

## Co-ordinator's Report on the 4th Session

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# Irrigated Farming Systems

It has been my privilege to coordinate a session of which it can be said without hesitation that the different contributors have been really up to the task of bringing forward the intricate problems associated with irrigated farming systems in semi-arid and arid zones and of discussing possible solutions and advisable practices to cope with these problems. I apologize to them, in particular, and to all the participants in this colloquium for not doing justice to their excellent papers in the short summary I will give in the next few minutes.

An overview of the subject was given in the main paper of the session, presented by Professor *Fereres*. Specific aspects were addressed by Drs. *Lekchiri*, *Aragüés*, *Enyi* and *Tahir Saleem*.

It is well known that irrigation significantly increases crop yields in areas of insufficient rainfall, where water is the limiting factor for crop production, but one should not view irrigation in these areas as a way to remove a constraint but as a factor to be optimized. In fact, when the system is considered as a whole and most of the constraints for crop production are removed with adequate management practices, crop yields of the irrigated arid and semi-arid zones are the highest anywhere for a given crop and approach the theoretical potential limits for crop production. However, there are many problems to be overcome and pitfalls to be avoided in order to maintain these high yields, both on a short-term and on a long-term basis. It was comforting to hear Prof. *Fereres* express the view that the basic home-work has been essentially done, that the science and technology to be applied is already available and that these problems can be solved if we carry out the necessary adaptive work to connect, in a pragmatic way, theory with practice.

The short-term problems are complex because of the intricate interplay of the different factors that affect production, which make optimization a hard task. Dr. *Fereres* highlighted the most important factors and interactions:

– Soil water levels play a very important role with respect to nutrient movement and uptake in many ways, some of which are now well understood. Thus, improvement of the soil water status by irrigation increases the nutrient demand as the shoot growth rate is accelerated upon relief of soil water stress; the enhanced transpiration under irrigated conditions increases convective transport to the roots and therefore a greater contribution of nutrients by mass flow; irrigation also increases diffusion of nutrients in the soil by increasing the cross-sectional area for nutrient movement.

Although more or less elaborate models have passed the test of agreement with independent sets of data in the case of nitrogen transformations in the field, the overall dynamics of nutrient transport and transformation have not so far been domesticated into useful models at the field level able to predict patterns of nutrient uptake, because of the large spatial variations in soil water and nutrient parameters. Irrigation affects root growth. Rooting depths in irrigated and nonirrigated crops are usually similar, provided that the soil profile is fully charged, but the distribution of root-length density in the soil profile is markedly affected. Water uptake patterns are consequently altered, which in turn affect nutrient patterns and should affect our fertilizer placement strategy.

– Irrigation methods markedly affect nutrient movement, nutrient distribution and nutrient uptake. Dr. *Fereres* has reviewed a considerable body of data that show how the irrigation method is probably the most versatile tool in our hands to solve a great variety of nutrition problems. I will not try to summarize his summary, but will make a brief comment on a pertinent example presented by Dr. *Lekchiri*. He brought us up-to-date on his progress in a long-term experiment designed to investigate the effect of irrigation method in the supply of the high phosphorus and potassium requirements of citrus trees. He has shown ways to improve the migration of P and K, both under micro- and macroirrigation conditions, to the levels where the absorbing roots are concentrated and he has been able to ascertain increased nutrient levels in the leaves. It remains to be seen what the effects of the proposed practices will be on actual yields and on the PK status of the soil.

A second general aspect of irrigated farming systems in semi-arid and arid zones is represented by the long-term effects. Irrigation can be bread for today, hunger for tomorrow. We are now becoming painfully aware of the tremendous environmental impact of the introduction of irrigation in extensive areas. Poor irrigation management as practiced by many farmers can produce irreversible damage to soil productivity in a very short time. Salinity, soil erosion and ground water pollution are among the main long-term effects of irrigation. Salinity is probably the most difficult to deal with under the conditions of limited water supply prevailing in the semi-arid and arid zones. In connection with this problem, Dr. *Aragüés* presented interesting cases at the river basin and at the irrigation district levels (in the Ebro river), of how extreme the salinity situation and the deterioration of return flows can become as the irrigated areas are increased.

For irrigation agriculture to be permanent, the salinity problem must be controlled. Although technology already exists for a very precise irrigation water management, it will not be easy to implement such technology on a grand scale in developing countries and it will probably be necessary to develop new technologies and adapt the existing ones so that the specific circumstances of these countries are taken into account.

– *In situ* technology development is essential because technology transfer has been shown to be a slow process and, at least in some cases, has even lead in the wrong direction. Two excellent papers, one by Dr. *Enyi*, on the response of rice varieties to applied fertilizer in semi-arid zones of Senegal and Mali, and one by Dr. *Tahir Saleem* on wheat fertilization in Pakistan exemplify this idea.

Finally, I would like to bring to your attention and open up for discussion two questions, which have been only marginally treated in this colloquium: i) The first one concerns the connections (or lack of them) between theoretical studies (models), trials in experimental stations, trials in farmer's fields, and actual agricultural practice by 'contest' farmers and by average ones. ii) The second question impinges on the possible contributions of traditional plant breeding and the recently developed genetic engineering techniques to the solution of specific problems of aridoculture. Are our expectations exaggerated?