New Frontiers in Unirrigated Farming

Unirrigated areas fall into different groups. Firstly, there are areas in regions where irrigation facilities can be created such as the Indo-gangetic plains, but which have no assured source of water supply and agriculture is entirely dependent on rainfall. Secondly, there are areas with abundant and assured rainfall, such as the monsoon belts in the coastal regions where water is available in plenty during the monsoon period but where drought occurs during the rest of the year. For example, there is scarcity of water for crop plants in Kerala during the period December-April. Thirdly, there are regions which have low rainfall and where there is chronic moisture deficit. Some of the principal districts falling under this category are listed in Table 1. In about 80% of the total cultivated area the possibility for even a protective irrigation does not exist and crop growth is conditioned by precipitation. The improvement of the yield and income potential of the farms in such regions is therefore of much significance from the soical and economic standpoints. The precise approach towards achieving this goal will vary from region to region and a broad prescription will have no value. However, the principles underlying the destruction of both the barriers to high yields and the factors responsible for instabilit in production are broadly similar for all regions since they are based on fighting

the effects of atmospheric drought caused by hot and dry air and of soil drought resulting from the lack of moisture in the root zone. A combination of both these forms of drought does the maximum damage to yield.

The problem of improving the production potential of dry areas has two dimensions. One aspect relates to the long term measures of creating irrigation facilities, soil conservation measures and artificial rain-making wherever scope ~~of~~ for this exists. Such measures naturally need heavy investment and would become gradually feasible when the economic prosperity of the country improves. The other aspect relates to what can be done immediately with existing resources and with only a small additional investment which can be obtained through loans, as a part of the agricultural credit policy. I shall deal only with this second aspect, since our first duty should be to do what can be done immediately to spark off the chain reaction of agricultural progress and creation of the wealth necessary for further progress.

Principal approaches:

1. Soil structure and level: A primary factor needing attention in unirrigated areas in soil structure as related to the conservation and utilization of moisture. The problem here is of two kinds. Firstly, the water received

through rainfall should be conserved and not allowed to be lost quickly either through run-off or through rapid evaporation. For this purpose, attention should be paid to the level of land and every farmer with about 4 hectares of land would do well to possess a bullock-drawn buckscraper and attempt to achieve with the help of a mason's level a degree of land shaping which is conducive to the retention of the moisture received. Secondly, the sub-surface structure of the soil has to attend to both for enabling the development of a good root system and for preventing rapid loss of moisture through evaporation. The presence of a loose crumbly layer below the surface of the soil helps in disturbing the pore allignment and thereby helps to conserve moisture (Fig. 1). The principle is somewhat similar to puddling in paddy soils, which helps to disrupt soil structure and thereby enables the conservation of soil moisture. Suitable ploughs should be used to do the deep ploughing necessary to achieve such a sub-soil structure.

Over a long period of time, our soils have been subjected to rather shallow ploughings because of the nature of the plough used. This has resulted in the formation in several areas of a hard pan or sole just about 10 to 15 cms below the surface. When such a pan is present, even deep-rooted crops like cotton are not able to develop deep roots. Hence, they

have to tap the moisture present only at the surface. Also, the moisture present at the lower layers is not easily available for the plants since the pan obstructs the capillary movement of water from below to the surface. When there is good rainfall, such a pan leads to the water wither remaining in the upper layer and getting lost quickly through run-off and evaporation or else the water may go down through openings in the pan and become unavailable to the plants. It is probably this phenomenon which has led over the centuries to the accumulation of an enormous underground water resource in the Indo-Gangetic plains. We have now started exploiting this capital resource left to us through long periods of poor tillage.

Wherever ~~this~~ there is a hard pan just below the surface, the breaking of the pan through deep ploughing would help better root growth and better availability of the sub-surface water to the crops. Also, this would reduce water less through surface run-off.

2. High yielding varieties: The crops and varieties cultivated in dry areas have been selected in the past more than their ability to survive atmospheric and soil drought, rather than for productivity. The attributes necessary for survival are not necessarily the same as those essential for higher productivity. Many legumes like *Cicer arietinum* (Bengal gram)

Lathyrus sativus (Khesari Dal) are popular in dry areas because they are able to grow and give some yield (about 300-400 Kg. per hectare) under conditions where other crops do not do well. The legumes have the advantage that they can synthesise the nitrogen they need. The genetic tools now available enable us to reconstruct the morphological architecture and developmental rythm in such a way that the varieties grown can not only survive but also produce well under low moisture availability. For example, in wheat the work of Dr. R.D. Asana and his colleagues at the Indian Agricultural Research Institute has revealed that a ~~varei~~ variety with a large number of grains in the main tiller, a good root system, and about 7 leaves which are horizontally disposed so that they can retain the dew, would give much higher yield than what is obtained from the currently grown varieties. Research is in progress at the I.A.R.I. for developing such strains. Among the strains available now, the following do very well under barani cultivation and are recommended:

(a) Chotti Lerma (S.331 Selection)

Culture 1675 of S.331 appears to be the most promising for barani conditions.

(b) Kalyan Sona (S.227 selection)

This has a large number of grains in the main tiller (upto 100) and does very well both under irrigated and unirrigated conditions.

(c) H.D.1704 : This is a culture derived from the cross (N.P.875 x E.4849) x N.P.830 While the above cultures can be cultivated immediately with profit and could yield upto 3 tonnes per hectare when grown with the type of soil management and fertilizer practices described in this article, strains with far superior yield potential are now in the breeder's assembly line. Special wheats with a branching habit (Fig.2) in the ear and hybrids between wheat and rye, known as Triticale (Fig. 3) are now under development at the I.A.R.I. for rainfed areas.

In crops like jowar and bajra studies have shown that hybrids like C.S.H.1 and H.B.1 are both better and more stable in their yielding ability under conditions of drought. In chronic moisture-deficit areas, seeds of these hybrids could probably be made available at subsidised rates. In legumes also, strains which do much better under dry conditions are being selected in gram, arhar and other crops.

3. Double Cropping: In most of the low rainfall regions, two crops can be taken provided some attempts are made to preserve the moisture. Also, crops and varieties should be so chosen that they undergo grain development before severe atmospheric drought sets in. Short duration and photo-insensitive varieties are now available in the major cereals and millets and they can be grown in such a way that the extremely hot and dry

months (usually March to June) can be avoided. It would be useful to have a cereal-legume rotation, for building up soil fertility. Some of the dwarf rice varieties like Taichung Native-1 and I.R.8 are also drought-resistant and can be grown in areas where the rainfall during the monsoon period exceeds 20 inches. In evolving the cropping pattern for barani areas, the choice of varieties should fall on those which are quick growing, whose root system is good and whose sowing and harvest can be synchronised with the most favourable periods during the grain development phase.

4. Fertilizer application: The yield of a plant depends on its innate genetic potential and on the availability of sunlight, moisture and nutrients. Sunlight is abundant in most parts of our country. Moisture is low in many areas but can be conserved, as already discussed. The availability of nutrients, on the other hand, is the most important limiting factor for getting yields from the varieties with a good genetic potential for yield. It is often difficult to make nutrients available through the soil in the conventional manner due to the lack of adequate moisture in the soil. Research at the I.A.R.I. has shown that foliar feeding is the most effective method of making nutrients available in barani crops. It has further been shown that as high as 35% concentration of Urea can be applied, provided the size of particles can be broken down in a low volume sprayer. This has opened the possibility

of aerial spraying of fertilizers and pilot studies on the economics of this practice will be undertaken during the rabi season of 1968-69. The standardisation of techniques for using high concentrations of Urea (normally only 2% and below is the recommended concentration) will render the widespread use of this fertilizer in unirrigated area possible. The fertilizer should also be applied at certain critical stages in the plants' growth for getting the best return from it. The precise stages will vary with the crop and will have to be determined for each region.

The practice of cultivating pulse crops in unirrigated areas should be fostered, since this will add to soil fertility. The long-duration pulse varieties generally grown now should be replaced with quick growing and high yielding strains, so that in most of the unirrigated area at least 2 crops can be taken in a year. Also, the practice of adding efficient Rhizobial cultures to legume crops should be popularised and made feasible.

Foliar feeding of nutrients will also be beneficial in high rainfall areas such as Assam and Kerala, where there is a possibility of much loss of nutrients supplied through the soil due to leaching.

5. Use of hormones and other chemicals

Research is in progress in countries like Australia on minimising through chemical sprays the loss of moisture by transpiration. Efficient chemicals for widespread use may become available in the future. There is none which can be recommended immediately for general use.

Depending on the crop, hormones could ba profitably used for specific purposes in unirrigated areas. For example, in the case of Coffee showers during blossom development are critical ~~and~~ in determining the yield. It should be possible in such cases to prevent the fall of the buds through hormone sprays in years when the blossom showers are erratic.

To summarise, the use of a bullock drawn buckscraper and a plough capable of going deep, the adoption of a suitable crop rotation using photo-insensitive and quick-yielding varieties, the feeding of nutrients through the leaves and the use of bacterial fertilizers for pulse crops will open altogether new vistas in the yield and income potential of unirrigated areas. With moisture conservation, it would be possible to adopt double cropping, such as the cultivation of maize and wheat or jowar and wheat or a cereal and legume, and thus harvest over 3 tonnes of grains per hectare in a year in areas with about 50 cms of rainfall. A series of national demonstrations will be laid out in farmers field by scientists during 1968-69

to demonstrate this possibility. Our immediate aim should be to at least double the production in moisture deficit areas through the use of the available knowledge. 1968 will hence be a significant year in the evolution of high yielding farming in dry areas.