Neutron Probe Operation Manual

ICT International Pty Ltd
PO Box 503
Armidale NSW 2350
AUSTRALIA
Phone: [61] 2-6772-6770
Fax: [61] 2-6772-7616
Email: sales@ictinternational.com.au
Web: www.ictinternational.com.au

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Section 1

THE NEUTRON PROBE

The Neutron Probe, because of its technical nature was originally regarded as useful only in research. Since then there has been considerable research effort devoted to simplifying the operation of the Neutron Probe in the field. The rapid development of electronics has increased the portability and reliability which, when combined with a simplified field operation, has meant that the Neutron Probe can be used by people with limited technical training. Field personnel such as insect checkers, agronomists and consultants can now use these instruments on a regular basis to monitor the soil moisture level and make irrigation decisions.

The technique used for scheduling irrigation requires only the identification of the full and refill point for each field, and the measured changes in soil water contents over time.

For an explanation of how to operate the probe in the field, see Section 2 'Field Operation of the Neutron Probe', p. 12.

1.1 How it Works

The soil moisture is measured by lowering a source of fast neutrons and a detector tube down a hole in the soil. Holes are drilled at selected locations on the land and cased with aluminium tubing (access tubes) to prevent cave-in, as these locations are to remain permanent for the life of the crop.

The Neutron Probe measures soil moisture with a neutron moderation technique. Fast neutrons (part of an atom) are emitted from a decaying source of Americium 241 beryllium (like bullets from a machine gun). They fly through the aluminium tube (like light going through glass) and into the soil where they bounce around and gradually slow down in the process.

The detector tube of helium is responsive to weak slow neutrons, but is not responsive to high energy fast neutrons. When the neutrons have bounced around sufficiently to slow down, they can be detected by the helium tube.

Neutrons ricochet strongly from large objects (like a golf ball hitting a bowling ball) and it requires several hundred collisions with such atoms to slow down a neutron to the point where it can be detected by the tube. Neutrons are dramatically slowed down, however, if they collide with hydrogen atoms (like one golf ball hitting another golf ball), the hydrogen atoms are the same mass as the neutron and the loss of energy in such collisions is great. It requires only 20 collisions to slow down a fast neutron when the collisions are with hydrogen.

In most soils, the only source of hydrogen would be water, hence the only slowing down of fast neutrons would be due to water. The fast neutrons would bounce away from the detector with no water present. Whereas, with water present the neutrons slow down sooner with fewer collisions and the probability of a detector collision is increased over the dry conditions.

1.2 How it is Used

Three aluminium access tubes are installed at a selected location in a field. These aluminium tubes will remain in the soil until the end of the season in annual crops or permanently in perennial or tree crops. On a 2 to 7 day schedule the probe is lowered into a tube, the moisture readings are taken and recorded at depth levels down to 1.2 m, and the Neutron Probe is then moved to the next tube. The readings at the various depths give a complete profile of moisture conditions throughout the entire root zone.

Both the amount of water readily available to a crop and the daily water use by that crop are required to schedule an irrigation correctly. Dividing the water available by the daily water use gives the number of days until an irrigation will be required.

The Neutron Probe is used to gather the required information. Correct irrigation scheduling requires identification of the full point (the wettest you want the soil to ever be), the refill point (the point at which irrigation should occur), and periodic moisture measurements by the Neutron Probe. Periodic soil moisture measurement with the Neutron Probe will give both the current soil moisture content and the rate of water use by the particular crop. A graph showing soil water content plotted versus time, with the refill point indicated, will give a visual means of forecasting accurately the date of the next irrigation. Variations caused by interim weather changes can be accounted for by making an estimate of the daily water use, and using this to also predict the next irrigation date.

1.3 Equipment Needed

503DR Hydroprobe
Aluminium Access Tubes, sealed at the bottom, 50 mm (2 inches) OD, 1.5 m (6 feet) long.
Auger Set for drilling holes for access tubes - 1 m spiral, 1 m shell, 0.6 m extension and a T handle.
Auger Motor to attach to auger set
Tube Driver
Tube Extractor

1.4 Selecting a Site in the Field

Choosing the right site is critical to getting the best information for decision making. Observing a few common sense rules will help ensure selection of a good site.

Three tubes are used at each site. This gives a good chance of getting a good reading. Dr Peter Cull in his PhD work found that using less than three tubes dramatically reduced the chance of getting a representative reading, but that increasing the number of tubes past three did not greatly increase the probability of getting representative readings. The tubes should be placed within the same shift so that they are watered at the same time. A distance of ten to twenty metres between the tubes is standard practice.

It is important to realise that precise measurements of one point in the field are being taken and used to make decisions about the whole field. Therefore the site needs to be representative of what is going on in the field and tubes placed so that they give an accurate a picture as possible. This should include considerations of soil type, crop growth, the irrigation system, waterlogged areas, under-watered areas and anything else which might cause variation in the field.

The tubes should be located where it is easy for the operator to access them. This is so that disturbance of the crop around the tube is minimal and the job can be done quickly and easily. The best location is usually in a part of the field watered first if the field is watered over a number of days.

Placement of the tubes in relation to the crop and the irrigation system is critical. It is important to put the tubes somewhere where the extraction of water by the crop and the application of water by irrigations and rainfall can be reliably measured and reflect the changes in soil water content in the whole field as accurately as possible.

The tube needs to be where the root system is active. In row crops this means putting tubes in or close to the plant line where there is a good average stand. In tree crops placement must be where the root system of the tree is active, for example it might be half way between the trunk and the canopy edge of the tree. The site must also measure applied irrigations and tubes must be located where the wetting up from the sprinkler, drip or furrow irrigation system is representative of what happens in the whole field. In some situations it may be necessary to put in a grid of tubes across plant rows, within plant rows and across and within irrigation systems to find the best location.

If there is a range of soil types or situations it may be necessary to have more than one site in a field. An understanding of how soil moisture levels change as a crop uses water and as irrigations are applied is the basis for good irrigation management. An evaluation of a number of sites in a field may be needed to allow the selection of the best site possible. Some farmers have put in more sites than they need, then abandoned some of the sites when no longer required.

1.5 Some Examples of Tube Placement

1.5.1 Row Crops

Tubes are usually placed in the plant line with an average stand alongside the tube and in the adjoining rows. This usually works well although there can be exceptions, one particular exception can occur when there is surface sealing on raised beds. Water runs off the sealed surface and into the furrows. If the furrows are dyked then the water is caught in the furrows, if not then significant runoff can occur. With dyking the furrow can get very wet but the hill can remain dry. To get an accurate measure of soil moisture in these sealing soils both furrow and hill may need to be measured.

1.5.2 Permanent Plantings on Sprinkler Systems

Tubes need to be placed within the throw of the sprinkler. The preferred pattern is to put one tube next to the sprinkler, one at the edge of the throw of the sprinkler and one half way between. Some growers put all three half way between the sprinkler and the edge of the throw and get good results. The more uniform the sprinkler distribution the less critical placement of tubes is.

While doing this, it is essential to keep in mind the placement of the tubes in relation to the tree. It is not enough to measure the irrigations, crop water use must also be measured. A good rule of thumb is to put one tube close to the tree trunk, one at the edge of the canopy and one half way between these two. Alternatively all tubes could be in a similar place relative to the tree but in different positions relative to the sprinkler system.

1.5.3 Drip Systems

The most commonly used method is to place the tubes half way between the dripper and the outer limit of the wetted area. Tubes are usually placed on the same level on the slope or on the uphill side of the dripper. An alternative is to put one tube under the dripper and another at the very edge of the wetted area so that the two extremes are measured.

This is one system when putting in a grid system makes good sense. To manage drip systems well, a good understanding of soil water content under and around the drippers is needed. A well thought out pattern of tubes should give an accurate 3 dimensional picture of soil water content.

The problem with drip systems is that there is a gradient of soil water contents starting from very wet under the drip to very dry at the edge of the drip. To measure through drainage, measurements need to be taken directly under the dripper. However to measure under irrigation or a drying subsoil tubes need to be at the edge of or outside the wetting pattern. Investigation via a grid of tubes should allow the user to select the appropriate site or sites to indicate a satisfactory water content to maintain at these sites. The grid should run from the dripper out into the inter-row area and also from the dripper along the plant line to cover the full range of the dripper and plant root zone.

1.6 Tube Installation

The Auger Set is used to drill a hole for the Access Tubes. There are some different combinations for drilling holes and the following method is one commonly used in clay soils. First the spiral is attached to the motor and this is used to drill a hole down to one metre. The motor should be raised and lowered as it is augering so that the spiral is self cleaning and does not jam.

Once this is done the shell auger is used to finish digging the hole. The handle, extension and shell are put together and then used to auger out the hole. When the shell is full of soil it is pulled out of the hole and cleaned out and this is repeated until the hole is the required depth. This method works well in clay soils but may need some modification in other soil types. In some light soils only the shell is needed while in other soils a little water is needed in the hole to make the soil stick to the auger.

One of the most crucial things is not to disturb the plants and soil around the tube. If the plants or the soil are disturbed too much and it affects plant growth or soil structure it will affect the readings.

Once the hole is finished the closed end of the tube is placed in the hole, the tube driver is placed in the end of the tube and a hammer used to tap the tube in. If tubes are very difficult to get in it may be necessary to make the holes a little bigger by running the auger down the hole to make it bigger, or the diameter of the auger may have to be made a little bigger by adding a little hard face to the auger. The hole should not be too big, a reasonably tight fit will give the best results.

Normally the tubes are left with 10 cm (4 inches) sticking out of the ground although this is flexible. When 10 cm of tube is left above the surface, and the distance from the end of the cable which is attached to the detector assembly to the first stop is 40 cm, the first reading will have its centre of measurement at 20 cm below the surface. If some other height is used then the cable stops must be adjusted accordingly so that detector is at the correct depth in the tube. A rubber stopper or cap of some type should be placed over the tube to stop it filling up with rain or irrigation water.

1.7 The Readings

The tubes are generally 1.5 metres long allowing readings to be taken to a depth of 1.2 metres. Tubes can be longer than this if measurements to greater depths are required. Depths at which readings are taken in the 1.5 metre tube are 20, 30, 40, 50, 60, 80, 100, and 120 cm. The 20 to 60 cm readings cover the main root zone of most irrigated crops, The depths below this are less critical in terms of soil water used by irrigated crops but are more important when looking at through drainage of water and subsoil water content.

The Hydroprobe is operated in the raw count mode and the number displayed on the Hydroprobe screen is the raw count, typically a number between 5000 and 20,000 depending on the soil type, the soil water content and the probe itself. To change the Hydroprobe into raw count mode first check that the head is in the **READY** mode, then press **UNITS** on the number pad on the probe display, then press **STEP** until **MUNT CNT** is on the screen and press **ENTER**.

The raw counts are converted to Volumetric Soil Water % (VSW %) by calibration equations supplied by ICT International. The VSW % number simply means the percentage of a volume of soil which is water at a particular depth. In some cases units other than VSW % are used, for example 50 % VSW equals 6 inches per foot. These numbers are then used to calculate the amount of water in each layer of soil in millimetres or inches. Typically the layers used are 0–70 cm, the main root zone; and 0–130 cm, the total profile measured. Other layers can be used to suit the particular needs of the user.

It is standard practice when using three access tubes to take readings over 16 seconds. The source of neutrons does not emit a constant number of neutrons at any given point of time. Therefore a period of time is used to get a good average. In general 16 second counts averaged over three tubes gives good results.

In cases where less than three tubes are being used, e.g. in a grid around a dripper, it is recommended that the measurement time is changed to 32 seconds. This is done by first pressing **TIME** on the probe head when it is in **READY** mode. Then press **STEP** until the required time appears, then press **ENTER** and the time should be changed.

Readings should be taken on a regular basis. At Narrabri in cotton crops using 8–10 mm of soil water per day and with 60–90 mm of available soil water, readings are taken at least twice per week in every field and some fields will be measured more often. In cooler regions or during winter, where crops are using much less water but have similar deficits, readings may be less frequent, perhaps once a week. The limitations of the irrigation system, the length of the irrigation interval, and other agronomic considerations will determine how critical the intervals between readings will be. When rainfall interrupts the irrigation cycle it can be critical to measure soil water to evaluate the effectiveness of the rainfall and determine changes if any to the irrigation cycle.

1.8 Using the Data

Data is stored in the Hydroprobe as raw counts. The raw counts are uploaded into the computer and posted to the readings spreadsheet for each site. Readings are displayed on the spreadsheet in Volumetric Soil Water % (VSW %) and the mm of water in the chosen layers is calculated from the VSW % numbers. The VSW % numbers show us changes in water content at each depth while total mm in each layer show us changes in the total water content of the profile.

A typical depth graph of VSW % versus Depth is shown in Figure 1. One of these lines by itself has little meaning. If however we add other readings we can begin to find out what changes are happening to soil water content in the soil profile. For example in figure 1 two readings have been drawn. This shows that from the 20/12/92 to the 27/12/92 the water content at 20, 30, 40, 50 and 60 cm decreased showing us that the crop was using water at 20, 30, 40, 50 and 60 cm in decreasing amounts.

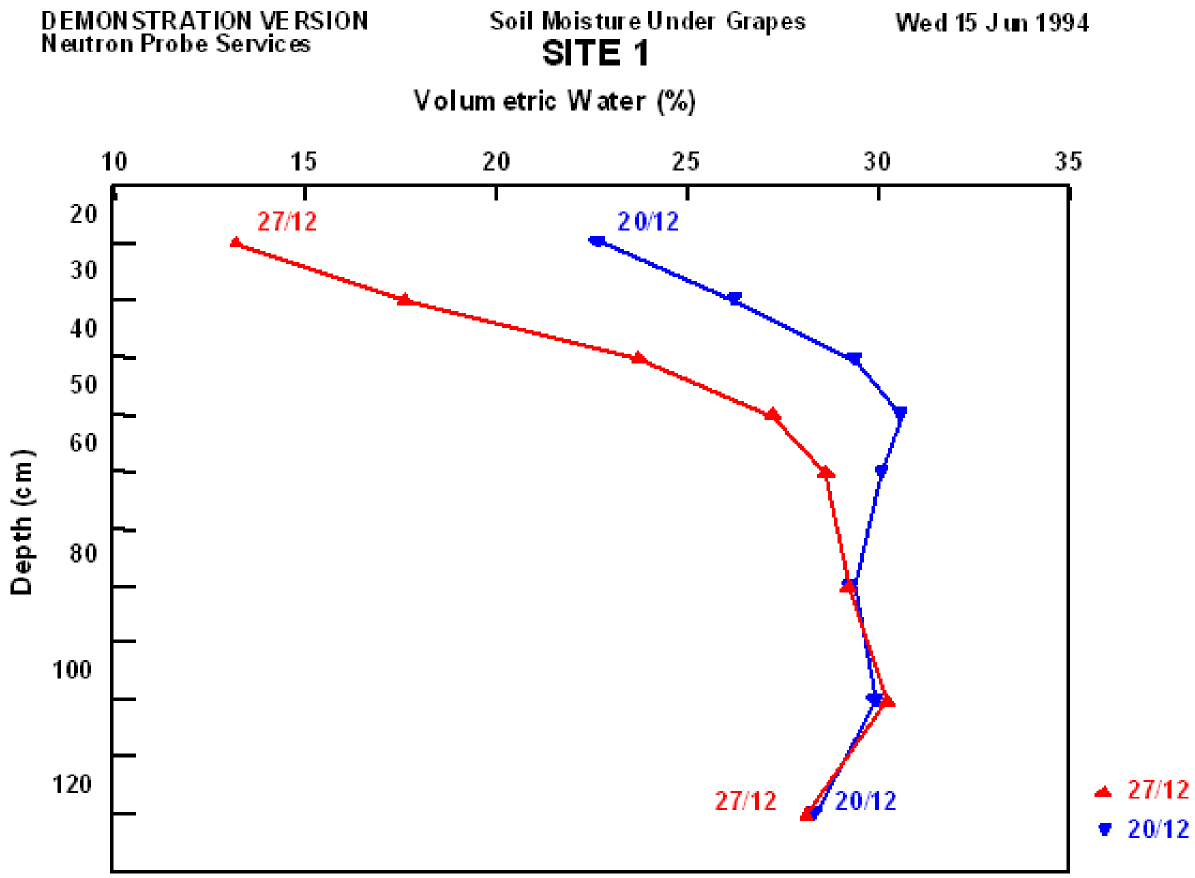

Figure 1: VSW% versus Depth

From the VSW % numbers we can work out mm of water in the profile on each day, and by dividing the mm difference by the number of days we can calculate the daily water use in mm per day.

It is important to note a general rule of thumb for sites with three tubes using 16 second counts that changes need to be 0.5 % VSW or greater to be a significant change. If the change is 0.5 % or greater then you can be fairly sure that it is due to changes in soil water content and not the variability of the probe. The change need not be over consecutive probe readings but could take place over a number of days or weeks.

Knowing what changes are occurring in the profile is important, but it is essential for growers to gain a good understanding of what is the optimum range of soil water content for their crops, their soils and how best they can maintain this water content if they are to make best use of the probe for crop management and irrigation scheduling.

The first, and often most important task, is to define the full and refill point for each site. Each site will have its own full and refill point which may differ despite being the same soil type and crop. Previous crop history and particularly previous trafficking of the field with machinery and the soil water content at that time can all affect the full and more commonly the refill point at each site.

1.9 The Full Point

The full point is the soil water content when the soil is as wet as you ever want the soil to be. It is usually equal to field capacity but may be some other water content in some situations. The full point is usually found by taking a probe reading after a big irrigation or rainfall event has filled the profile. The reading should be taken after enough time has elapsed for drainage and runoff of excess water to take place, usually 24 hours.

In the majority of situations this procedure is very simple. However there can be some problems. With flood irrigation a problem can occur in surface sealing soils or soils where there is poor lateral movement of water from furrows into hills or beds. Irrigations and rainfall may simply end up as runoff. The solution is usually to take the reading from an irrigation after a cultivation which breaks up the surface seal.

Rainfall often wets up the profile more effectively in these situations so readings after big rainfall events may be a better indicator of full point. Surface sealing or poor infiltration rates can also be a problem under sprinkler systems. This can make it very difficult to purposely wet the soil profile up to full point with a sprinkler system because of the excessive runoff that can occur.

Prolonged rainfall can wet the profile up to the full point very well but it can also saturate the soil to a point well over the full point. This is particularly noticeable where there is a light textured, freely draining upper layer of soil over a impermeable or relatively impermeable clay layer. In these soils it is possible that the light textured soil is wetter than the full point but the impermeable layer is preventing drainage of the excess water.

In flood irrigation one has little or no control over the amount of water that enters the soil profile. If the soil is freely draining then the full point can be found after drainage of excess water has ceased. In soil that is not freely draining then the water content after the irrigation may be wetter than is desirable for optimum growth and the soil will be waterlogged. In this case the full point is often defined as the soil water content 24 hours after irrigation even though it is waterlogged.

1.10 The Refill Point

The refill point is the driest we want the soil to be and the point at which an irrigation should be applied. This is a very simple definition of refill point and unfortunately finding the refill point is not always that simple. The reader should read the application notes **ICT101 (www.ictinternational.com.au/appnotes/ICT101.htm)** and **ICT102 (www.ictinternational.com.au/appnotes/ICT102.htm)** for a more detailed description of some of the plant physiology involved in defining the refill point. There are numerous crops in a wide range of soil types and environments all of which can influence the refill point.

1.10.1 Flood Irrigated Cotton in Narrabri, NSW, Australia

The full point is simply found by taking a reading 24 hours after the irrigation. This reading is very repeatable and at every irrigation the soil water content will be at or very close to the original full point. The heavy grey clays commonly used for irrigated cotton in this area have very poor internal drainage and at the full point the profile is waterlogged.

For most cotton crops the refill point is just above the point where the crop's water use requirements are greater than the crop's ability to extract water from the soil. Below refill point plants will visibly wilt, daily water use will decline and often water extraction will take place at depths below the usual root zone as the plants seek out moisture. Some visual symptoms like darkening of young leaves and slowing of growth during the vegetative phase can be used to help identify the refill point. The crop also senses that soil water content is low and begins to shed young fruit so that it can commit more resources to finishing off older fruit.

In an effort to conserve water and remain hydrated plants will close their stomates. This stomatal closure will interfere with the plant's ability to "breathe" in carbon dioxide, an essential input in photosynthesis. At this stage photosynthesis will be reduced and dry matter production will decline. The yield of cotton is largely dependent on the accumulation of carbohydrates in the fibre and a reduction in the amount of carbohydrates available will lead to a reduction in yield.

Due to the waterlogging problems associated with these soils it is essential to extend the irrigation intervals as long as possible. Growers try to water crops at or very close to the refill point, often on the actual day the refill point is reached. A scarcity of irrigation water also makes it essential to minimise losses which occur at each irrigation and to take maximum advantage of rainfall by having the smallest number of irrigations possible without stressing plants.

1.10.2 Wheat in Western NSW, Australia

With many crops where yield is related to maximising photosynthesis to get the maximum accumulation of carbohydrate in the plant, the refill point defined in the above example is a good one. However, due to limitations of soil type and the irrigation system the refill point may not be used as the point at which the grower applies an irrigation.

Lateral move irrigators are used to apply irrigation water on a range of summer and winter crops, one of the largest being wheat. The soils have a tendency to form a surface seal particularly with overhead irrigation which means that only 25 to 30 mm of water can be applied in each pass or a large amount of runoff occurs.

The soil has about 70 to 80 mm of readily available water. However the crop is not allowed to dry the profile down to the refill point nor is it always wet up to the full point. Generally the soil water content is kept in a range from a 20 mm deficit (20 mm drier than full point) to a 50 mm deficit (50 mm drier than full point). This effectively means there is a 30 mm working deficit equal to about what each irrigation puts on the field. There are some very practical reasons for doing this. If the crop is kept too wet certain areas can become waterlogged, particularly low spots in the field. Also when the field is too wet the irrigator can have problems getting through the mud and can get bogged.

At the other end of the scale by not drying the profile back to the refill point the grower leaves a 20 to 30 mm buffer to allow for breakdowns in the system. The final consideration is that in the later stages of the season crop water requirements increase dramatically often placing pressure on the system's ability to supply enough water. To try and ensure the largest moisture reserves possible the grower tries to fill the profile right up to the full point just before this period of high demand.

1.10.3 Wine Grapes at Robinvale

The soils in the area are freely draining and the irrigation water is saline. Problems with rising water tables and salinity associated with over irrigation are very serious throughout the region. Growers need to over irrigate to flush salts out of the root zone but this contributes to a rising water table. It is thought that a 10 % leaching fraction is needed to stop salt accumulating in the root zone and affecting plant health. At this level of over irrigation it is thought that the water table will remain stable as additions to the table will be matched by drainage of the water table towards the river systems.

The full point is easily set by applying a large irrigation and then taking regular probe readings to determine when drainage ceases. This may involve taking two or three readings a day until the dynamics of the site are understood. It should be noted that in some soils measuring the full point is not always easy. In soils which drain very quickly a reading 24 hours after the irrigation may be too late, while in very slowly draining soils the changes may be very small and be masked by crop water use. Nevertheless it is very important to find out if through drainage occurs in your soils and to try and identify ways to minimise the losses. In this case drainage of excess water out of the profile is fairly rapid.

These crops have no visible signs of stress at their refill point. The visible appearance of stress means that the plant is under severe stress and potential yield loss will be high. Growers generally follow their own experience, the experience of other growers and the local agricultural department as to the amount of readily available water for each soil type, usually 50 to 70 mm. The grower simply subtracts this amount from the full point to get the refill point. Growers with overhead irrigation systems can easily apply this amount in a normal irrigation cycle.

At each irrigation the grower aims to apply an amount of water that will take the soil water content just over the full point to just get the desired leaching fraction and no more. By going just over the full point they hope to stop salts building up in the profile and avoid large over irrigations which will add significant amounts to the water table causing it to rise. If the quality of the water was good and salt in the profile not a problem then the irrigator should be trying to avoid going over the full point. This would be a waste of pumping costs, through drainage would leach nutrients from the root zone and the potential for a rising water table is increased.

1.10.4 Celery - Selling Cell Expansion

The return a grower receives for producing celery is largely determined by the length of the celery stalk. The longer the stalk the better the return and the length of the stalk is determined by the rate of cell expansion of cells in the stalk as it is growing. As cell expansion is maximised at the full point (see **ICT102 - www.ictinternational.com.au/appnotes/ICT102.htm**) the grower should aim to keep the crop at full point at all times. Variations in soil water content can also affect nutrient uptake and if the nutrient balance is upset, especially for calcium, nutritional disorders can render the crop unsaleable.

Freely draining soils are preferred to allow drainage of any excess water as the soil is kept wet all the time. In this example a T tape drip system is used to enable the application of small and precise amounts of water at short time intervals.

The crop is watered twice daily at times which coincide with high rates of crop water use and the aim is to replace just the amount of water used by the crop. Regular probe readings are used to make sure that the right soil water content is being maintained. In this example there is no refill point, the aim is to keep the soil water content constant at the full point.

Section 2

FIELD OPERATION OF THE NEUTRON PROBE

This section describes the mechanics of operating the probe in the field. Mostly the descriptions are step by step instructions of which buttons to push on the probe top when taking readings. For an explanation of interpretation of probe readings see the previous section, 'The Neutron Probe'.

The Neutron Probe must be **formatted** to clear its memory of data, so make sure to upload and post existing data **before** formatting.

2.1 Date and Time

The Neutron Probe does not have a real-time-clock, but date and time can be recorded using keydata items 1 and 2. This is done by recording an **ID=0**, and the date as keydata item 1 (**K1**) and time as keydata item 2 (**K2**). When recording the date and time in this way the probe must be formatted with at least 2 keydata items.

An extension of this system is available that allows dates and times to be entered as **K1** and **K2** at any site, not just with an **ID=0**. A utility programme (**ALTER2**) is available from ICT International that will process the post file, converting dates and times recorded as keydata items **K1** and **K2** into a form that **PostReadings** can read and automatically post at the corresponding date and time.

2.2 Format Neutron Probe

This procedure must be done before taking a new set of readings in the field.

Press key...	Read...
FMT	REC XXX
ENTER	K DATA X

Enter the number of keydata items. If you do not wish to enter any, enter **0**. If you wish to enter the date in the field, enter **1**. If you wish to enter the date and time in the field, enter **2**.

0	K DATA 0

or

1	K DATA 1

or

2	K DATA 2

ENTER	DPTHS 8

Enter the number of depths at which readings are taken, usually 8.

8	DPTHS 8
ENTER	SET FMT?

Press **ENTER** to confirm the format setting.

ENTER	REC XXX

Press **ENTER -** there will be space for **XXX** sets of readings (tubes).

ENTER	READY

The Neutron Probe is now ready to take readings in the field.

2.3 Entering Date Only

To enter the date

Press key...	**Read...**
LOG	ID 592

Enter **ID=0** for a date/time marker.

0	**ID 0**
ENTER	**K1 0**

Enter date as **ddmm** (or **mmdd**) e.g. **1306** (or **0613**) for 13 June.

1306	K1 1306
ENTER	TAKE 8

Press **STEP** (usually 8 times) to skip until probe reads **DATA OK ?**

STEP	DATA OK ?

Press **ENTER** to store readings.

ENTER	READY

The date is now entered into the Neutron Probe. This procedure can be repeated at any time, but should be done at the start of each day if readings are taken over several days without the data being uploaded and the Neutron Probe re-formatted.

2.4 Entering Date and Time

To enter the date and time.

Press key...	**Read...**
LOG	ID 592

Enter **ID=0** for a date/time marker.

0	ID 0
ENTER	K2 0

Enter time as **hhmm -** e.g. 1430 for 2:30 p.m.

1430	K2 1430
ENTER	K1 0

Enter date as **ddmm** (or **mmdd**) e.g. **1306** (or **0613**) for 13 June.

1306	K1 1306
ENTER	TAKE 8

Press **STEP** (usually 8 times) to skip until probe reads **DATA OK ?**

STEP	DATA OK ?

Press **ENTER** to store readings.

ENTER	READY

The date and time are now entered into the Neutron Probe. This procedure can be repeated at any time, but should be done at the start of each day if readings are taken over several days without the data being uploaded and the Neutron Probe re-formatted.

2.5 Taking Readings with the Neutron Probe

To begin taking readings place the Neutron Probe on the access tube, then lower the detector assembly down the access tube. Usually the 120 cm reading is taken first then the 100 cm, 80 cm etc.

The farm and site number must first be entered as an ID number, and then the probe is instructed to take a reading and store the count.

2.5.1 Procedure

Press key...	Read...
LOG	ID 592

Enter farm and site number in the format that will be used when posting. E.g. for farm 2 site 16 enter **216** if **FFSS** used, **2016** if **FSSS**. The ID for each tube at a particular site must be identical. The software finds successive tubes with the same ID and averages counts for these tubes regardless of how many tubes there are.

216	ID 216
ENTER	K2 0

Enter keydata item and **ENTER**, or press **STEP** to skip. To enter date or time see '2.4 Entering Date and Time' above.

STEP	K1 0
ENTER	TAKE 8

Press **ENTER** to store the count (or **START** to read again).
Move the detector assembly to the next cable stop or depth.

ENTER	TAKE 7

Repeat the last two steps until **DATA OK?** is displayed.

ENTER	DATA OK?

If data is OK press **ENTER** and move onto the next tube.

ENTER	READY

If the data is **not** OK, press **STEP** to cycle through the keydata and counts and re-enter the keydata or take a new count. Pressing **CLEAR** when **DATA OK?** is displayed will abandon the record.

When all the tubes at a site have been read, move onto the next site. All the tubes for one site must be done as successive tubes on the probe.

Pressing **RCL** will allow some previous data records to be recalled. Unfortunately the design of the logger means that if a particular ID number is used more than once you can only recall the last tube.

2.6 Count Mode

To use the PROBE programme the Hydroprobe must be in the count mode. To change the Hydroprobe into count mode first check that the head is in the **READY** mode.

2.6.1 Procedure

Press key...	Read...
UNITS	MUNT COUNT

The probe is in count mode and doesn't need changing.

CLEAR	READY

OR

Press key...	Read...
UNITS	???
STEP	MUNT CNT
CLEAR	READY

ICT International Pty Ltd
PO Box 503, Armidale NSW 2350, Australia
Ph: [61] 2-6772-6770 Fax: [61] 2-6772-7616
Email: sales@ictinternational.com.au
Web: www.ictinternational.com.au