ROTHAMSTED RESEARCH

The Use of Electricity in Agriculture

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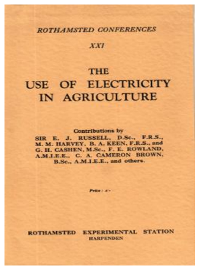
ROTHAMSTED CONFERENCES

XXI

THE
USE OF ELECTRICITY
IN AGRICULTURE

ROTHAMSTED EXPERIMENTAL STATION
HARPENDEN

Electric Power - How to Obtain It and How Best to Use It

M. M. Harvey

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"ELECTRIC POWER—HOW TO OBTAIN IT AND HOW BEST TO USE IT."

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Summary of Contents.

The general purpose of this paper is to indicate how farmers who are within reach of a public electricity supply may obtain the greatest benefits for their outlay of capital, and the general trend of electric farming development as related to the various types of farms.

The sections dealing with wiring and motors have not been dealt with at great length, owing to the fact that several other authorities are dealing with these specialised applications at this conference.

I have mentioned tariffs and indicated the reasons for the various charges to consumers, as there is often some confusion in the minds of consumers for the reasons for guarantees, minimum charges, two-part tariffs, etc.

The types of farms using electricity are tabulated with some specialised applications, and in section three, the various appliances are discussed at greater length.

The other sections deal with private plants; the verdict of farmers already using electricity; some details of actual installations; tables of running costs and other data collected from various sources and authorities.

This paper only deals with practical applications and those which have been successfully adopted in one type or another of farming, no " futuristic " applications are discussed.

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INTRODUCTION

LOOKING back over the last six years, the points which strike one who is connected with the electrical supply industry, is the changed attitude of the agriculturist and rural dweller to the use of electricity in the house and on the farm. To one who is connected with a group of companies supplying current to an intensely rural and scattered area with a very low population ratio, this changed attitude is very welcome. You may ask what change is this? It may be summed up very concisely: a decade ago the farmer said to us when we were obtaining wayleaves, " keep those ugly lines as far away from my farm as possible, I don't want the current it is too dear, and I don't know anything about it." We had the task of developing this rural area, as far as economically possible, and the greatest difficulty we had was to arouse interest of the rural dweller. Now, however, as the result of articles in the press, the agricultural trade papers, exhibitions at village halls and agricultural shows, and the universities and colleges, the farmer has become quite electrically minded, and comes to us and asks for a supply and for the lines to be brought near his farm, instead of the other way round.

Rural electricity development is discussed at every rural and parish council meeting and at national farmers union meetings, and, if the remarks are not always complimentary to the electrical supply industry, these remarks at least show that interest is aroused and rural dwellers are taking an interest in electricity, even if they do not perhaps realise the difficulties of supplying a thinly populated area, with a relatively small return on outlay.

The points discussed in this paper are rather in the shape of a review of well-known and tried applications of electricity such as are used on the farms of the south and west midlands and part of south Wales, the immediate area supplied by the company to which I belong.

Some of the points are controversial perhaps, but this is all the better from the point of view of a discussion.

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1. RURAL DISTRIBUTION OF ELECTRICITY

Before and immediately after the Great War, electricity supply was restricted to urban areas, and the immediate area around the large towns. Electricity was also available in some small country towns, where it was generated by small power units at low pressure, very little rural development was to be observed.

In 1919, the Electricity Acts provided for the setting up of the Electricity Commissioners and the transfer of the powers of the Board of Trade to the Ministry of Transport. This was for the promotion of schemes for re-organising supplies of electricity, and special orders with joint authorities.

The Act of 1926 organised, on a national basis, the country at large as a whole system, with schemes for various urban and small areas. Provision was made for interconnecting generating stations, and for the shutting down of small inefficient generating stations, also for the organising of a standard voltage or pressure of supply, and a frequency of 50 cycles. This means that there is now more or less a standard electricity supply available which cheapens production of manufactured electrical goods and obviates the nuisance of an electric iron bought in one area being useless if used in another area. The grid lines are therefore actually interlinking super station to super station and are not for distribution purposes as so many people imagine. The Act of 1926 put the generation of electricity on a national basis, the distribution to consumers being left to local authorities and companies. This corresponds to the organised selling and Marketing Boards set up for agricultural produce.

In areas where no power station is situated, power companies and authorities may purchase current from the grid for sale to their consumers.

These grid lines on large steel towers work at a pressure of 132,000 volts with some secondary lines at 66,000 volts. Power authorities also have their distribution high pressure mains of 66,000, 33,000, and 11,000 volts ; when these reach a village, hamlet or town these pressures are transformed to a working pressure of 400 and 230 volts.

Farms within easy reach of the low tension mains are in most cases connected up, and more and more in the future the question of supply to farms from high tension lines, or long lengths of low tension mains will be the leading factor of rural electrification.

Wayleaves have been necessary between supply authorities and landlords and tenants, to enable these lines to cross land, and it

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says much for the rural dweller that generally an amicable arrangement has been arrived at for the erection of these towers and poles, so that there is the minimum of interference with agriculture. Farmers should understand however, that every deviation from a straight line, means extra cost in line construction, extra strong supports, stay wires, etc., which put up the cost of construction and tend to limit development of an area on the score of capital cost.

Farmers naturally say, " How can I obtain a supply of electricity as I am not near to a village supply with low pressure mains ? "

It is quite uneconomical to tap high pressure lines of 66,000 and 33,000 volts for isolated farms, but most authorities will tap 11,000 volt lines on some basis of charge.

This tapping of lines includes as a capital cost: switchgear, transformers, isolated sub-stations to hold this gear, and lastly the low pressure lines to the farm, and the authority has to cover itself on loans for capital expenditure, depreciation and maintenance of equipment and transformer losses which run on continuously for 24 hours per day, year in and year out. This means that each tapping has to cover in its charges a sum equal to this amount, and, if included as a flat rate per unit, the cost would be too high per unit to make the use of electricity economical for some purposes. Therefore, there has been developed a system of tariffs in some areas whereby the authorities generally bear part of the cost of the transformer and H.T. switchgear and transformer losses and maintenance, and the farmer pays for his low pressure lines to be erected by the Authority, or erects them himself to a standard construction.

The price per unit is then fixed at approximately the same price as if the farm was on a low pressure village system, plus a standing charge or guarantee to cover the extra cost of this equipment to give electric service to this isolated consumer. In fact, we say to the consumer, " We will supply you with current at approximately the same basic price per unit as if you were in a village, but it has cost us a certain sum of extra money over a village scheme to make this service available to you, and we therefore ask you as a business man, to guarantee a sum per annum as a contribution towards the cost of this service, based on a percentage of the total capital cost involved, or guarantee that you will use a minimum amount of current per year to meet these charges." Most farmers, as business men, immediately see the point, especially as most guarantees include a number of units of electricity in this amount. These guarantees may be fixed as a percentage of capital cost, or based on the demand likely to be made by the farmer, or on the size of his buildings and number of rooms in his house. It is not often realised that the percentage costs of giving electric service to a rural area are in the region of 75 per cent. for distribution mains, and are totally different to town supplies. Also, an authority has to raise loans from investors to erect these schemes, and the investors naturally require a return on their money. If this return is not available investors will not lend money and the development automatically ceases.

This system of a guarantee and a lower rate per unit than a flat rate may be explained in this way. In any business or farm, there are certain overhead charges, such as rent, rates, living expenses and labour which go on continuously whether large or small quantities of produce are produced. Now, if a farm is producing a certain quantity of product per year the price obtained at a flat rate per gallon or ton has to cover these charges, whether all or any of the product is sold, and if a smaller quantity is sold the revenue obtained must be larger to cover these overhead charges or a loss is incurred. It is therefore, better to sell all products if possible, even if a lower rate is obtained, as long as the overhead costs are covered. Thus, one might suppose a buyer to say to the farmer, " I will guarantee to take your products, but instead of paying you at the flat rate per gallon or ton, I will contribute a certain sum per annum according to the quantity you produce or sell me, to cover your overhead costs. These will then be covered, and you will not be at a loss. You can then let me have your produce at a lower figure than the flat rate, or just above the cost of production. You will then be in a better position than if you sold in the flat rate market, as you are fully covered for overheads and can afford to sell at a lower figure per ton or gallon for your produce as you have a guaranteed market." This is really the basic principle of all marketing schemes.

A simple explanation of the extra cost of rural distribution over town distribution is as follows : Suppose a farmer retails 100 gallons of milk daily from vans in a town or a few streets, his customers are close together and a few vans can deal with this retailing, and the delivery costs per gallon are low. Now suppose that a farmer had to retail to the same number of customers the same number of gallons over the whole of his county, his distribution costs would immediately rise many times per gallon over his town delivery costs, and he would have to obtain a higher price per gallon to cover this. This explains why the rural dweller has to pay a slightly higher price per unit than the town dweller. Some farmers may ask, " Why am I charged at a higher standing charge for a large transformer than a small one ? You are penalising me if I want to occasionally make a larger demand on your system." The explanation is as follows : Suppose a purchaser was willing to take 50 gallons of milk daily as a maximum from you. You could budget for sufficient cows to give this daily supply, and as long as he did not exceed this quantity he would be a satisfactory consumer, but supposing he said " I want 50 gallons of milk daily, but perhaps for one day only in the year I may require 200 gallons from you." You would be in an awkward position of having to keep a larger herd just to supply this one day's demand, and you would be justified in coming to some arrangement with this customer to pay you extra for this availability of supply of milk, as your overhead charges would have to cover these extra cows for one day's supply only of their product. This is the same in effect as our maximum demand charges; it pays any producer better to have a constant demand at a lower maximum output than an erratic spare-time demand at a higher level.

Isolated farms and estates should view the capital expenditure on service lines in the same way as they would capital invested in private plant, looking at it from the point of view that the farmer is freed from all generating worries, plant upkeep, and has generally a greater horse-power available for farming and larger domestic appliances. Most companies fix guarantees within reach of the annual consumption when electricity is used in a reasonable way, and, although guarantees may seem hard at first, many farmers have found that they have an incentive to use current to the best advantage, and often find the labour saved in pumping and dairy and poultry appliances goes a long way to offset the guarantee. The Chester area have found guarantees to work quite satisfactorily and numerous testimonials, with names and addresses of farmers who gave them, will be found in E.D.A. Booklet No. 1179, read at the R.A.S.E. Show at Derby in 1933, by Mr. S. E. Britton (*Five Years' Progress in the Electrification of Agriculture Round Chester*).

Many of our farmers are on this guarantee system, and they see that they use up to the amount they have to pay for. Some details of the number of units used for various operations on an average farm will be of interest. I have also indicated the unit consumption per ton or cwt. for various machines. These will be found in the appendix.

Farmers desirous of obtaining a supply of electricity, if within reach of high or low-pressure lines, should apply to their local electric supply office, where they will have to obtain an application form, and fill up the various sections relating to the amount of load to be connected to the mains, and to the tariff to be adopted. The supply authority will then advise him of the length of main to his premises, the contribution or guarantee required, and when a supply can be made available. The consumer should have his premises wired by an established supply company's wiring department or skilled electric contractor. A good installation is worth the little extra first cost; it is good to remember the old slogan, "Service and convenience are remembered after first cost is forgotten."

Farmers will ask, "How much shall I use per year?" This will obviously depend upon the type of farm and the installation. The average consumption of various types of farms on the S. W. & S. power company's mains suggest that the highest consumptions are from dairy and poultry farms, which average 2,000 to 7,000 units per year—one large hatchery consumes 17,000 units per year—some mixed farms with hops average 2,000 to 5,000 units per year.

Two large dairy farms reach over 9,000 units per year. The average consumption for 29 farms reaches over 4,000 units per year.

Regarding tariffs, the supply authorities have various methods of collecting the first part of the two-part tariff, some being on the acreage of the farm, some on the connected load of farm motors, some on the lighting installation, others on the number of rooms, or the area of the house, plus a standing charge on the floor area of the main farm buildings. This may seem very confusing to the consumer, but in practice the cost of current to the user works out practically the same whichever method is adopted to collect or assess the standing charge. All these systems have a small unit charge, and the assessment for the first charge only increases the unit cost for the whole premises by a very small fraction of a penny per unit if adequate use is made of electricity.

2. TYPES OF FARMS

Obviously the greater number of farms using electricity are situated near the larger towns or villages, and are of the intensive or semi-intensive type, such as poultry and dairy farms, whose productive methods and marketing more closely approach the factory system, and machinery is used to a greater degree than on the prairie types of farms, as these factory type of farms produce perishable foodstuffs, and constant delivery service is everything.

Taking the various types of farms, one is struck by the fact that the geographical position and methods of agriculture and even marketing schemes and political development determine the consumption of electricity, for instance, the large poultry farms and hatcheries of the North and the Midlands ; the better prospects of the hop farmers during the last few years, and the dairy farms near Birmingham, and then turn to the sheep farms of Brecon and Radnor, where very little machinery is used, nor can it ever be owing to the geographical position and the type of farming.

The various types of farms and their installations are outlined below.

Poultry Farms

There has been a tendency during the last few years to go "back to the land," or free-range rearing of chicks and housing of laying stock where the land has been available. Electricity is used for : incubation in small and mammoth machines ; rearing, where the semi-intensive or intensive method is used, and even where "limited" free range is used we have fitted up portable foster-mothers with heaters and trailing cable ; electric lighting for winter egg production in large and medium size laying houses ; warming drinking water ; egg candling ; and on the larger farms mash mixers ; hot water for mashes ; egg grading ; poultry plucking on table bird farms ; water pumping ; egg washing and drying, and other uses ; and of later times lighting of hen laying batteries.

Dairy Farms

Electricity on dairy farms is used for water-pumping ; refrigeration where a bottled trade is done ; milking machines, both for pipe line and combine or recorder types of milking machines fixed in bales near the buildings ; cow clipping ; food production and mixing ; bottle washing ; hot water ; separating and churning (though this application is not now so much used) ; sterilizing utensils ; steam production ; general lighting of milking sheds and buildings ; and on the larger retail distribution farms bottle-filling and capping machinery ; motor agitators for pasteurizers ; curd mills ; fans, etc. ; and for electric vans for town delivery from near-by farms.

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Mixed Farms

This term is very elastic, as in Worcestershire and Herefordshire we have perhaps not specialized so much on one type of farming as in some other counties, and I often say we have not felt the Agricultural depression so much, owing to the farmers having several "strings to their bow" in cattle production, pig production, milk, poultry, fruit, corn, hops, and sometimes market gardening. I know one large farm in the Vale of Evesham where practically every section is carried on. The electrical equipment of these farms varies more than any other type, as the bulk of the power farming is done on the land and not in buildings such as on the dairy and poultry farms. The applications will partake of a little of each type, such as a certain amount of the dairy and poultry machinery, food production and corn grinding, threshing, pumping, motor-driven fans for hop kilns, and lately air compressors for fuel-oil hop-drying plant; and of course, general lighting. In the West Midlands some of our large fruit and mixed farms have installed small canning plants, with motors for bottle-washers, fruit graders, canning machines, etc. Taken as a rule, I find that although the connected motor load is often larger for these mixed farms than for the other types, the consumption per horse-power is lower owing to the fact that the uses of the machines are more seasonal.

Large Arable Farms

Electricity on these large prairie types of farms is generally confined to the farm-house and general lighting in the farm buildings —water-pumping, motors for driving barn machinery, threshers, grinders, mixers, hoists and grain-dryers, etc. The electrical equipment for these large arable farms does not tend to be so great as on the poultry, dairy and mixed farms, as the power is most used on field operations, and the indoor work forms only a small part of these mechanized farms. Of course, if the farmer launches into any other system of agriculture his uses will increase with the acquisition of dairy and other equipment. The unit consumption, per acre, of electricity is generally at its lowest on these types of prairie farms.

Hop Farms

Except in a very few cases, these farms are not specialized hop-growing farms, but carry on a certain amount of other types of mixed farming, chiefly corn production and cattle feeding. The uses of electricity in the hop kilns are motors for driving ventilating fans of the exhaust and pusher types, motors for hop pocket hoists and bagging presses, small motors for air compressors for fuel oil fired kilns, and electrical thermostats for the control of the flow of oil to burners. Lighting of hop kilns, bagging and cooling floors is always adopted where a supply of current is available. The safety of electricity for lighting is most helpful in combating the

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fire risk in hop-pickers' quarters. Some of our Midland growers are contemplating the use of their hop kilns for grass drying in the spring and summer, and already some few have done this. One or two in the Vale of Evesham have dried herbs for the market gardeners in their kilns.

The yearly consumption of hop farms is reasonably good, but as it is a highly seasonal operation, the bulk of the units are over a four to six weeks' period in September.

The use of hop kilns for grass or crop drying will assist the farmer to keep down the heavy proportion of capital costings on kilns and equipment only used one month in the year, by spreading this over a greater period.

New Developments

As already mentioned, the drying of short grass in the spring and summer of the year, for producing a food of high protein value, is attracting a good deal of attention. During 1936 there should be quite a number of these plants working in the West Midlands. This particular type is marketed by one of our leading chemical and fertiliser firms, and it necessitates a special drying plant, using coke for generating producer gas for heat, or fuel oil may be used. A large electric motor is used for the fan.

Some of our farmers are contemplating adapting their hop kilns for this dryer.

Some of the fuel-oil heater firms also make outfits of large and small capacity—in one make the agitator tray is fitted to the kiln heater as an extension.

The use of the combine harvester has brought grain dryers into prominence and electric motors are used for the fans of these machines.

Market Gardening and Horticulture

This type of specialized agriculture does not usually come within the scope of the average farm, although some of our Worcestershire farmers have large field market gardening systems.

In the field type of gardening electricity has little outlet except for pumping for irrigation.

One large Worcestershire farmer during the last three summers has fixed up a pipe system along the headlands of his fields with convenient taps to which he attaches rubber pipes connected to long lengths of galvanized piping drilled every two feet or so, the pipes being mounted on low trestles across his strawberry and soft fruit plantations. This artificial rain has saved his crops during the drought seasons and amply repaid him for his outlay. The sets of pipes are periodically moved up and down the field. Water is obtained from the river.

Horticulture and Glass House Work

This does not come strictly within the scope of the farmer. We have glass-house owners using electricity for ventilating fans, pumping, lighting, and in one or two instances electric heat for frost protection in low temperature nursery houses.

I feel that at present one has to go very carefully into the economies of greenhouse heating by electricity on a commercial scale before advising its use for the higher temperatures required in cucumber and tomato houses.

A number of horticulturists are using soil-heating cable in a small way for propagating frames and where bottom heat is required.

There are several new electrical applications in horticulture, such as neon lighting, which are in the experimental stage as far as England is concerned.

3. ELECTRICAL INSTALLATIONS ON FARMS FOR DOMESTIC AND FARM PURPOSES

The House

The lady of the farm generally insists upon an adequate installation of electricity in the house, and apart from the convenience and greater illumination power of electricity, the saving in labour should not be overlooked.

One farmer in Herefordshire, who has used electricity for twelve years, has told me that since installing a cooker, vacuum cleaner, electric washing machine and iron, his wife can manage without a maid at £28 per year wages, her food and room. The electricity bill for his whole farm did not come to this amount in a year.

Electrical Wiring

Any of the well-known systems—lead-covered, tough rubber or conduit—may be used in the house. The first two are generally used in surface systems, and the latter is sunk work. An adequate number of points for lighting, heating and wireless should be put in when the work is installed, to save disappointment at a later date. Two-way switching should be used on all stairs and long corridors, bedrooms and large rooms with several doors.

Modern lighting fittings obviate the glare of exposed lamps. The lamps themselves should be of the new coiled coil pearl type.

Power outlets for the use of vacuum cleaners, fires and other domestic aids should be installed in every room.

Hot water may be cheaply supplied for the bathroom and kitchen, either from individual lagged heaters or from elements fitted into the lagged cylinder of airing cupboards working in conjunction with the back boiler of the grate. All these various types of water heaters are thermostatically controlled, giving the utmost efficiency of operation.

The kitchen is the workshop of the house, and there an electric cooker gives the most hygienic and unparalleled results : the oven is airtight and no fumes are given off ; while there is little or no shrinkage of the meat, owing to the efficient lagging and airtightness the heat is retained for hours after the oven is switched off, and puddings, etc., may be cooked after the heat is switched off. The cost of cooking averages out at about one unit per person per day.

An electric refrigerator keeps the food fresh and saves wastage ; and electric irons, kettles, washing machines, wash-boilers, etc., help the housewife in her work.

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It is noticeable on the " family-run farms " of South Wales, that often the wife and daughters are doing outside barn work and stock feeding while the electric cooker prepared the midday meal without attention.

Many ladies now use electric hair-dryers and curling-tongs, and ceiling type reflector fires are a boon in the bathroom.

Electricity in the home cuts out the drudgery of work and gives large-town amenities to the rural dweller.

Many farmers when seeing the usefulness of electricity in the home have adopted it on the farm.

Finally, go to reputable electrical engineers for your installation.

ELECTRICITY ON THE FARM

Wiring Systems

As another speaker is dealing with the details of farm wiring systems, I will only briefly touch on them.

The usual systems for farm work are somewhat similar to those in the house. The systems may be vulcanized indiarubber cable run on cleats, and where liable to damage enclosed in galvanized piping —tough rubber-sheathed cable with all insulated fittings. I am partial to this system, or a galvanized screwed piping system, which is a very fine job, though more expensive in first cost. I am not in favour of lead-covered cable in farm buildings.

Fuse-boxes protect the circuits, and detachable ceiling roses are useful for cleaning lamps and shades.

For carrying mains between buildings, simple iron brackets or wall spikes fixed on the walls with small shackle or reel insulators may be used with an insulated cable of the appropriate class. These mains should be erected high enough to clear any harvesting waggons.

Power Wiring

This is usually carried out in steel conduit with ironclad switch-gear and ironclad switch plugs for portable motors. Generally a few points for portable motors scattered round the buildings will suffice for most jobs.

With this 400-volt power wiring, attention should be paid to earthing ; and if doubtful of the earth, use should be made of the small earth leakage trips now on the market.

Farm Lighting

Lighting is the first and most useful application in the farm buildings and yards, and its use is encouraged by many authorities, including the N.F.U. insurance department. A man working with a hurricane lantern at night is a " one-armed man."

Adequate lighting in dairies and milking sheds is a profitable investment.

For barn lighting, a light high up over the centre waggon space will suffice, as the sides are usually filled up with hay and straw.

For stables, lights on the centre line will be adequate, the number depending on the size of the stable. Do not forget a plug for the horse-clipper when wiring the stable.

In food-preparing rooms, I recommend placing the lamps near or over the machines, clear of all shafting.

In the milking sheds, the position depends on the layout of the cow standings, and whether one or more lines of stalls are in the sheds. In some cases of low-roofed single-line stall sheds, the beams may interfere with suspended roof lights ; in these I recommend angle lights on the wall at the rear of the cows, pointing down to the cows' hind quarters. In the case of two-line sheds, these generally have a central gangway and two gutterways, the cows' heads being against the feeding gangways on the side walls. If two lines of lamps over the line of the cows' udders are not used, one centre line over the gangway may be installed clear of any manure carrier.

For yard lighting, lamps may be fixed in corner wall brackets to light two ways, or suspended on a catenary system from rough poles over roadways. Watertight fittings must be used, and two-way switching is an advantage on long lines of sheds.

Plugs mounted on walls for hand lamps are useful in piggeries and cow sheds during illness of animals, and appreciated by the "vet."

A portable floodlight is often useful round buildings and yards for night work. One of our farmers in South Wales uses a 1,000-watt floodlight on a pole in a small paddock near his house during the lambing season, so that his shepherd may attend to his ewes. This has saved him many ewes and lambs.

In the modern pig house, lights over the feeding gangways assist at feeding-time.

In the dairy itself, totally enclosed fittings are the most hygienic and the standard of illumination is higher than that of the outside barns and sheds, plenty of light being required near the milk-cooler and weighing platforms.

The washing-up and sterilizing rooms should be fitted with watertight fittings and switches because of the prevalent steam—bulkhead type fittings are useful here.

On poultry farms the lights in the laying houses should be placed as high as possible to light the floor, food hoppers and perches ; 40-watt lamps ten to twelve feet apart are usually fitted. In brooder houses lamps centrally placed over the runs are adequate ; some farmers use a dimmer for providing a night light for extra feeding-time for the chicks ; this is often done on table bird farms. In houses for the laying batteries for adult birds, a good light is necessary ; these are generally placed in the gangways.

Generally, central lighting is used in incubator rooms with plug outlets for inspection lamps, egg-testing and candling. A desk bracket type of daylight lamp of about 250 watts is used over the benches for chick sexing, for which a good light is necessary.

General lighting suffices for hop kilns with plugs for hand lamps for use in the kilns, and often an outside light over the loading floor for night work.

Pumping on Farms

The electric pump is usually the first appliance the farmer installs after lighting. For shallow wells there are many types of small centrifugal or piston plunger pumps ; these are either direct-coupled or rubber belt driven from motors of ¼ h.p. to 1 h.p., mounted on the pump castings ; these small pumps stand up to an amazing amount of work. Practically all these pumps are self-priming.

Pumps may also be obtained to pump liquid manure, and gritty liquids, without damage to the rotors. These standard types of small pumps are for shallow wells and suctions up to 27 feet.

For deep well pumping one may use a motor driving a well head gear with rods down the well, or one of the deep well devices such as the injector system, with two pipes down the well ; part of the water pumped up is forced down again to bring up water from a greater depth. There is also the totally submerged electric pump for deep wells, which is becoming very popular ; this is very simple to install, and is watertight.

A useful type of pump is the pressure tank automatic type. A quantity of water is stored under air pressure in a cylinder ; this system avoids large overhead storage tanks, and is useful for small water schemes for groups of cottages. An automatic switch stops and starts the pump according to the quantity of water in the tank.

Electric pumps using storage tanks may be controlled by a float switch mounted in the tank, this again automatically controls the pumping. This automatic control is the great feature of electric pumps.

Small pumping outfits may be mounted on four-wheel trollies for headland irrigation and spraying work—the motors being fed with tough rubber cable.

Barn Machinery and Motors

As another speaker is dealing with electric motors, I will only briefly outline various points.

We find on a number of Midland farms that the farming technique is tending to cut out some of the barn machines, such as chaff-cutters, cake-breakers, and sometimes root pulpers. Grinding is now the chief barn application. The average farm grinder takes from 5 to 10 h.p., and is either driven from the shafting feeding other machines or, if used every day, individual drive by rubber " V " belts. Driving by means of " V " belts is being used to a greater degree, making it possible to use larger pulley ratios and higher speeds and cheaper motors. These barn machines are driven by stationary motors on beds or by means of portable motors driving shafting.

Chaff-cutting takes about 3-5 h.p.; cake-breaking 1½-2 h.p.; and root pulping about 1-1½ h.p.

The heavy applications are threshing, ensilage cutting and blowing. Threshing requires from 12½-20 h.p., according to size of drum and baling gear. Ensilage cutters and blowers take 15 h.p. and corn driers about 10 h.p.

Regarding individual drive to each machine, except in the case of pumps, poultry and dairy appliances and a certain amount of specialized applications on hop-drying, grass and corn-drying, we feel that the average barn machinery does not warrant individual drives; one motor driving a length of shafting, generally, gives a farmer all the convenience he requires. Use is often made of a fixed motor for barn machinery and a portable for odd jobs.

The S.W. & S. power company have developed a semi-portable motor, consisting of a standard motor and starter, mounted on wood baulks with quickly detachable rubber wheels, which has proved popular. The flat wood baulks give a flat surface for foundations, obviating the use of "chocks" for the wheels. When the motor is in the barns driving shafting, the farmer may use the wheels and spindle as a low trolley for farm transport; this has proved very useful. Except for outdoor work, the use of special protected motors is not necessary.

Starters should be robust, and in the larger sizes oil-filled—it pays to fit a good starter.

Contrary to what some authorities say, we find that the fixed and unit drive motors are in the smaller sizes, and the larger ones are made portable.

It is now compulsory to fit a switch adjacent to each power plug for portables, if the wiring rules are to be observed.

In villages where only one-phase supply is available, the position is eased by the fact that prices have been reduced for repulsion induction motors, and capacitor motors have been recently introduced. These particular types overcome the difficulty of starting against small loads.

The small motors used on incubators, small pumps, separators, bottle-washers, milk-coolers, clippers and shearers are generally of the single-phase type, and unit drive is the only correct scheme for these types of drives.

Electric motors are less in capital cost per horse power than other sources of power, and farmers appreciate their time-saving qualities, convenience and low running costs.

Dairy Applications

The dairy farm has varied applications—the motors have been dealt with in the previous section. Milking machines are becoming increasingly popular, and many farmers are installing the releaser type with electric drive, where the bale is near the buildings.

The accredited milk scheme has made the farmer machinery-conscious. The tendency in the S.W. & S. Power Company's area has been for the purchase of milking machines, and a very great interest in electric hot water produced by thermal storage heaters or even wash boilers, and in electric sterilizing chests. We have found that current at 1¼d. per unit is not uneconomical when taking into account the labour saved in stoking and ash handling, the capital cost of boiler houses and the longer life of electrical appliances. These sterilizing chests vary in price, a small one being obtainable for £11 10s. 0d. I prefer the type with washing water heating facilities, and it is an advantage to have a means of turning off the steam at the end of the operation. Some of our farmers have used their low-pressure steam-tight chests for blowing through the rubber tubes of the milking machine units ; this is accomplished by fitting a tap to the top of the chest.

The hot summers of the last three years have resulted in the increased demand for milk coolers and cold rooms, especially among producer-retailers and every satisfaction has been expressed in their use.

The milk schemes for schools have aroused interest in electric bottle-washers, of which there are now many makes on the market.

A new type of storage milk-cooler has been marketed, in which the churns of milk are immersed in a water tank cooled by pipe coils in the water.

Cow-clipping has been successfully catered for by small portable clippers, mostly of the hand motor type.

In some districts near residential areas there is a steady demand for cream, and many separators have been converted to electric drive by means of ¼ or ⅓ h.p. motors.

The protection of motors in dairies is generally of the drip-proof type, or in some cases totally enclosed motors are used.

The larger dairy applications have not been dealt with, as a visit to the London dairy show will convince anyone how impossible it would be to carry out these factory type of processes without electricity.

We have very few cheese farms in our area of supply ; the few that exist are using motors for curd cutters, whey pumps, electric hot water, and fans for ventilation and cooling dairies and cheese rooms.

The cleanliness of electricity has made it an indispensable power for the dairy.

Electricity on Poultry Farms

Where available, electricity has been used in increasing amounts during the last few years. There are two noticeable points : the first is the changed system of chick rearing in many farms, the policy

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now being to breed and rear for stamina by getting the chicks out on grass as early as possible. This means that there is not such a great use made of battery brooders and large brooder houses, except for table bird production. We have equipped a number of outdoor foster mothers with heaters and fed them by means of trailing cable, or tappings from an overhead cable system stretched between poles.

The second noticeable change is the general adoption of large mammoth cabinet incubators, generally of the all-electric type, instead of using a number of small incubators. The day-old chick trade has helped to bring this about. In a treatise published in 1935 by The Oxford University Department of Agricultural Engineering Research (author, C. A. Cameron Brown), the running costs of all-electric incubators has been discussed and illuminatory figures given to show the fallacy of the statement that oil-heated cabinets are much cheaper in running costs than the all-electric types.

In rearing appliances, opinions are still divided on the question of luminous or lamp type heaters as against black heat types such as plates or boards. Many of our consumers have arrived at the conclusion that there is no difference in quality of the chicks produced. These brooders are now much more robust and simple than the early types and thermostat control is becoming recognized as a means of economy of current and labour.

In battery brooders preference is generally expressed for the types employing a separate warm compartment and a cooler feeding compartment.

Our poultry farmers and general farmers install electrical rearing appliances as a matter of course as soon as a supply of electricity is available.

Where laying houses of the semi or intensive type are in use, one invariably finds electric lighting installed for extended hour lighting for winter egg production; the morning system or, alternatively, the late lunch system of lighting at 9 p.m. for one hour, seems the most popular in our area. Owing to the seasonal tendency of the egg prices to become dear early in the autumn, we find lighting is often started in September and left off in late January. The lighting cost generally works out at $\frac{3}{4}$-1 unit per bird per period of five months.

The increased interest in table bird production has given rise to increased use of motors for mash mixers, ventilating fans for large fattening houses, poultry plucking machines, in addition to incubators and brooders.

Many farmers who handle eggs in large quantities are now installing egg-washing and egg-grading machines, and trough heaters for water systems are used on farms where adult bird-laying batteries are in use.

Chick sexing would be impossible without the intense light furnished by electricity, daylight lamps being used. A moveable type of bracket or table fitting is the most convenient type to install.

Some of our larger farms have small woodworking plants and machines electrically driven, to undertake repairs to houses and equipment, and many prefer to make their own wood equipment.

Electricity appeals to the small man just as much as to the large man, inasmuch as his labour costs are reduced, and labour is a serious item in the poultry industry today.

Electric Heat on Farms

Apart from the dairy applications of hot water and sterilizing and the poultry heat applications, electric heat may be used in food boilers, warmers, soldering irons, grain sprouters and radiant or tubular heaters for farrowing pens. One farmer in the North of England has successfully used reflector bowl fires screwed to the angle supports of his farrowing pens directing heat down on to the young pigs in the corner of the pen. These fires may be obtained for 8s. 6d. upwards. I am rather in favour of the radiant type of heater for young pigs. This type of heater could, of course, be used for other animals in cases of illness.

Hop Farms

Increasing use is being made of electricity for driving ventilating fans of various types, both for exhaust use in the top of the kiln and for "pusher" type of fans for use with the various heating systems using crude oil or low grade fuel, giving pure hot air through the hop bed. These motors vary from ½ h.p. to 20 h.p., depending on the size and type of the plant. Probably due to the controlled marketing of hops, the hop farmer seems to be more ready to spend money on new equipment, and more use is being made of unit drive for fans, blowers, etc. This outlook is being aided by the makers of drying plant who prefer electric drive, and build compressors and fans incorporating unit electric motor drive. Hop growers advise us that they prefer electric drive if obtainable.

A number of modern kilns have been recently erected in Worcestershire, incorporating thermostat control electrically operating the oil supply to the burners. An electrical hop-bagging press has lately been placed on the market; this incorporates an ammeter reading in lbs. pressure, and the whole outfit is a compact assembly.

In my opinion electric heat for kilns is not yet economical; when it is applied it will have to be fitted to kilns of the multi-tray type or a dryer designed for continuous operation.

As previously mentioned, some of our hop growers have dried short grass in their kilns. One should, however, fit perforated metal floors instead of the hessian mats. As the temperature required for grass is much greater than with hops, we also found that one had to increase the volume of air going through the grass bed, also increase the heat. Analysis proved that the dried sample was quite good in feeding value.

Hop growers use lighting extensively in hop pickers' barracks, where the installation of electricity has cut down the fire risk. Needless to say, the installation should be robust.

Grass Drying

During the last twelve months there has been great interest in our area in grass drying. The size of the motor required for the fan is generally about 25 to 30 h.p. These dryers may also be used for drying corn or other seed crops threshed direct from the field.

In one particular drier the grass is dried in two stages by a current of hot air drawn up through the grass beds—the drying is continuous. The hot air is produced by gas from coke or anthracite burned in a firebrick-lined chamber. The average drying time per load is 25 to 30 minutes and from 4 to 8 tons of wet grass can be handled in 8 hours, giving 21 to 33 cwts. of dried grass. Drying goes on from April to September or October. The costs of electrical fan drives are given below.

The makers state that the electricity consumption will amount to 28,000 units per season, so that these plants will be good consumers of electricity, if somewhat of a seasonal load.

Dried grass, either from the bale or ground into meal, may be fed to most farm animals.

Special Applications of Electricity

Electrical battery vehicles give a simple means of delivery transport for dairy farmers in towns for house-to-house delivery. The use is generally governed by the distance from the farm to the town, although some farmers transport their milk in petrol lorries to a central distributing depot for delivery by electric vehicles. The advantages of an electric vehicle are that there are no fumes or smells, lubrication problems, erratic starting on cold mornings, no danger of frost, good acceleration, no vibration, therefore little wear on the chassis and body, easy to drive. Batteries are charged in the evenings, generally at special rates. The cruising speeds are generally 16 to 25 miles per hour, and the range at 20 miles per hour is about 40 miles per day. The average current used is one unit of charge gives 5 miles' service, therefore about 8 to 9 units per day are necessary for charging. This application should be noted by farmers who reside near towns.

Electric motors are used for driving fruit graders for apples, plums, and even soft fruits ; these are generally of the 1 h.p. size, but may be as low as ½ h.p.

A number of farmers have installed motors of small sizes for operating can-sealing machines in home canning plants.

Although humane killers do not come within the scope of the general farmer, some possess butchers' shops, and the use of an electric stunner should not be overlooked by the country butcher.

There are a number of horticulture applications which give evidence of becoming commercially possible, such as neon lighting for prompting plant growth.

In the poultry industry a certain make of incubator fits a time switch controlling motor driven egg-turning gear, and also an animal and bird dryer consisting of cages through which is blown warm air.

In apiculture, centrifugal honey extractors driven by fractional h.p. motors have long been in use.

4. PRIVATE PLANTS *versus* PUBLIC SUPPLY

A farmer often says, "Why should I pay a supply authority £150 or so for giving me a supply when a private plant will generate current for me at a fraction of a penny per unit ?"

There are many points in this question which are not so delightfully simple as they appear at first glance.

First of all, the generation of electricity is a specialist's job, and a farmer has enough to do to look after his own particular industry without trying to run a miniature power station, with all its worry of charging, repairs, purchase of fuel, etc.

Secondly. The first cost and installation of a plant with its batteries is generally a larger charge than the sum asked by a supply authority to give an isolated supply. A battery plant of 50 volts and only ¾ k.w. costs about £100 with erection and fitting, and a 1½ k.w. plant of the fuel oil type would be over £200 fitted.

Admittedly one can get light, and perhaps run a few very small domestic appliances, but one is prohibited from using room-heating, cooking, motors of several horse-power, and often I have been told one has to run the engine while the ladies are using the iron. Therefore, a farmer has a large capital outlay without being able to get as great a use from electricity as if he had taken a public supply.

Thirdly. One hears wonderful figures on running costs, but farmers have told me their plants have cost them in the region of 9d. to 10d. per unit when all legitimate charges have been allowed, such as standing and running charges, depreciation and upkeep, so many plant users do not realise the very low annual plant load factor of their private installations.

A recent paper read before the Institute of Electrical Engineers by J. A. Sumner, Esq., gives some illuminating figures on the cost of small private plants from figures collected from the owners themselves—these vary from 6.1d. to 12d. per unit.

Now if you will look at Volume II of *Farm and Machine—The Report of the Oxford Agricultural Research Institute in Engineering*, you will find an article on electricity tariffs in which is given the average unit cost in a number of supply authorities' areas. For the house the figure of 2.3d. to 2.5d. per units seems a fair average in truly rural areas. For the farms, the truly rural areas work out at the figure of 1.5d. to 1.6d. per unit.

On the total costs for house and farm combined the unit average price is 1.6d. to 1.76d. per unit.

Therefore one can see that it obviously pays to take a public supply where one is at all available.

Many farmers who have changed over to our mains would never think of changing back to their old system.

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5. OPINIONS OF FARMERS USING ELECTRICITY

For detailed testimonials I would refer interested parties to the E.D.A. Booklet No. 1179, *Five Years' Progress in the Electrification of Agriculture round Chester*, by S. E. Britton, Esq. This contains many actual testimonials with names and addresses.

Our own farmers say they would not return to their old methods —a point which many of them stress is that when the men come home from the fields at 4 to 4.30 o'clock on a winter's afternoon, they will push a button to start a motor to do half an hour's barn work, where in the past it was difficult to get them to start up an oil engine or run in and belt up a tractor for that short period. Many farmers have found it does not pay to run in their tractors to do a short time barn job, as by the time the tractor has warmed up it is time to shut it down.

Dairy farmers on our supply, with electric dairy equipment, make a feature of this in their advertisements to customers.

The ex-Chairman of the Herefordshire Poultry Association, who possesses two mammoth cabinet all-electric incubators, considers his costs to be one-third that which he used to pay for running small oil heated machines.

Many poultry farmers rear their own stock for breeding by electric methods, and report the minimum of losses.

Farmers with pumping schemes have been able to fight the drought of the recent dry summers.

Regarding interruptions of supply to poultry farms, we have many cases where supplies have been off for 3 to 9 hours on incubators with no ill effect. One poultry farmer quite voluntarily allowed us to interrupt his high tension line for 10 hours to effect alterations to switch gear. He had an incubator with 4,000 eggs in it, and he was quite happy about it.

A remarkable case of the hardiness of the embryo of the egg is illustrated by a recent incident at a poultry farm in our area. The farmer has three small electric incubators of 150 chick size each; on the fifth day of setting, he inadvertently switched one off at 5 p.m., he did not discover this until 8 a.m. next morning, a period of 15 hours. The room temperature was 45° F., he left them in the incubator to see what would happen—1 chick started chipping the shell to time, and the bulk of the remainder came out $1\frac{1}{2}$ days late, with a hatch of about 75 per cent.

Another farmer drying hops with two fan motors of 2 and 3 h.p. respectively and another 2 h.p. on the air compressor of his crude

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oil heater, recorded a maximum demand of 2 k.W. only, and used only 41 units for a 22-hour run on his kilns—this included six lights in his kilns as well as the motor load.

Finally I would urge farmers to make use of the electricity supply in as full a manner as possible, as by so doing they will not only be helping themselves to live under brighter and easier conditions, but will also assist many other industries, such as the British coal trade and engineering industries, which prosperity will in turn result in a better demand for the farmers' produce.

6. DETAILS OF ACTUAL INSTALLATIONS

In this section I am giving examples of wiring and consumption costs on three Welsh farms, with acknowledgment to the University College of Wales, Aberstwyth.

Farm No. 1.

This was a 71 acre holding, 4½ acres arable and 66½ acres grass. The main enterprise on the farm was milk production for which 17 dairy cows were kept. About 50 gallons of milk were sold daily but a sufficient number of calves to replenish the herd were reared. The farm buildings were lit with 6 (40 watt) lamps, 5 of which were fitted in the byre. Electric power was used for grinding, kibbling corn, root pulping and chaffing. It was the intention of the farmer to purchase an electrically driven milking machine immediately. The electrical equipment in the 6-roomed house consisted of 6 lighting points, but the only appliance used was an electric iron. The supply had been installed 18 months. Four people usually lived in the house.

Equipment and Installation Costs

	£	s.	d.	£	s.	d.
Farm:						
Wiring for light	5	0	0			
Cost of motor (6 h.p.)	24	0	0			
Installation of motor	3	0	0			
				32	0	0
House:						
Wiring for light	6	0	0			
Cost of iron		15	6			
				6	15	6
Total				£38	15	6

Current Consumption Costs

Rate per unit: Light, 7½d.; Power, 1½d.

	Light				*Power*				*Total*			
	Units	*Cost* £	s.	d.	*Units*	*Cost* £	s.	d.	*Units*	*Cost* £	s.	d.
January-March	15		9	4½	21		2	7½	36		12	0
April-June	15		9	4½	6			9	21		10	1½
July-September	17		10	7½	15		1	10½	32		12	6
October-December ..	38	1	3	9	38		4	9	76	1	8	6
Total	85	2	13	1½	80		10	0	165	3	3	1½

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Farm No. 2.

This was a holding of 100 acres, 2 acres of arable and 98 acres grass. Milk production was the main enterprise; 36 dairy cows were carried, together with a few young stock and a small flock of sheep. There were 16 lights in the farm buildings, 6 of which were in the cowhouse. In the farm-house of 5 rooms there were two outlets, both being in the kitchen. Electric power was used for milking, pumping and refrigerating. It had been installed in 1930. A bailiff, his wife and three small children lived in the house. The minimum charge was £4 for the year.

EQUIPMENT AND INSTALLATION COSTS

	£ s. d.	£ s. d.
Farm:		
Wiring for lights	16 0 0	
Cost of motor (2 h.p.) for milking	10 10 0	
Cost of motor (2 h.p.) for pumping	10 10 0	
Cost of motor ($1\frac{1}{2}$ h.p.) for refrigerating	9 0 0	
Installation of 3 motors	7 0 0	
		53 0 0
House:		
Wiring for light		1 15 0
Total		£54 15 0

CURRENT CONSUMPTION COSTS

Rate per unit: Light, $7\frac{1}{2}$d.; Power, $1\frac{1}{2}$d.

	Light				*Power*				*Total*			
		Cost				*Cost*				*Cost*		
	Units	£	s.	d.	*Units*	£	s.	d.	*Units*	£	s.	d.
January-March	191	5	19	$4\frac{1}{2}$	172	1	1	6	363	7	0	$10\frac{1}{2}$
April-June	38	1	3	9	287	1	15	$10\frac{1}{2}$	325	2	19	$7\frac{1}{2}$
July-September	30		18	9	260	1	12	6	290	2	11	3
October-December	77	2	8	$1\frac{1}{2}$	22		2	9	99	2	10	$10\frac{1}{2}$
Total	336	10	10	0	741	4	12	$7\frac{1}{2}$	1,077	15	2	$7\frac{1}{2}$

Farm No. 3

A 335-acre farm, 40 of which were arable, 260 grass and 35 acres rough grazing. The stocking of the farm was as follows: work horses, 8; other horses, 5; dairy cows, 40; other cattle, 39; breeding sows, 18; other pigs, 4.

The uses of electricity were for lighting, pumping, grinding, chaffing, pulping. The light circuit of the farm consisted of 13 points, whilst in the house there were 16 lamps. Two fires and one iron had been purchased for use in the house and one cooker had been hired. Five persons were resident in the house. The supply had been obtained just over 12 months.

EQUIPMENT AND INSTALLATION COST

	£ s. d.	£ s. d.
Farm:		
Wiring for light	11 1 0	
Cost of $\frac{3}{4}$ h.p. motor	7 0 0	
Cost of 9 h.p. motor	20 0 0	
Cost of installation of motors	4 6 0	
		42 7 0

House:

Wiring of light	13 12 0	
Cost of heater	2 5 0	
Cost of heater	1 0 0	
Cost of iron	15 6	
		17 12 6
Total		£59 19 6

Hire of cooker, £1 10s. 0d.

Current Consumption Costs

Rate per unit: Light, 7½d.; Power, 1½d.

	Light				Power				Total			
	Units	Cost £	s.	d.	Units	Cost £	s.	d.	Units	Cost £	s.	d.
January-March	164	5	2	6	480	3	0	0	644	8	2	6
April-June	48	1	10	0	1162	7	5	3	1210	8	15	3
July-September	48	1	10	0	671	4	3	10½	719	5	13	10½
October-December	149	4	13	1½	1001	6	5	1½	1150	10	18	3
Total	409	12	15	7½	3314	20	14	3	3723	33	9	10½

In some instances the cost of installation is rather high owing to the fact that totally enclosed motors were used, and the installation was carried out in 1928-1930.

The next data are the consumption of a number of S.W. & S. Power Company's farms, and comments on the trend of the use of current between the house and the actual farm.

DOMESTIC AND FARM CONSUMPTIONS ON 26 SHROPSHIRE, WORCESTERSHIRE AND STAFFORDSHIRE FARMS

	Farm	*Farmhouse*	*Farm Buildings*
1.	Poultry	About 20%	About 80%
2.	Mixed and Market Gardening	,,	,,
3.	Mixed Average	6,123	405
4.	Mixed	156	40
5.	Mixed Average	2,487	1,218
6.	Mixed	5,521	543
7.	Poultry	64(e)	1,101 (e) 20
8.	Mixed	749	281
9.	Mixed and Hops	—	771
10.	,,	73	1,756
11.	Dairy and Poultry	2,842	20
12.	Greenhouse	—	2,424
13.	Mixed and Hops	2,281	1,307
14.	Dairy and Poultry	265	2,595
15.	Arable and Cattle	427	166
16.	Mixed and Poultry	2,573	368
17.	Mixed including Hops	2,590	2,801
18.	Poultry and Fruit	1,089	2,764
19.	Poultry (small)	550	272
20.	Poultry	1,161	3,000
21.	Poultry	4,152	4,000
22.	Poultry	629	6,000
23.	Dairy	1,350	1,358

24.	Dairy	1,330	666
25.	Dairy	1,252	8,000
26.	Dairy	3,309	6,000

(e) Estimated.

On 12 farms domestic consumption is higher than farm building and power, on 14 farms power is higher.

Of the 4 dairy farms 2 show farming consumption much greater than domestic consumptions ; 1 shows level consumptions and 1 shows domestic about twice power consumption.

Of the 10 *poultry farms;* the 6 exclusively poultry show :
4 farming consumptions much higher than domestic consumption.
1 farming consumption about half domestic.
1 farming consumption about level with domestic.

Of the 4 *half-poultry farms:*
3 show farming consumption much greater than domestic.
1 shows farming consumption much less.

Of the 10 *mixed farms:*
3 show farming consumption much higher than domestic.
1 shows farming consumption slightly higher than domestic.
6 show farming consumption much lower than domestic.

The 1 arable farm shows farming consumption less than domestic.

The mixed arable farms show similar results.

The 1 greenhouse establishment shows a large farming load.

This sample of farms shows the large variety in consumptions and characteristics which might be expected from the diversity of farming conditions in the country.

Of the 26 farms, data show that 15 have cookers, 18 are using electric motors totalling 236 h.p. an average of 13 h.p. per farm. The range is from 5 to 26 h.p.

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7. DATA

This last Section deals with running costs of typical farm machinery, and costs at 1¼d. per unit.

Acknowledgments to various authorities are due for information in compiling this data sheet : The Agricultural Engineering Research Department of Oxford University ; The Agricultural Department of the G.E.C., Ltd. ; The University College of Wales, Aberystwyth ; The Institute of Electrical Engineers for private plant data from a paper by J. A. Sumner, Esq., on "Private Plants and Public Supply Tariffs" and the British Electrical Development Association.

In as many cases as possible I have used my own figures for running costs.

COST OF OPERATING FARM MACHINERY AT 1¼d. PER UNIT

GENERAL FARMING APPLIANCES

Implement	*Size of Motor or Loading Required*	*Cost*	*Work Done Per Unit*
Chaff Cutter ..	2½ to 5 h.p.	Small cutter 6d. per ton Large cutter 4d.	4 cwt. for 1 unit 7 to 8 cwt. for 1 unit
Root Pulper ..	½ to 1 h.p.	⅝d. per ton	2 tons per unit
Cake Breaker ..	½ to 2 h.p.	1¼d. per ton	1 ton per unit
Corn Grinding ..	3 to 14 h.p.	1¼d. per 1 to 1½ cwt. fine grinding	2½ bushels per unit
Corn Crushing and Kibbling	3 to 14 h.p.	3 to 5 cwts. for 1¼d.	7 bushels per unit
Threshing ..	12 to 15 h.p.	10d. to 1s. per hour	7 to 8 units per ton of grain
Water Pumping ..	½ to 3 h.p.	1,000 galls. for 2d.	600 galls. per unit
Dry Mash Mixer	1 to 10 h.p.	2d. to 2½d. per ton	10 to 12 cwts. per unit
Sheep Shearing ..	$\frac{1}{16}$ to ½ h.p.	20 sheep for 1¼d.	1 unit for 20 sheep

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Cost of Operating Farm Machinery at 1¼d. per Unit

Dairy Farming Appliances

Implement	*Size of Motor or Loading Required*	*Cost*	*Work Done per Unit*
Milking Machines	1 to 3 h.p.	½d. to ¾d. per cow per week	½ to ¾ unit per cow per week
Milk Cooler ..	¾ to 5 h.p.	25 - 30 galls. cooled for 1d.	35 galls. per unit
Electric Churn (20-gallon size)	½ to 2 h.p.	80 lbs. of butter for 1d.	100 lbs. of butter churned for one unit
Separator	¼ to 2 h.p.	120 galls. for 1d.	150 galls. of milk for 1 unit
Sterilising Chest	4 to 12 kW.	5d. to 1/3 per sterilising operation	4 to 12 units per operation
Bottle Washing ..	⅛ to ½ h.p.	2,500 bottles washed for 1d.	3,000 bottles for one unit
Water Heating Dairy Size	25 to 50 galls.	2½ to 3 galls. of hot water per unit	
Stunning ..	70 to 250 watts	1,500 animals stunned for 1d.	2,000 animals per unit

Poultry Farming Appliances.

Implement	*Size of Motor or Loading Required*	*Cost*	*Work Done per Unit*
Incubator (small)	200 watts	3 chicks for 1d.	25 units per 100 for 3 weeks
Incubator (large) 3,000 egg capacity	1,200 watts	8 chicks for 1d.	90 units for 900 chicks per week
Electric Brooder ..	200 watts, 100-chick size	¾d. per chick for 4 weeks	½ unit per chick per 4 weeks
Late Hour Lighting for Hens ...	60 watts per 200 sq. ft. floor area, 50 hens	At 8d. per unit for 4 hours per day, 2d. per day	2d. for 30 eggs 120 eggs per unit. Lighting Rate 8d.
Egg Tester ..	60 watts at 8d. per unit	1,500 eggs per hour ½d. per hour	24,000 eggs candled for one unit
Egg Grading ..	⅛th to ¼ h.p.	3,000 to 6,000 eggs graded per hour	15 to 18,000 eggs graded for one unit, or 1¼d.
Plucking	¾ to 1 h.p.	35 birds per hour	35 to 40 birds plucked per unit, or 1¼d.
Heating Water for drinking by chicks	15 watts	65 hours for 1¼d.	65 hours per unit

GENERAL DATA FOR FARMERS

1. *Comparative Prices per H.P. of Petrol, Paraffin and Crude Oil and Electric Motors*

	£	s.	d.
Petrol and Paraffin Engines complete			
2 h.p.	20	0	0
Per h.p.	10	0	0
5 h.p.	42	0	0
Per h.p.	8	10	0
10 h.p.	80	0	0
Per h.p.	8	0	0
Crude Oil Engines Complete:			
5 h.p.	57	10	0
Per h.p.	11	10	0
10 h.p.	90	0	0
Per h.p.	9	0	0
Electric Motors Complete:			
Squirrel Cage Motors—2 h.p.	12	5	3
Per h.p.	6	3	4
5 h.p.	19	4	0
Per h.p.	3	16	10
10 h.p.	24	13	6
Per h.p.	2	9	4
Slip Ring Motors:			
20 h.p.	55	2	0
Per h.p.	2	15	2
25 h.p.	62	6	0
Per h.p.	2	10	0

Electric Motors are complete with rails, pulley and control.

2. *Grass Drying Costs from the I.C.I. Handbook on "Grass Drying."*

88 units per ton of dried grass, therefore, at 1¼d. per unit this equals 9/2 per ton. With current at 1¼d. per unit electricity costs 12½% of cost of production per ton and 6% of valued cost of dried product.

3. *Hops Drying Costs from a Worcestershire Farm.*

9 tons of hops dried for 1,107 units of electricity or 123 units per ton of hops or 6 units per cwt. of dried hops.

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4. *Sterilizing Chest Costs. Tests Taken on a Worcestershire Farm.*

With a 4 ft. by 3 ft. by 3 ft.— 36 c. ft. electric sterilizing chest, 10 kW. loading—cold water in reservoir.

45 minutes to sterilize— 7½ units consumed.

When water at 120°F. was place in sterilizer water reservoir 30 minutes to sterilize—5 units consumed.

Tests on a Second Worcestershire Farm.

Chest 5 ft. by 4 ft. by 3 ft. — 60 c. ft., loading 10 kW. Chest unlagged—18 units—time taken 1 hour 50 minutes. With warm water at about 100°F. inserted in chest reservoir.

Same chest lagged—10 units—time taken 1 hour—with warm water at about 100° F. inserted in chest reservoir.

This illustrates the necessity for efficient lagging.

Data of Current Consumptions on Some South Wales Farms.

Table 1. *Consumption of Current* (48 *Farms*)

Groups	*Average No. of Lamps*	*Total Units used*	*Average Units per Lamp*	*Average Units per Farm*	*Average Cost per Farm*	*Average Cost per Lamp*
					£ s. d.	£ s. d.
Under 6 lamps	4	621	19	77	2 3 6	11 9
6-10 lamps ..	8	1,342	18	149	4 13 2	11 7
10-14 lamps	12	2,370	17	215	6 14 8	11 1
Over 14 lamps	22	6,855	15	342	10 14 2	9 5

Data of Motor Costs on Some South Wales Farms.

Table 2. *Cost of Electric Motors* (12 *Farms*)

Power	*No.*	*Average Size h.p.*	*Total Cost*	*Average Cost per Motor*	*Average Cost per h.p.*
			£ s. d.	£ s. d.	£ s. d.
Under 4 h.p. ..	6	1.75	57 0 0	9 10 0	5 9 6
Over 4 h.p. ..	10	5.50	213 0 0	21 6 0	3 18 2

Table 3. *Cost of Installation of Motors*

	Total Cost	*Average Cost per Motor*	*Average Cost per h.p.*
	£ s. d.	£ s. d.	£ s. d.
Under 4 h.p.	20 0 0	3 6 8	1 19 0
Over 4 h.p.	43 1 0	4 6 1	0 15 4

These figures are produced with acknowledgment to the University College of Wales, Aberystwith.

Actual mammoth incubator costs extracted from "Electricity in Poultry Farming" by C. A. Cameron Brown, Esq., with acknowledgments to the author and the Institute for Agricultural Engineering Research, Oxford University.

Cost per chick in terms of units with 80% hatch—over several makes of machines —.058, —.047, —.144, —.024, —.066, —.033, —.034, —.133, —.148 units.

These figures give the following figures of units consumed per 100 chicks produced —5.8, —4.7, —14.4, —2.4, —6.6, —3.3, —3.4, —13.3, —14.8, units.

Cost of one anthracite hot-water table mammoth .052d. per chick or 5.2d. per 100 chicks.

Costs of an oil-heated mammoth with electric fan drive with oil at 7d. per gallon and current at 1d. per unit, the figures are .052d. per chick for oil and .025 units for the fan per chick this equals.077d. per chick or 7.7d. per 100 chicks.

The overall cost of a group of various makes at a farm equalled .146d. per chick with oil at 7d. and electricity at 1d., this equals 14.6d. per 100 chicks.

These figures controvert the statement that oil heated mammoths are much cheaper than electric heated mammoths.

Electricity in the House

One unit of electricity will do the following household jobs: produce 3 gallons of hot water at 150° F. from a water heater; heat a 1,000 c. ft. room for 1 hour; boil a 3-pint kettle 5 or 6 times; do a day's cooking for one person; toast 50 to 60 pieces of bread; run a vacuum cleaner for 4 hours; drive a washing machine for 4 hours; heat a domestic iron for 3 hours; run a bowl fire for 2 hours; make 60 cups of coffee; heat your shaving water for 1 week; work a sewing machine for 21 hours; light a 60-watt lamp for over 16 hours; light a 25-watt lamp for 40 hours; keep the motor car warm for 10 hours; run a house fan for 25 to 30 hours.