated with all aspects of national economy.

Summary

Although India is basically an agricultural country, agriculture as is practiced today, is still on subsistence level. The methods of production are primitive, resulting in low output per unit area of land and per man.

To cope with the development pace of western countries and to solve her own food problem, India needs to increase her agricultural productivity. To reach the same goal, it is a matter of urgency to develop and apply modern technology to the processes of production.

But in a country like India where labour is already surplus, constituting a serious unemployment problem to the extent that some 2.8 million workers are already unemployed and an average Indian agricultural worker gets paid employment for only 7 months in a year, the application of modern technology, such as the introduction of large scale farm mechanisation, is likely to aggravate the problem further. There is no likelihood that the non-agricultural industries would be expanded at such a rate as to absorb by far the major portion of surplus labour. In contrast, the magnitude of unemployment is likely to increase further and it is estimated that it will amount to 5.8 million persons in rural areas by 1961. Opportunities

to provide employment to additional workers if displaced by mechanisation are thus remote.

According to the estimate of Bhattacharjee, such mechanisation of agriculture is likely to push out as many as 60 per cent. of the working population in agriculture. It is therefore obvious that under existing conditions, India would hardly be able to stand the full strain of large scale mechanisation without attaining social or economic disorder.

From the economic point of view, the financial capacity of an average Indian farmer, whose yearly net income hardly exceeds £25 or £30, is too low to offer him any possibility of mechanising his farm himself.

The average size of holdings (ranging from 5 to 15 acres) are also too much below the average economic unit to make the capital investment in mechanisation economically justified.

Against this background, the scope for mechanisation of individual farms appears to be extremely limited, but it is no exaggeration to say that the most important single factor in promoting economic development is the country's readiness to develop and apply improved technology to the processes of production so as to increase

productivity which is now urgent. The application of such technology to the processes of production, however, needs to be well planned and co-ordinated with all aspects of national economy.

CHAPTER V.

PROSPECT FOR THE MECHANISATION OF INDIAN AGRICULTURE

Scope for Mechanisation

From technological and economic point of view, as discussed in the Scottish chapters, mechanisation helps the farmers to increase the production. The net agricultural output, for example, increased by 51 per cent. in Scotland* between the pre-war years (1936/37 to 1938/39) and 1958/59.

The rationalisation of agricultural processes which happen to be so successful in Scotland in improving agricultural conditions may rightly give impetus to other countries such as India to follow the Scottish lines of approach. In course of time, every country of the world has to mechanise her agriculture in order to make it more productive. A country like India which is just at the threshhold of her economic development has some advantage to take over and apply modern techniques that have been worked successfully in more advanced countries like Britain or U.S.A.

But such an introduction of mechanisation is a matter of long term planning, subject to

---

* Scottish Agricultural Economics, Vol. X. 1960.

future conditions of the country. At the present moment the possibility of introducing complex implements drawn by mechanical power, appears to be extremely limited. The immediate programme should therefore be to improve existing implements under bullock power rather than to attempt to introduce tractor-drawn implements. There is a considerable scope for the animal driven implements and machines such as ploughs, water lifters, sugar cane crushers, threshers and by which more efficient cultivation can be expected. The improved tools are also expected to be within the capabilities of an average farmer to buy and to handle.

Although the scope for mechanisation of Indian agriculture appears to be obviously limited at the present moment attempts are to be made to create conditions by which mechanisation can be intrduced gradually. If mechanisation is so planned and so regulated that it displaces only so much labour as can be easily taken over by new industries to be set and no more, the transformation will cause little distress.

Critical Examination on the Present Scope For Mechanisation in India

In certain fields there is undoubtedly a considerable scope for successful application of mechanical power to agriculture, even at the present moment. Apart from reclamation of waste land, mechanical power can be of much use to meet the seasonal labour shortage. Another striking feature is that although India stands high in cattle population there is actually a shortage of draught cattle. This sometimes affects agricultural cultivation adversely. Mechanisation can play an important role to make up the scarcity of draught animals. It is interesting to assess such scope for mechanisation in India and to do so it is necessary to study the situation in detail.

In the very beginning of the discussion it should specifically mentioned, however, that whatever the scope might be, every attempt at mechanisation in India has to be pursued in accordance with local conditions. To proceed with the discussion further it is suggested that the following are the prospective fields where mechanisation could play a profitable role:

(I) Bringing in more areas under cultivation by reclamation or breaking in virgin land.

(II) To meet seasonal labour shortage.

(III) Shortage of draught animals.

(IV) Co-operative farming.

(I) Bringing in more areas under cultivation

In India there are millions of acres of uncultivated land. Tractors can most successfully operate in these areas to reclaim the land. It is estimated that present food shortage is likely to be made up if this land is reclaimed and put under cultivation. A detailed discussion has been made on this point in a Succeeding section. (217)

(II) Seasonal Labour Shortage

The whole issue of introduction of mechanisation has been so far discussed on the basis of the facts that there is no dearth of labour in India. Apparently it reflects that mechanisation has no field of operation so far as the labour aspect is concerned. But critical study on the labour situation throughout the year reveals a rather striking picture. There appears to be a substantial shortage of labour in certain seasons and for certain agricultural operations. Bhattacharjee (10) reported that "during the sowing and harvesting times in Kharif * season

---

* Kharif: Summer

there is shortage of labour caused by a heavy demand and resulting in a temporary increase of about 50 per cent. in agricultural wages". Findings of the Indebtedness Enquiry (8), conducted by Sriniketan, Visva - Bharati University, India, showed a significant shortage of labour in Berbhum district of West Bengal during harvesting period of paddy crop.

TABLE 42

LABOUR SUPPLY AND REQUIREMENT FOR HARVESTING OF AMAN PADDY IN BIRBHUM - W. BENGAL

Period of Harvesting	Required Number of Workers	Available Supply of Workers	Shortage (-) or Surplus (+)
15 days	388,120	247,868	-140,252
21 days	277,228	247,868	- 29,360
30 days	194,060	247,868	+ 53,808

Source: Rural Indebtedness in Birbhum, West Bengal.
Visva - Bharati Economic Research Publication No. 4.

According to its report (Table 42) the number of persons engaged in agriculture amounts to 247,868 whereas total labour requirements for harvesting Aman paddy as calculated on the basis of 9.39 man days required to harvest one acre, amounts to 277,228. This estimate is based on the assumption that harvesting is to be completed in a longer period of 21 days, i.e. three weeks. If the harvesting is to be completed in 2 weeks time, the requirement of labour would have amounted to 388,120. It therefore appears that unless the harvesting operations are spread over more than 21 days, there will be a shortage of labour in Birbhum. With a three week harvesting period, the shortage of labour amounts to 29,360 persons or about 12 per cent. of the supply or 11 per cent. of the demand.

The above facts and figures clearly show a distinct shortage of labour at a particular time of a year. This shortage of labour, on many occasions, delays the agricultural operations duly performed and which, in turn, affects the production. For example, the intervals available for preparation of seed bed and sowing Khariff crops is often very short and delay, even of a few days in sowing, is of material importance in

determining the stand of the crop and finally its yield. Similarly in rabi* preparation, particularly when sowing is dependant on stored rain moisture in the field, the area sown, germination and the successful growth of the crop depend on how quickly the farmer is able to finish the sowing operations on his holding because the land loses moisture very fast during that period.

The application of mechanical power in these occasions to complete the agricultural operations in time will be of very significant use. There is wide scope for the introduction of mechanisation in these respects. But here again the only possibility to use mechanical power is through contractor's service or through co-operative agencies. Contractor's service appears to be befitting to Indian conditions. It will offer an average farmer the benefit of expert centra-supervision and all the advantages of mechanised cultivation without increasing heavy expenditure in purchasing costly machinery.

---

* Rabi: Winter.

(III) Shortage of Draught Animals

It is striking to note that while India ranks high among the countries of the world in cattle population, she suffers chronically from a shortage of draught cattle. The cattle population in India amounts to 158.9 million and out of that working bullocks amount to 58.41 million, although the same number of bullocks does not appear to be sufficient for the agricultural requirement. Insufficiency is such as reported by Farm Management Survey in West Bengal (23) that one-third of the farms do not possess any draught cattle at all, as a result of which agricultural operations suffer considerably.

Scope for the introduction of mechanical power to substitute the shortage of bullocks is therefore likely to be considerable. Even the existing draught cattle can be replaced by mechanisation without any harmful effect. It would provide an opportunity in that case, to release land for food production. It is argued that there are difficulties in the way of replacing cattle by mechanisation in India (17), but the fact is that the replacement of animals by machines and loss of farm-yard manure has not led to any harmful effect at all in Scotland. On the contrary,

mechanisation in Scotland has added more land for food crops by releasing land needed for the production of fodder for horses.

(IV) Co-operative approach to Farm Mechanisation

Co-operative approach to farming has been already pointed out as a suitable way for the successful introduction of mechanical power to Indian agriculture. Co-operative farming basically implies mutual assistance and pooling of individual resources for the benefit of all, encouraged both by private and state initiative. It also includes joint purchase and use of different machinery and sometimes joint cultivation, although land and means of production remain the property of the individual farmer. Co-operative system of use of machinery and cultivation was remarkably successful in some of the European countries which might serve as impetus to India to follow it.

Quoting the report of the International Review of Agriculture, Sayanna (54) described a brief history of the growth and functions of co-operative societies in some European countries in pre-war period as follows:

There were about 30,000 agricultural syndicates or general agricultural co-operative societies in Europe in 1938. In addition to

these, special co-operatives are also found to fulfil the same needs, e.g. there were 283 co-operatives in Estonia and 400 in Finland for the use of machinery, 670 threshing co-operatives in France and 800 in Germany, 286 co-operatives for machinery in Latvia, 133 in Lithuania, 460 in Switzerland and 64 in Yugoslavia. In many cases the State has a recognised role in the matter either by way of giving subsidies or by provision of loans at concessional rates, regulation on manufacture and import of agricultural machinery with a view to meet the requirements of the small farmers. The Ministry of Agriculture in Hungary bears $33\frac{1}{3}$ per cent. cost of animal drawn machines and $66\frac{2}{3}$ per cent. cost of mechanical equipment operated by hand. To ensure satisfactory quality of the machines, a law was enacted in Latvia for the inspection of agricultural machines manufactured or imported. State aid was also given for establishment of machine depots for manufacture of machines suitable for small farms or the specified types. To illustrate the extent of mechanisation of small farms it may be mentioned that according to the investigations made in Denmark in the year 1932-33, on farms with an area under 10 hectares, there were machines, instruments and other implements valued at 235

crowns per hectare; on farms between 10 to 20 hectares 193 crowns per hectare; between 20 and 30 hectares 152 crowns; and on large farms between 30 and 50 hectares 128 crowns per hectare; and broadly on large farms the value of implements was assessed at 112 crowns per hectare. On the islands 35 per cent. of holdings of less than 5 hectare were noticed using sowing machines; roughly 40 per cent. of farms with an area of 5 to 10 hectares used reapers; 30 per cent. of small holdings between 1.7 and 3.3 hectares had threshers. This widespread use of machinery in Denmark in relation to the cultivated area is attributed to the existence of small and medium sized farms.

In Britain, the Co-operative Movement in farming has also been intensified in recent years through individual initiative and Governmental support. Co-operative uses of machinery through Machinery Syndicate have been proved to be effective and ideally suited to the comparatively small farmers. The first organised Machinery Syndicate (43) was set up in Hampshire in 1955 and the movement has progressed so that today there are some 82 syndicates in different parts of the country.

The Government has given much encouragement to the progress of organisation of farmers' syndicates for the co-operative use of machinery. The Government now intends to make a (32) one-third capital grant towards expenditure incurred in future by landowners or farmers when they provide buildings to house machinery and grain drying and storage equipment for use by machinery syndicates.

What is reflected from the history is that introduction and practices of mechanical cultivations are possible and economically justified to increase the productivity even on small holdings, if the idea of co-operatives catches properly the imagination of small holders. In India, where increase in productive efficiency is so urgently required that immediate introduction of mechanical cultivation appears to be the only effective way to achieve it but at the same time since small holdings and meagre financial resources of holders stand as main obstacles to implement it, A scheme of joint purchase and joint use of machinery appears to be the only way of introducing productive mechanical cultivation to Indian agriculture. Scope for the introduction of

mechanisation through co-operative efforts is therefore wide and prospective. Fortunately some progress has already been made in this direction and that has been discussed in the foregoing section.

PROGRESS OF MECHANISATION IN INDIA

Attempts have been made in India to introduce mechanisation to Indian agriculture since the end of the first World War. In 1919 several wealthy farmers began to adopt modern methods and several tractors were purchased. The benefits that accrued were negligible and when the depression came the tractors were left to rust. In those days the price of the crop did not even pay for the oil the tractor consumed. In 1932 the protection given to the sugar industry produced the necessary incentive for intensive cultivation. Cane growers needed deep tillage instruments and bought tractors for the purpose. Once again attempts were made at mechanisation in Bombay, Hyderabad (Deccan) and Sind, but these attempts made by individuals were isolated and never fruitful. Government appeared to be still not interested on the issue of mechanisation.

It was only since the outbreak of World War II attempts were more systematic and planned, made by individuals and private agencies. The

Government also started taking much initiatives. It received further impetus from the problems which cropped up after the war and the Rad-cliff award concerning rehabilitation of ex-servicemen and refugees.

Central Tractor Organisation

A programme of extensive mechanisation was started with the installation of Central Tractor Organisation in 1946 (46) and this became a very effective body in accelerating the growth of mechanisation in India. It first started its operation in 1947-48 with about 200 old tractors purchased from the American Army disposal. It was assigned at the time to reclaim about 3 million acres of weed-infested lands of the States of U.P., M.P. and Bhupal in the course of 7 years. Between 1949-50 and 1950-51 the Central Tractor Organisation further procured 240 heavy Crawler tractors from American Army disposal.

Having a strength of about 2,000 persons, the Central Tractor Organisation operates today a large fleet of heavy tractors for agricultural purposes having 18 units, 3 divisions, 2 base camps and more than 270 heavy Crawler tractors. The workshop of C.T.O. in Delhi manufactures spare parts and servicing of many vehicles.

A Tractor Training Centre has already been established in Bhopal and it is proposed to establish one more centre in order to provide opportunities for training for mechanics and drivers. Early in 1957 the Indian Agricultural Research Institute, New Delhi, assumed responsibility for trying out foreign implements on its farm to determine their suitability to local conditions and those considered promising are sent to the State Directorate of Agriculture for further field trials and ultimate promotion.

The Government of India has also taken a lead by setting up its own two large mechanised farms, one in Jammu and Kashmir and the other in Bhopal. The purpose of establishing such mechanised farm is also to demonstrate the merit of mechanised cultivation to local people, apart from increasing its own productive efficiency.

State Tractor Organisation

The Central Tractor Organisation undertakes only reclamation operation and its activities have been limited to four States where large blocks of land were available.

The responsibility for getting the newly reclaimed land actually cultivated rests upon the State Governments. In the State Government of Uttar Pradash four main colonization schemes were

successfully implemented: Ganga Khadir in the Meerut District (where a jungle - covered tract of nearly 47,000 acres of useless land have been cleared and sown): Tarai and Kashipore in the Naiwital district (where nearly 50,000 acres of useless land have been brought under the plough): and Dunagiri in Almona district. Three more areas, namely Manunager in Rampur district, Bharasar in Garhwal district and North Afzalgarh have also been selected for settlement. In colonization areas, lands are alloted only to agricultural graduates, agricultural diplomats, political sufferers, landless labourers and displaced persons from Pakistan.

Similarly, other States have taken considerable initiative to reclaim waste land by their respective tractor forces. Substantial work has been already done and further progress is expected to be made in future.

Reclamation of Private Waste Land by Owners Themselves

For these schemes the State Government are offering incentive like remission of land revenue for the first year of cultivation, grants and loan s for the purchase of equipment necessary for cultivation.

Achievement by Central and State Tractor Organisation

During the first Five Year Plan period 1951-52 to 1955-56 more than one million acres of land were reclaimed through the Central Tractor Organisation and 1.4 million acres through State Tractor Organisation. Besides this, about 5 million acres have been developed by cultivators through programmes such as assistance for mechanised cultivation, lending and levelling and reclamation of land by manual labour. C.T.O. also helped in the rehabilitation of more than 3,000 families of displaced persons from Pakistan as well as political sufferers and ex-servicemen in Tarai area of Uttar Pradesh, very successfully where malignant malaria was completely eradicated and jungle lands were converted to prosperous agricultural farms.

During the second Five Year Plan period, 1956 - 57 to 1961-62, the Central Tractor Organisation was scheduled to reclaim about 96,000 acres of fallow and jungle land and ploughing up of about 14.9000 acres of land which was previously under cultivation.

In addition to that, the Central Tractor Organisation along with the State Tractor Organisation and manual labour of individual

cultivator was entrusted to carry out reclamation work of 1.5 million acres of land and improvement measures over an area of 2 million acres.

GROWTH OF THE IMPLEMENT AND MACHINE MANUFACTURING INDUSTRY

Manufacturing of agricultural implements and tools is predominently in the hands of the village blacksmiths. The small manufacturing industries were extremely unorganised and inefficient. Isolated attempts by individual workers, agricultural engineers and others have been continuing for the last forty or fifty years, but neither the scale of these attempts nor their result can be regarded as very satisfactory. However, since 1950 serious attention was given to the manufacture of improved agricultural implements when such equipment was needed for agricultural extension projects initiated under India's first Five Year Plan, the Community Development Programme and the "Grow More Food" Campaign.

As a result of the new development programme, several new factories have been built up in recent years. Information obtained from a recent report (46) on Structure of the Industry reveals that India at the present time has 62

factories in the "large-scale" sector of the industry, manufacturing the following implements by "large-scale" units:-

(i) Machinery for seed-bed preparation.

(ii) Seeding and planting machinery.

(iii) Inter-cultivation machinery, ridges, etc.

(iv) Harvesting and threshing machinery

(v) Dairy machinery.

(vi) Irrigation machinery.

(vii) Terracing and soil conservation machinery.

(viii) Agricultural processing machinery

(ix) Plant protection equipment

(x) Machinery for storage and preservation.

These 62 large producers have an estimated annual capacity of approximately 26,880 long tons in terms of steel.

Small-scale units have also been encouraged and there are at present more than 350 such establishments which employ about 5,250 people according to the Planning Commission of the Government of India.

In addition there are at least 62,000 blacksmiths who produce simple implements for village needs.

Manufacturing of engines, such as diesel engines and power-driven pumps, is progressing gradually.

While the information on production prior to 1954 is lacking, it has been estimated that annual production of diesel engines rose from 8,652 in 1954 to 23,200 in 1958. The second Five Year Plan (1956/57 - 1961/62) provides for a production target of 25,000 engines a year by 1960-61. Like diesel engines, the production of power-driven pumps per year climbed up from 28,000 in 1954 to 75,960 in 1958. The second Five Year Plan calls for a production target of 86,000 power-driven pumps a year by 1960-61.

Outlook and Potential

Demand for improved agricultural implement is steadily rising. As the economic position of the rural population advances by virtue of the various proposals included in the second Five Year Plan (1956-61) demand for improved metal implements should grow. It is expected that a planned increase in acreage under cultivation would also lead to greater need for modern agricultural implements.

The Community Development and National Extension Programmes under the second Five Year Plans have already influenced the trend of demand for agricultural implements in India. These programmes have a primary object of

increasing agricultural production through the introduction of new techniques. In the First Five Year Plan period (1951-56) the programmes were extended to cover 1,200 national extension blocks, comprising 123,000 villages, having a total population of 80 million. Under the second Five Year Plan (1956-61), the National Extension Service has served almost the entire country, and not less than 40 per cent. of the National Extension Blocks are expected to be converted into Community Development Blocks at a cost of R.S. 200 crores (2,00 million pounds).

In view of the above factors, a substantial annual increase in the demand for agricultural implements appears to be likely. It has been expressed by some American experts (25) that India's development programme would create at least an average yearly increase of 15-20 per cent. in the demand of implements.

It has been reported that demand for improved agricultural implements in some cases, has increased so much that producers have not been able to cope with the increased demand owing mainly to the non-availability of raw materials and the inadequacy of working capital. But in most of the other cases, such as tractor and tractor-drawn implements, demand is seemingly

restricted to a limited number of users, primarily those who have large agricultural holdings. But due to the recent legislation for upper acreage limit, there would be no such big holder in future. The imposition of ceilings applies to those who have large areas of land under possession. The level at which the ceiling applies, of course, vary from State to State, depending upon class of land and other considerations, from 30 acres up to 50 acres in former Madhya Bharat, but in any case it does not appear to be large enough for maintaining a tractor. The extension of co-operative farming appears to be the only favourable solution in this condition. Some progress, i.e. joint pooling of land and joint management has been already achieved and further progress is expected in future. Planning Commission of the Government of India in 1951 and 1956 has also laid much emphasis on the development of co-operative farming. It has now become essential that co-operative farming should be developed as rapidly as possible and it is there that the scope for mechanisation lies.

The Tractor Situation

Until very recently, India did not have any agricultural tractor manufacturing plants. Recently, however, the Ministry of Defence, India, in agreement with a Japaneese firm, has undertaken the task of manufacturing tractors in Indian Ordinance factory and the first six manufactured in the ordinance factory have been brought into use on a land reclamation project in the State of West Bengal. The tractors that are operating in India until now are mostly imported from foreign countries such as Britain, U.S.A., U.S.S.R., and Japan. The rest are assembled in India but all machinery parts are imported.

The Government of India has also authorised three firms to produce annually 4,000 - 5,000 tractors. Another local company was licensed in 1959 to manufacture equipment for earth moving and land reclamation operations in collaboration with an American firm. These Indian manufacturers would at some time go into scheduled production, although few Indian made tractors have already been brought into use.

India, however, is up till now, one of the least mechanised countries in the world. Although no recent Indian machinery statistics

is yet available, figures relating to population in different years (Table 43) shows that India possessed only 33,700 tractors in 1957. The number looks very small indeed in comparison with that of America and Western European countries. If the number of tractors per 1,000 ha. cultivated land is taken as an index of the degree of mechanisation (which is of course a very rough index) India's position comes out as a possessor of 0.2 tractors against that of Scotland's 28.08 tractors.*

---

* Relates to Machinery Census Figure of 1956, since no Machinery Census was taken for the year 1957.

TABLE 43

ABSOLUTE NUMBER OF TRACTORS AND NUMBER OF TRACTORS PER 1,000 HA. CULTIVATED LAND

	1955	1957	Tractors per 1,000 Ha. in 1955	Tractors per 1,000 ha. in 1957
Scotland	46,179*	51,405**	25.2*	28.08**
India	24,855	33,700	0.2	0.2
West Germany	447,172	619,000	31.4	43.4
U.S.A.	4,450,099	4,620,000	10.0	10.4
France	337,000	530,000	10.0	15.8
Netherlands	39,155	57,600	17.0	25.0

* Relates to 1954 figures

** Relates to 1956 figures.

(In Scotland, Machinery Statistics for 1955 and 1957 were not taken).

Source: I 'Mechanisation and the Small Farm' by F. Coolman and H. Williams, Published in "Mechanisation in Agriculture by" J. L. Meij

II. Agricultural Statistics for Scotland.

In this situation, India needs to strengthen her stock of tractors rapidly. The need is so much as Memoria (46) estimated some time back that for the development of waste lands alone there will be needed in India about 25,000 tractors if calculation is made on the basis of one tractor for 400 acres. Urgency of the situation has also been expressed by the Tractor Committee. The Committee measured the increasing demand for tractor and tractor-drawn implements and reported that need of India by 1960-61 would be at least 5,100 tractors per annum.

The Government of India, on the basis of the recommendation of the Tractor Committee, has taken the present move of manufacturing tractors in India.

CO-OPERATIVES

The movement of Co-operation in different farming practices in India was started a long time back but, so far, has proceeded without much success, although there are at present about 2,000 (24) co-operative farming societies functioning in different parts of the country. But it is insignificant in relation to the needs of the country. The reasons for this slow movement are manyfold. On the one hand there is a strong individualistic attitude of the Indian farmer which does not provide the psychological condition necessary for the voluntary transition to co-operative farming on a large scale. On the other hand, there is a lack of proper approach on the part of Government officials to pursuade the farmers to follow the co-operative lines. On the whole, co-operative farming does not still appear to have caught the imagination of farmers and consequently the progress has been slow.

But the country needs to come up from this stage to a stage of vigorous agricultural development and this can be successfully attained through the efforts of co-operation in different activities concerning the agricultural industry.

There is no vital reason why co-operative systems in the field of agricultural operation, which were so successful in introducing mechanical cultivation to the countries of small peasants' farms such as Estonia, Lithunia, Denmark etc. will not succeed in India where conditions, such as small farms, are not much different.

On the realisation of the prepondering importance of co-operative systems, the Government of India has framed ~~out~~ different schemes for the development of co-operative farming as follows:-

During the first Five Year Plan period a number of suggestions were made to encourage and assist small farmers to group themselves voluntarily into co-operative farming societies. Each society would have its own tractor which would plough the land of each member with the result that the land then remaining uncultivated would be brought under cultivation. Planning experiments were recommended with a view to envolving suitable methods and techniques of co-operative farming under Indian conditions.

The second Five Year Plan also laid down different well planned schemes for the development of co-operative farming.

These plans have now been implemented with certain degree of success. Attempts are being still made to make it more successful. As a result of this, co-operative farms are now in a better position than before. They are now assisted by technical experts and necessary financial aids are provided by the Government and other different agencies. While leasing out the reclaimed lands by the Government, preference is first given to the co-operative farming societies. Another important function that the Government now performs is to assist financially and technically to develop non-agricultural employment opportunities for members of the co-operative farming societies and others associated with them.

The Government has also taken effective measures for land reforms such as Zamindar* Abolition Act and Ceiling on large holdings. Provisions have been made to re-organise the surplus areas available after the imposition on the ceiling agricultural holdings on co-operative lines and, at the same time, to encourage the

---

* Zamindar: Landlord.

holders of below the basic economic unit to be grouped into larger units of operations through co-operative acitivity.

With the growth of co-operative farming societies and the development of co-operation in various non-farm activities, the rural economy is expected to be stronger. This will, in course of time, it is hoped, provide a diversity of occupations within and outside agriculture. A stage will eventually come when it will be within the means of a farmer or a group of farmers to introduce improved implements and to utilize power with a view to modernising agriculture.

ECONOMICS OF MECHANISATION

One of the main impulses to mechanise in most countries of the world is derived from the experiences that mechanisation is one of the methods of reducing unit cost, more specifically labour cost.

The possibility of such reduction in labour cost under Indian conditions, however, raises a controversy. The progress of mechanisation is retarded where there is cheap supply of labour which is again one of the unfortunate consequences of over-population. India is well known as a chronic sufferer from this malady. The extent

to which mechanisation will be profitable is a matter of cautious and careful calculation.

While there is less scope for any economic return from mechanisation at national level due to a number of reasons, such as abundance of family labour etc., individual farm or farms which can afford to mechanise agriculture are expected to derive benefit from it. This expectation is based on the assumption that at present, when agricultural wages in India have increased tremendously in comparison with pre-war level, and when the efficiency of labour in India on the whole is not improved upon the pre-war standard, mechanisation is likely to be profitable proposition, at least for farms which can use medium sized tractors. The cost of a tractor ploughing (65) as calculated under Indian conditions amounts to nearly ₹10 per acre compared with the prevailing rate of ₹15 for bullock ploughing an acre of land, it is obviously much cheaper.

It will be worthwhile to quote here few case studies in this connection. Table 44 prepared on the basis of statistical information provided by Subbaraju (65) shows that the cost of work and the capital outlay for power farming, as compared to animal power, is much less.

TABLE 44

COMPARISON OF COSTS BY TRACTORS AND BULLOCK POWER

Particulars	Ploughing by a 40 H.P. Tractor with a Mould Board Plough	Ploughing with 40 Pairs of bullocks Equivalent to 40 H.P.
1. Capital Outlay	Tractor and Implements..£1,825	At £30 each bullock....£2,400
2. Depreciation per year	5 year's life.....£ 365	10 years life.....£240
3. Interest	4 p.c.....£ 73	4 p.c.....£ 96
4. Running Expenses	Cost per hour:- 2 gallons fuel oil....4s. $\frac{1}{3}$ gallon lubrication..2s. 1 lb. grease.....2s. Misc.....1s. Cost per hour.....9s. per Year of 2,000 hours of working.....£900	Fodder @ £2.15s. per mouth per pair of bullocks and per year for 40 pairs.....£1,320
5. Repair	@ 1s.6d. per hour and for 2,000 hours of working in a year.....£150	@ 15s. per set of implements and for 40 sets.....£30
6. Labour Charges	Driver @ £7 per month and cleaner @ £2 per month for 1 year.....£108	30 men for 8 months and 10 men for 12 months at £1.75 per month.....£630
Total operating costs per year including interest and depreciation , running expenses repair and labour charges	£1,596	£2,316
Total anticipated output of work	at $1\frac{1}{2}$ acres per hour and for 2,000 hours of working in a year.....3,000 acres	3,000 acres
Cost per acre	₰10	₰15

Source:' Mechanisation of Indian Agriculture' by V. Subbaraju, Published in "The Indian Journal of Agricultural Economics", Vol. IV, No. 1. March, 1949.

Some interesting points emerge from the Table. In the first place, it is significant to note that bullock farm is more capital intensive than mechanised farm. The capital investment in case of bullock farm amounts to £2,400 whereas the same investment amounts to £1,825 in the case of mechanised farm. A further breakdown of the Table presents some interesting features. Requirement of labour which amounts to 3o men for 8 months and 10 men for a whole year in the bullock farm has been reduced to only 2 men (1 driver and 1 cleaner) in the mechanised farm. This has accounted a net saving of £522 on labour item alone. Similarly cost of bullocks and maintenance are much higher than that of a tractor. These have resulted in a cheaper cost of production per acre in the case of mechanised farm (Ø10) than that of bullock farm (Ø15).

Agarwal (3), in discussing cost of wheat cultivation per acre on mechanised and non-mechanised farm, showed that the cost of wheat cultivation per acre is only £12.3.9d. in a mechanised farm, whereas the same is £23.0.6d. in a non-mechanised farm. In this particular case, mechanisation economises the cost of cultivation per acre by £10.

Mechanical power appears to be effective in reducing the operational costs not only in tillage works alone but in other works such as irrigation work. Cost of irrigation by power pump as calculationed by Subbaraju (65) is significantly lower than that of Mhotes. While irrigation by bullock costs £18 per acre, the same cost £13 by power pumps.

The facts and figures illustrate that mechanisation reduces the cost of production everywhere and in almost all cases. Ferguson study from all over the world shows, as Agrawal (3) states that replacement of animals by a tractor can increase income from 50 to 150 per cent. according to the size of the farm. This economic aspect of mechanisation will draw considerable attention in course of time and it is expected that this will also be one of the accelerating factors for the growth of mechanisation in India.

In the western countries, as has already been discussed, inventions and introduction of new machines economise the cost of production and simplifies many laborious operations which were previously performed by manual labour. In more recent times tractors are being manufactured in Britain and Japan for small farms. It is very likely that, in course of time, India will also enjoy the benefit of mechanisation as western countries are enjoying today.

Summary

At the present moment, the scope for the successful application of mechanical power to Indian agriculture, befitting to Indian conditions, appears to lie in at least some fields such as reclamation of wasteland and co-operative system of use of machinery and cultivation. Uses of tractors and machinery service through contractors or through co-operative agencies can be of some use to meet the seasonal labour shortage during busy periods such as sowing and harvesting etc.

Some progress has already been made in these directions. During the first Five Year Plan period (1951/52 to 1955/56) more than one million acres of land were reclaimed through the Central Tractor Organisation controlled by the Central Government and 1.4 million acres through State Tractor Organisation, controlled by the State Governments. During the second Five Year Plan (1956/57 to 1961/62), a target for reclaiming and improving a much larger area was fixed through these organisations.

Several new factories have been built in recent years to manufacture improved implements. As the economic position of the rural population advances by virtue of the various proposals

included in the two Five Year Plans, a substantial annual increase in the demand for the improved agricultural implements appears to be likely. The Government of India has recently installed a tractor manufacturing plant in India. Three other private firms have also been authorised to produce 4,000 - 5,000 tractors annually.

The Government has also laid much emphasis on the development of co-operative farming with the idea that in a country like India where holdings are small in size and the financial capacity of an individual farmer is meagre, the scope for the introduction of mechanical cultivation in order to increase agricultural productivity lies mainly in the success of the efforts of co-operatives in different sections of the agricultural industry. Co-operative farming still does not appear to have caught the imagination of farmers and consequently the progress has been slow, but the Government has taken positive steps in this direction. Small farmers have been encouraged to group themselves voluntarily into co-operative farming societies in order to take the advantages of different financial aids and technical assistance from the Government, with a view to increasing production by modernising farm practices.

With the growth of co-operative farming societies and the development of co-operation in various non-farm activities, it is expected that it will be possible for a farmer or a group of farmers to introduce improved implements and to utilise mechanical power with a view to modernising agriculture.

CHAPTER VI

SUMMARY AND CONCLUSIONS.

The modern era of farm mechanisation in Britain started with the invention and introduction of steam power and uses of other improved machinery to the processes of farm production in the middle of the nineteenth century, but progress in mechanisation was slow throughout the entire period. The progress, however, became more rapid after the outbreak of World War II. In Scotland, for example, the number of tractors rose from 15,330 in 1942 by 273 per cent. to 57,189 in 1959. Horses have almost been replaced by tractors. In 1939 only 24 per cent. of the total requirement of motor power was furnished by tractors. In 1959 it rose to 96 per cent. The number of combine harvesters and other machinery also increased remarkably. Per unit area basis, Scotland now possesses 13 tractors and slightly less than 1 combine harvester for every 1,000 acres of crops and grass.

The progress of mechanisation has not, however, been uniform in all parts of Scotland. It is in the Eastern part of Scotland where crop-farming predominates that the advance in mechanisation has been very rapid, but in livestock producing areas the progress has lagged behind.

As to the effect of this on labour, the reduction in the number of workers appears rather low as evident by the fall of only 19 per cent. between the years 1939 and 1959. But there should not be any surprise in it. It is to be remembered that the net agricultural output has also increased by 51 per cent. during the same period, leading to the same degree of rise in gross output per man. In other words, it suggests that had there been no progress in mechanisation it would not have been possible to increase production to anything like the same extent. In the second place, unlike manufacturing industry, it is difficult to adjust the requirement of labour and machinery to a definite formula from the point of view of full employment. Farmers maintain a larger number of employees than would have been required if the work could have been distributed uniformly throughout the year. In the third place, mechanisation has been proved to be more effective in reducing labour requirement associated with crop production than those associated with livestock production, as evident from the greater fall in number of workers in crop farming area but Scotland as a whole, is a predominantly livestock

producing country, the reason for less fall of workers is therefore evident. In the fourth place, Scottish farming is still considered to be in the first phase of mechanisation where the effect is to lighten work rather than to reduce labour requirement. In the second phase of development, it will be possible to reduce labour requirement more effectively.

Specialised machinery, such as combine harvesters, potato harvesters etc. have already been proved to be very effective in reducing casual labour requirement substantially.

The make-up of the labour force has been considerably influenced by mechanisation, leading to the increase in number of skilled workers.

Lastly, it needs to be mentioned that the reduction in the number of farm workers is caused not only by pushing pressure created by uses of mechanical power and machinery but by the pulling force generated by the increase in requirement of labour by non-agricultural industries as well. In Britain, the 'pulling force' started operating first, followed by the 'pushing pressure' later.

Turning to the point of farm costs and returns in recent years, the costs rose higher than the returns. The cost of production for every £100 gross income, for example, climbed up

from £76.6s. in 1948 to £93.7s. in 1960. While the operational cost of machinery rose tremendously high, the costs in labour did not fall proportionately.

The steadily rising costs of production and total investment, mainly due to increase in mechanisation, and the tendency for farm incomes to fall, as evident from the fall in net farm incomes from £40.6 million in 1954/55 to £38.5 million in 1960/61, become steadily increasing problems.

The experiences of other countries, such as U.S.A., however, suggest that the first effect of mechanisation is to make work easier, but it often increases the farmer's costs instead of reducing them. In course of time, however, it will be possible to re-organise the farms to take full advantage of the machinery available and thereby reduce the cost of production. It is therefore expected that Scottish farmers will also derive full benefits from mechanisation by re-organising the farm planning in course of time.

Experience has proved that tractors and machinery can reduce the labour requirement and thereby economise the labour costs substantially from the point of view of individual farms.

In Scotland, at least some of the benefits of mechanisation have gone to the workers in the form of lightening work and shorter working hours and comforts.

In India, the conditions are entirely different. Although agriculture is the most important branch of the national economy, accounting for nearly 50 per cent. of the national incomes and employing 70 per cent. of the population, it is still a "depressed" industry. The output both per man and per unit area is low, resulting from backward and primitive methods of cultivation.

The application of modern technology, such as the introduction of mechanisation, is therefore necessary to intensify production and thereby to improve the overall economic conditions of the country.

But again, India is a quite different case from that of any of the Western European countries. It is an over-populated country where surplus labour itself constituted a serious unemployment problem, in addition to considerable unemployment problem. Introduction of large scale farm mechanisation, under these conditions, might mean aggravating the problem further. According to the estimate of Labour Enquiry Committee,

2.8 million workers are already surplus in rural areas and the number is likely to have risen further to the extent of 5.8 million persons by 1961, in spite of the creation of employment opportunities in non-agricultural sectors. This means that the non-agricultural industries are not likely to develop at such a fast rate as to absorb all surplus workers from the land in the near future.

It is therefore obvious that the extent to which mechanisation is desirable or will be profitable is a matter of cautious and careful planning. From the financial point of view also, the financial capacity of an Indian farmer (whose net incomes hardly exceed £25 or £30 per annum) is too low to offer him any great possibility of mechanising his farm himself. Mechanisation means a heavy capital investment as a very light four-wheeled tractor with accessories costs, for example, between £600 and £700 and which is obviously beyond the financial means of an average Indian farmer. Even in Scotland, where farmers are far more resourceful and wealthy, they are undergoing financial strain in order to cope with the increasing investment in mechanisation. From the point of view of size of farms, the average size of

Indian farms (ranging from 5 to I5 acres) are also much below the economic unit to make the capital investment justified.

Against this background, it is obvious that the scope for the introduction of large scale mechanisation to Indian agriculture is limited at the present moment. Any abrupt attempt at mechanisation could affect the Socio-economic conditions adversely and interrupt the existing balance and as the writer progressed with his analysis it became increasingly clear that the history of farm mechanisation in Scotland- even the relatively rapid power-switch from horses to tractors- can-not give any clear cut guide as to the speed or method of introducing mechanisation in to agriculture in India , although it has made it clear that the increased out-put achieved by Scottish farms could hardly have been achieved without mechanisation and more food must be produced urgently in India.The exhaustive brek-down of the total Scottish figures into Regions (of largely) differing types) which was necessary, disclosed that althoguh livestock and dairy farming were fairly well mechanised in their own special directions (eg. milking machines) it was the Eastern part of Scotland which is pre-dominantly an arable farming

area that deserves special attention in this context. The spectacular progress of mechanisation in the eastern part suggests that the mechanisation is more effective in arable farming than any other ~~farming~~ type of farming and therefore the writer is almost certain that India which is predominantly an arable farming country can certainly take the cha nce of mechanising her agriculture with less possibility of failure inspite of the paradox of too many workers already. It is good to have a stable policy of employment but resistance to mechanisation means throwing out the possibility

the possibility of getting more food per acre of land and more food per person, of an ever-growing nation.

It is argued that there are difficulties in the way of replacing draught cattle by mechanisation in a country like India, but the fact that the replacement of animals by machines and loss of farmyard manure has not led to any harmful effect at all in Scotland. On the contrary, mechanisation in Scotland has added more land for food crops by releasing land needed for the production of fodder for horses. In India, machines can be used to replace draught cattle (and there is really a shortage of such cattle) even without causing temporary human unemployment, and there is no contradiction that the most important single factor in promoting economic development, is the country's readiness to develop and apply modern technology, including mechanisation, to the processes of production.

It is argued sometimes in India that a large team of horses or bullocks can do as much work as a tractor or engine can accomplish and therefore there is no extra gain in switching over from animal power to mechanical power . Although the argument bears some truth in theory at least it overlooks other two important

considerations . In the first place , it must be remembered that it is much easier to handle and maintain to maintain a tractor than a team of say, eight horses. It is also less likely that maintenance of eight horses costs less than that of a tractor. Secondly it is now absolutely impracticable both from economic and technological consideration to expect animal power effectively to draw modern items of machinery like seed drills and fertiliser distributors very greatly valuable as they most certainly are in themselves. Application of mechanical power therefore in the writer's opinion is necessary to operate modern implements. Although to buy a tractor for the purpose of drawing such implements is beyond the means of an average Indian farmer it does not mean, in any case, that tractors have not got any advantages over the animals both from technological and economic point of views.

In the writer's opinion, India must mechanise her agriculture although the scheme of carrying out such mechanisation needs to be planned within the frame work of country concerned.

In an economically under-developed and densely populated country like India, co-operative approach to farming appears to be one of the most suitable ways for the successful introduction of mechanisation. Co-operative

farming basically implies mutual assistance and pooling of individual resources for the benefit of all. It also includes joint purchase and use of different machinery. Co-operative systems were very successful in introducing mechanical cultivation to the countries of small peasants' farms, such as Estonia, Lithunia and Denmark.

The movement of co-operation in farm practices was started in India a long time back but, so far, has proceeded without much success.

The Government has, however, taken positive steps in this direction. Small farmers have been encouraged to group themselves into co-operative farming societies so as to take advantage of different financial aid and technical assistance from the Government with a view to increasing production by modernising farm practices.

There are at present 2,000 co-operative societies functioning in different parts of this country.

With the growth of co-operative farming societies and development of co-operation in various non-farm activities, it is expected

that it will be possible for a farmer or a group of farmers to introduce farm mechanisation in course of time and such gradual transformation will cause no distress. Use of tractors and machinery services through contractors can be of some use to meet the shortage of draught cattle and seasonal labour shortage during busy period such as during the time of sowing and harvesting, even right now.

There is also a considerable scope to reclaim the waste-land by using mechanical power at the moment. Some work has already been done in this direction. More than 2.4 million acres of land have already been reclaimed by Government controlled tractor organisations. A target for reclaiming much larger areas has been fixed for the future.

The Government of India has recently installed a tractor manufacturing plant in India and three other private firms have been authorised to produce 4,000 - 5,000 tractors annually.

As the economic position of the rural population advances by virtue of various developmental programmes, included in the two Five Years Plan, the introduction of mechanisation should become comparatively easy.

Under to-days condition in India foreign exchange appears to be wasted in importing consumption goods-including food stuffs- which might be produced at home whereas the foreign exchange might better be used for as capital for economic growth. The Government of India has taken certain steps, as described above, to introduce mechanisation to Indian agriculture but in the writer's opinion appreciation of the over-riding requirement of a food surplus from agriculture lacks due emphasis. One,however, appreciates that the transformation is bound to be slow. The writer can not give any clear cut line as to how to make the process speedy but from his analysis of Scottish farming progress is able to stress three main impacts of mechanisation: in reduction of product cost; in reduction of extremly hard physical toil; and as the corollary of incresed production.

Reduction in product cost is important in that, apart altogether from its reflection of reduced input per unit of produce - particularly of labour in this instance, it permits through increased net cash income increased power to buy equipment or pay for its co-operative use.

Reduction of extreme hard physical toil is important in that the physical and mental

condition of rural workers- often at present living at less than optimum Calorie intake for the work expanded- must be of concern to any humanist-whether he be also an economist or not. In the writer's view, it is essential that rural social conditions and capacity and incentives to produce a surplus for sale be kept in step with industrial calls for food. This is not to say that one does not appreciate that a monotonous diet and some what labourious living may have to be continued for a while-just as present enjoyment of consumption goods of all kinds has to be postponedin favour of capital formation.

The importance of mechanisation as a corollary of increased production does not perhaps need more reiteration. Scottish experience confirms beyond question that the increased production achieved there since the war could not have been achieved without mechanisation. Which'comes first' in individual farms hardly matters,-one can not get the one without the other and in India one does not need the one without the other . If detailed justification was thought necessary the writer points to his conclusion that many of the most product-increasing processes can not be employed without at least mechanised draught.

APPENDIX

TABLE 1

NUMBER OF TRACTORS AND EXTENT OF MECHANISATION, BY SCOTTISH COUNTIES

	Tractors (Absolute (Number) (1946)	Tractors for every 1,000 acres of crops and grass (1946)	Tractors (Absolute Number) (1959)	Tractors for every 1,000 acres of crops and grass (1959)	Per cent. increase in number of tractors between 1946 and 1959	Number of Workers per Tractor (1946)	Number of Workers per Tractors (1959)
Highland							
Argyll	247	2.4	1,466	14.7	493.5	14.3	1.8
Inverness	303	2.1	1,735	12.8	472.6	12.5	1.3
Ross	523	3.9	1,475	11.0	182.0	8.2	1.5
Sutherland	75	2.5	471	16.0	528.0	10.6	1.1
Zetland	36	1.7	457	21.9	1,169.4	55.9	1.9
Total	1,184	3.0	5,604	13.0	373.3	12.2	1.5
North Eastern							
Aberdeen	3,313	5.4	9,150	14.8	176.1	3.7	1.1
Banff	848	5.5	2,419	15.6	185.2	3.5	1.0
Caithness	447	4.7	1,307	13.9	192.3	4.1	0.9
Moray	525	5.7	1,308	12.3	149.1	4.1	1.4
Nairn	115	4.7	319	12.9	177.3	4.5	1.2
Orkney	688	6.4	2,098	19.1	204.9	3.1	7.7
Kincardine	807	7.0	1,808	15.4	124.0	3.2	1.2
Total	6,743	6.0	18,407	15.0	172.9	3.6	1.1
East Central							
Angus	1,538	6.5	3,634	15.1	136.2	4.2	1.6
Clackmanan	90	6.2	179	12.7	98.8	4.1	1.4
Fife	1,479	6.5	3,030	13.7	104.8	4.3	1.7
Kinross	158	5.1	371	12:0	134.8	4.1	1.5
Perth	1,768	5.6	4,221	13.6	138.7	4.4	1.6
Total	5,033	6.0	11,435	14.0	127.2	4.3	1.6
South Eastern							
Berwick	1,091	5.9	1,792	9.8	64.2	3.4	1.6
East Lothian	704	6.7	1,377	13.1	95.5	6.6	2.2
Midlothian	571	5.1	1,171	11.5	105.0	7.1	2.3
Peebles	201	4.7	397	9.4	97.5	4.3	1.8
Roxburgh	768	4.4	1,351	7.9	75.9	4.2	1.9
Selkirk	109	3.7	252	9.0	131.0	5.0	1.8
West Lothian	324	6.3	655	13.1	101.0	4.4	1.6
Total	3,768	5.0	6,995	10.0	85.6	4.9	1.9
South Western							
Ayr	1,038	3.5	3,312	11.6	219.0	8.0	1.9
Bute	40	1.6	297	11.6	642.5	16.3	1.5
Dumfries	972	4.2	2,488	10.8	155.9	5.4	1.6
Dumbarton	234	5.7	487	12.9	108.1	5.8	1.8
Kirkcudbright	469	2.8	1,471	9.1	213.6	7.0	1.8
Lanark	1,106	4.8	2,723	12.6	146.2	6.9	1.8
Renfrew	230	3.3	719	11.2	212.6	9.5	2.0
Stirling	566	5.4	1,274	12.7	125.0	4.6	1.5
Wigtown	504	3.5	1,417	10.0	181.1	7.3	2.2
Total	6,504	5	14,188	11.0	118.1	5.3	1.8
Scotland	23,252	6	56,629	13.0	143.5	4.9	1.5

TABLE 2

NUMBERS AND AVERAGE SIZE OF HOLDINGS IN SCOTLAND

Year	Total	Average Size of Holding	Over 1 acre to 50 acres		Over 50 acres to 75 acres		Over 75 acres to 100 acres	
				Proportion to Total		Proportion to Total		Proportion to Total
	No.	Acres	No.	p.c.	No.	p.c.	No.	p.c.
938	74,017	61.6	49,033	66.3	5,666	7.6	4,364	5.9
939	74,291	61.4	49,331	66.4	5,668	7.6	4,385	5.9
943	75,879	58.3	51,334	67.8	5,714	7.5	4,390	5.8
947	74,878	58.9	50,407	67.3	5,704	7.6	4,335	5.8
951	74,606	58.9	50,196	67.2	5,657	7.5	4,327	5.8
955	73,026	60.1	48,694	66.8	5,594	7.8	4,276	5.8
958	65,948	66.4	42,188	64.0	5,148	7.8	4,085	6.2

Source: Agricultural Statistics, Scotland. (Department of Agriculture and Fisheries for Scotland)

(a) The figures are related to the acreage under crops and grass, excluding any acreage of rough grazing.

TABLE 3

PROPORTION OF ALL HOLDINGS UNDER DIFFERENT FORMS OF TENURE - SCOTLAND

Year	Total	Owner-Occupier		Tenant	
		No.	per cent.	No.	per cent.
1939	74,291	17,756	23.9	56,535	76.1
1943	75,879	17,161	22.6	58,718	77.4
1947	74,878	17,418	23.2	57,460	76.8
1951	74,606	20,434	27.3	54,172	72.7
1955	73,026	22,958	31.43	50,068	68.3
1958	65,948	24,089	36.5	41,859	63.5

Source: Agricultural Statistics, Scotland.

TABLE 4

AREA AND PROPORTION OF OCCUPIED LAND (CROPS AND GRASS)

OPERATED BY OWNER-OCCUPIERS AND TENANTS

Year	Owner-occupier		Tenant		Total
	Acres	Percentage	Acres	Percentage	
1929	1,350,091	29.0	3,302,897	71.0	4,652,988
1939	1,451,564	31.8	3,106,647	68.2	4,558,211
1943	1,366,545	30.8	3,060,877	69.2	4,427,422
1947	1,423,608	32.2	2,989,957	67.8	4,413,565
1951	1,607,974	36.5	2,785,932	63.5	4,393,906
1955	1,895,963	43.2	2,490,835	56.8	4,386,798
1958	2,158,202	49.3	2,218,045	50.7	4,376,247

Source: Agricultural Statistics, Scotland.

TABLE 5

INDICES OF CAPITAL (TENANT'S) INVESTMENT - SCOTLAND

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
Machinery and Equipment	100	113.2	126.2	138.5	155.3	170.2	184.7	189.9	195.4	199.0	202.5
Other Items	100	111.2	115.6	119.5	127.0	142.6	149.7	154.1	156.5	171.5	171.4
Total	100	111.6	117.8	123.5	133.0	148.5	157.1	161.6	164.7	177.3	178.0

TABLE 6

INDICES OF COSTS OF PRODUCTION BY SCOTTISH FARMERS

	1948/ 49	1949/ 50	1950/ 51	1951/ 52	1952/ 53	1953/ 54	1954/ 55	1955/ 56	1956/ 57	1957/ 58	1958/ 59	1959/ 60	1960/ 61
Labour	100	100.3	103.1	110.6	111.4	117.6	117.6	122.6	126.1	130.7	136.3	133.2	135.6
Machinery	100	112.5	128.4	138.8	149.3	152.7	159.0	168.0	181.9	195.8	208.3	215.9	215.2
Total	100	112.1	121.6	131.9	137.9	152.5	160.0	168.9	175.4	183.3	189.3	192.1	194.6

TABLE 7

INDEX OF GROSS OUTPUT PER MAN - SCOTLAND

(AT CONSTANT PRICES)

1937/38)		1945/46	99	1953/54	130
) 100					
1938/39)		1946/47	92	1954/55	135
1939/40	106	1947/48	96	1955/56	139
1940/41	101	1948/49	104	1956/57	151
1941/42	93	1949/50	113	1957/58	151
1942/43	98	1950/51	112	1958/59	151
1943/44	99	1951/52	116	1959/60	166 *
1944/45	94	1952/53	129		

* (Provisional)

Economics & Statistics Unit, D.A.F.S.,

12th. October, 1961.

ACKNOWLEDGEMENT

I thank Professor S. J. Watson for providing me with the necessary facilities to carry out this work. I express my gratitude to Mr. M. A. Knox, Senior Lecturer, and Mr. J. Harkins, Lecturer, for their guidance and supervision. I am also grateful to Mr. O. J. Beilby and Mr. G. F. Hendry, Department of Agriculture and Fisheries for Scotland, for their help and co-operation.

BIBLIOGRAPHY

1. Alderman, E.G. — Farm Labour since 1894. Agriculture, Vol. XI No. 6, September, 1954.

2. Allan, R. J. — North Eastern Farmers, 1851-1951. Scottish Agriculture, Vol. XXXI No. 1, 1951.

3. Agarwal, G.D. — Economics of Mechanisation of Agriculture. The Indian Journal of Agricultural Economics, Vol. IV, No.1, March, 1949.

4. Ashby, A.W. — Labour Organisation and Management on the farm. Management in Farmers, H.M.S.O., (1949).

5. Ashby, A.W. — Capital Formation and use in United Kingdom Agriculture. International Journal of Agrarian Affairs, Vol.II No. 3, July, 1957.

6. Barker, M.G. — Mechanisation and Farm Management. Mechanisation in Agriculture, edited by Meij, J.L., 1960.

7. Bellerby, J.R. — The relative incidence on Agriculturists and other groups of the benefits resulting from technical change in agriculture. Proceedings of the International Conference of Agricultural Economist (Ninth Conference),1955.

8. Bhattacharjee, J.P. — Rural Indebtedness in Birbhum, Visva-Bharati Economic Research Publication, No.4,1946.

9. Bhattacharjee, J.P. — Cost of Production and Size of farms in West Bengal. Visva-Bharati Economic Research Publication, No. 4, 1946.

10. Bhattacharjee, J.P. — Mechanisation of Agriculture in India - its Economics. The Indian Journal of Agricultural Economics, Vol. IV, No. 1, March, 1949.

11. Bomford, D.R. — Machinery in Modern Farming. Farming and Agriculture, Edited by Easterbrook, L.F., 1944-45.

12. Campbell, O.K. — Rural Population Movement in relation to economic development. Proceedings of the International Conference of Agricultural Economist (10th Conference), 1958.

13. Coolman, F. and Williams, H. — Mechanisation and Small Farm. Mechanisation in Agriculture, edited by Meij, J.L., 1960.

14. Cowie, W.J.G. and Giles, A.K. — An inquiry into reasons for 'The Drift' from the land. Department of Economics, Bristol University, December, 1957.

15. Culpin, C. — Farm Mechanisation and Management. Crosby Lockwood & Son, Ltd., London, 1959.

16. Das, R. — Industrial Efficiency of India, 1930.

17. Driver, P.N. — Fact and Fallacies about Mechanisation in India. World Crops, Vol.X, No. 10, October, 1958.

18. Duncan, J.F. — Agricultural Labour under war conditions. The Scottish Journal of Agriculture, Vol. XXIII, No. 3, July,1941.

19. Duncan, J.F. — Reflection. The Scottish Journal of

Vol. XXXVI, No. 4, Spring, 1957.

20. Fussel, G.E. — Farmer's Tools. London, 1952.

21. Government of India. — Royal Commission on Agriculture, 1942.

22. Government of India. — Report of Agricultural Labour Enquiry Committee, 1952.

23. Government of India. — Studies in Economics of Farm Management in West Bengal, 1954-55.

24. Government of India. — Second Five Year Plans by Planning Commission, 1956.

25. Government of U.S.A. — World Survey of Agricultural Machinery and Equipment. U.S. Department of Commerce, Business and Defence Service Administration, 1959.

26. Hendry, G.F. — The terms of trade for Scottish farmers. Scottish Agricultural Economics, Vol. IV,1953.

27. Hendry, G.F. — Some feature of the Mechanisation of Scottish Agriculture. Scottish Agricultural Economics, Vol. V, 1955.

28. Hendry, G.F. — Labour in Scottish Agriculture. Journal of Agricultural Economics, Vol. XI, No. 4. January, 1956.

29. Hendry G.F. and McEwan, L.V. — The Changing Labour Situation. Scottish Agricultural Economics, Vol. X, 1960.

30. Hendry, G.F. — The Fifties in Retrospect. Scottish Agricultural Economics, Vol. XI, 1961.

31. Hirch, G.P. — Migration from the Land in England and Wales. The Farm Economist, Vol. IV, No. 9, 1951.

32. H.M.S.O. — Annual Review and Determination of Guarantees, 1961.

33. Horsburgh, A.S. — Economic Aspect of Tractor Work. Economic Report No. 56. The Edinburgh School of Agriculture, 1957-58.

34. Hughes, J.D. — A note on the decline in number of farm workers in Great Britain, The Farm Econom Vol. VII, No. 9, 1957.

35. Jones, D.O. — Economics of Sugar-beet Growing in the West Midlands. Manchester University - Bull. 79/Ec/44, 1953.

36. Jones, J.O. — Proceedings of the International Conference of Agricultural Economists (10th. Conference) 1958.

37. Jones J.O. — Comparisons between Industrial and Agricultural Mechanisation and their Consequences. Mechanisation in Agriculture, edited by Meij, J.L., 1960.

38. Jussawalla, M. — Mechanisation of Agriculture. The Indian Journal of Agricultural Economics. Vol. IV, No. 1, March, 1949.

39. Lloyd, D.H. and Rowley, J.H. — The problem of seasonal Farm Work. Agriculture, Vol. LXIV, No. 8, November, 1957.

40. Long, W.H. — Farm Management and Best Use of Capital. Agriculture, Vol. LXVII, No. 5, August, 1960.

41. Macdonald, J. — On the Agriculture of the County of Sutherland. Transaction of Highland Agricultural Society, 4th Series, 12, 1880.

42. Mackenzie, A.M. — Variations in Earnings of Scottish Farm Workers. Scottish Agricultural Economics, Vol. VII, 1956

43. Machinery Syndicate — Report, 1960/61

44. McEwan, L.V. — The Progress of Mechanisation in Scottish Agriculture. Scottish Agricultural Economics, Vol. VII, 1956.

45. Mejer, E. — The Effect of the War on Conditions of Agricultural Labour in England and Wales. University of Nottingham, School of Agriculture, (1917-1951) Part II, 1951.

46. Memoria, C.B. — Agricultural Problem in India, 1958.

47. Nag, D.S. — Unemployment in Rural Sector. A.I.C.C. Econ. Review, April, 1955.

48. Nanavati, M. — Problems of Indian Agriculture. Proceedings of the International Conference of Agricultural Economists, Sixth Conference, 1947.

49. Nash, E.F. — Rural Movement. Proceedings of the International Conference of Agricultural Economists. Tenth Conference, 1958.

50. Osborne, B.M. — Recruitment to Agriculture, Ministry of Labour, Central Office of Information, London, 1949.

51. Paranjpe, V.M. — Mechanisation of Agriculture. The Indian Journal of Agricultural Economics. Vol. IV, March, 1949.

52. Pederson, J. — The impact of technical change on employment situation within agricultural and occupational structure of population. Proceedings of International Conference of Agricultural Economists. (9th. Conference) 1955.

53. Robinson, R.D. — Tractors in a Village: A Study in Turkey. Journal of Farm Economics. Vol. 34, November, 1952.

54. Sayanna, V.V. — Mechanisation of Agriculture with special reference to cultivation of waste-land. The Indian Journal of Agricultural Economics. Vol. IV, No. 1, March, 1949.

55. Scola, P.M. — The changing age structure of the farm labour force. Scottish Agricultural Economics, Vol. VI, 1955.

56. Shemilt, H.J. — Labour in Scottish Agriculture, 1946/47 to 1950/51. Farm Economics (Scotland), No. 23, Spring 1952.

57. Shemilt, H.J. — Changes in Efficiency on stockrearing and feeding farms since 1946/49. Scottish Agricultural Economics, Vol. VIII, 1957.

58. Shemilt, H.J. — The Financial results of farming in 1957/58. Scottish Agricultural Economics, Vol, X, 1960.

59. Sinclair, Sir John — General Report, Vol.IV, Edinburgh, 1814.

60. Singh, T. — Poverty and Social Change, 1946.

61. Sturrock, F.G. — Productivity of Labour in Agriculture. Journal of Proceedings of the Agricultural Economic Society, Vol. 9, No. 1 July, 1950.

62. Sturrock, F.G. — Efficiency in the use of farm labour. Farm Planning and Budgeting Service in Farm Management Advisory Work. April, 1954.

63. Sturrock, F.G. — Full employment - the managerial problem. Agricultural Review. Vol. I, April, 1956.

64. Sturrock, F.G. — The promotion of labour efficiency and productivity in farming in the United Kingdom. Lecture held at the general meeting of the Royal Netherlands Society for Agricultural Science on December 30th, 1957 at Ut. recpt.

65. Subbaraju, V. — Mechanisation of Indian Agriculture. The Indian Journal of Agricultural Economics, Vol. IV, No. 1, March, 1949.

66. Symon, J.A. — Scottish farming past and present. Edinburgh, 1959.

67. Turner, R. — Silage Harvesting. Forage Harvesters: Costs and Labour Organisation. Economics Department, West of Scotland Agricultural College. Report No. 38 (1957) 1957.

68. Warriner, D. — Economics of peasant farming. Oxford University Press 1939.

69. Watson, J.A.S. and Moore, J.A. — Agriculture: The Science of British Farming. 10th. Edition, Edinburgh, 1956.

70. Williams, H.T. — Principles for British Agricultural Policy, 1960.

71. Witney, D. — Economics of Mechanisation on farms with special referance to farms up to 100 acres. Journal of the Institute of British Agriculture Engineers, April, 1950.

72. Witney, D. — Mechanisation and Farm Management. Farm Planning and Budgeting Services in Farm Management Advisory Work, 1954.

73. Worley, T.K. and Ingersent, K.A. — The Use of labour in farm scale vegetable production. Department of Agricultural Economics (1957) University of Nottingham

74. Wright, S.J. — Farm Mechanisation. Farm and Mechanised Agriculture. Edited by Easterbrook, 1944-45.