https://doi.org/10.29321/MAJ.10.A01443

Farming will never be a success unless the farmer had more voice in the disposal of his produce—P. Morrel.

The
Madras Agricultural Journal

(ORGAN OF THE M. A. S. UNION)

Vol. XVIII] FEBRUARY, 1930 [No. 2

PLOUGHS AND PLOUGHING

BY

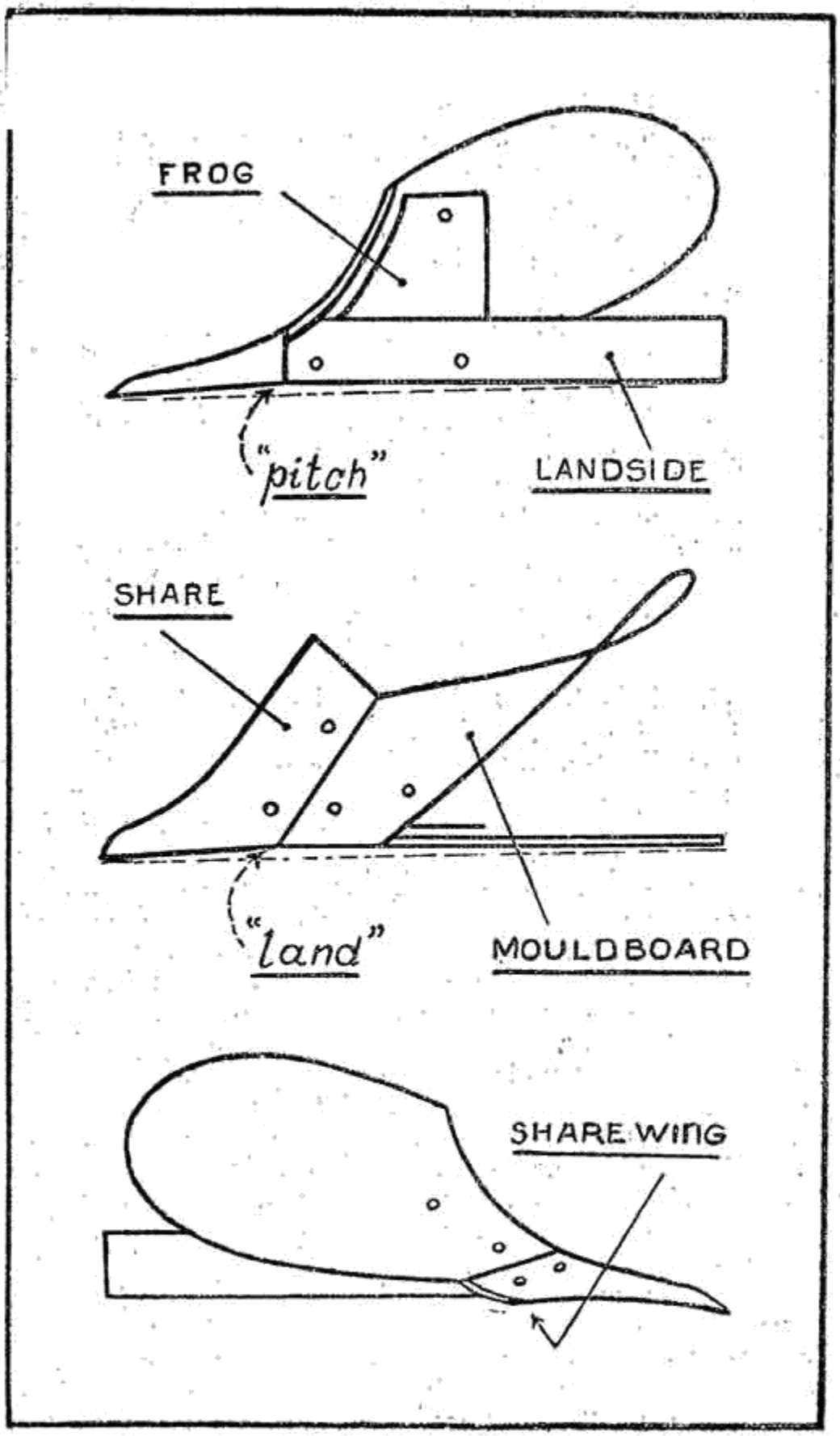
N. G. CHARLEY

The plough is the vital part of the ryot's equipment. Ploughing is the first and foremost operation in the preparation of the soil to develop tilth. This is just as true to-day as it ever was, despite the introduction of many other forms of tillage implements. The productiveness of the soil depends upon its physical condition, its humus content, the amount and availability of water and the amount of available plant food. The ground must be ploughed to break up and pulverise the soil. Pulverising is necessary to aerate the soil and make available the plant food which envelopes each soil particle. The soil must be aerated in order that it may be thoroughly oxidised, a condition necessary to the healthy maintenance of soil bacteria. Ploughing is necessary to cover surface trash or manure and mix it with the soil so that it will decay and maintain the stock of humus and plant food. The ground must be ploughed for the purpose also of increasing the ability of the soil to absorb moisture. The seed bed must be in a well pulverised and compact condition so that the seed can germinate according to its natural inclination and the plant produce a root system necessary for vigorous growth and flowering.

Clods in the seed bed cause large air spaces which arrest the rise of moisture from the subsoil by capillarity. The particles of soil composing the clods are not aerated, nor can the tender roots of the young plant penetrate the clods which retard root growth. The soil particles should be in close proximity though minute air spaces should exist at the same time. It matters not how good the seed is, if the soil is not in the right condition to make plant food available to nourish the starting plant; otherwise growth will be stunted and a poor start can never be made up at subsequent stages of the plant's growth.

The plough bottom, viz., the mouldboard, share and landside with the frog which holds them together is the vital part of the plough. All other parts of the plough are for the purpose only of enabling the ploughman to make the bottom work correctly. A large variety of plough bottoms are made to meet the various soil conditions and to do the various kinds of ploughing required by farmers. Plough makers have not yet been able to design any one plough bottom that can be adapted to all the different kinds of soil. They have been able to build plough bottoms that will plough remarkably well in all types of soil that have certain common characteristics, but when the demarkation is too pronounced, it is necessary to change the shapes of the mouldboards in order to properly work the soil.

There are many soil combinations, but the most common are clay, clay loam, loam, sandy loam, loamy sand, sand and muck. Clay is the most difficult soil to till on account of the peculiar effect water and air have upon it. It holds moisture longer than the other types of soil, bakes hardest, cracks deeply permitting great quantities of moisture to escape and forms clods easiest. Clay soils when ploughed too dry form large clods which are very hard to break down into pulverised condition. If such soil lacks humus in sufficient quantities to keep it friable, it nearly always forms a powdered surface and if sufficient rain comes while the soil is in this powdered condition, the soil will run into a sticky plastic mass which will later dry hard, crack and become very difficult to break up successfully. Clay being of a plastic nature is puddled by wet ploughing. If it is turned over in a closely compacted manner, the top dries out and cracks occur which form avenues of escape for the moisture below and a cloddy formation at the bottom of the seed bed is the result. Great care must be exercised in the handling of clay soils. The correct kind of plough bottom must be used to get the best results and the ploughing must be done when the moisture conditions in the soil are just


FROG
"pitch"
LANDSIDE
SHARE
"land"
MOULDBOARD
SHARE WING

right. Loamy soils are made up of sand and clay in such composition that the identity of each is lost. Loam crumbles readily making it easy to plough and cultivate. It forms into a mellow compact seed bed. In clay loam, clay predominates in the soil composition and in sandy loam, sand predominates. A clay loam soil should be treated more like a clay soil and a sandy loam more like a sandy soil. Clay loam is much easier to plough and cultivate than clay because the sand in the loam breaks up the compact relationship between the clay particles. It has the clay characteristics of cracking and drying out and should be handled in such a way as to avoid this. Sandy loam is a mixture of sand and clay in which the sand predominates. It is more porous than loam or clay loam, works up easily and does not form large unbreakable clods. Loamy sand contains very little clay, it dries out quicker than any other type of soil, never forms clods and is the easiest soil to plough. It is a soil that should be handled with the greatest care or it will produce nothing. As soils vary from one extreme to the other, so must plough builders make plough bottoms to meet these variations.

The plough bottom is similar in its action to a three-sided wedge. The cutting edge of the share and the landside, which cut the furrow slice free from the subsoil and the furrow wall, form the flat sides of the wedge. The mouldboard and upper part of the share are curved and made to perform the functions of lifting, pulverising, turning and compacting the soil into an inverted position. The principle of the pulverising effect of the mouldboard is illustrated by bending a pack of cards or the pages of a book. The layers of particles composing the furrow slice like the cards in the pack are made to slide one over the other so that the cohesion of the soil particles is broken. In addition to this shearing action, the bending of the furrow slice by the mouldboard produces a direct breaking effect which assists in the pulverising of the soil. Whether the furrow slice is broken into larger or smaller clods depends on the tenacity with which the particles hold together and the shape of the mouldboard for pulverising. Clay would be broken into clods with the same type of mouldboard that successfully pulverises sandy soil. For this reason all types of plough bottoms that are used in ploughing the looser soils are bluffer than those used in ploughing soils that stick together, such as clay. The mouldboard should lean more towards the bluff as sand predominates in the soil composition and more towards the longer curve as clay predominates. The pulverising of the more tenacious clay soils cannot be effected by increasing the abruptness of

the mouldboard curvature as one might at first expect. In soils containing much clay, the furrow slice will suffer disintegration due to direct breaking and will be broken into clods if a bluff mouldboard is employed. The shearing of the soil particles which plays the biggest part in pulverising will be resisted by their cohesion and pulverising will not be effected.

A mellow loam soil and soils of similar texture which are capable of being directly pulverised with the plough should be ploughed with a pulverising bottom. As the clay content and so the cohesion of the soil particles increases, the mouldboard curvature should be made longer and less abrupt. If clay soils are in the right condition for ploughing, they can be successfully pulverised with the right kind of plough bottom, though never to the same extent, of course, as loamy soils. If, however, they are too moist or too dry, they must be ploughed with a bottom that will invert the furrow slice without materially disturbing its composition and pulverised afterwards with other implements.

The amount of moisture the soil contains as well as the texture of the soil determines whether the ground should be ploughed with a pulverising mouldboard or an easier turning mouldboard that will turn it over without so much attempt at pulverising. Up to a certain limit, moisture in the soil will greatly facilitate pulverising and it is very desirable that the condition of the ground should be carefully studied and the ploughing done as far as possible when the moisture conditions in the soil are such as will permit the best quality of work. A mouldboard that does a perfect job of ploughing in a soil in right condition will fail to work if the soil contains too much moisture. The cohesion of the granules of a closely textured soil like clay is increased by the pressure of the soil against the mouldboard if the soil is ploughed too wet and the soil granules will not fall apart in the act of ploughing. The wet plastic soil in passing over the surface of the mouldboard is moulded into a solid mass in the curve of the mouldboard. A sticky wet clay cannot, therefore, be pulverised directly with the plough and requires a mouldboard with a long gradual curve that will turn over the furrow slice almost intact leaving it to be pulverised with a disc harrow or other implement after it has dried out sufficiently. Similarly, for the ploughing of wet lands containing more than a certain amount of clay, a flattish mouldboard is required.

Between the short abruptly curved mouldboard and the long gradual curve are many styles of bottoms to meet the many

different soil conditions, but for general use, bottoms may be classified as breaker, general-purpose, stubble, black-land and slat mouldboard bottoms. The breaker is used in tough sod where complete turning of the furrow slice without materially disturbing its composition, is desired. In ploughing sod all portions of the grass should be completely buried and the ground packed as closely as possible to exclude all air and sunlight so that the grass will die and decay rapidly. Wherever a ray of sunlight is able to peep through the furrow tops the grass will sprout again. The mouldboard of the breaker plough has, therefore, a long gradual curve. The general-purpose bottom is equipped with a mouldboard of medium curvature and meets the demand for a bottom that will do satisfactory work in the varying conditions found on the average farm. Stubble bottoms have high bluff mouldboards and are specially adapted to ploughing in old ground where good pulverising of the soil may be effected. The black-land bottom is made for use in heavy, sticky, black or chocolate soils which are hard to break and harder still to scour. It is built with a low front and easy tapering mouldboard designed to shed the soil and draw as lightly as possible. The black-land type of bottom is a very suitable one for wet lands, particularly where clay predominates in the soil composition. The slat mouldboard bottom which is described further on in this article is made for loose, sticky soils in which solid mouldboard ploughs completely fail to scour. There is, of course, a number of variations of these general bottom shapes.

For deep ploughing down to eight inches or more, a plough bottom of the right type should be used. If a bottom of not more than six to seven inches capacity is used, the furrow slice cannot be properly pulverised and portions of the slice will pass over the top of the mouldboard or, in soils that stick together, the furrow slice will be set on edge and roll back into the furrow as the plough passes on. A plough bottom will usually do its best work when ploughing at a depth equal to half its width.

In some countries where clay land predominates and rainfall is excessive, underdraining is practised. A plough is used which has a share narrower than the mouldboard. In ploughing the land a portion of the furrow is not cut entirely off. The mouldboard pushes the cut part of the furrow solidly against the preceding furrow shaping the furrow to leave the top diamond shaped with drainage facilities at the bottom. This gives the furrow slice an opportunity to dry out so that it may be successfully tilled.

A knowledge of what constitutes good ploughing is necessary before one can judge whether the bottom is particularly adapted to the soil. It does not matter what type of soil is being tilled. The conditions necessary for plant growth must be the same. The soil must be well pulverised and properly compacted so that natural agencies may have the greatest effect whether the soil be clay, sand, muck or any other. Unfortunately, no method of expressing or measuring tilth in a concrete manner has yet been devised and the ultimate test of tilth must be found in its effect upon the plant itself. It is impossible, therefore, to lay down a set of laws or rules to determine what constitutes prize ploughing. The most beautiful job of ploughing on the surface is no proof that the ground will grow the best crop. Before the best results can be expected, however, we know that the following requirements should be fully met. Each furrow should be straight from end to end. The top lines of the furrows should be uniform without breaks or depressions. The top of the furrow may be slightly ridged. The ground should be thoroughly pulverised from top to bottom of the furrow with no air spaces anywhere between the furrow slices. Trash must not be visible in the line of the furrow and should be buried in the lower outside corner of the furrow to interfere as little as possible with the upward trend of moisture by capillarity. Furrows should be of uniform width and depth, compared one with the other. In the case of loose sandy soils, the more level the ground is left after ploughing the better, since less moisture will escape under these conditions than if the furrow tops are left ridged or crowned. The right plough bottom must be used to leave the ground in this condition. The best method of judging ploughing by these standards is to take a spade or similar instrument and observe the condition of the bottom of the furrow by carefully removing some soil so that a full depth cross section of a number of adjacent furrows is exposed. Clods, trash and air spaces, if any, may thus be revealed.

Ploughs are made of steel and cast iron and the ryot should consider which type will best suit his particular soil conditions and give him the most economical service. The latter type of plough is usually referred to as a 'chilled' plough because of the chilling process the cast iron wearing parts are subjected to in the process of hardening them. In steel ploughs of the best quality the principal wearing parts, the mouldboards and shares, are made from what is known as soft centre steel. This steel is composed of three layers fused together. The two outside layers are of high carbon steel to ensure hardness and good scouring and wearing

properties and the centre layer is of soft steel to impart toughness and prevent the breaking of the brittle outside layers. A steel mouldboard of this kind is about a quarter of an inch in thickness. These soft centre steel bottoms are in more general use than solid steel bottoms in advanced agricultural countries. They have very much better wearing and scouring properties than the solid steel bottoms. Solid steel shares are sometimes used with soft centre steel mouldboards where soil conditions do not require the more costly soft centre steel shares for scouring. The steel ploughs which are being manufactured for this country have mouldboards and shares of solid steel which is less costly and the thickness of the mouldboards varies from about one-eighth of an inch on ploughs of the popular 'Meston' class to about three-sixteenths of an inch on those of the 'Victory' size. Solid steel bottoms, however, have not such good scouring properties as soft centre steel bottoms because they cannot be tempered for fear of rendering the steel too brittle and are likely to break under shock and heavy loads in difficult soils.

Chilled ploughs are constructed by an entirely different process from steel ploughs. The parts are cast in moulds and the *chill*, as plough makers call the term of hardening, crystallises the metal so that the grain of the metal is edgewise of the surface instead of lengthwise as it is in steel sheets due to the rolling process in the course of manufacture. The ends of the metal crystals thus form the surface of the mouldboard and for this reason chilled mouldboards are very hard and wear for many years. The share and other wearing parts are chilled in a similar manner. The thickness of a chilled mouldboard is about three-eighths to half an inch. The chilling effect is usually made to penetrate about a quarter of an inch of this total thickness so that a chilled mouldboard will present a hard chilled surface until the entire thickness of the chilled portion is worn away. A properly chilled casting has a flinty hardness which it is impossible to duplicate in steel by the best hardening process. This exceptional hardness enables a chilled plough to much better withstand the scratching action of sand, stones and like material which will quickly wear away a steel plough and ruin the polish on its mouldboard so that it will fail to shed the soil. In fact, there is no abrasive action of the soil that will affect the scouring qualities of a properly chilled metal. The more a chilled plough is operated in sandy soil, the smoother it becomes and the higher polish it takes. The ends of the metal crystals form the surface for scouring and the dirt passing over the ends of the crystals has a tendency to polish rather than cut

grooves in the metal. Chilled ploughs are not affected by rust. The needle crystals of the metal merely corrode on the ends which form the surface and the surface can be repolished after long exposure to the weather by turning a few furrows with the plough.

Steel ploughs are unsuitable for soils containing sand or stones and are subject to rapid wear in such soils. Steel shares, nevertheless, may prove an advantage in ground containing large stones which are likely to break a chilled share. A steel plough after use in sandy soil will fail to scour when put to work in sticky soils. The sand scratches the steel and leaves a feather edge which ruins the dirt polish and the plastic silt fills the scratches and causes the soil to adhere to the mouldboard.

A plough bottom must scour if good work is to be done with it. The most common cause of a plough failing to scour is the lack of this earth polish. An extra hard finish is necessary to make a plough scour well and the material from which the mouldboard is made and the way it is made have very much to do in the matter of scouring. Improper adjustment of the plough, incorrect shape of mouldboard, or a dull or incorrectly set share, are other causes. The trouble may be due again to the plough not running in the true line of draught or the soil may be too loose and not exerting sufficient pressure on the mouldboard to prevent the soil from sticking. For loose, sticky soils the curvature of the mouldboard should be very slight to disturb the furrow slice as little as possible in the act of turning. Ploughing a little deeper will put more pressure on the mouldboard and often overcomes the difficulty of sticking soil. Scouring troubles may be due to soft spots in the mouldboard. If the surface of the mouldboard has a cloudy appearing spot which is darker than the surrounding surface, this spot is softer than the rest of the surface. The only remedy is a new mouldboard. The chilled surface may be worn through in spots till the soft unchilled iron is exposed or in the case of soft centre steel the hard outside layer may be worn through and the soft centre exposed. In cheap low grade ploughs, the mouldboard will often consist of soft low grade steel and the surface will never scour except under very favourable conditions. High grade ploughs do much superior work, are lighter in draught and are very much cheaper in the long run.

There are some soils so sticky by nature that the ordinary mouldboard plough bottom will not scour in them at all, no matter how good the surface of the mouldboard and how gentle its curvature. A slat type of mouldboard is the only type that will prove

effective under these conditions. By substituting slats for the regular mouldboard, the friction of the furrow slice is concentrated on a smaller area making it scour better and with less draught. The slats at the same time present sufficient surface to constrain the motion of the furrow slice.

Loams free from coarse sand, sticky clay soils and tough waxy soils can be worked most successfully with steel ploughs because these soils have in them the properties necessary to make the dirt polish on the mouldboard without scratching it. Whenever such conditions prevail, steel ploughs are to be preferred. Though generally more expensive than the chilled plough, the steel plough has the advantage of being lighter in weight and the steel shares may be repaired cheaply by the local blacksmith with a little experience of such work. In certain soil conditions a combination of chilled iron share and soft centre or solid steel mouldboard is used with good results.

From the foregoing it is obvious that the ryot can use both types of plough to good advantage and where it is possible to interchange the steel wearing parts with chilled parts, the advantage is double because of the saving in expense.

Knowing how to drive the team properly, making the hitch correctly and knowing that the plough bottom is in correct condition, are points that determine good ploughmanship. The share is the most vital part in making the plough work successfully provided the plough bottom is suited to the particular soil conditions. Draft, penetration, steady running and good work all depend on the share. If all adjustments have been made on the clevis and the plough still fails to work successfully some part of the plough bottom is out of shape and in all probability it will be the share. If the share has the correct shape for penetration and land suction, there should be no difficulty in making the plough work correctly. The plough bottom should run level and cut all furrows the same depth and the same width. If the plough develops a tendency to ride out of the ground, the share has become worn round on the underside, giving it a sled runner effect. Sharpening the point on the top side or replacing it with a new one are the only remedies. If the plough has a tendency to move forward with a jumping motion and the furrow bottom is uneven and full of gouged places, the plough is running on its point. Provided the hitch is not too high so that the whole plough bottom is tilted, the share point is bent down too much. This should not occur with a new factory-made share but may happen if a steel

share has been handed to an inexperienced blacksmith for sharpening and setting. Many of the iron ploughs working in this country will be found to be running on their points and a good deal out of proper adjustment so that they are not giving their best results. Those who are adopting the iron plough should bear carefully in mind the difference between this implement and the country plough in the setting of the point. The country plough is tilted at an angle with the furrow sole so that the point will engage sufficiently to keep the plough in the ground. The iron plough bottom must run perfectly level to give the best results. Its point is already set down at the required angle to cause sufficient penetration, and tilting of the whole plough bottom will cause the point to gouge into the furrow sole and seriously impair the efficiency of the mouldboard in pulverising the furrow slice. Not only must the plough bottom be level in a fore and aft direction, but also in a lateral direction. An even more objectionable practice than running the plough on its share point is the practice of leaning the plough over towards the land side so as to incline the point away from the land and prevent the plough from taking too wide a furrow. In holding the plough handle vertically upright, as it should be held, so that the plough bottom is perfectly level when viewed from behind, the ryot finds that the plough runs much too far into land. This is due to the wide yoking of the bullocks. The plough tends, of course, to take up a position immediately behind the mid point on the yoke where the plough rope or pole is attached. One bullock must walk in the furrow. As the land side bullock is yoked closer to the furrow bullock, the mid point of the yoke comes closer to the furrow and more directly over the line of the furrow which the plough is required to cut. It is of very much importance, therefore, that the bullocks should be yoked sufficiently close together to bring the point on the yoke where the plough rope is attached, directly ahead of the plough. There will then be no necessity to cant the plough to prevent its taking too much land. The canting of the plough raises the mouldboard so that most of the furrow slice passes underneath it. The mouldboard is thus rendered largely ineffective and the work is necessarily of very poor quality. If a walking plough is in perfect adjustment, only the slightest effort should be required on the handles to keep the plough in running position. Walking ploughs require more wing on the share than wheeled ploughs. This additional wing surface is necessary as a bearing to keep the plough running level. On wheeled ploughs, the wheels carry the weight and keep the plough on an even keel. If a walking plough has a tendency to lean over landwards, the wing of the share is bent up too much and if to the

opposite side, the wing is too low and the cutting edge should be raised. If these incorrect settings of the share occur on a wheeled plough, the wheels have to bear the brunt and either the land wheel or the furrow wheel has to carry too much weight and the bearings and axles wear out quickly. To do the best ploughing, the share must be kept sharp and well adjusted. The accompanying illustrations show the proper shaping and angle of the point and the correct form of the share wing. The point should have a gradual wedge-shaped slant extending a slight distance landwards from a line parallel with the landside to make it hold the land and slightly downwards below a line parallel to the bottom of the landside to hold it in the ground. The amounts the point is deflected are called respectively the 'land' or 'land suction' and the 'pitch' or 'under point suction.' The amount of pitch depends on the type of plough and the soil conditions. Stiff clay soils are harder to penetrate than loam soils and require more pitch on the share point. The wing of the share should be so shaped as to keep the plough bottom level. When the plough is placed on a level board so that only the point of the share is allowed to project beyond the edge of the board the under-surface of the landside and the edge of the share should be in contact all round with the surface of the board. Shares and bottoms made by different makers have differences in shapes, but the general principle is the same.

The object of the landside on a mouldboard plough is to keep the plough from gouging into the furrow wall or swerving to one side whenever the share strikes some obstruction such as a small root or stone or encounters an irregularity of soil texture along the cutting edge of the share which will tend momentarily to deflect the plough from its straight course. It is obvious that since all the soil is turned to one side, there is a constant tendency for the plough to shear off into the land and the landside is constantly resisting this tendency. The landside pressure against the furrow wall holds the plough in its true line. On the country plough, each side of the plough bottom does an equal amount of work in pushing the soil aside and only variations in soil texture tend to move the plough from its straight course. There should be sufficient area of surface on the landside to render it effective. Ploughs for shallow ploughing require a long and narrow landside to give the required area. On general-purpose ploughs the necessary surface can be acquired by giving more height and not so much length to the landside. Some plough bottoms are made with a sloping landside and cut a sloping furrow wall. When the

furrow slice is turned by the mouldboard into a vertical position, it falls over due to its own weight because it has no square edge which will tend to support it in this position like the furrow slice which has a vertical furrow wall. The result is that it is lodged against the previous furrow slice with a greater impact, is so shaped that it fits more snugly at the outside bottom corner of the furrow so that no air spaces remain and, on account of its chamfered edge, leaves the surface of the ploughing more level. This is an advantage in sandy soils. Another advantage of the sloping land-side is that the shin cuts the furrow wall with greater ease just as a knife cuts a piece of wood better when operated with a slanting cut. This has a tendency to lighten the draught.

The curvature of the upper portion of the share and the mouldboard and the angle of the mouldboard with the furrow line have much to do with the draught of a plough bottom as well as its pulverising qualities. The draught of a plough is determined largely, however, by the scouring qualities of the metal of which it is made. Chilled bottoms being harder than steel bottoms are somewhat lighter in draught. The amount of moisture in the ground, the looseness or compactness of the soil and the amount of stubble, trash and roots, etc. are determining factors in the draught of the plough. Too much moisture in the soil adds draught in the same way as not enough moisture. Generally speaking, the plough bottom that does the best work pulls the hardest because it requires more energy to break a clod into many pieces than into only a few.

The theoretical line of draught between the centre of draught or centre of weight of the plough bottom and the centre of power on the bullock yoke will always straighten. Because this draught line straightens the depth and width adjustments can be made with the clevis on the front of the beam, in the case of short beam ploughs. To plough deeper the clevis is raised and to plough shallower the clevis is lowered. If it is desired to take more land, the clevis is placed to the right on right hand ploughs and if a narrower furrow is required, the clevis is placed to the left. On a left-hand plough, like the 'Monsoon', these two adjustments for width of furrow are opposite. It should be mentioned here that a head or gauge wheel is not intended as a means of adjusting the depth of furrow but only as a means of keeping the plough steady and maintaining a uniform depth of ploughing after the desired depth has been determined by means of the clevis adjustment. The head-wheel should be adjusted so that it bears only lightly on the land after the correct depth

adjustment has been made on the clevis. In almost all cases where a head-wheel is being used by the ryot, it will be found to be so adjusted that it is working in opposition to an incorrect setting of the clevis, preventing the plough going too deep, so that the wheel is under heavy load instead of a gentle pressure against the land. This incorrect adjustment of the head-wheel causes rapid wear of the axle and bearings and a very considerable increase in the draught of the plough. In the case of ploughs with long poles, the depth adjustment is made by altering the angle of the pole with the plough bottom, or, if the pole is a fixture on the plough, by lengthening or shortening the hitch. Reference has been made to the improper adjustment of many of the iron ploughs working in this country. The long draught pole is responsible for much of this. With a long shaft, incorrect adjustments do not show up so plainly and a plough bottom running on its point is a source of discomfort to the bullocks rather than to the ploughman. The gouging action of the point in the furrow sole jerks the shaft and the shock is transmitted to the bullocks' necks. The draught of the plough is also considerably increased. With a short beam, the pitching of the plough would offer a plainer warning that something was out of order and the discomfort of handling the plough in this condition would probably induce the ploughman to investigate the cause. The short beam, also enables the landside to function to its full extent and keep the plough bottom running straight despite the small sideways deflections of the line of draught due to the deviations of the bullocks from their straight course. With a long shaft, the plough bottom must follow every lateral or vertical movement of the bullock yoke and the quality of its work is considerably impaired. The plough should be in perfect balance at the end of its rope much in the same way as a kite remains in equilibrium at the end of its string. The rigid pole defeats the purpose of most of the essential features of plough design which contribute to that perfect balance so essential to the production of good work, minimum draught and ease of handling.

Chilled shares on account of the nature of the iron cannot be sharpened by heating and hammering out like steel shares. The only way they can be sharpened is by grinding on the upper side on an emery wheel or grindstone until a bevel edge appears. Soft centre steel shares require considerable care in sharpening. Care should be taken that only the portion of the share which is to be pounded out is heated and only as much as can be hammered should be heated at a time. The body of the share should remain

cool to prevent warping and disturbing of the fitted edges. The hammering should be done from the upper side with the bottom of the share flat on the anvil. This keeps the cutting edge down and works the hard steel of the upper layer over the soft steel layer in the centre thus preserving for the share a hard cutting edge. Care should also be taken not to dent the share on the upper surface when hammering. Solid steel shares may be sharpened by drawing out in the same way and though there is no upper layer to be carefully worked as in the soft centre share, it is better to do the hammering on the upper edge as there is less danger in this way of mis-shaping the share edge. A piece of steel may be welded on the point or on the wing if there is not sufficient metal in the share to be drawn out. Only the part of the share which requires drawing out should be heated and only just sufficient heat should be applied to put the metal in condition for working. Working the share at a high heat destroys the quality of the steel.

Soft centre steel shares should be rehardened after setting to the correct shape. The entire share should be heated uniformly to a cherry red and then dipped into a tub of clean cold water with the cutting edge down. Shares of solid high carbon steel should not be hardened all over as there is a danger of their breaking in work. Only the point and cutting edges should be treated. Mild steel and similar low grade material, of which many of the steel ploughs made in this country are built, is, of course, not capable of being hardened. Soft centre steel may be left very hard as the hard brittle outside layers are protected by the tough central layer of low carbon steel.

The disc plough has altogether a different effect upon the ground than the mouldboard plough. The mouldboard plough turns the soil with a crunching, pinching, pulverising motion, while the disc turns the soil with a rolling motion. The rolling motion of the disc plough leaves the soil in a looser condition than the mouldboard plough, hence the soil is better able to absorb moisture after disc ploughing. The mouldboard, however, does a better quality of pulverising and turns a better furrow in light sandy soils, weedy stubble fields and grass lands where the mouldboard plough has no difficulty in scouring. Often the ground becomes too dry and hard to be successfully turned with a mouldboard plough. The disc will do good work in ground in this condition. The edge of the disc cutting the soil is constantly changing in position as the disc rotates and for this reason the edge will retain its sharpness a great deal longer than the edge of a share. This fact has a lot to do with the superiority of the disc

plough in hard ground. The disc works with great success in black waxy soils where the mouldboard plough has great difficulty in scouring. Scrapers can be fitted to the discs and scouring difficulties are overcome. The disc plough also operates to advantage in very loose ground and in stony and rooty land. An advantage of the disc plough is that when it is desired to do deep ploughing better results can be secured by having each disc cut a narrow slice. Whether one cuts a wide or a narrow slice with the disc it always does an equal quality of work, whereas cutting too wide a furrow with a mouldboard plough leaves an unploughed strip and in cutting too narrow a furrow the soil is not properly pulverised. The principle of draught of a disc plough is entirely different from that of a mouldboard plough. The shape of the share and mouldboard of a mouldboard plough causes the bottom to be pulled into the ground. The disc plough must be forced into the ground by weight and draught combined. The disc plough despite its rolling motion does not pull any lighter than a mouldboard plough in turning over the same volume of ground.