THESIS

RELATION OF FARM MECHANICS TO THE FARM

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Agricultural
Machinery

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By

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In the spring of 1916, having been graduated from the Agricultural Division of the Michigan Agricultural College the preceding year, I moved into the country and began the entirely new adventure of farming. An entirely new adventure for me, as it was the first I had ever worked on a farm, my home having been on Mackinac Island where no farms existed. At the present time I am still on the same farm of 100 acres, located on Miller Road 2-1/2 miles south of Lansing. I trust the above details will give a clear conception of the position in which I had placed myself, and a fuller conception of the relation and adaptibility of the mechanical side of farming.

My first work was getting in the spring crops, which included the operation of the plow, drag, roller, drill, manure spreader and corn planter, each implement an individual problem in Farm Mechanics.

Other mechanical problems which have since been solved were the remodeling of house and barns, the installation of a water and sewage system, the erection of a silo, 400 rods of new fence, building a stock tank, portable hog houses, grading roads, tiling and clearing fields.

By using the aforesaid farm as a background for the previously mentioned operation, together with three winters additional experience as a Short Course Instructor of the Farm Mechanics Department of the Michigan Agricultural College, I present this thesis as a summary of seven years work and observations which has convinced me that the relative importance of Farm Mechanics to the farmer is far greater than any other phase of agriculture.

PART I

PRINCIPLES.

RELATION TO FARM MECHANICS TO THE FARM.

Farm Mechanics is the practical application of engineering to the farm. It consists of three main divisions: Buildings and conveniences, machinery, drainage and land clearing.

Buildings and Conveniences.

In this locality the study of the farm building group is of the most vital importance. In this group belongs the farm house, the center from which all activity radiates. The dairy barn, a factory where human food is produced, and where the sanitary requirements of light, ventilation and cleanliness cannot be over-emphasized.

Here also we have invested 40% of our total investment, it is here where convenient buildings become an accumulative saving of labor, where comfortable buildings conserve feed and insure maximum production. Small wonder is it that we could well stop and meditate here before taking any momentus step.

Out Buildings.

The outbuildings on this farm consisted of a 40' x 58' timber frame gambrel roof, basement barn, a 24' x 30' gabel roof horse barn and carriage shed, a 16' x 30' grainary, a corn crib, poultry house and ice house.

All these buildings were built at a time of cheap labor from local material with no consideration as to interior conveniences, but with good relation to each other and to the farm.

With the change of time and type of farming the original usefulness of these buildings had depreciated to a marked degree so that, in order to meet the demands of the present, I had to either rebuild or remodel.

Financing.

Immediately the financial question presented itself, just how much could I spend on each of the different expenditures that were absolutely necessary without running the risk of tying too much working capital in two or three ventures and thus so seriously cripple a reserve fund as not to be able to continue business. I grouped my needs into two classes, Class A, those needing immediate repair or purchase and Class B, as those dependent on Class A for future attainment.

Had I the necessary finance I could have attacked this problem in an entirely different manner and could have more rapidly arrived, at least theoretically, to the point of efficiency or success, as a farmer, to which I am striving. In this case Class B would have been considerably smaller and Class A proportionally larger. The power of money might have given me a tremendous advantage, in reality, especially considering my inexperience as a farmer, I think it would have been a disadvantage. Circumstances keeping the original Class A very small made success a premium and a necessary step to advance any of the B factors to the A Class.

To be more accurate and arrive at a just division of the two classes I studied data relative to distribution of capital invested in local farms of similar size and operation, and derived the following conclusions:

Invested Capital.

Land	35%
Buildings	40%
Live Stock	15%
Machinery & Tools	10%

Knowing the land investment the building proposition was reduced to remodeling or new buildings, here my Farm Mechanics training proved invaluable, for out of a chaos of poor interior arrangements arose the strong framing skeletons and a few hours with a measuring stick and drawing equipment convinced me as to the economic possibilities of remodeling. Having a general idea of what percent of the allotment the buildings were really worth, I could easily determine how much I could afford to expend,

Roughly classifying all improvement then into Class B as a resultant of the business end, I headed Class A with machinery, tools and live stock. Here again arose the problem of over investment in these two factors, should I begin with purebred or grade cattle? To invest too heavy in high priced pure-bred cattle with no appropiate place to keep them seemed unwise, or to start with too large a herd for the same reason.

Type of Farming.

Dairy farming having been decided as the major issue, the relative importance of the herd and barn was immenent. By playing an extremely small game on my financial chequer board and using Class A and B as opponents I finally decided that by buying only part of my machinery I would have enough capital to invest in ten grade Holstein cows, erect a silo and remodel the dairy barn.

By so doing I could immediately put my milk producing machinery in operation.

Farm Returns.

Another most important factor, in reality the most important factor, was what would the farm return? Of what would it avail me to invest in anything unless I could get a reasonable interest on the investment? The result was something like the following: Dairy farming was the most profitable in my locality, such farming could not be persued without dairy cattle, dairy cattle were dependent upon good care and management, which in turn could not be given without adequate housing.

Even though a man had a fair working capital, had information relative to what he could invest on various farm ventures, if he did not have definite information on the farm's return he stood in a dangerous position of making an irrevocable error. However, if he is careful to consider his market, the present demand and opportunity for expansion, and will take a summary of market conditions over a period of years, then only is he in a position to combine this information with his previous calculations. His investment now can be in direct proportion to what the farm will return.

Sentiment.

Another factor of great importance, is the pride and sentiment of the owner. Often where capital is more easily obtained it is this factor that over-balances good business reasoning and becomes too alluring a temptation for over-investment. On the other hand it is a potential factor, furnishing a lasting stimulas

and is directly responsible for the majority of our better looking farms.

Relation to Farm Activities.

The relation of farm buildings in the building group must never be neglected. Usually the plan of the farm has already been determined by previous owners. The buildings have been located and a general permanency exists which is seldom practical to change and which at the least consideration would take considerable time. So the importance of a well planned building group becomes magnified when considered in connection with new buildings and new fences. However, changes can always be made for the better even on the old established farm, and quite frequently many conveniences can be gained without involving any great amount of money or time, providing there is considered a general scheme of future development.

With respect to the public highway, the buildings are usually within 100 to 200 feet. Theoretically they should be in the center of the farm, in such position all fields would be accessible from a center point, which would mean a great saving of time and labor.

Buildings so located near the highway sacrifices the many advantages of a central position, but in turn possess distinct advantage of their own. So located they have a more humane touch and intimate connection with the neighborhood, church, school and town. Need the buildings be newly erected the following relationships should be considered. The house should, if possible, be

on a slight levation, thus affording a better lookout and better drainage. Between house and highway should be a good expanse of lawn with shrubbery decorating the border and approach, which should be more winding than straight.

Location.

Barns should, as a rule, be back of the house at a distance of about 100 feet and not in the direction of prevailing winds. The barnyard should be on the opporite side of the barn to which the house is.

Other important factors to consider are:

1. Size of fields, which should be uniform.
2. Availibility of fields to barn lot and implement house.
3. Needless fencing an objection.
4. Pastures aljacent to buildings.
5. Natural alvantages such as water supply, drainage, windbreaks, to be made use of.
6. South or east slope more desirable.
7. Garden plot to be near house.
8. Valleys as building spots should be avoided, they lack drainage and air.
9. Several views from the house are desirable.
10. All buildings should serve as windbreaks.

Conveniences.

Primarly conveniences are of two kinds, interior arrangement and accessories of buildings, and the arrangement of the buildings in the building group. In case of new buildings the

farm layout is the first and most important, in case of established farms the interior arrangement and accessories take a similar role.

Conveniences are determined by necessity and value received. If it were not necessary to economize on time, save labor and do the same work easier there would be no need of conveniences. By value received would not necessarily mean cash value, on most every farm there are some particularly distasteful jobs, varying with the nature of the farmer. Such a chore, meager though it be, is generally neglected or has an ill influence on the worker's spirit, could that offending chore be eliminated by the addition of a piece of machinery it would quite generally be a justified purchase.

Fundamentally a farmer sells his time to the farm and collects his pay by performing the duties demanded. He can, by the installation of proper conveniences, so minimize the time on labor as to have considerable time left, which he can employ in various ways, such time gained becomes an asset when used to good advantage, but a debit when wasted, as in this case it has worked such a man out of his job.

Home and Conveniences.

In the construction of a new house, durability and beauty are of great importance, but greater still to be considered is the function of the house. Primarily it is for shelter, but happiness and comfort are so vitally necessary to our lives that the home should be the embodiment of each, all these can be achieved by proper arrangement and size.

The size, to a great extent, being determined by the arrangement. The proper application of the above deduction is of an economic nature seldom appreciated by the farmer. Too often he demands a maximum of room as testified by the majority of farm houses in any locality, the outstanding feature of which is the large kitchen and inaccessibility of rooms.

The possibility of installing conveniences in an old house is a more difficult problem, but very satisfactory results can be obtained with time and study. The house where I am now living furnishes an excellent example of the old style farm house and how simple conveniences can be added as shown by blue-prints.

The main division of home conveniences in their relative importances are water, heat, light and sewage. I am showing, by blue-print, the type of gravity water system installed and which has given excellent satisfaction for seven years. As yet we are still using stoves, and owning our own woodlot find it an economical heating system. Electric lights are still in Class B and kerosene lamps have been our source of light so far. I have found that the mantel lamp gives a higher efficiency than any other type of kerosene lamp. The mantle, which is suspended above the flame, is composed of materials which reach a high degree of incandescence when properly heated, and in consequence yields a soft and pleasing white light. These lamps require considerable care in trimming and adjusting the wick and as the mantles are very fragile they frequently need replacing.

Provisions are to be made in my next house for electricity which will be furnished by the Consumers Power Company.

The Michigan Septic Tank, as designed by the Farm Mechanics Department of the Michigan Agricultural College, has given excellent service. After six years use without having even been uncovered I took a class of students and made observations of its condition. Our conclusions were that I could reasonably be assured of an additional six years of constant service without its having been cleaned.

The septic tank has had a great influence on rural life, its simplicity and economy has appealed to the farmer and has generally been a fore-runner to additonal conveniences. There are ten in our neighborhood.

Influences of Conveniences on Farm Life.

In a recent advertisement the Delco Light Company published the following poem which, I believe, is a most apt description of the influence of conveniences in the farm home.

WHICH SHALL IT BE?

An even-balanced day of work well planned;
An evening time of work well done,
Of rest and deep content?
A home where power and light combine for happiness;
Where power eliminates the ceaseless round of drudgery,
The tedious, irksome tasks of husbandry;
Where light takes up the burden of the setting sun
And makes the evening hours the best of all;
Where cheerfulness and helpfulness join hands to lighten labor?

Or shall it be a home of gloom and discontent,
Where toil takes toll of heart and mind and soul?
Where toilers eat - and sleep - and eat - to toil again;
Where children bow beneath the weight of never-ending chores,
Where men and women barter love and hope for paltry gain?

Then choose the home where power and light do their full part,
Transforming, at your touch, the tedious task, the darkened way
Bringing the balanced day.
The evening time of rest and deep content,
The home where happy children play;
Where laughter lives, and joy and cheerfulness;
The home where leisure lengthens out the years--
Broadens the mind and lifts life to a grander plane,
As God intends.

FARM MACHINERY.

Until the beginning of the last century the farm work was performed by crude hand tools, with the application of power other than man power the development of machinery was most rapid. Previous to the advent of the steel plow in 1833 a crude cast iron affair was in use, which was a decided advantage over the old crooked stick of still earlier days. Up to the advent of the binder in 1834 and the grain drill in 1857 wheat, the universal grain crop, was sown by hand, cut and bound by hand with a cradle and rake and threshed with a flail. From that period until the present time new inventions and improvements have made wonderful progress. Next to becoming a free nation in 1776 the advent of farm machinery was the greatest occurence in American History.

Effect on Agriculture.

The effect on agriculture was tremendous. From the beginning the cultivation of the soil has been synonomous with deadening toil and drudgery. Farm machinery changed all this. It opened and subdued our vast western country, it shortened the length of the working day. It increased the worker's wages, by working with a machine more could be accomplished, and it increased the quality of the product, allowing for a better and more uniform output. It is very doubtful if farming would appeal to the young man of today had not this change from hand methods occured.

Effect on other Industries.

In 1800 the population of the farm was 97%. Today it is rated at 33%, in the course of one hundred twentythree years 64% of the rural population have gone to the cities. Only one thing

ever permitted of such a change. In 1880 but a small excess could be grown over the family need. The advent of farm machinery so increased mans efficiency that now one man can do what it formerly took five to do. Farm machinery was a help to the farmer in two ways, it made the man who wanted to stay on the farm as efficient as five men and provided employment for those who didn't.

The result was the creation of countless other industries to supply the manufacturing need, until now the industries of this country are so intermingled, so dependent oneach other that to distinguish their dependency would be a most difficult task, but if it be true that agriculture is the mainstay of a nation then farm machinery will always rank as foremost in importance.

Selection.

In equipping a farm with machinery there are again many factors that need be taken into consideration.

First is the size of the farm. This factor, in at least ninety percent of the cases is the limiting factor in buying machinery. A small general farm of about forty acres growing crops similar to a two hundred acre farm cannot support the machinery that the larger farm can. Here the man on the small farm must figure the cost of machinery with the net returns of the farm and determine the machinery most economical for him to buy, and the type best suited for dual purposes. The man on the large farm can best afford machinery suited to his various lines of production.

The type of farm is the determining factor of the kind of machinery to be used. After knowing what the machinery will cost it is most important to select the type best adapted to

the work. Here again, as in most cases, the man on the large farm has greater range than the one on the small farm. A farmer ought to have some definite system of farming and purchase the best machinery for that system. If for instance he has a regular rotation with an occasional change of one crop, can he afford to add to his regular equipment machinery for that crop? In my mind it wouldn't be profitable to do so, but would be a better practice to select a crop that could be handled with the machinery on hand.

(The next factor would be the cost of machinery, but by a) knowledge of the preceeding factors this would automatically take care of itself. Closely allied to this is the labor problem which causes a necessity for different machinery in certain localities where labor is scarce or too high priced, that could be more economically left out in other localities where labor is plentiful and cheap.

After considering these factors and before purchasing the farmer should also consider the availability of renting machinery. If his neighbor should have a grain binier, and neither had enough grain that a day or so at harvesting would make much difference, would it be advisable to rent or buy? This would apply to many other machines, not affecting the larger farmer as much as the smaller one. Also would it be best to pool in with two or three neighbors or own your own machinery?

The next thing to consider would be power, all the other factors taken with the general condition of the locality would determine this problem.

Standard Machinery.

A more universal staniarlization of machinery would be to the advantage of the farmer. His one weakness has been his gullibility to the clever salesman with no regard as to the availability of local repairs. A farm implement or machine is efficient only when it gives good service and if delay is occasioned in securing parts the efficiency of the machine is lost. Also by buying of a reputable manufacture the farmer is more assured of satisfaction. The determining points between like machines should be:

1 - Durability.
2 - Mechanical Construction
3 - Simplicity of Construction
4 - Ease of replacing parts
5 - Ease of operation

The following list comprises the equipment I found necessary to own for a four year rotation of corn, oats, wheat and clover, and is typical of the local 80 to 160 acre farm:

Preparation of Seed Bed.

1 - Walking plow
1 - Sulky plow
1 - Spring-tooth harrow
1 - Roller, cultipacker preferred
1 - Disc harrow

Planting

1 - Clover seed sower
1 - Disc grain drill, fertilizer attachment
1 - Corn planter, fertilizer attachment

Cultivation

1 - Riding cultivator

2 - Walking cultivators

Harvesting

1 - Corn binder

1 - Grain binder

1 - Mower

1 - Dump rake

1 - Side-delivery rake

1 - Hay loader

Barn Equipment

Hay car

Slings

Hay forks

Litter carrier

Miscellaneous

1 - Manure spreader

2 - Wagons

1 - Gas engine

1 - Set fence stretchers

Other machinery of necessity which has always been procurable by hire is threshing and silo filling equipment and other jobs requiring belt power. Special machinery for a crop outside of the standard rotation, is seldom a profitable investment and it would be better economics if such a crop was selected so that available machinery could be used.

An additional list of hand tools could be given but would

be of no particular value as the assortment would possess too great a variance. The limiting factor of purchase in this class is practically unlimited as necessities are continually arising which would warrant the use of these tools.

Power Machinery.

A machine is a device consisting of two or more parts arranged to modify forces and motions to produce a desired effect or do some useful work.

Wind is the oldest power and due to its economy and permanency of scource has ever proved most satisfactory.

The most universally used farm power is the horse. For centuries he has been a most faithful servant of man; "Where-ever has been a foot print, there also was the hoof beat". As compared with other domestic animals, the horse is peculiar in the ability to work and not as a scource of food.

Some of the more modern transference of power is through the gas engine, electric motor and steam engine.

Need.

The relative uses on the farm of each vary according to the requirements. The three methods of pumping water are by the windmill, gas engine and electric motor. Where facilities for storing water is considered, the windmill has proved the most popular power. It requires less efficient care and the initial cost is practically the final cost. The disadvantages are that it can be used only when the wind blows and is not desirable to operate a line shaft.

The gas engine, requires a continuous cost of operation, and more efficient care. In return it is always available for power

and of a convertable nature. Effectively operating different units at the same time.

Where electricity is available the electric motor is proving more popular than the gas engine, while it does not develope its own power as does a gas engine, it transfers power to greater advantage.

The larger gas engine, formerly of a stationary nature, is being replaced by the tractor, whose application to the farm will be discussed later.

The steam engine has its greatest use on the farm for belt power and was most popular in threshing outfits. The local demand seems to be changing and the requirements are lighter threshing machines operated by gas tractors.

Need.

On all farms there is need of power, pumping water and working the land is universal, the amount of power required varies with the size of the farm and the amount of work done.

The kind of power is determined by:

1 - The initial cost

2 - The operating cost

3 - Adaptability to desired conditions

4 - Type of farm

A dairy or truck farmer spending less time in the field make more economical use of a tractor than if they were enabled to work longer hours.

Horse versus Tractor on 100 acre farm.

The problem of horse power or tractor power on all farms of 100 acres has to be solved by the farmer. It would be impossible to state definitely which would be the more profitable. An efficient operator could economically run under the same conditions a tractor that under different operation would show a loss, which means a high type of labor required for tractor operation.

Farms of similar size vary considerably in the amount of land under cultivation, the more land being worked the greater the tractor need.

As this problem is chiefly an individual one I will discuss in on that basis, only, and enumerate the points I considered in determinating it.

The advantage of farming with machinery is that work is done with less man labor and more accomplished in the same length of time. This applies to the tractor, it will do more work in less time than a horse.

Were this the only deciding point probably every farmer would be equipped with a tractor. But if the previous mentioned factors which determine the kind of power be true, then a more complicated condition results, namely;

1 - The initial cost.

2 - The operating cost.

3 - The adaptibility to desired conditions.

4 - Type of farm.

The initial tractor cost on the average 100 acres is within reach of most farmers. The Fordson costing no more than a good team of horses, however, on the established farm any duplicate machinery would increase the initial tractor cost. In this respect to continue with horses no new machinery is needed. On a new farm this difference would be less pronounced. The cost of horse machinery is less than that of tractor machinery.

Cost of operating.

The labor required for tractor operation calls for higher type, which necessarily is more expensive, the tractor doing the required work in less time than the horses leaves more time for other farm work. This is a disadvantage to the farmer, for while he could afford to pay higher wages for tractor operation he cannot afford such wages for other farm work, thus he cannot so well utilize his labor.

The consumption of gas and oil takes tangible cash from the farmers's possession. The upkeep of the tractor itself is more expensive, as the more complicated the machine the more parts to go wrong, the more expensive the machinery the more expensive the repairs. The deterioration is more rapid, the average life of the tractor, as determined by the U. S. Government is six to sever years, the average working life of the horse is twelve years.

The horse is a self producer, which gives the farmer the priviledge of manufacturing his own power and saving a profit on an initial cost. He is self feeding, and utilizes for fuel home grown products which does not necessitate the actual transference of cash, and which often have no great market value. He is self controlling, which tremendously increases his value on the farm.

From January 1, 1922, to January 1, 1923, I conducted a test on four horses to satisfy myself as to the relative cost per hour of the horse as a motor. Accurate accounts of feed used and hours of work done were kept. The following data shows the economy of the horse.

Economy of the Horse.

Number hours work - 1920, Number horses - 4 - 1400#, period of feed and work - 1 year.

Roughage	Market value at farm		Manurial value.
1. 6 ton corn stover	$3.00 per ton	$18.00	$6.00
2. 3 " hay left by cows			6.00
3. 5 " timothy hay	13.00 " "	65.00	10.00
4. 200 bushel oats	.40 " Bu.	80.00	15.00
5. 150 " corn	.40 " "	60.00	10.00
Cost of feed		$223.00	Credit $47.00
Value derived from manure		47.00	
Total cost of feed		$175.00	
Cost of Shoeing		16.50	
Cost of Feed and Shoeing		$192.50	

Total cost per horse per year equals $192.50 divided by 4 or $48.125 Total cost of $192.50 divided by 1,920 (total number of hours) or 10¢ per horse hour work.

Items 3-4-5, including timothy hay and grain were the items which comprised the expense of the ration and were needed to furnish sufficient energy to enable the horse to maintain his flesh and do hard work.

Items 1-2 were of a nature which increased their value by having been consumed and furnished sufficient nutrient to maintain the horse in good condition at rest.

I conclude that a non-working horse instead of a debit, is really an asset in converting the practically non-marketable roughages into a more readily and more valuable form of manure. The manurial value of items 1 & 2 being greater than their market value as feeds.

I have made no attempts to determine the deteriation of the horse,as a motor, or the cost of housing necessary, harness repairs, etc.

I have had no need of a veterinary for horses in seven years of farming, and except where weather conditions prohibited, there has never been a time when one or all were not available for work.

Adaptibility.

A farm of 100 acres is considered a one man farm, on that farm machinery must necessarily do the work. Good farming requires a crop rotation and the keeping of livestock, which again necessitates the division of the land into fields. The crop rotation devides the field work into seasons which better enables the horse to furnish the power, and the land division usually restricts the efficiency of the tractor by either irregularity or size of fields.

On this farm the work is greatly diversified, no one line of work being of long duration, to meet these conditions the tractor is not readily adaptable. A typical day in hay harvest

is a few hours cultivating corn while the hay is drying in the morning, then a transfer to some haying implement. Under this and similar operations the horse has proved more adaptable than the tractor. On hilly and stony land the horse gives satisfaction.

By his adaptability, the horse has proved himself indispensable. The tractor is not indispensable, but is a wonderfully good supplement to the horse. Consequently, when one team of horses are a necessity, and an additional horse or two will furnish the required power, the average farmer is better off without a tractor.

LAND CLEARING.

Every possible acre of farm land should be used to its maximum capacity. A few acres of waste land on any one farm are a loss to the individual farmer, and the total of these patches throughout the country, enormous in the aggregate, is of most serious concern to the entire nation. Serious, not because of the necessity of additional cultivated land but because the space taken up on farms already equipped to do farm work prohibits an economical cultivation.

Boulders, stumps, worthless timber, swamp land, mud holes and meandering streams present obstacles to the farmer's progress and rob him of time, enjoyment and the efficiency of his machinery.

My experience in land clearing has been of a most elementary nature, consisting of the removal of boulders from the fields by the use of a stone-boat and horses or by the digging of a hole and burying them. When a few stumps were the offenders I have burned or dug them out. When these obstacles exist it is necessary to leave considerable area of uncultivated land around them as it is impractical to try and work too close with machinery. In addition to its other disadvantages this area provides a breeding place for weeds and crop pests.

My immediate problem of land clearing is removing stone piles in every field, the method I intend to employ is the excavation of a hole by the use of a team and scrapper and then burying the pile so the bottom is below the frost line and the top below the plow.

Land clearing is one of the oldest and least developed phases of agriculture. From the early pioneer days it has first been

essential to clear land, the methods in use then are still greatly used. The axe and saw were used to fell the trees, the timber then used commercially, for fuel or burned in great piles and the stumps allowed to remain in the ground for the full period of decay or when partially rotted to finish by burning or pulling by team.

Such land was put in a grain crop, seeded and the resulting grass left to pasture during the period of decay. The time required varied in accordance with the kind of timber. On the average Michigan farm this process extended over a period of years.

Land clearing methods failed to develope with other phases of agriculture because it was the land already cleared that furnished the great necessity for farm machinery. The vast western areas that did not require clearing could now be subjugated with machinery, and consequently the ease of breaking this new land as compared to clearing a farm so appealed to the farmer that a general migration westward resulted. The men who still had a few stumps to remove or an occasional field to clear furnished no very attractive market for machinery of this class.

Within the past ten years farming has been revolutionized, land has increased so in value and labor become so scarce and expensive that to pursue many of the old methods has proved ruinous. Time has become so important an element as to almost eclipse any others.

Under these changed conditions the vast areas of lumbered stump land, of which Michigan has thousands of acres, has become an object of desire and consequently furnish a demand for more rapid and efficient land clearing methods. Explosives and stump pulling devices have solved the problem. The greatest and most economical efficiency is gained when these two methods work hand in hand.

Dynamite and picric acid, the two explosives in general use, prepare the stump to be pulled by cracking it and loosening it in the ground. Where the puller is used first the explosive is used to crack the stump and blow loose the dirt adhering to the roots. Explosives are also increasing in popularity as a means of shattering rocks and tearing through the hard pan of mud holes and providing drainage.

Where the commercial puller is used the vertical drum is more popular, but in general a straight line pull or some other home made device, such as the Mallet Stump Puller, furnish all the power necessary to pull the stump after it has been loosened and cracked by an explosive.

On large areas of coniferous stumps, which have a tap root and pull fairly clear of dirt and which are very resistant to decay, the commercial puller works to its greatest advantage.

Where the stumps are of the deciduous variety with a branching root system the tendency of the puller is to raise too much land with the stump. Here explosives can best be used to prepare the way and when the stump is loosened, cracked and freed from adhering dirt the more simple home made pulling devices prove most economical.

DRAINAGE.

All vegetation is dependent upon the water or moisture in the soil for life and growth. Nature does not always supply water to the soil in quantities conductive to the most satisfactory growth to the plant. Often there is too little water and many times there is too much. Land is drained for the purpose of relieving the soil of the surplus water.

The practice of land drainage runs back to a very early date. Land drainage by means of tile was introduced in Europe as early as 1620 and in the United States in 1835. The first tile making machine was introduced about 1848 and was a great impetuous to tile drainage. Up to that time all tile was hand made and the ditches dug by hand. Hand labor in digging is still in general use and probably always will be, especially where the jobs are small, but there is on the market, and in general use, most efficient machinery which dig the ditches and leave the bottom ready to lay the tile.

The area of land in this country which can be reclaimed by drainage is estimated by the United States Department of Agriculture as 70,000,000 acres. In addition to this there are large areas of land that could be made more productive and more valuable by drainage.

The two methods of drainage are by the open ditch and by the use of tile.

Necessity.

A consideration of the benefits to be derived and an estimate to determine the advisability of the expenditure required, from the standpoint of an investment, should always precede the installation of a farm drainage system. In general drainage is expected to either

reclaim the land for farming purposes or make it more productive.

Benefits.

The soil is made firm by lowering the level of the free water.

Soil is made finer in texture, the particles becoming smaller and the capillary action of water increased.

The growing season is lengthened, drainage is conductive of a more uniform movement of the water resulting in a less cracked surface and consequently in less evaporation. Less water being in the soil the temperature is more easily raised and retained.

The ventilation is increased by air occupying some of the space formerly filled with free water.

The water handling capacity of the soil is so increased that surface wash is prevented.

The soil depth is increased, roots working deeper in warmer and better aerated soil.

The danger of drouth is decreased as the greater depth and fineness of the soil enable a more pronounced capillary action to take place.

The action of frost is reduced as the drained soil stays warmer longer and does not heave so badly.

Land under Cultivation.

In the spring of 1922 under the auspicies of the Michigan Agricultural College I made a collection of different sized samples of tile from practically every tile factory in this State. These samples were wanted to determine their relative merits. It is not my purpose to describe this experiment but to relate the impression of drainage I received. I was formerly of the opinion that if mud

holes were present in a field or water readily apparent to the eye it needed drainage, imagine my incredulity when an old tile man issued the information that an acre of ground that was worth farming was worth tiling. As I continued from factory to factory I discovered this opinion universal.

My own experience justifies the importance of tile drainage. Five acres of low muck land adjacent to the road and west of the house was nearly always under water. A year ago last fall I had it surveyed and tiled it, last summer I raised the greatest crop of corn on that five acres that I had ever raised on any similar sized piece, and now instead of its being an unsightly and annoying piece of swamp it is a most productive tract of land.

Without giving consideration to the cash or asthetic value this may have increased the farm, the actual returns was corn enough to fill a silo that formerly had always consumed twice that acreage. By the expenditure of $118.00 for tile and $80.00 for labor or a total of $198.00 to convert nothing into something, I harvested a crop that produced at least 70 ton of ensilage valued, as compared to hay, at $3.00 per ton, or a gross proceed of $210.00. Considering the fact that this land now works in the regular rotation I am well satisfied with my investment, and expect as soon as possible to tile 15 acres of low pasture land on the back end of the farm.

CONCLUSION.

In the past few years many editorials have appeared before the public lamenting the movement of the farmer to the city. Much emphasis has been laid on the abandoned farm house and the agricultural crisis on the horizon, much unnecessary sympathy has been wasted on the farmer, while the farmer, and by that I mean the man as well versed in his work as a man would expect to be in any other business, has steadily gone forward, and not only kept up the agricultural supply with its ever increasing demand, but actually increased it.

A reduction of 60% of the farm population from Washington's time to the present would necessitate an increased production of at least 120%. In the meantime our exportations have increased enormously, yet our production more than supplies the demand, nor does it even keep pace with our ability to produce. Apparently there is no limit to the application of farm mechanics to increase production.

There are still too many of the so called farmers who contribute nothing to agriculture, who by their inefficiency prohibit economical production and stand in the path of the farmer who has

the ability to adjust himself to changing conditions and profit by the knowledge of the day. The present agricultural condition is an evolution whereby the better farmer, as in other business, will steadily crowd his less adequate competitor out of the field.

It is this man, already equipped with knowledge and other facilities who will gladly shoulder the burden of production. It is for this man that land clearing, drainage and other improvements are especially advocated so that he can still more efficiently and economically cultivate the soil to its maximum capacity.

Instead of lamentations and pessimism it is my opinion that a monument of optimism and achievement be erected to the agricultural engineer.

PART II

APPLICATION.

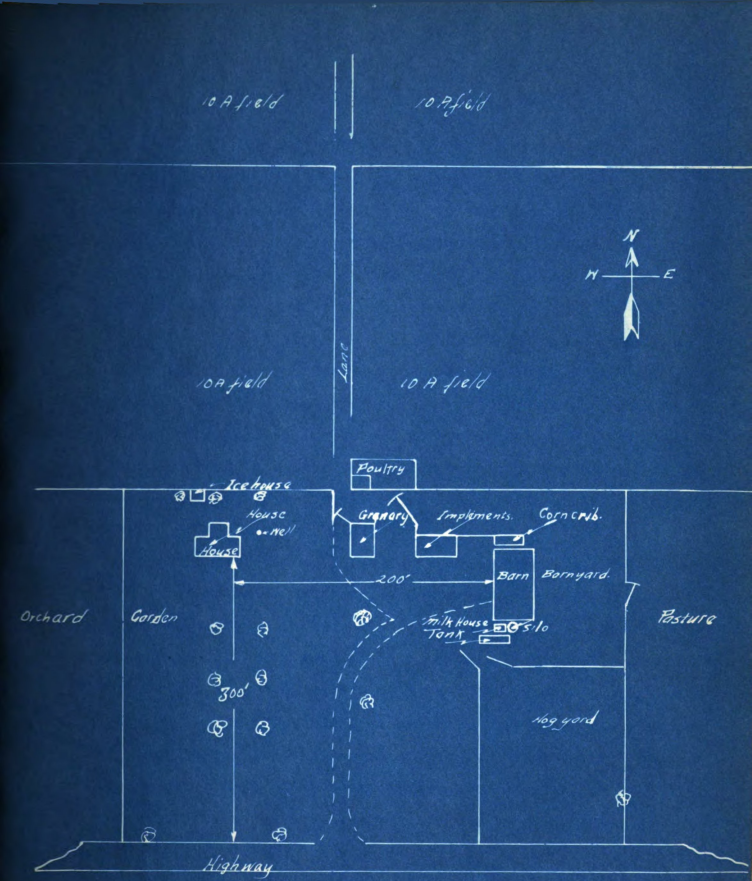
The following blue-prints are the application of Part I. The evolution of a training in Farm Mechanics. They embody the main issues and expenses of my agricultural work and have proved the most productive in the promotion of contentment and efficiency, and the saving of that all important element, time.

THE FARM LAYOUT.

In purchasing an established farm but little can be done in changing the building relations, consequently this is a point well worth considering in a contemplated purchase. The illustrated "Farm Layout" shows good relation of buildings. The house is well back from the highway, of a good distance from the barn, and is located on a well drained site. The ice house, garden and poultry house are well related to the house,

The barn faces in the approved direction, provides an east and south barnyard and an approach on the west side, accessibility to the lane and highway without having to drive through the barnyard, which is a decided advantage. A barnyard approach usually necessitates considerable time lost in opening and closing gates. The corn-crib and granary are both well related to the group and the implement house is accessible from both sides.

In erecting the three new units, silo, milk house and stock tank these conditions were considered. The stock tank should accomodate both cattle and horses, should be near the entrance to the horse stable and accessible from either side of the barnyard fence. The milk house is closely related to the stock tank on account of cooling the milk. The interior plan of the barn, with a central feed alley, determined the silo to be on either end. The south exposure is more desirable on account of freezing.



Farm Layout.

Implement house was formly the horse barn.
Silo, milk house and tank are additions to the original farm layout.

March 1916.
H.J. Gallagher.
Scale 1" = 100'

THE REMODELING OF THE DAIRY BARN.

As a rule it is better when capital is limited to provide for the business end of any enterprise first. Farmers are severly critized by other people for either remodeling or building their barn before they do their house. Such critism is hardly justified. The farmer can better withstand temporary inconveniences or hardships, if necessary, for a period than subject his live stock to them. He has the advantage of intelligence, the stock are utterly dependent and through lack of care become a financial loss.

In order to farm I required an immediate income, my inclinations were to better our living conditions at once, one had to be postponed, the barn was remodeled, living conditions were improved some two years later.

Without ever having worked in a dairy barn I designed the plans as illustrated and remodeled the barn accordingly. After continuous use of this barn for seven years with an average number of eighteen to twenty head of dairy cattle I have had no need for improvement. The application of a Farm Mechanics training enabled me, with my lack of previous experience, to remodel this barn so efficiently from the standpoint of economy, conveniences and saving of labor, that after years of practical experience I am still thoroughly satisfied with the results achieved. Instead of finding chores a drudgery they have been more of a pleasure. Entering the barn of a morning to encompass a row of fifteen cows alighned in a flood of sunshine is an infinitely more pleasing sensation than to go into an ill lighted barn with its depressing gloom. If it is

a fact that on the days work is reflected the mood of the worker, this factor is well worthy of consideration. It is a fact, too, that on a farm with well planned buildings hired help is better satisfied and easier to retain.

The original barn floor plan provided only for the necessities of shelter, restraint and feeding.

One window 2' x 2' furnished the light for 1443 square feet of floor space alotted to cattle, or one square foot of light for every 361 square feet of floor space. An idea of the efficiency of this window can be gained by a comparison to the generally accepted standard of one square foot of light to twenty square feet of floor space. To go upstairs it was preferable to leave the barn and enter from the approach outside then to wade through the mud and manure to a stairway at a remote end of the barn.

The handling of the manure was a most detestable job, great holes having been dug in the dirt floor back of the cattle by this continuous chore. The plank platform upon which the cows stood was a most unsanitary affair. The wooden mangers were full of holes and next to impossible to keep clean. Nine hundred square feet of floor space, back of the cattle was devoted only to the accumulation of manure, and no door on the east side to facilitate its removal, except a narrow one immediately back of the cattle.

In handling this manure, planks were laid over the mud and the wheelbarrow used, that too was the method used when horses were kept on the south side. Provisions having been made to

accomodate horses here as well as providing a separate building for the same purpose.

To have tried to bolster up the weak spots of existing conditions looked like a discouraging job, everything was so out of relation. Realizing the necessity of careful planning on this building, that the dairy herd required daily care, sanitation, comfort and ventilation, I decided to clean out the whole interior. This was done, after the east side, except supporting columns were torn out. The floor was graded eight feet in the clear.

The interior planning was comparatively easy. It was economy to include the horse barn in this plan, hay left by the cattle furnished the greater bulk of the horses roughage and the chores all centered in one place. As a matter of convenience in watering and accessibility to the fields it was desirable to keep the horses, as shown in the remodeled plan. The law requires a partition between horses and cattle. A slide door in the rear and trap doors to the mangers fulfilled the requirement, the trap doors aiding in feeding.

Dairy cows are so extensively fed that time so used is an accumulative expense, a central feed alley is the best solution, supplemented by a feed truck. Sunlight is the cheapest and best antiseptic known to man. The gutter of a dairy barn, one of the worst scources of infection, to relate the two was an easy matter and provided the additional advantage of handling manure from the one alley.

Box stalls are necessary for calves and maternity pens, it is desirable they be about four feet high and of a convertable nature, a correct system of gates makes this latter possible.

Where the limiting factor of size is the manger space, entrance should always be otherwise provided. The expense of a bull pen was minimized by taking advantage of the strength of wall construction at the corners, erecting a concrete manger and providing twelve feet of one-half inch horizontal steel cable, for exercise, to which the bull is chained with a six foot length of chain from the neck to a sliding ring on the cable. This open pen gives him full view of the herd and barn activities, permits of free air circulation and ease of feeding and cleaning.

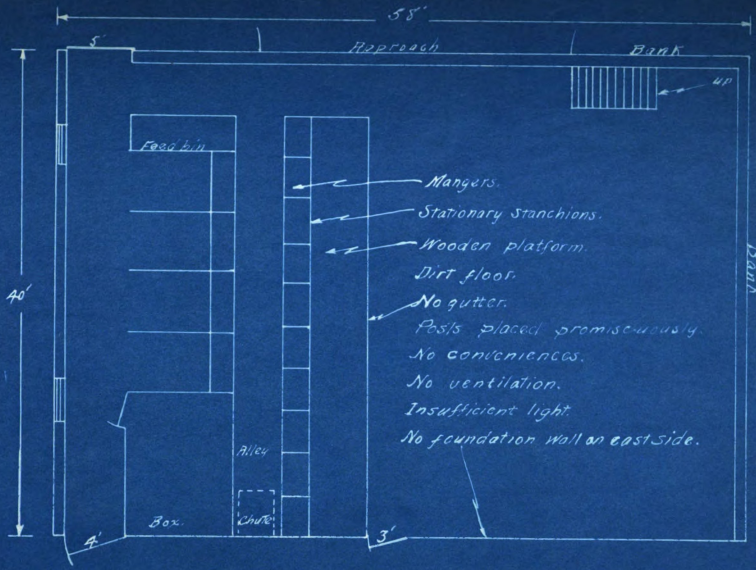
A replacement of weak floor joists allowed a straight alignment of columns under the main girders, 8" iron posts were set on concrete piers and spaced to serve as partitions between cows. To provide for passage of litter carrier to bull pen and box stalls and also allow for passage of manure spreader when desirable to draw directly to the field, an eleven foot drive was left on the north end, the gutter was carried through to the wall. The convertable feature of stanchioning three additional cows and still using this drive was accomplished by the use of this gate. Detail of which is illustrated in accompanying blue-print.

Convenient feed alleys should be four to six feet wide and clear of any obstructions. The mangers should be easy to clean. I use the open type with concrete trough which sweeps out very easily and permits of watering the cows on stormy days by attaching a hose to a faucet in the stock tank. The eight windows in the cow stable allow one square foot of light per eighteen square feet of floor space and in the horse stable one square foot of glass for nineteen square feet of floor space.

The silo was built at the south end as a result of the plan for a straight feed alley and less probability of freezing. Provision was made for the erection of another silo, when found necessary, to the east and feeding into the present chute. A wooden stave silo was selected on account of its initial investment, it being considerably less, and of good durability,

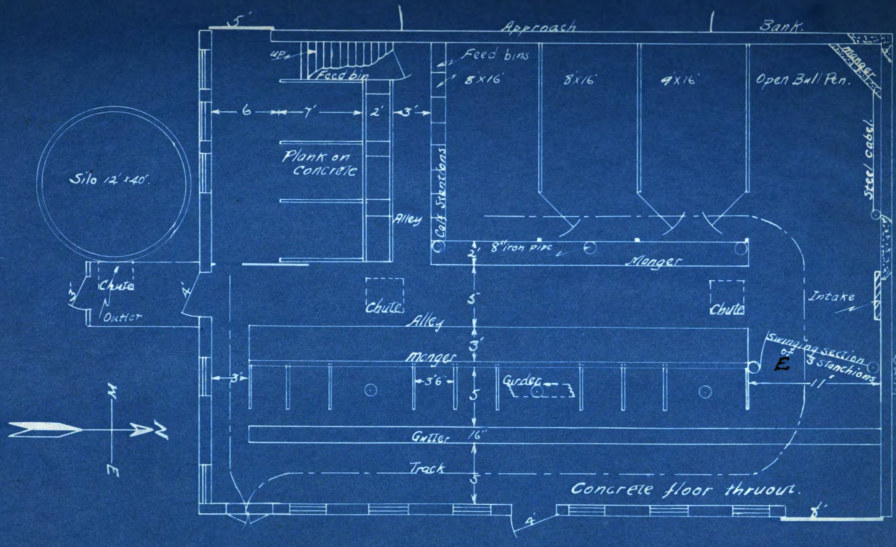
By moving the stairway, as shown, it became more accessible and the space underneath provided a convenient feed bin. A grist of grain driven on the floor above is easily emptied into this bin by lifting up the top step which is hinged to the riser beneath. The floor of the ensilage room is on a level with the feed alley and three feet above the grade, the slope being to the south. The provision of an outside door here made it most convenient for the loading of cattle or hogs, as the bottom of a wagon box when backed up to the door is level with the floor.

To supply a ventilating system I hinged an eighteen inch section of the bottom of the door between the barn and ensilage room and insulated the silo chute and ensilage room. Under most conditions this has proved a satisfactory out-take. The in-take, on the other end of the alley, enters between three floor joists and is built down two feet on the outside to check a direct draft. While this could not be advocated as an entirely efficient ventilating system, it has proved a satisfactory substitute. No provision being made to correct the dead air pockets occuring on the west side.



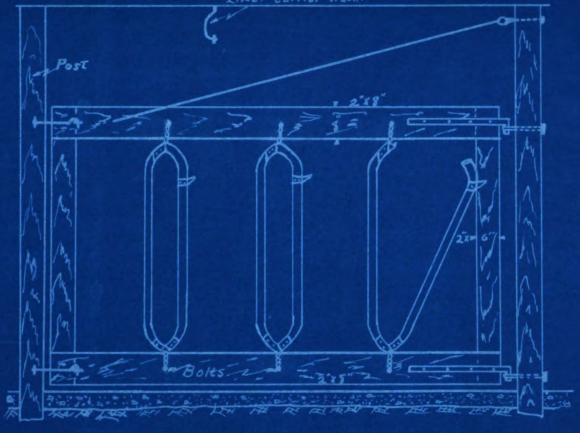
Before remodeling, March. 1916. Scale $\frac{1}{8}$"=1 foot.

H.J. Gallagher



After remodeling, Oct. 1916. Scale 1/8" = 1 foot.

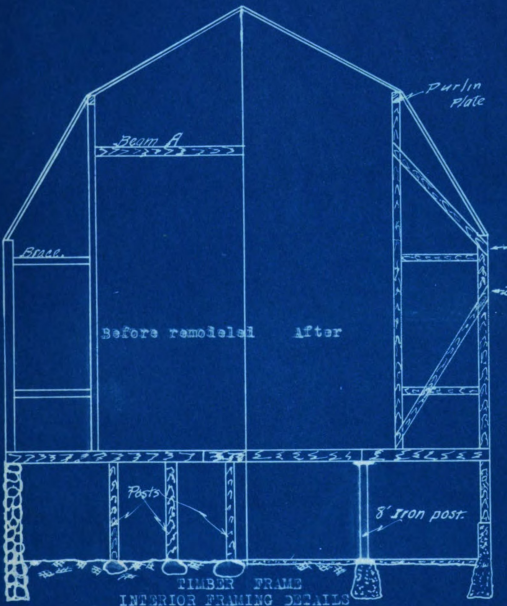
H.J. Gallagher



Detail E of remodeled barn floor plan.

H.J. Gallagher.

Scale 1-½ /ft.



TIMBER FRAME
INTERIOR FRAMING DETAILS

Beam A prohibited the use of a hay track.

Note placement of posts, stone piers, dirt floor, etc.

Diagonal braces answering purpose of beam A allows open interior for use of hay car.

Note concrete floor, iron post, pier, wall, etc.

IMPROVING LIVING CONDITIONS IN THE HOME.

The disadvantages of the original house as we encountered them were the lack of running water, no sink, no bath or toilet or no relation of rooms to each other. To get water we went with a pail to the well a distance of thirtyfive feet from the kitchen, quite often the pump had to be detached from the windmill, often too, it needed priming, annoying features both. Our daily supply of water meant an average of five trips to the well, a distance traveled daily of 350 feet or 25 miles a year, a waste of time and an appalling waste of energy, fortunately there was but a one step rise to the porch. Wash days were especially tedious. What water was brought in, of course, had to be taken out again, dishwater, etc., and to open a door from a warm room in winter to throw away such refuse was not only a most disagreeable task but conductive of ill results in the sudden change of temperature upon the heated body.

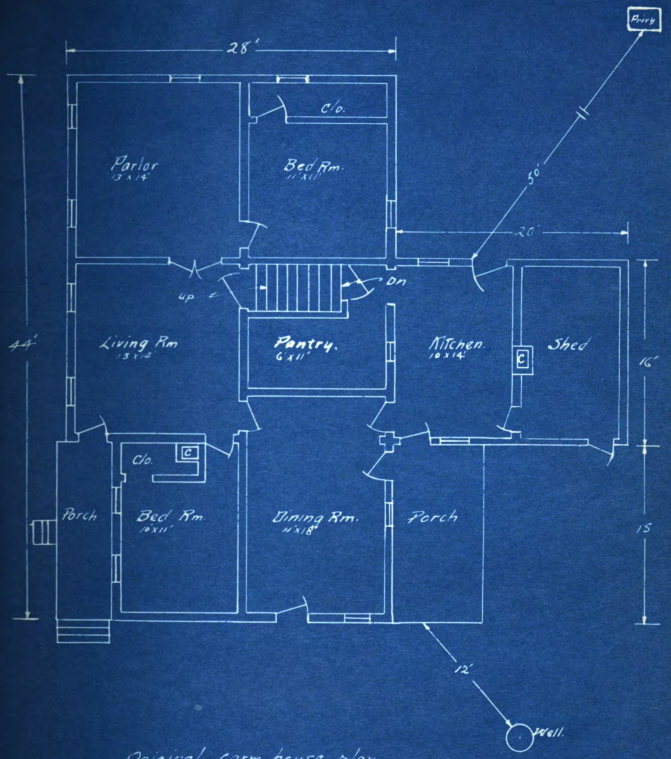
Having no bath or access to an inside toilet proved another very annoying inconvenience.

The relation of the rooms were such, as shown by the blueprint, that considerable time was wasted in performing house work, the pantry was larger than necessary and was too far removed from the dining room. The west wing of the house was accessible only through the dining room, which reduced its use considerably. The upstairs too was accessible only through the living room, which meant not only the tracking of dirt through the kitchen, dining room and living room but continuous wear of rugs, etc., and a lack of seclusion when help was employed.

A persual of the plan after the house was remodeled shows how most of the previously mentioned objections were overcome, and how conveniences were installed.

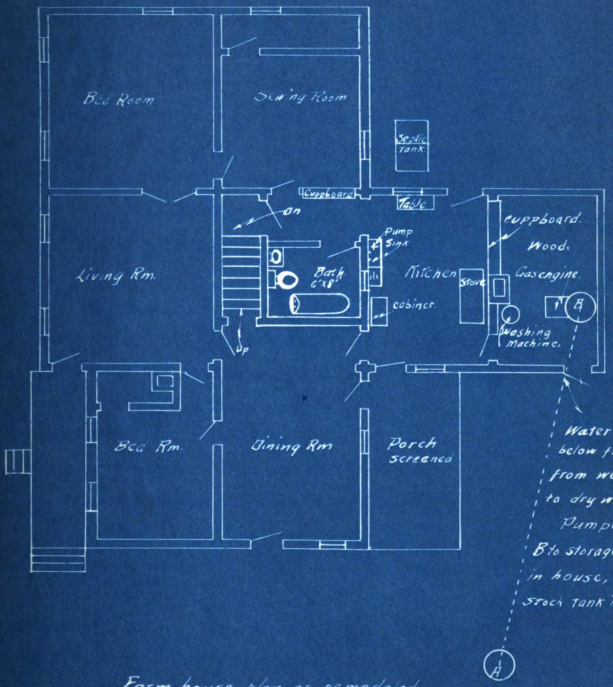
The installation of but one door made the west wing more livable, the closing of the former stair entrance into the living room and the moving of the stairway gave more wall space for furniture in the living room, eradicated the diagonal path from the front door to stairs, and made the stairway more directly accessible from a greater number of rooms.

The stairway now reduced the original pantry of 6' x 11' to 6' x 8' which made a good sized and most conveniently located bathroom. This house has proved quite livable, but it in turn does not compare very favorably with the plans for the house I contemplate building this summer.



Original farm house plan.

H. L. Gallagher
1/8" Scale 1 ft



Farm house plan as remodeled.
August 1918.

H.J. Gallagher.
Scale 1/8" = 1 ft.

WATER SYSTEM.

From the main well water is pumped horizontally by the pump connected to the engine, as shown in the remodeled house plan. The supply pipe is continuous from the storage tank in the house to the stock tank in the barnyeard and provided only with the horizontal check valve, as shown, and a faucet in the stock tank.

By opening this faucet and starting the pump the stock tank fills first, it being thirty feet lower than the other; when the faucet is closed the water is forced up in the storage tank and held by the check valve. The overflow from this tank drains in the bath tub.

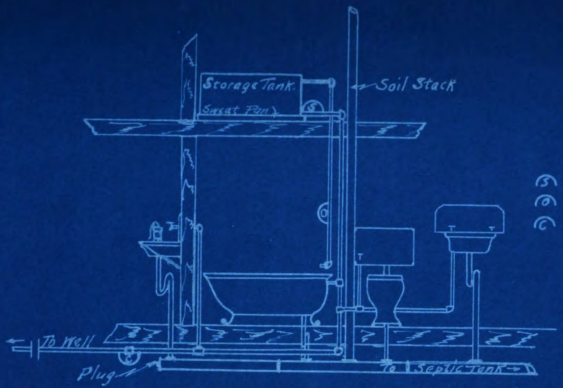
Before going to milk in the evening the pump is started, when passing the stock tank the faucet is opened, as the milk house is adjacent to the tank it requires no inconvenience to note when the tank if full, then the faucet is closed and when the overflow from the storage tank runs in the bath tub anyone in the house receives the notice and stops the engine, should no one be present no harm would result except the wasting of a little water.

Attached to the casing over the main outside well is a common lift pump, this proves most convenient, especially in the summer for watering poultry, etc., as water is thus obtainable direct from the well without having to enter the house.

Soft water is pumped by hand from a cistern with a pitcher pump fastened on the kitchen sink.

The supply pipe, overflow and soil stack are close together and against a wall, which permits of their being boxed up and obscure from view.

A plug on the end of the soil pipe facilitates its cleaning, should the necessity arise. The storage tank too is easily cleaned by draining through the supply pipe which enters near the bottom. This tank should always be provided with a dust-proof cover. A sweat pan eliminates the danger of an excessive condensation causing trouble.



Details
(A) Supply Pipe.
(B) Overflow Pipe.
(C) Check Valve.

Showing installation of water system in remodeled house

H.J. Gallagher. Scale 1" = 1 foot.

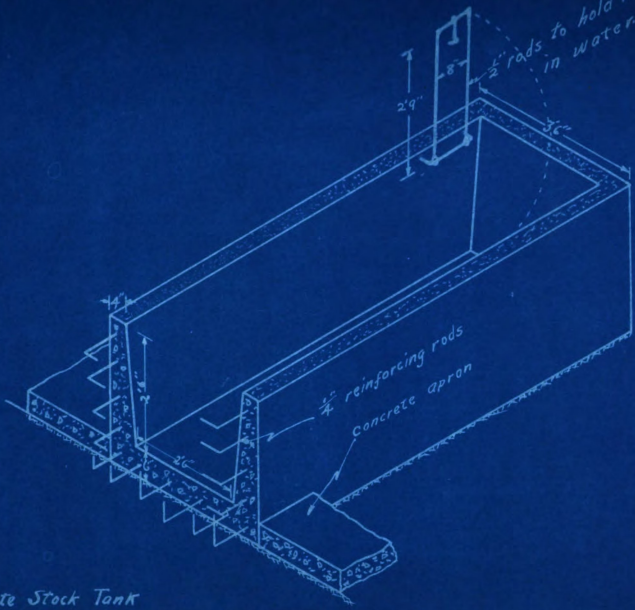
CONCRETE STOCK TANK.

This tank was built on the surface. The feed pipe from the pump enters the bottom from below ground. An out-take pipe is provided for cleaning the tank.

After the concrete had set and the forms removed the interior was plastered with cement and then washed with a cement wash. The tank is of the right height to accomodate milk cans if so desired.

The iron rod device illustrated can be used to hold an empty can low in the water. By straining directly into this can as soon as each cow is milked the cooling process is effectively and efficiently accomplished.

The concrete apron on each side of the tank protects the ground from being torn up by the cattle and horses.



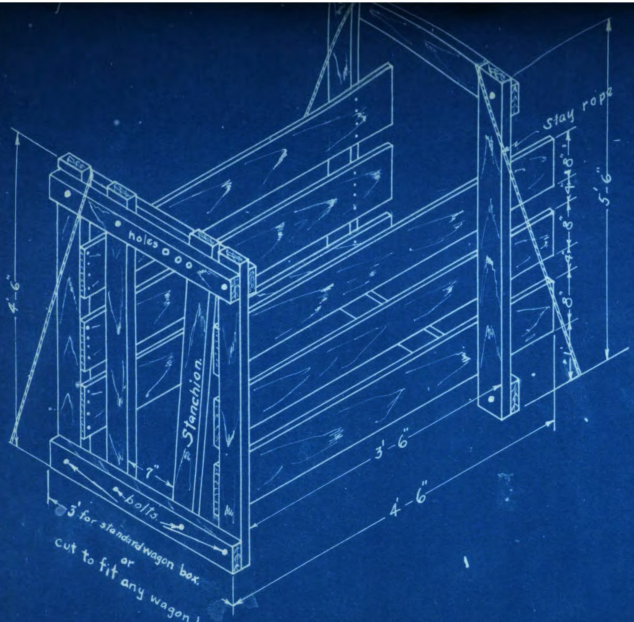
Concrete Stock Tank

H.J. Gallagher. Scale ½" = 1ft.

CATTLE CRATE.

In building up a dairy herd considerable changing of cattle was necessary. The combination stock rack, universally used, proved too fragile and the sides too low to permit satisfactory transportation.

The illustrated cattle crate was built to meet conditions, it proved satisfactory and has had four years of community use. It has been used as successfully on the auto truck as in the wagon box. Two such crates furnish an economical double unit.



Bill of Material.				
No.	Size	Bd ft.	Kind-Price	Amo
4	2"×4"×4'-6	12		
5	2"×4"×3'	10		
6	1"×8"×4'-6	18		
	total	40	Y.P.@ 7¢ ft.	$2
9	3/8"×4"		Bolts@ 5¢	
3	3/8"×5 3/4"		Bolts@ 6¢	
2"	# 8d		Nails@ 8¢	
			Sum Total	$3.5

CATTLE CRATE		
F.M. Dept.	Pl. H.J.G.	Dr.
M.A.C.	Ch. H.J.G.	Tr.
East Lansing	Scale:- 3/4" =	
Michigan.	No. A-210	

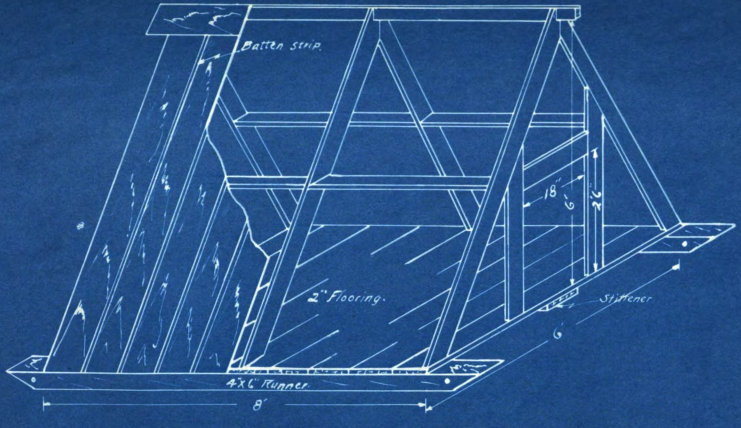
PORTABLE HOG COT.

The portable hog house is unquestionably the better type on a farm where the production of pork is only a side issue. The construction is comparatively simple and inexpensive. They are not a permanent farm fixture and are convertible into cash. They afford individual farrowing quarters and allow for a continuous change of pasture which also promotes better sanitation.

I built three as designed about four years ago and have found them most satisfactory, a window at each gable answers for ventilation and at farrowing time a 2" x 4" on edge 6" from the floor across each end helps to protect the pigs from being crushed.

A lantern hung inside maintain a more uniform temperature.

These houses were constructed of material salvaged from the remodeling of house and barn.



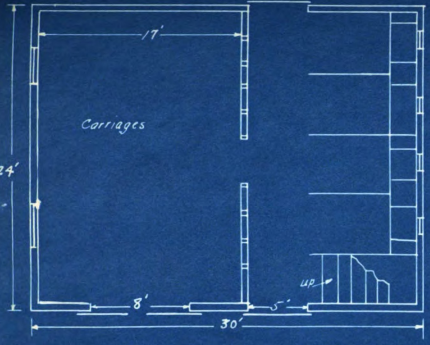
Portable Hog Cot.

H.J. Gallagher Scale $\frac{1}{2}$" = 1 ft.

IMPLEMENT HOUSE.

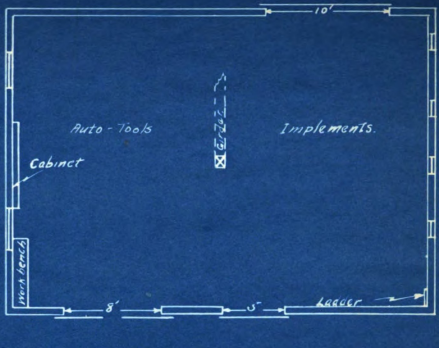
By converting the original horse barn into an implement house the price of a new building was saved. It fortunately was so located in the building group as to be convenient to the fields.

Having a one-third pitch gable roof and a six foot height from second floor joists to plate this building made an ideal implement house, the space aloft was the covertible feature of storing the smaller implements or for hay or grain as desired.



This building originally used as a horse barn, room for storage above.

A horse barn separate from the main barn means more chores and greater feeding costs.



Same building with center partition partition removed and larger door cut on north side, also ladder answers purpose of stairs in going aloft.

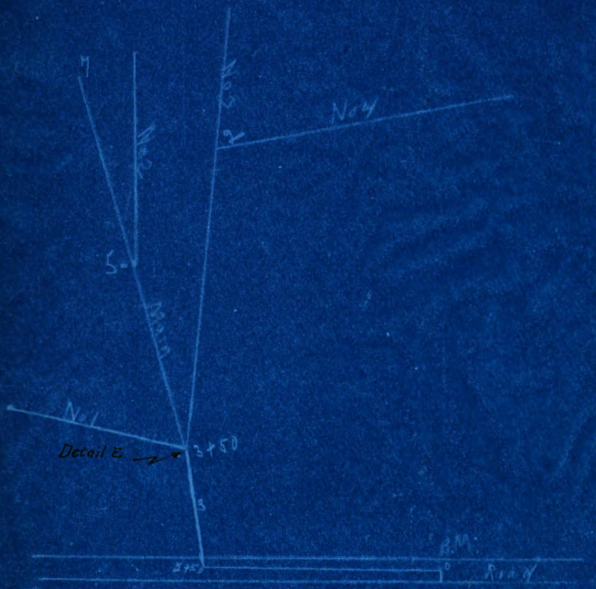
The work bench and cabinet for bolts, small tools etc is a necessary feature of any implement house

H. J. Gallagher.
Scale $\frac{1}{8}$" = 1 ft.

DRAINAGE MAP.

This map shows the general relation in which the tile were laid in the five acre tract of land previously mentioned.

Detail E shows a good method of uniting branches to the main tile. Such a catch basin gives a good check on the action of each entering line and furnishes a place to deposit silt where it is accessible for removal.

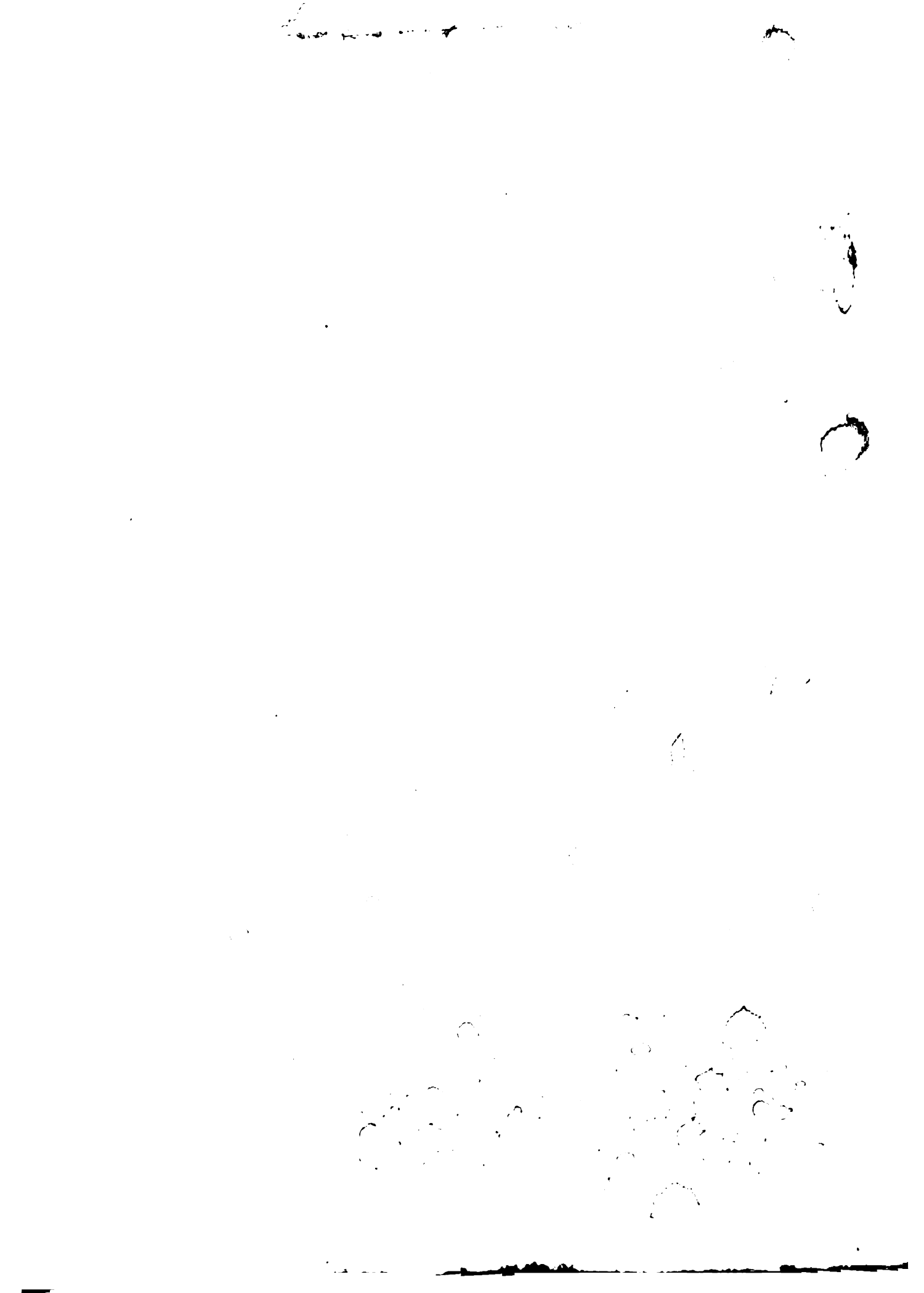


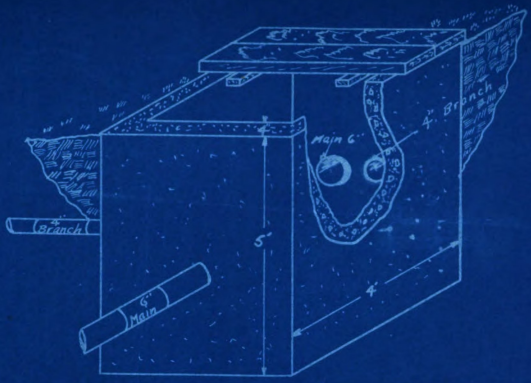
DRAINAGE MAP
of
Parcel H - S Swamp
Described as _____
Sec. _____ T. _____ R. _____
Comprising 50 Acres

N
W E

L. N. S. 3-41-41
Sheet No. 2 / 4
Project No. I-2-41

Extension Service
Farm Mechanics Dept.
Michigan Agricultural College
East Lansing





CATCH BASIN.

Detail E of drainage map.

H. J. Gallagher. Scale 1/2" = 1 foot.

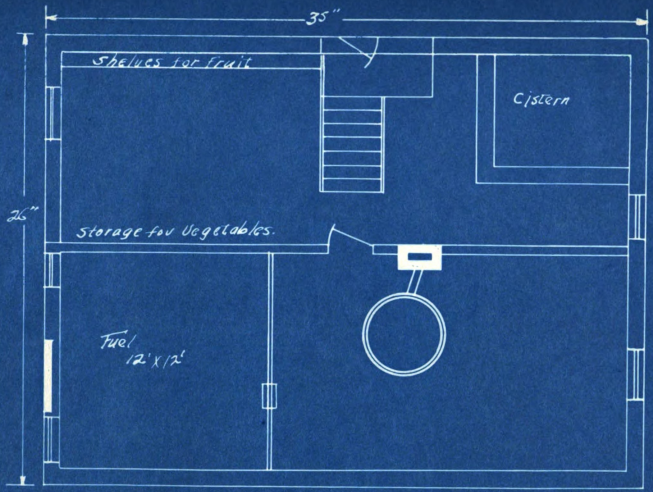
PLANS OF A PROPOSED FARM HOME.

These floor plans are illustrative of how the great economic principle of size being determined by arrangement can be accomplished. In this plan there is embodied more useable room than in our present house of twice the size, and those conveniences which promotes permanent comfort and ease of work. Since 1917 any changes made on the farm have been with a view to this house in mind.

Basement.

Provision is here made for soft water storage, fuel, furnace, vegetables and fruit.

The furnace will be centrally located and in close relation to the fuel room, the vegetable room and fruit room should be away from the furnace and in the coolest part of the basement. Both fruit and vegetable rooms need light and ventilation.



Basement.

H.J. Gallagher.

Scale 3/16 = 12" Fe

First Floor.

The arrangement of this plan provides for the accessibility of all the rooms, except the bedroom, from a small central hall. The combination washroom and laundry allows the farmer and help to enter, wash and go to other parts of the house without interfering with the kitchen work. It simplifies the plumbing and saves having the laundry in the basement, which on a farm usually means more expensive drainage and a more extensive use of the stairs.

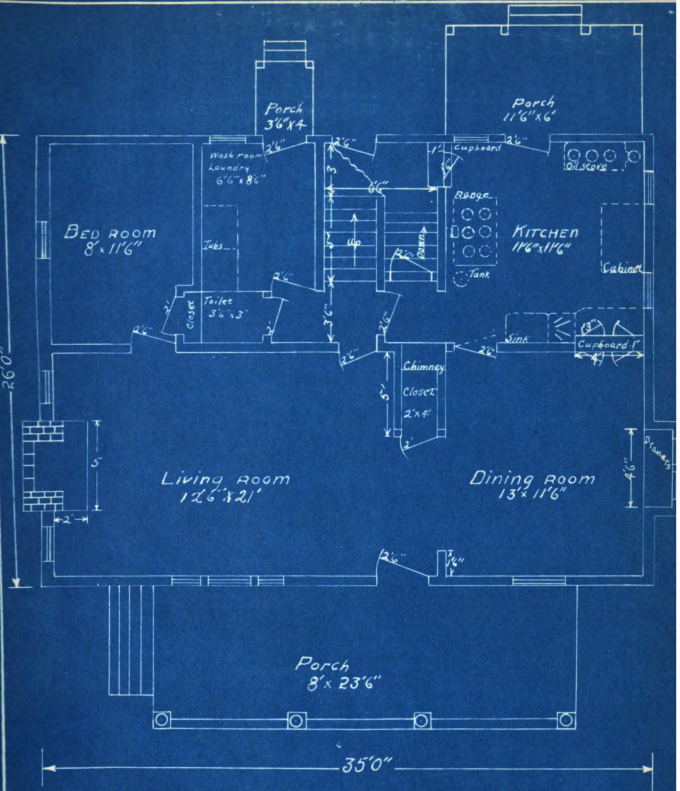
A main floor toilet proves so convenient in our present house as to be a definite feature in a new one.

The living room is of good size and shape and the bedroom has the convertible feature also of being used as either a den, office or library. With its south and west exposure, fire-place and coat closet this would be a very attractive and livable room.

The dining room has the desired relation to the kitchen and living room, and is so arranged that during threshing and silo filling, when a number of men have to be fed, an elongation of the table into the living room will accomodate the entire number.

The bay window, with drawers beneath adds in attractiveness and convenience, the drawers furnishing ideal storage for the dining room linen.

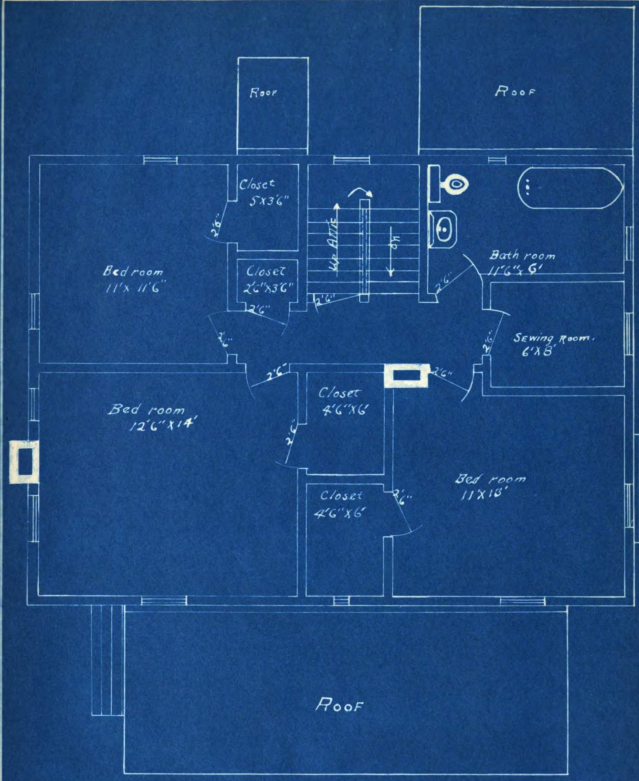
The kitchen, on the northeast corner is a bright cheerful room of a morning and is provided with plenty of light and conveniences. The plumbing is better protected by being on an inside partition and the sink and cupboard arrangement conductive of the least handling of the dishes.


Porch
3'6"x4'
Porch
11'6"x6'
Wash room
Laundry
6'6"x8'6"
Cupboard
Dr.Board
Range
Bed Room
8'x11'6"
Tubs
Up
Down
Kitchen
11'6"x11'6"
Tank
Cabinet
Toilet
3'6"x3'
Closet
Sink
Cupboard
Chimney
Closet
2'x4'
26'0"
Living Room
12'6"x21'
Dining Room
13'x11'6"
Porch
8'x23'6"
35'0"
FIRST FLOOR
S
HOUSE PLAN
H.J. Gallagher.
Scale 3/16" = 12" Feb. 1917

Second Floor.

The second floor plan furnishes a good arrangement and good sized bedrooms, each provided with a clothes closet and plenty of light and ventilation.

The hall space is reduced to a minumum and a linen closet provided. A bathroom over a kitchen reduces the plumbing and is generally kept warmer. A sewing room is a convenient feature where it can be economically provided.



Second Floor.

HOUSE PLAN

H.J. Gallagher.

Scale 3/16 = 12" Feb 1917

Elevations.

The end and front elevations show the square type, hip roof architecture, not as desirable in the country where the natural setting is more conductive to the low rambling type, but more economical of construction, and furnishes a better opportunity of convenient room arrangement and heating facilities.

The two dormer windows add to the appearance and enlarge the attic space.

HOUSE PLAN

H J Gallagher

Front Elevation

Scale $\frac{3}{16}$" = 12" Feb 1917

East Elevation.

H.J. Gallagher