

GRADUATING THESIS.

TILLAGE.

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TILLAGE.

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Tillage.

The stirring and working of the soil, such as will enable us to produce maximum crops with minimum soil exhaustion, or proper tillage, is the most essential factor in crop production. Though drainage, humus, fertilizers, and improved seed have their importance, yet from a Kansas stand point, observation and experience will justify placing good tillage as the most influential and economical factor in securing a profitable harvest. The value and benefits of good tillage is not fully appreciated and enjoyed, however.

Primitive man was satisfied with nature's methods. But in time there arose a demand for a greater quantity and better quality of plant products. Tillage was introduced to meet these demands. From the first crude dragging of the soil with a scraggly branch, or prodding the ground with a sharpened stick, thro long centuries of change and improvement has evolved, the effecient method and imple-ments of modern tillage. The most noteworthy fact in relation to the tillage of today is the study given and the knowledge known of the principal and effects of tillage. Jethro Tull, two hundred years ago practiced methods and secured results equal to the best of today, but his philosophy of tillage was at fault.

The soil becomes packed and puddled by beating rains. Animals and machinery compact it. Washing rains remove surface plant food. Soil moisture becomed deficient. Soil organism are dormant because of unfavorable environments. Weeds occupy the land. Such is the condition of unstirred and uncared-for soil. Good tillage is the preventive and cure of these various soil ills.

It is often well to begin tillage operations by disking. If land is thoroughly disked early in the spring or soon after harvest,

a deep soil mulsh is secured. This can be quickly done and will leave the ground in excellent shape for plowing later. Moisture being concerved, and a pulverized surface produced which will enable good plowing to be done.

Plowing is the great tillage and the plow the great tillage implement. In its construction and principal, the plow may be spoken of as a twisted inclined plane, the mold-board, to which is attached a cutting edge or shear, which severs the furrow slice from the land. The shear being attached at an angle, allows a shaving cut which gives minimum draft. The severed furrow slice, is raised, pulverized, and inverted by the peculiar shaped mold-board. The action of the mold-board on the severed furrow slice, has been well explained with the leaves of a book. Bend the leaves of a book and note how some of the upper leaves, slide back on those below them. In the same manner the soil particals are subject to a sliding or sheering stress during the passage of the furrow slice over the curved mold-board. As with the book, the thicker it is, and the more abruptly bent, the more noticable the sliding action, so with the furrow slice, the thicker it is, and the more abruptly bent by a steep overhanging mold-board, the greater the pulverization of the soil by plowing. Naturally, better results require greater energy. But since ninety percent of the draft of a plow is used in cutting and raising the furrow-slice it would be poor economy to greatly lessen the effectiveness of plowing, to secure a little reduction in draft. If the soil is plowed while damp, the shearing action is more effective. If the soil is plowed while wet, the action may be excessive, and a puddled soil result. A dry soil decreased the action.

The coulter, a plow attachment that throws up a small furrow, from the land side of the furrow slice, aids the effectiveness of the plow. It gives fine soil, for turning into the bottom of the furrow. The slice is also better kinked and broken in falling and draft is decreased.

Subsoiling has been much discussed and experimented with as an auxilliary of plowing. Theory would recommend it. But experience, the moisture capacity and root pasturage were increased, because of the cost, danger of puddling and injury to soil capalarity does not justify the general practise of subsoiling.

For breaking up a natural or an artificial hardpan, subsoiling may be helpful. When practiced it should be done some time previous to seeding.

Rains puddle the surface soil. The evaporation of water, holding salts in solution, clog the soil pores. The absorptive power of the soil is thus decreased, and much of the rain fall is lost by surface drainage. Plowing opens up such soils, and enables the rain fall to be absorbed. The volume of a well prepared soil is over one half air pores or spaces. These can be used for the temporary storage of water. When gravity removes the excess of water, twenty or thirty percent still remains held in the small capillary pores or as a film surrounding each soil grain. The film area varies from one fourth to four acres per cubic foot depending on the soil texture. The finer the texture, the greater the film area, and the greater the film area, the greater the amount of moisture held. Plowing by pulverizing and fining the soil thus increases its moisture holding capacity.

Plowing provides for the airation of the soil. Plant roots and soil organisms require oxygen. Carbon-dioxide must escape from the

soil. This ventilation is through the large capillary pores. When these pores are closed, and oxygen cannot be secured by the nitrifying organism, instead of the organic matter being transformed into nitrate, we have the denitrifying organisms active in transforming the valuable nitrates into volatile gases. Fertility is thus lost to the soil. The warmth, moisture, aeration, and bareness resulting from plowing and subsequent tillage, gives ideal conditions for nitrification. Heavy washing rains remove plant food from the surface soil. To surface washing is due seven-eighths of our loss of soil fertility. Root absorption also lessens the plant food in the upper soil. Because of this washing and root absorption it is necessary to bring up fresh soil from below by plowing. The new soil under the weather action of atmospheric agencies is soon rendered available for plant use, especially if the plowing is done in the fall.

Plowing by loosening the soil enables better root development. An abundance of roots is necessary in securing moisture and food for the plant. The destruction and burial of weeds is another important result of plowing.

After the land is plowed it should be immediately packed. The harrow and disk will do this in a way, it can be best accomplished with the subsurface packer.--An implement provided with a number of wedge shaped wheels. These wheels are pressed into the loose plowed ground, compressing the sub-surface soil, and bringing the clods to the surface, where they may serve as an admirable anti-evaporating and anti-blowing mulch. If it is desired to grind up the clods, they are at the surface where implements may act on them. Packing obliterates the large air cavities and reduces the excessive air circulation of freshly plowed ground. The soil is packed firm-

ly about the buried trash and capillary is established with the sub-soil. The resulting upward flow of moisture enables the decomposition and nitrification to progress rapidly. Moisture will also be present in readiness for seeding and an early vigorous root growth is insured.

From packing to seeding and when ever possible throughout the growing season a coarse, dry, moderately deep soil mulch should be kept on the land to retain moisture. Lack of sufficient moisture during the growing or ripening season is the great draw-back to large crops in Kansas. It is not so much the lack of moisture with us, but rather lack of proper distribution by nature, or lack of conservation by man. Water is one of the most essential factor in plant growth. It is the great solvent, transporter and transformer of plant food. With the average farm crop, about three hundred tons of water is needed to produce a ton of dry matter. It has been estimated by Professor Burrill that a large apple tree may absorb a ton of water a day. A forty bushel wheat crop uses 1358.4 tons of water per acre. A large amount it seems, yet one half ^{our rain} fall would supply it. Seven or eight inches of our rain fall, flows down the Mississippi. Much of that which enters the soil is soon evaporated because of improper soil handling. A method of tillage that will enable the soil to absorb and then retain the rains for the growing crop is the great consideration in Kansas agriculture. Good plowing provides for absorption and a coarse, dry soil mulch two or three inches in depth, will at lease reduce the evaporation one half or two-thirds.

When the moisture films are entirely evaporated from any portion of the soil, the passage of capillary moisture is extremely slow. The friction of the water films on the dry soil grains almost

equallizing the attraction of soil molecules for water molecules. The soil is dried in preparing a mulch and the upwardflow of water checked. The soil particles in the mulch also being coarser than in unstirred soil, there are fewer avenues by which the films can reach the surface. The efficiency of a mulch is lost with time, and it should be re-stirred every ten days or so or after a rain. A heavy rain destroys the mulch and enables a rapid flow of moisture through the surface. If the mulch is not re-established soon, not only may the late rain evaporate but much of moisture that was present before the rain may be lost besides.

The drag harrow is a good general purpose mulch producing implement. If the soil becomes compact the disk, acme or spring tooth harrow is better adapted for mulch production. Eight or ten spring shovel cultivators give good results tilled crops.

The ability of weeds to hold their own in the struggle for existence have stimulated some farmers to good tillage. They were forced to look upon weed destruction as the main object of tillage and in conquering the weeds some of the other important results of tillage was secured. To such, weeds are friends in disguise. Weeds must be kept in control for the best growth of other crops. A clean seed bed and tillage during the sprouting stage usually settle the seed question.

A proper inversion, pulverization, and stimulation of the soil by good plowing, securing a clean compacted seed bed, providing for moisture absorption and conservation, and the subjugation of all plant competitors, are the essentials of good tillage.