Chapter 5

Conclusion: Future Prospects of Drylands
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The concept of dryland farming is based on the fact that rains are scanty and irregular and that there is hardly any irrigation facility. Thus the extreme variability in the amount and distribution of rainfall is the main problem. The only thing that is absolutely certain in these areas is the uncertainty of rainfall. One does not know when there will be rain, and of what magnitude. In some areas heavy downpours occur for short periods resulting in floods and the destruction of crops. The start and closure of the rains may vary and the onset and withdrawal of monsoons may be gradual or abrupt resulting in the prolonging or shortening of the rainy period. Another problem is that our drylands are more hungry than thirsty. The soils are generally deficient in nitrogen and phosphates. While soil organic matter gets depleted then the acidity may be the problem in heavy rainfall areas, salinity and alkalinity assume an importance in the low rainfall areas.

Arid and semi-arid regions comprise almost 40 per cent of the world’s land area and are inhabited by some 700 million people. Approximately 60 per cent of these drylands are in developing countries. Low rainfall areas constitute from 75-100 percent of the area in more than 20 countries in the near east, Africa and Asia. Farmers in these regions produce more than 50 per cent of the groundnut, 80 percent of pear millet, 90 percent of the chickpeas and 95 percent of the pigeon peas. These dryland areas will continue to produce most of the world’s foodgrains for expanding population in the years ahead.

In India at present 70 percent of the agriculture is rain-fed which contribute 42 percent of food and supports 40 percent of the human population. All rain-fed areas are not alike as there are massive regional variations in rain water availability and other natural resources. About 30 percent of the country (109 m. ha.) spread over 99 districts is drought prone. In these districts not only the agriculture is un-sustainable
because of critical water shortage, the region as a whole suffers chronically from serious drinking water problems. The mean annual rainfall is about 70 percent of the country is less than 1125 mm. For the country as a whole, 74 percent of the annual rainfall is received during the June-September period. Poor rainfall distribution causes drought more than once during the crop seasons in the arid and semi-arid rain-fed lands. On the other hand soil erosion and runoff due to high intensity rains are the problems of heavy rainfall (>1125 mm) areas.

The people living in dry areas have meager resources and low management skills; thus the level of development is also low. It is also accompanied with low literacy rates. Most of the dry areas are sparsely populated and due to this, the average size of the land holding are larger as compared to other areas with better rainfall and irrigational facilities. The level of income of the people is generally low except for certain developed pockets. The development of an infrastructure, i.e. communication lines, marketing centers and storage facilities are poor.

Food- grain constitutes the predominant production in most of the dry areas. Millets like bajra, jowar and sorghum; pulses like arhar and moong; fodder like cow peas and some crop mixtures like arhar with urad and arhar with moong find an important place in the cropping pattern. In certain areas where the soil is suitable, commercial crops like cotton, groundnuts, castor, soyabean, etc. are also grown. Almost the entire production of coarse grains, pulses, oilseeds and cotton comes from these areas. In areas where there is a wide variability of rainfall, drought-resistant, low-yielding and low-cost crops, like inferior millets are grown. Mixed cropping is also a common practice to guard against wholesale crop losses.

In Indian drylands the present level of production is very low. However, the methods for improvement are available and therefore the potentialities for increasing food production by dryland farming are tremendous. An increase in the yield per hectare by even 2 quintals could mean an increase by 1.5 million tonnes. Since not much can be done to ‘discipline rains’, scientists have tailored technology to suit the
eccentricities of the nature of the dryland zone so that the food production from such areas can be ensured and increased. Apart from raising the food production with less investment, dryland farming will also increase the income of 80 percent farmers who depend on it. Hence, a suitable or appropriate technology is needed for dryland development.

Summary Statement

In the present study, there are chapters, which systematically study various aspects and bring some of the important conclusions, and they are being put to highlight the significant point of the study. Specially in the arid zone, rainfall is the major control of land use as many activities are carried out close to their minimal water requirements. Hence, even small rainfall fluctuations can produce major effects on the crop growth and the animal survival. The significant accomplishments have been made in the technology of arid land agriculture, with Israel and the south-western U.S. as the prime examples. In Israel, for instance, agricultural output has been multiplied eight-fold in the last 25 years, largely through highly efficient and sophisticated irrigation systems. The problems of dryland farming are particularly related to the yield, out turn, agronomical characteristics, soil and moisture needs, and environmental changes, such as waterlogging and the increase in salinity, the relation between the dietary habits and the nutritional characteristics of these crops, marketing problems, labour input, the fodder value of these crops, the competitive position of these crops in comparison with other crops growing in the region and numerous other infrastructural technological aspects.

Dryland ecosystems are extremely heterogenous with wide variations in topography, climatic conditions and soils. Even here, though, there are variations as in some environments, precipitation is relatively reliable on a seasonal basis, while in others rain never occur for years at a time. They are extremely fragile with quick and easy destruction and their slow and difficult reconstruction. There natural rate of restoration are not well known, but in some cases estimates range from more than 200 years to perhaps more than 1000 years, with recovery time directly associated with
the degree of degradation of the ecosystem. The work on dryland ecosystems has suggested that while water availability is the key factor, controlling biological productivity, deficiencies of nitrogen and phosphorus can also limit the primary production. The nature of the dryland environment also makes it difficult to calculate budgets for different elements as considerable spatial variations occur. It is well known, for example, that nitrogen builds up in areas beneath desert shrubs, whereas only a few meters away the very low values can be recorded. Average values for such environments can, therefore, sometimes give a false impression of what is actually going on.

Israel has already proved herself to be amongst the most efficient countries in the world in terms of obtaining maximum economic output from minimum water input. However, the problem of continued population growth, together with the increase in standards of living, will put even greater strains on the water supply network in the future. How long Israel can go on supplying these expanding needs from its present water resource base without some demand areas beginning to suffer considerably is a matter of conjecture. A feature of the last two decades has been the growth in demand of domestic supply as population numbers have increased. At the same time, per capita use has gone up as standards of living have risen. Agricultural use still remains the dominant one, though its relative importance has been falling steadily.

The agricultural sector in Israel consumes 1.2 billion cubic meters of water annually, of which 900 million is potable. The remaining water comes from effluents, flood water, salt water or saline wells. Since much of the country lies in a semi-arid and arid zone, it is constantly searching for new technologies to help cope with water constraints. The variety of climatic regions within the country are characterized by vast differences in rainfall. Average yearly rainfall in the north of the country is 700-800 mm, while in the central part it is between 400-600 mm, and in the south (Negev and Arava) the average yearly rainfall is 25 mm. Since the founding of the state, agricultural output has increased twelve-fold, while water consumption per hectare has remained constant.

Most developing countries differ greatly from Israel in their history, demographic composition, size, literacy level, class structure, ideology, economic status, military
situation, and many other relevant factors. For this reason it is clear that comparisons will always be conditional, and that lessons learned in Israel may not be directly applicable elsewhere. But certain specific similarities might be useful in application to any situation of agricultural development. Indians could learn some lessons to develop their drylands for more sustaining and equitable life. Indian drylands have lot of scope for development.

Dryland agriculture plays an important role in the food system of India. About seventy per cent of the cropped area in India is cultivated under dry conditions and a large proportion of output of important crops such as cereals, pulses, oil-seeds and cotton comes from these areas. These areas produce forty-two percent of total food grains, almost all the coarse grains and more than three-fourth of pulses and oil-seeds of the country. About ninety per cent of jawar and bajra is produced in arid and semi-arid regions and about two-third of rice and mustard and nearly one-third of wheat are cultivated in dry areas. Although the problem of the dryland/rainfed farming had been with us for a long time, it was brought into sharp focus only after the phenomenal growth of agriculture under the 'Green Revolution' strategy, which started in the mid-sixties. The production gains of the 'Green Revolution' under the new technology were confined mostly to crops like wheat and rice in regions with good water resources and assured irrigation. Variation in the performance of HYV seed-fertilizer technology and its close association with assured rain and irrigation facilities have been well observed and highlighted by several studies.

The dryland farming in India is looking for new horizons because the traditional methods of production are inadequate to meet the new situations. A new awareness is necessary to encourage the farmers to fully exploit all the advantages of the new strategy. By selecting the right crop and the latest improved varieties, by timely sowing (timely preparation, tillage to control weeds and save moisture), by using fertilizers and controlling weeds and by adjusting crop plans to suit the season, drylands can grow more food than their 42 per cent contribution. It will be much more difficult to further increase food production from the irrigated lands, while it will be relatively easy to step-up production from drylands. While intensive irrigated
farming is imperative for ‘survival’ dryland agriculture is necessary for ‘equity’. The growing gap in incomes between farmers blessed with irrigation resources and those dependent on rainfed agriculture has to be considerably narrowed, and that too soon. Adopting available improved dryland technology is the only way to achieve this goal.

Therefore the transfer of technology is what keeps the wheels of agricultural development moving. The success of agricultural and rural development strategy, initiated, planned and developed by the policy maker, the planner and the scientist, wings on the effectiveness of the extension machinery and personnel, whose task is to transfer the technology from the lab to the land. Technology transfer has brought about a transformation in the lives of people in the countryside and the farmers and other who have adopted the new technology and methods of cultivation are happy to share their experiences with others. ‘Seeing is believing’ and success is one place triggers a chain reaction, enthusing others to emulate it. Technology transfer is the complex task, which is multidisciplinary and multi-institutional in approach. Technological changes are taking place more rapidly now then at any other moment in the history of mankind. The latest slogan is “Innovate or Perish”. The future belongs to those countries that can successfully compete in this race for technological innovation. Old technologies are becoming obsolete and giving way to the new ones for improving efficiency and reliability. The dry land farming which of late has acquired considerable importance, has witnessed a sea change, and modernization is taking over. Its time for Indians to develop their drylands to accommodate and feed the growing population, by learning lessons from Israel.

**Strategic Framework**

Improving water conservation in the root zone implies increasing infiltrability, decreasing runoff and reduces losses due to evaporation. Infiltrability depends upon surface soil conditions and presence and absence of crust. Adverse effects of crust can be minimized by mulching, which prevents formation of surface seal or by mechanical means to break the seal already formed. The beneficial effects of mulch
versus regular mechanical disturbances are well-tested. If mulch is not available, mechanical measures of water management are often successful. One of several useful measures is the practice of tied-ridging. Tied ridging is a system of building cross ties across furrows to conserve water \textit{in situ}. Ridge cropping, widely adapted in rainfed or dryland farming is practiced with a range of variations to suit local needs. The variations include ridges made along the slope to drain excess water from poorly drained soils, across the slope to conserve soil and water, with cross ties in furrows to hold surplus water and allow longer time for water to infiltrate and with gentle gradients in furrows to facilitate water harvest. The most efficient and cheapest approach for rainwater management is that maximum rainwater is conserved \textit{in situ}.

Pre-monsoon summer tillage especially in flat dryland areas having loamy sand to sandy loam texture should be done to keep the land ready to absorb subsequent rains quickly. Field bunding and compartmental bunding in the field, ridge and furrow configuration and tillage across the slope should be practiced along with leveling operations. Significant improvement in soil water storage with these soil surface modifications can be achieved where these improvements were more pronounced in normal rainfall years than in abnormal rainfall years. Pre-monsoon deep (25 cm.) tillage in leveled lands and shallow tillage after each effective rainfall resulted in maximum conservation of rainwater.

In water management practices, Israel has established herself as the pioneering country. Israel is amongst the most efficient countries in the world in terms of obtaining maximum economic output from minimum water input. However, the problem of continued population growth, together with the increase in standards of living, will put even greater strains on the water supply network in the future. How long Israel can go on supplying these expanding needs from its present water resource base without some demand areas beginning to suffer considerably is a matter of conjecture. A feature of the last two decades has been the growth in demand of domestic supply as population numbers have increased. At the same time, \textit{per capita} use has gone up as standards of living have risen. Agricultural use still remains the dominant one, though its relative importance has been falling steadily.
As rainwater has to seep into the soil through the surface, the land has to be kept open for receiving more and more moisture. It should also be free of weeds and leveled, wherever necessary, so that the maximum amount of rainwater seeps into the soil. Since timing and precision are two important factors in dryland farming, seeding and weeding must be timely. Therefore, land must be prepared before the sowing in order to capitalize on the moisture available at the time of harvesting the previous crop and also the rains receiving during the off-season. Improved ploughs and blade harrows should be used for this purpose. For sowing and applying fertilizer simultaneously, improved fertilizer drills are easily available.

A suitable package of practices such as using improved seeds, timely sowing, the judicious use of fertilizers, plant protection measures, etc., will also help in achieving a high yield level. Given a suitable technology and the necessary inputs, the farmers in most of these areas would not be found wanting in their desire to improve agriculture. Since the farmers of such areas are poor, the inputs should be supplied on a subsidized basis. Plant protection measures have to be taken on a community basis and credit should be provided on liberal terms. There is also a need to protect the farmers against the risk arising out of the adoption of the new technology. Another important measure would be the provision of an infrastructure, i.e., Communication, marketing and storage facilities.

Dryland crops of short duration and high yielding varieties have been developed with a short maturing period to ensure their harvest before the withdrawal of the monsoon. Besides, Dwarf varieties with a favourable root-shoot system make them more tolerant of drought. Better varieties are becoming available, for example, the sorghum hybrids (CSH1, CSH2), the bajra hybrids (HB1, HB3), the new early castor variety (Aruna), and short duration varieties of arhar and moong and several varieties of wheat, rice and cotton. The results of agricultural research has also shown that sorghum, pulses of different varieties, pearl millets, groundnuts, chick pea, maize, rapeseed, rice, barely and wheat have proved to be the most suitable crops of dryland farming.
Fertilizers can be profitable used in dryland farming. Areas receiving more than 70 cm. of rain can be supplied with fertilizers with much less risk, and in areas receiving less rainfall, perhaps less fertilizer is necessary. Thus, high levels of crop production are possible in areas receiving more than 80 cm. rainfall where a balanced dose of fertilizer could be used. The new varieties are highly fertilizer responsive.

In arid and semi-arid regions growing of food crops alone may not be a profitable enterprise because of erratic and uneven rainfall. Inclusion of tree component with arable crops for food, feed, fodder, fuel and fertility may be remunerative cropping systems. In agro-horticultural alley cropping system including Ber (Ziziphus spp.) fruit plantation along with rainy season dryland crops such as cluster bean and anjan grass (cenchrus spp.) green fodder proved to be better inter crops under agro-horticultural/agro-forestry system, growing of these inter crops with Khejri (prosopis cineraria) and Kiker (Acacia spp.) also gave promising results.

Alternate land use system not only help in generating much needed off-season employment in mono cropped drylands but also minimize risk, utilize off season rains which may otherwise be lost as run off, prevent degradation of soils and restore balance in the ecosystem. The experience has shown that in drought years where there was a total failure of grain production, the Leucaena spp. hedge rows in the alley cropping system produce 5 tons/ha of green fodder. Alley cropping, pasture management, tree farming, silvi-pastoral management systems and agro-horticultural system which are more relevant to dryland situations have to be adopted for successful dryland farming system.

In the overall task of conception, development, evaluation, and diffusion of dry-farming technology, there are several stages where social scientists, particularly economists, can play an important role. Social scientists do not generate technologies, but they can help in defining the contours and contents of the problems and likely solutions in the context of which relevant technologies can be generated.
**Action Oriented Recommendations**

The transfer of technology being a complex and continuous process, there is no alternative but to develop human resource to achieve desired goals. Transfer of improved technology has become very crucial in bringing improvement in crop productivity. For effective and efficient transfer of technology the following suggestions should be kept in mind:

1. Proper emphasis should be given on development of appropriate technology taking into account farmer's need, problems, and social-economic background.

2. Efforts should be made to develop profitable and low cost technologies, which will make use of locally available resources.

3. Efforts should be made to develop location specific package of practices involving optimum level of inputs such as fertilizer, insecticide and irrigation so that small and marginal farmers can adopt them to increase their yields.

4. The technology should be simple to use, compatible with previous experience and cultural norms.

5. The technology should be introduced to the potential user in a manner that he can understand easily.

6. Information and inputs should be extended side by side for effective transfer of technology.

7. The successful demonstrations should be repeated for the sake of farmers to confirm the truth of technology and to avoid the conflicting results, which lead to retardation in the process of transfer of technology.

8. Coordination committees consisting of representatives of development departments, input supply, credit service and marketing agencies should
be made more functional and active. Similarly, all institutions charged with farmer’s training should be constituted at district and state levels so as to chalk out appropriate training programme for farmers.

(9) Strong linkages should be established within and between the research, extension, and client system.

(10) Need based adequate training in subject matter, communication process, handling and use of extension teaching methods and audio-visual aids should be imparted to the extension workers so as to enhance their communication skill and increase their credibility for transfer of agricultural technology.

(11) More emphasis should be given on production of farm literature in all local languages so that the farmers can understand the message clearly.

(12) Mini communication kits consisting of package, input specimens, simple publications and flannel graph and recommended package of practices should be provided to field level extension workers.

So, while developing and verifying prospective technologies, it has been clearly established that large-scale adoption of dryland technologies requires much stronger institutional and infra-structural support than is currently available. This is because dryland technology is resource centered, rather than crop centered. Unlike in the well-endowed areas, generating and diffusing technologies in dryland agriculture is not an easy task; it is made more difficult by the severe constraints imposed by the harshness and variability of the agro-climatic environment. Consequently, researchers and policy makers, as well as the public, will have to be content with location-specific and more modest but progressive improvements in agricultural productivity.

While intensive irrigated farming is imperative for ‘survival’ the development of the dryland agriculture is necessary for ‘equity’. The growing gap in incomes between farmers blessed with irrigation resources and those dependent on rainfed agriculture
has to be considerably narrowed, and that too soon. Adopting available improved dryland technology is the only way to achieve this goal.

To sum up, Indian agriculture can surely pin its hopes on new methods of farming in the dryland areas of the country. If the country could incur an expenditure of Rs 70,000 for irrigating a hectare of land, why could Rs 6,000 not be spent on developing a hectare of rainfed land? The adaptability of Israeli technology for India’s agricultural development in water management, farming methods, dairy, poultry and livestock development may be assessed and put possibly into practice. There should be region-specific research and development with adequate importance given to extension centers. Such an approach has led to the toning up of the acreage-wise density of production in Israel.

The time is ripe now come to think more seriously to develop our drylands. That would increase productivity and income of our small and medium farmers. We should raise dryland farm output in the overall interest of accelerating the pace of agricultural production. There is no time to relax, but to be consistent to either innovate or perish.

It is important to gain out of the experience of a friendly country like Israel. And therefore we must have proper exchange of ideas, practices and experience, both at the government and people to people level.