HYGIENIC WATER SUPPLIES FOR FARMS.

By B. M. Bolton, M. D.,
Biochemic Division, Bureau of Animal Industry.

The importance of a sanitary water supply both for drinking and for purposes of cleanliness has long been recognized, and the improvement in the health of communities which has followed the introduction of abundant supplies of pure water bears testimony to the importance of every precaution in this direction. While the value of a sanitary water supply for cities and towns has thus been demonstrated, too little consideration has been given to the water supplies for farms. Contaminated water used in connection with farm products may affect not only the farmer himself and his immediate family, but all of those who use his products. All the products of the farm which are washed before sending to market and all vessels and containers for food may be made dangerous to health by being washed in polluted water.

There is perhaps no one source of danger so great as that arising from the use of polluted water for washing and rinsing the vessels used for milk. It should be borne in mind that bacteria of various sorts flourish in milk, and that bacteria are the cause of many diseases. Milk is one of the best media for the growth of bacteria, and one drop of polluted water contains enough bacteria for the contamination of almost any amount of milk.

The few drops remaining in the can after it has been rinsed with impure water are sufficient to contaminate all the milk put into the can, and the bacteria introduced into the milk in this way multiply rapidly unless the milk is kept very cold. The danger from polluted milk is not only that there may be microbes present which may cause special diseases, such as typhoid fever and scarlet fever, but also that many bacteria cause changes in the milk which make it injurious to health, particularly injurious to children. In this case the bacteria themselves may be of such a kind as not to produce disease if taken into the stomach alone, but they may nevertheless change the milk so as to make it to all intents a poison. The same thing is true to some extent with all food, particularly with food which is eaten raw, but it is specially the case with milk for the reason just given that the bacteria flourish in milk, and it has just been pointed out that impure

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water may be a source of contamination of milk; not the only source, it is true, but directly and indirectly it is perhaps the main source.

It is evident, therefore, that the public health may be endangered by unhygienic conditions on the farms and particularly by insanitary water supplies. The importance of water supplies for towns is very apparent as affecting the welfare of a large number of individuals in each case, but the supplies of farms, taken all together, are of scarcely less importance to the general health. The number of persons interested, even if the farmer and his immediate family alone were concerned, is in the aggregate very large, but, in view of the facts just stated, the interest of the whole population becomes evident, particularly as affecting the health of young children through contamination of the milk cans.

In this connection it may not be out of place to correct an erroneous idea which seems quite prevalent in regard to milk contamination through polluted water. The belief among farmers appears to be quite widespread that milk may become contaminated by the impure water drunk by the cows, the conception being that in some way bacteria pass from the stomach of the cow through the udder into the milk. There seems to be no good reason for believing that this takes place. It is true that milk becomes tainted by garlic and weeds which the cow eats, but this is a very different matter from the passage of bacteria from the cow's stomach into the milk. The danger from bacteria in milk arises mainly, if not wholly, from the use of unclean vessels and from slovenly methods of handling the milk after it has been drawn from cows. It is true, however, that if the cow is diseased, particularly if tuberculosis exists, or disease of the udder, bacteria may get into the milk from the cow. But bacteria from foul water do not pass directly from the stomach of the cow into the milk. It is nevertheless important for the health of cows that they have an abundance of pure water to drink.

REQUIREMENTS OF A SANITARY WATER SUPPLY.

The three factors necessary for a sanitary water supply are purity, abundance, and convenience. The most important of these factors and that which has received most consideration as a rule is purity. People naturally prefer clean, pure water, and they are generally educated up to the dangers arising from polluted water as a possible source of infection. Hygienic examinations of water supplies often begin and end with a determination of bacteriological or chemical contamination to the neglect of questions regarding proper location, abundance, and convenience—factors which can not be safely ignored. The water may be pure and sufficient for drinking purposes and yet

not sufficiently abundant for cleanliness. For sanitary purposes it is essential that the water should be in such quantity at all seasons of the year that there is no need for stinting in any direction. There should be an abundance for personal cleanliness, for the laundry, for washing the utensils of the kitchen or dairy, and for the premises generally. The importance of the unrestricted use of water is so great that some hygienists condemn the use of water meters in private houses in cities with a central water supply because many people are apt to stint themselves if the water is paid for according to the amount used.

Convenience is probably the least important factor, but it is nevertheless essential for a sanitary water supply. It seems from the result of the inspection of about 300 farms around Washington that this requirement is more often neglected than the matter of purity or of abundance. Most farmers take pride in what they regard as the purity and abundance of their water supply. Each one in the neighborhood will frequently boast of his spring or well in these respects, but many of them will year after year draw the water up in a bucket out of an open well, or pump it by hand into a pail, or bring it by hand uphill from the spring. Where such exertion as this is necessary in good and bad weather alike, persons will resort to economy in the use of water, at least for cleaning purposes.

No one rule for preserving health is more important than cleanliness, the frequent bath, clean clothing, clean vessels used for food—particularly receptacles for milk—and cleanliness of dwelling and stables. Nothing is so conducive to cleanliness as an abundant and convenient supply of clean water, and anything which facilitates the unrestricted use of pure water is in itself a hygienic measure.

SOURCES OF WATER SUPPLY.

Of the water which falls to the earth as rain, hail, or snow, a large part is evaporated from the surface of the earth and taken back into the air. Of the rest a part runs off to feed the brooks and rivers, and a part sinks into the soil to feed the springs and wells which are the source of domestic water supply for the farm. It percolates through the soil until it reaches the so-called "water table," which is a more or less porous layer of gravel or sand resting upon an impervious stratum of clay or rock. (See fig. 37.)

The water table follows the dip of the rock or clay layer, and is consequently to be found at various depths or may crop out at the surface, forming a spring. Where it is tapped by a shaft it furnishes the water for a well (fig. 37). When this water table lies between two impervious layers, if the point at which the well is sunk is at a lower level than some part of the water table, the water will

flow out and constitute an artesian well (fig. 37). A subartesian well is one in which the water comes up nearly to the top of the shaft.

SOURCES OF POLLUTION.

Water may take up something from most things with which it comes in contact. Some things like common salt and potash, as everyone knows, are readily dissolved in water, while many other substances are dissolved in very small traces. Not only solid substances but gases and liquids, as well as living micro-organisms—microscopic plants and animals—and minute particles of dust are all taken up by water. On its way through the air the water takes up various gases,

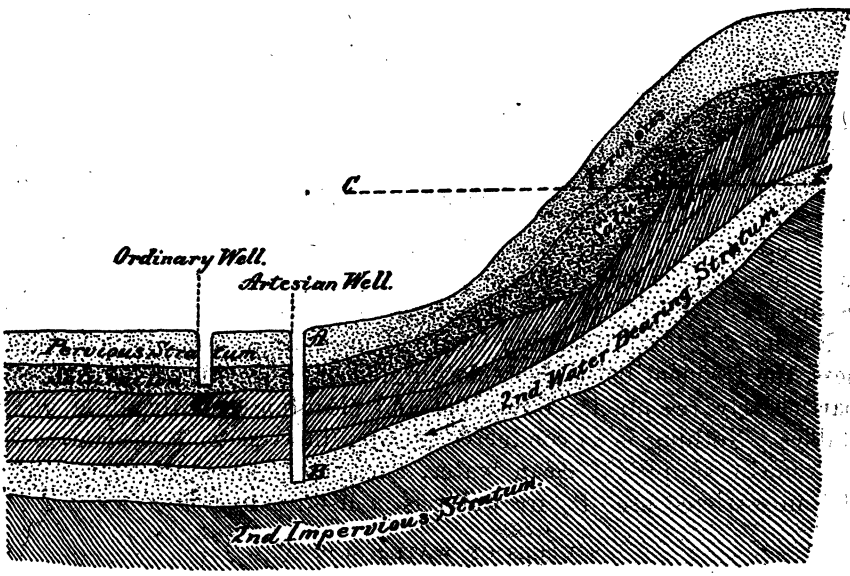

FIG. 37.—Geological formation showing manner in which water is secured from wells of varying depths. (From Harrington's "Practical Hygiene," 1901.)

such as oxygen, nitrogen, carbon dioxid, ammonia, etc., as well as fine dust particles and bacteria. On its passage through the soil it dissolves various minerals from the rocks, such as lime and magnesia, and if the soil is polluted in any way it takes up whatever it can dissolve of the pollution. In the upper layers of the soil the water also comes in contact with bacteria, which cause its contamination.

Many of the substances taken up by the water are harmless and some may be beneficial, others are undesirable, while still others may be harmful. The nitrogen and ammonia from the air are probably without significance from a sanitary point of view, though these may be of some value as sources of food for growing plants. The oxygen and carbon dioxid serve a useful purpose in giving life and sparkle

to the water, and in this way impart an agreeable taste. The bacteria which the water takes from the air are probably seldom of any significance, though it is true that occasionally bacteria of certain diseases have been found floating in the air, and these may be taken up by the water; still, this is probably not frequent, at least in rural districts.

The mineral matter, particularly the salts of lime and magnesia, make the water "hard" and, although this does not affect the health of those who consume the water unless the minerals be present in large amounts, it makes the water less suitable for purposes of cleanliness. The presence of sewage is of course an indication that the water may be injurious to health, for, as everyone knows, outbreaks of typhoid fever and of disorders of the bowels have been frequently traced to water that was polluted with sewage.

PURIFICATION OF WATER IN THE SOIL.

But while the water in its passage through the soil may become polluted with the substances just enumerated, on the other hand it undergoes a process of purification. The solid particles of dust and the bacteria taken up from the air are filtered out by the soil, particularly if the soil is sandy. It has been found that, at a comparatively short distance below the surface—4 or 5 feet—there are usually but few bacteria present in the ground, and the water which percolates through the soil, although it may become contaminated in the upper layers, is rid of bacteria on its passage farther downward. Deep-ground water usually contains few bacteria, but of course it may become contaminated when it is tapped for a well. If the layer of soil through which the water percolates on its way to the water table is saturated with filth some of the pollution may be carried down, particularly if the layer of soil is not deep.

PROTECTION FROM POLLUTION.

The water supplies of farms come from wells, springs, and cisterns. A recent inspection of the water supplies of some 300 dairy farms in Maryland and Virginia showed that wells are used much oftener on these farms than either of the other two, the proportions being about 5 wells to 3 springs and 1 cistern.

WELLS.

To guard against the pollution of wells the location is of importance. Where it is possible the ground should slope away naturally on all sides and the pump should be on top of a mound which should be well sodded or cemented all around. Sources of domestic

or of other pollution should be separated from the well by an impervious layer below ground to avoid the danger of pollution from seepage.

The ground immediately around the well should be protected from animals by a fence or otherwise. The shaft of the well should be thoroughly tight, and for this reason the use of terra-cotta tiles or metal pipe for the shaft is preferable to walling up with bricks and mortar. In any event the space immediately around the shaft proper should be puddled with clay or cement, or, as advised by Koch, have the upper part packed around with sand. The use of open wells, or even the use of chain pumps, is not to be recommended, since they are

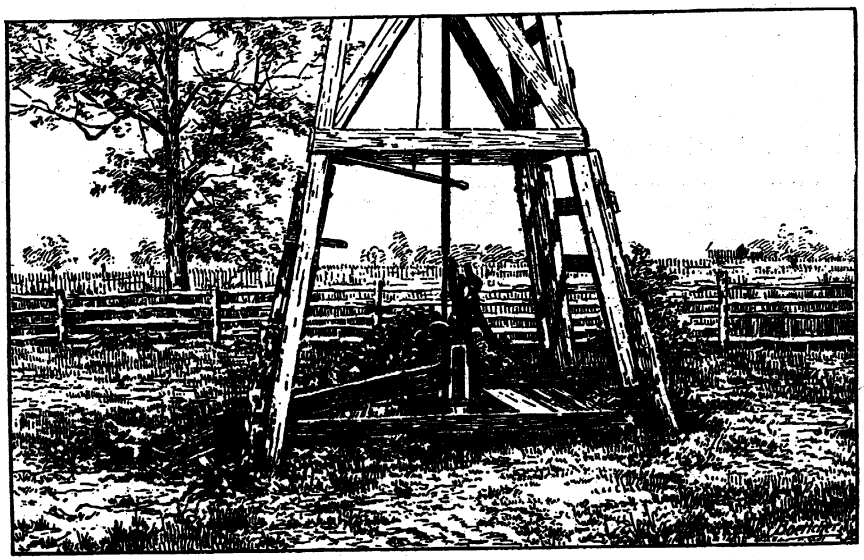

FIG. 38.—A well with good natural location, but with slovenly surroundings; not properly guarded against pollution.

more liable to pollution from the introduction of impurities down the shaft. In all cases the well should be guarded by a tight coping and cover. It is an advantage to cover over the well with a tight cover, and to place the pump to one side of the well shaft with an elbow connection.

A form of well known variously as the tube, or driven, or Norton, or Abyssinian well is good from a sanitary point of view. It consists merely of an iron pipe screwed together in sections driven down to the water-bearing layer. The lowest section of pipe is armed with a point and is perforated with a number of holes. In a well of this character there is no danger from seepage into the shaft and it is cheaply and quickly constructed. In case one such tube fails to furnish sufficient water others can be driven close by and all connected with one pump.

Every precaution should be taken to prevent the contents of a cesspool from soaking into the soil, for even if the cesspool is at a distance from the well the ground between may eventually become saturated and fail to act as a filter. As already stated, the presence of an impervious stratum between the well and the cesspool is a good protection, but where such a stratum does not exist the cesspool should be made watertight. The crude methods of sewage disposal still quite commonly in vogue in the country are a continual menace to the water supply.

Figure 38 illustrates a well which is imperfectly guarded against pollution and with very slovenly surroundings. The situation of the

FIG. 39.—A well with surroundings protecting it from pollution.

well in this case is good. It stands at a considerably higher level than the barnyard, which is below and at the left, and is separated from the well by a ledge of rock, while the domestic sources of pollution lie to the right and are several hundred feet away. The well is only about 7 feet deep, but it is bored into the solid rock, and in spite of its want of depth there would appear no good reason why it should not be made to fulfill the requirements of a sanitary supply, yet when it was inspected it was found to have a loose coping and there was no provision against pollution due to stray animals.

Figure 39 shows a well bored into solid rock, and although it is only 16 feet deep it would appear to be well protected from any source of contamination. Besides the protection afforded by the natural rock, the curb and cover are tight and, moreover, the cover has a slant so as to shed water.

An arrangement which seems to leave nothing to be desired is shown in figure 40. The well in this case is over 100 feet deep through rock; the barnyard lies off to the left and is at least 10 or 12 feet lower than the well. The dwelling is to the left and in front,

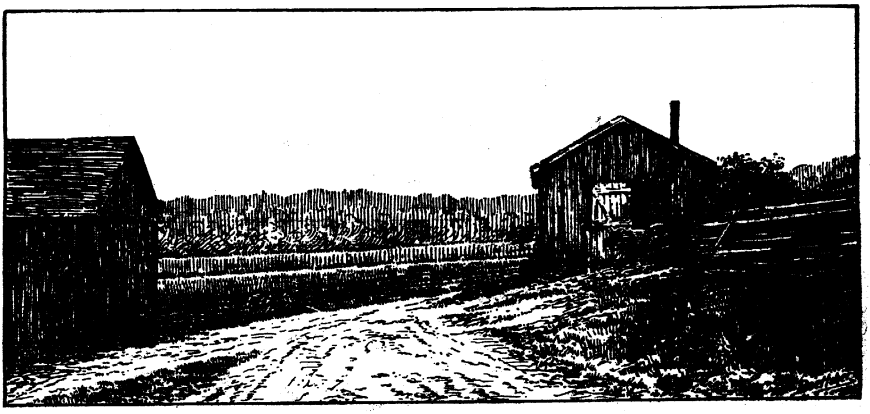

FIG. 40.—A well (in building at right) with excellent location.

and is still lower and farther away than the barn. The site of the well is near the top of the hill, inside the building seen at the right of the picture. The building shown is the dairy; the floor is cemented, and when it was visited it was found to be scrupulously clean.

SPRINGS.

What has been said of wells applies equally to springs, but, in addition to the danger of pollution from surface drainage and from seepage, if the spring is open it is liable to pollution by the introduction of impurities in dipping the water out. This source of contamination may be guarded against by inclosing the spring in a concrete casing on all sides and providing a tight cover and a pipe cemented in on one side to allow the water to run out. The cover should be removable, however, to permit of the cleaning out of the sand which always accumulates. Instead of the concrete casing a section of wide terra-cotta drain tiling has been used in some cases, and answers the purpose admirably if it is set in cement over the point where the water wells up out of the ground. The tiling should be provided with a tight-fitting cover and a pipe to allow the water to run off. Either of these two arrangements would obviate the danger of polluting the water by dipping unclean vessels into it. Some springs, although excellently protected by a coping on three sides and in other ways, are made liable to pollution by having steps leading down to the water's edge. Under such conditions the danger of introducing impurities from the soles of dirty shoes is of course apparent.

FIG. 1.—A SPRING WITH A GOOD LOCATION.

FIG. 2.—A SPRING WITH GOOD NATURAL LOCATION, BUT WITH INSANITARY SURROUNDINGS WHICH COULD EASILY BE REMEDIED.

Unless a spring has a tight coping on all sides and is provided with a tight cover and spout, so that the water does not have to be dipped up, it falls short of the requirements of a sanitary supply. Where it is possible the water from the spring should be conducted by pipe to the house, dairy, and barn.

In the inspection conducted by the Bureau of Animal Industry, already referred to, but few springs were found which were properly protected. Some of them had cement or tight stone coping on three sides with steps leading down on the fourth side. Some had a tight coping on all sides, but the coping was level with the ground and the water thus exposed to pollution. But in most cases the water ran out of fissures in the rock into a natural or artificial basin, or bubbled up from the bottom of such a basin. In such cases no special care was exercised to guard against pollution.

Plate XLVIII shows two springs surrounded on three sides and over the top by natural rock, but unprotected on the lower side in each case. The spring shown in figure 1 is remote from sources of domestic contamination, though it is in a pasture lot and is not fenced in. The dwelling is situated above and several hundred feet away up the hill shown to the right of the picture. The barn is still farther away in the same direction. The ground intervening between the house and the spring is in sod. The water is pumped up by a windmill to a tank near the house. The spring could be perfectly protected with little difficulty. In figure 2 the spring lies at the foot of the barnyard hill, and is shown in the picture to the left of the dairy house. Some protection from wandering stock is afforded by the railing seen in the picture. All the surroundings were untidy. There was filth up to the very edge of the spring. The fence seen to the left in the picture incloses the hog pen; and above, to the front and left, is the barnyard, though it is true the slope does not incline directly from the barnyard to the spring. This is naturally an excellent supply, and could be made to fulfill all sanitary requirements.

CISTERNS.

Where there is no spring and where for any reason it is not feasible to sink a well it becomes necessary to resort to cisterns, and if these are properly constructed and operated they may be made to fulfill all sanitary requirements. The walls should be water-tight, of course, both to prevent water from leaking out and to guard against pollution from without. The best cisterns are those constructed with two chambers separated by a porous brick partition through which the water is filtered. The water from the roof is made to run into one chamber, and is pumped out of the other after passing through the partition. The rain pipe from the roof should be provided with an arrangement for preventing the first water which falls in time of

rain from running into the cistern, since the first water after dry weather may become polluted with dust or bird droppings on the roof. The roof from which the water is caught should be preferably of slate. Water from wooden shingles is often tainted.

ABUNDANCE OF SUPPLY.

The average amount of water used in various cities in America and in Europe by each inhabitant per day varies greatly, being from 15 gallons in Vienna to 100 in Rome, 108 in New York, 120 in Detroit, and 122 in Chicago, Ill. But this amount includes the water used for all purposes—manufactories, street sprinkling, etc. A reasonable average amount for domestic purposes, as stated by Vernon Harcourt, is 25 gallons per day for each individual, and this is probably the amount which should be allowed on farms. Since the stock is usually watered at running streams this need not be taken into account in the reckoning. On farms generally, the supply is ample. It may occasionally run short in times of prolonged drought, but there was no evidence of scarcity on any of the farms recently visited by representatives of the Bureau of Animal Industry.

CONVENIENCE.

Comparatively few farmers seem to realize the importance of convenience in the matter of water supplies, even from a purely economic point of view, and much less from the bearing which such convenience has upon the cleanliness and consequently upon health. Less than one-fifth of the dairy farms recently inspected have windmills, rams, or other means of bringing the water into the house or dairy.

Year after year on many farms water is pumped by hand or brought up the hill from the spring in buckets at the expenditure of a great amount of labor in the aggregate. Where it is at all feasible the water should be pumped into a tank and conducted at least into the dairy and the kitchen by pipe. Even where the water has to be pumped by hand it is desirable to have a tank, for this insures abundance for purposes of cleanliness. But of course, if feasible, resort should be had to some mechanical device—a windmill, engine, or ram—for forcing water up to a tank to furnish a convenient supply for the house, barn, and dairy, in each of which there should be at least one spigot.

In conclusion it may be said that it is not usually a difficult matter to comply with all the requirements of a sanitary water supply on the farm. It requires only ordinary intelligence in selection of the site and subsequent management, besides a certain expenditure of time and money necessary for the construction of devices for protection and convenience. Each supply presents its own problems, which must be solved with proper recognition of the objects aimed at, and these are purity, abundance, and convenience.