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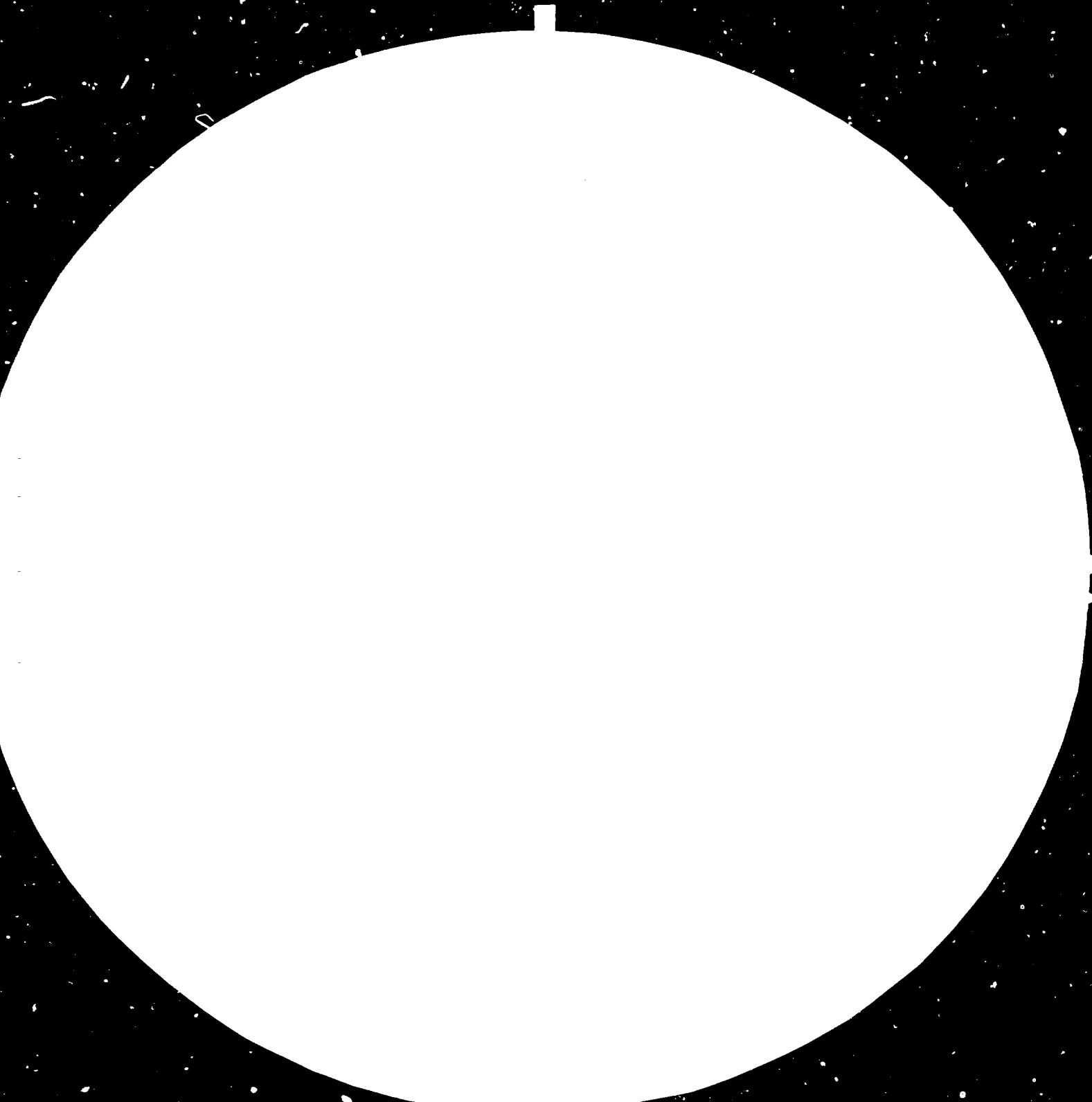
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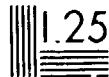
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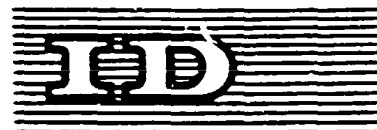




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TECHNOLOGY TRANSFER OF PLASTICS IN AGRICULTURE
IN SEMI-ARID AND ARID AREAS*

by

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1. Introduction

Semi-arid and arid zones are characterised as areas of low rainfall and high insolation. With the resulting high day-time temperatures and limited water resources efficient agricultural production is much more difficult to achieve than in temperate zones. However, these problems present excellent opportunities to develop the use of plastics for water conservation and water management applications as well as for crop and livestock production. These agricultural needs cover a wide range of applications including, rainfall harvesting, wells, storage, distribution, irrigation, water troughs, mulching, tunnels, greenhouses, shading and windbreaks etc. There are other papers dealing more specifically with some of these applications.

The agricultural problems which face the farmers and growers in these semi-arid and arid zones presents a real challenge. At best there is only a very small percent who can make any real profit from such agriculture while there are by comparison many millions who make only a subsistence living. At worst successive years of drought and failed crops resulting in famine, to be followed by starvation and death unless Governments are able to provide emergency food supplies. Such pressures lead to declining village populations and a drift to the cities with the subsequent loss of both inherited agricultural skills and also potential agricultural productive lands.

The use of plastics in resolving agricultural problems in the industrialised countries has not gone un-noticed by developing countries. The problem has been how to transfer and adapt such technology to each country's specific requirements.

During the last few years United Nations Industrial Development Organisation (UNIDO) has been promoting the use of plastics in developing countries as part of its programme to assist the industrial development of such countries. One key area for the application of plastics is its potential use in increasing agricultural outputs and efficiency. As a result of these promotional efforts there are now five UNIDO projects in the process of implementation. These projects are located in countries having semi-arid or arid areas as follows:

1. Saltillo , Mexico.
2. Alexandria, Egypt.
3. Ougadougou, Upper Volta
4. Nicosia, Cyprus.
5. Amman, Jordan.

2. UNIDO Projects

2a Mexico project

This plastics in agriculture project is located in Saltillo within an existing institution, the Centre for Investigation of Chemical Applications (CIQA). This town is situated on the edge of the Coahuila desert in the north of Mexico. In this desert area there are a number of villages where life is at subsistence level. As a means of up-grading the economic viability of the people in these villages, and thus deterring a population drift to the towns and cities CIQA was established to investigate and assist the development of the natural resources of the desert area. One of the first programmes they undertook was the development of natural rubber from the guayle rubber bush which grows well in desert areas under water stress conditions. While this development still continues a second programme was started. This involves the examination of desert plants as a potential source of pharmaceutical chemicals.

It was at this point that the UNIDO project for developing plastics into agricultural applications was started in 1979 as a means of improving the agricultural outputs and thus providing an adequate food supply and source of income for the village communities. The initial programme covers the use of tunnels, trickle irrigations and mulching.

Mexico which are carrying out related projects which will assist in achieving the overall objective of developing the local natural resources. The Institute of Technology and Higher Studies of Monterrey has carried out a series of experimental trials on rain-fall harvesting and storage utilising both plastics and other materials. However, further large scale trials of the more promising systems were postponed since at that time there were insufficient funds available. The Institution of Advanced Irrigation had carried out some valuable evaluation trials using plastics trickle irrigation systems. In both cases the research work was of a very high quality and reflects the excellence of the workers involved. All this work supplemented CIQA's programme. Yet, at that time, there was no co-ordination or knowledge of each others programme, a deficiency which has since been corrected.

CIQA are also developing their equipment facilities under the UNIDO project so that they will be able to undertake both plastics product testing and also product development through the use of appropriate pilot plant. They will also increase their graduate personnel for this purpose who will receive overseas training through the project. International experts will also be made available to provide technical assistance and demonstrations, as well as on the job training.

2b. Egyptian Project

This project is for the establishment of a Plastics Development Centre (PDC) to support and strengthen the development of the Egyptian plastics industry. One of its immediate priority areas is the development of applications of plastics to increase agricultural outputs and efficiency. The project implementation started in 1979 and the building, located in Alexandria, is expected to be completed by the end of 1980.

The Centre will be well equipped with both testing and pilot scale plant to cover a broad spectrum of development activities. Key graduate-level personnel have been recruited and additional professional and other staff will become available when the building is ready for occupation. Overseas training is to be provided

by the project as well as the provision of international experts.

Over the last three years there have been some ad-hoc trials carried out in Egypt with plastics in agriculture using locally manufactured products. These have covered mainly film applications for mulch and channel lining. Earlier trials in 1965-70 with polyethylene film for tunnel covers were also undertaken, but these were not successful at that time. In the current year the Department of Agriculture is starting a series of cultivation trials using plastics covered greenhouses under a World Bank financed programme. The PDC will be co-operating with this project in the evaluation of 'long-life' films. In addition the Ministry of Land Reclamation has a Food and Agriculture Organisation (FAO) project the 'International Centre for Rural Development' just starting. Through this Centre a number of trials with plastics will be organised by the PDC.

The Agricultural University of Alexandria has offered its facilities for agricultural trials, and a co-operative programme with the PDC for developing the use of plastics in agriculture is already under discussion. The Ministry of Irrigation have established, with bi-lateral aid, their own factories for the production of PVC pipe which is used for land drainage. There is a very large scale scheme under implementation which involves the drainage of most of the land within the Nile river area. A co-operative programme with the PDC for plastics technology assistance is under discussion.

In Egypt some ninety five percent of the population live within 50 miles of the river Nile. The Government has a programme of land reclamation in hand to further develop the natural resources of the country. Since the area beyond the Nile river valley is all desert land this means that water resources are limited and trickle irrigation and mulching will therefore be required to maximise the use of this resource. These schemes are started by the Ministry and at an appropriate time are transferred to public sector farming companies; thus the direction of the development remains centralised. Within Egypt there is a relatively good supply of young graduate personnel so that the development of the new agricultural farming techniques will have a good prospect of effective utilization.

The Government also encourages young agricultural graduates

to farm newly reclaimed desert areas by suitable grants. Thus the problem of resistance to change, which is normally exhibited by the older generation of farmers, has and is being successfully overcome.

Within different areas of Egypt there are various development trials being undertaken using plastics in agricultural applications. However, they appear to be un-coordinated. As a means of resolving this situation and to provide a common platform for the various and diversely interested parties the Director-General of the PDC has taken the first steps to form an Egyptian Committee for Plastics in Agriculture. In addition it is planned to further promote this subject by holding an Egyptian Plastics in Agriculture Seminar in the autumn of 1981.

2c. Upper Volta Project

This Centre for plastics in agriculture project is located within an existing institution, the Agriculture Research Institute at Kamboinse, some 10 kilometres from the capital Ougadougou. The building for the project is expected to be completed by mid 1980, and will be equipped with some plastics basic testing equipment and fabrication facilities of a strictly limited nature, but simple and effective in operation.

Due to lack of educational facilities and of educational opportunities in the past there are very few graduates available within the country. For this reason it has been difficult to find and recruit suitable staff for the project. Nevertheless a small team of six non-graduate personnel has been recruited and also undergone overseas training in plastics technology with a concentration on practical work. This team is now back in Upper Volta and in early 1980 began the first experimental trials and demonstrations with plastics for mulching, shading, wind-breaks, and trickle irrigation working under the supervision of international experts.

There are two plastics processing factories operating in Upper Volta. These are capable of providing the plastics

products for agricultural applications once these have been technically established thus aiding local industrial development.

2d Cyprus Project

This is a small project concerned with the development of a 'long-life' film for greenhouse use and is being undertaken by the service of a part-time expert.

Cyprus has widely adopted the use of plastics in agricultural applications as one of the tools for increasing its agricultural outputs and efficiency. This was given a boost after the Turkish invasion when the Cyprus government was faced with many refugees who had to be provided with jobs. Many were provided with small plots of land and finance to build greenhouses in order to grow crops with export potential. Technical assistance of Cyprus experts was also made available to train these non-agricultural personnel into the techniques of intensive crop cultivation. In the past few years there has been a large increase of both greenhouses and tunnels. In addition trickle irrigation of both citrus and banana plantations has become more widespread as well as that of row crops. However, the use of mulch is only just being evaluated.

One of the problems that faced the greenhouse growers was the short life of the low density polyethylene film covering, lasting only 10 to 12 months in that climate. There are two plastics companies on the island who produce such wide-width film for greenhouses but they lack any facility for technology development, and are dependent on information provided by their raw material suppliers.

This UNIDO project is aimed at increasing the useful life of the film, with a target life of three years or more, using only the existing facilities available within Cyprus.

The trials were carried out with the full co-operation of the plastics film producers, and the trial films are currently being evaluated on a greenhouse roof at the experimental station of the Agricultural Research Institute. Manpower to remove the samples of

the films at fixed time intervals so that the change of mechanical performance can be monitored has been provided by the Ministry of Industry Extension Service and also by the Cyprus Standards Organisation. Testing facilities for plastics are being progressively built up by the Cyprus Standards Organisation under another UNIDO supported project, and these are located within the Government Laboratory. This latter organisation is supplying the manpower for testing the film samples.

Thus by co-ordination of the existing facilities it is possible to carry out this development programme.

Since this project was first started the price of plastics raw materials has increased considerably. The development of a greenhouse film which will last longer and therefore be more economic has become a matter of great interest to the growers in that country.

This programme is still continuing.

2e. Jordan Project

This is also a small project to provide some plastics technology inputs to investigate and evaluate plastics in agriculture applications, particularly in the Jordan valley. The project is located within the Royal Scientific Society (RSS), a scientific centre of excellence, situated on the outskirts of Amman, and is being undertaken by them with the co-operation of the Agricultural Department of the University of Jordan and of the Ministry of Agriculture.

In 1976 there were hardly any plastics used in agriculture in Jordan yet in 1980 there will be some 40 hectares of greenhouses and about 400 hectares of tunnels in use, as well as mulching of both open and protected row crops, and trickle irrigation. This rapid growth was due to an agricultural production-led development promoted by the selling activities of overseas agents. Unfortunately the systems which were sold were developed to suit European conditions and did not have sufficient ventilation for the very hot climate of the Jordan valley. As a result growers were faced with difficult

disease problems.

The Government and the University thus became involved and the latter decided that a number of research programmes ought to be initiated in order to resolve some of the problems faced by the growers and also to acquire knowledge of the use of plastics.

This project was evolved in order to provide the necessary inputs to some of these selected research programmes which had a plastics content, as distinct from those which involved purely agriculture technology such as cultivation and pest control investigations. Due to financial limitations the scope of the programme has been restricted but will cover the development of a long-life film, evaluation of low-cost trickle irrigation systems, reflective mulch and perforated, flat tunnel covers. The programme is due to start in September 1980.

Local plastics processors are co-operating, and providing production facilities for the necessary development trials. The RSS has a well equipped plastics testing laboratory within its Mechanical Engineering Department, and some additional items are being provided by the project. The University is providing the agricultural facilities such as land, water, pumps, agricultural supplies, cultivation of the crops as well as manpower for data recording, such as temperature, soil moisture, water usage, crop yields etc.

The Ministry of Agriculture are providing a trained post-graduate horticulturist, and the RSS are providing trained and skilled personnel for the plastics technology inputs to the project as well as for the overall co-ordination of the project. In addition the project will provide international experts and some overseas training in plastics in agriculture.

Although this is a relatively small project lasting only one year, it can be regarded as a 'seeding' project since if it shows itself to be effective then a more extensive project is likely to be developed.

3. Technology Transfer

Developing countries have an urgent need to improve their overall agricultural performance, and this generally represents one of the national priorities of such countries. It is against this background that the UNIDO project had been requested by the respective Governments so that the necessary facilities and expertise could be made available to them.

Plastics applications in agriculture in industrialised countries were developed to resolve each country's specific problems. The main common problem that emerges in retrospect was to increase agricultural outputs and efficiency with reduced labour content since this was becoming an expensive and scarce resource. Relative to such costs the investment cost of using plastics was low, however, against the economic background of a developing country such costs are relatively high. Moreover, in many developing countries, there is a prime need to provide work opportunities where labour is generally more readily available and also low in cost.

It is normal practice in transferring the technology of plastics applications in agriculture to start by examining existing systems which are known to work in industrialised and other countries, and to carry out demonstration trials of some selected systems in the local conditions of the developing country. This is an acceptable practice and has much to commend it since it permits skills and experience to be developed before reaching the adaptive technology stage. The results of such trials generally provide the necessary data and information on which the second stage of the development can be planned. This has to take account not only of the plastics and agricultural technology requirements, but also must reflect the overall background and the needs of the ultimate users. It is this factor which varies greatly from country to country, and constitutes the real technology transfer - 'technology adaption'.

4. The Poverty Trap

If plastics are to have a significant impact on food production it is necessary that its use should be capable of being extended not only into large sized and middle sized agricultural units, but ideally should be capable of being extended into a reasonable proportion of the small scale units. It is necessary therefore to ensure that this latter group will be able to afford the investment cost that the use of plastics will involve. For this reason the relative cost of the plastics and of the specific plastics systems has therefore to be carefully examined in relation to the local situation as well as the financial benefits that can be derived from its use. Two examples will serve to illustrate this point.

In Jordan, plastics in agriculture systems, originally developed for use in France are currently in use and the investment cost is relatively high. These systems, through lack of adequate ventilation, are giving rise to several technical problems. Nevertheless vegetable crops are being produced with them, and a large proportion of the crop is being exported to the Gulf States where there is no local production of vegetables. Due to the very high prices which can be obtained in this market situation profits are more than adequate to off-set the high investment cost of the plastics systems.

This development was started by persons having access to finance whom can be designated as 'rich farmers'. Following their success others saw the financial advantage to be obtained and they, in turn, raised the necessary funds and invested in the use of plastics and entered this market. These growers can be designated as 'middle income farmers'. This is the present stage which the development has reached in Jordan. Now the group of 'poor farmers' will wish to join in, and the question that needs to be asked is, how can they raise the necessary funds? Experience shows that this will be very difficult and efforts should be made to ensure that such funds which can be made available should be used more economically. Lowering the initial capital investment requirement is one method by which this can be achieved, and this will enable this latter group of farmers to have an opportunity to enter this market area.

Reduction of the initial investment cost is therefore one of the aims of the UNIDO project to enable the widest range of farmers and growers to benefit from the use of plastics so that the national economy as a whole will also benefit.

In Upper Volta there is a very much different picture. The country is one of the least developed countries in the world, and also one of the poorest. No individual farmer could afford the cost of current European prices for plastics systems for agricultural applications; and if the costs of the systems are reduced it remains doubtful even then if they could afford them. Here then is a very difficult problem. However, it must be viewed in relation to the country as a whole.

Here is a country which suffers periodic spells of drought which necessitates the imports of large quantities of foodstuffs to enable the population to survive. Even when there is no drought their agricultural yields/outputs are often so poor that food imports are still necessary. The country has insufficient income to pay for such imports on the scale required, and has therefore to resort to foreign aid either by way of loans or gifts, generally the latter for this purpose. One possible method of funding the necessary investment cost for plastics in agricultural applications could come from such loans or gifts as an alternative to providing imports of foodstuffs. Self-help is the prime building block by which such countries will be enabled to develop their own resources; and at the appropriate time consultations between the parties concerned could be initiated to achieve this objective.

Consideration would need to be given to determine whether such aid might be more usefully and efficiently employed to subsidise the introduction of selected and proven plastics in agriculture applications to increase local agricultural outputs. One of the aims of the UNIDO project is to develop the effectiveness of the plastics systems under local conditions, and also to reduce their cost. Only when these programmes are completed will the necessary data become available on which the economics of such a possible subsidy scheme can be determined. Other diverse and novel funding methods will also require to be examined in an effort to resolve this difficult problem.

From these two examples it will be apparent that if rich farmers can see a potential financial advantage in using plastics applications in agriculture they are quick to respond. Having access to the necessary investment they are prepared to take the risks involved based on the technical information that may be available to them at that time.

At the other end of the scale the poor farmers have little opportunity of pursuing such potential advantages or of taking such risks since he is dependant on other sources for his funds and these are generally much more conservative in their approach.

If this situation, arising from the transfer of the technology of plastics applications in agriculture, were allowed to develop then these countries would automatically fall into the age-old poverty trap where the rich will become richer, and the poor will become poorer. To try and avoid this situation arising it is necessary that each country should carry out a programme of adaption of the transferred technology so that it will fit each country's own and specific needs and requirements. In this respect it must be emphasised that plastics is merely a tool in agricultural development, and it remains for each country to learn how to use this tool so that it not only resolves the technical problems of increasing agricultural outputs and efficiency, but that it is also developed to fit within their economic framework.

5. Adaption Technology

The UNIDO plastics in agriculture projects in these countries provide suitable facilities so that the experimental and development necessary for effecting the appropriate adaption of the technology can be effectively undertaken. How is this adaption technology to be evolved? Basically by utilizing the same approach as used by the original researchers in developing the applications which are now in common use in the developed countries; but with the advantage of hind-sight. For example, knowing which systems work and which have failed and why they failed, and by access to a wide range

of technical experience, in addition, a multidisciplinary approach is now possible which was not the case with some of the early developments.

The programme starts with a detailed analysis of the agricultural problems in the country concerned, and then applying a knowledge of the plastics technology to resolve the problem within the economic concepts of the country. To reduce the initial investment cost it is necessary to reduce the actual weight of plastics material used per square metre of agricultural ground if any significant reductions are to be achieved. This can be achieved by new systems design on the one hand, and by the application of plastics technology on the other hand.

Solutions may lie in the design of new types of plastics systems as illustrated for example by the Spice wind-break and shading systems which utilise strips of black polyethylene film threaded by hand through an open mesh knitted plastics net. These are considerably cheaper than the traditional close woven or extruded plastics netting. In trickle irrigation systems basic and fundamental questions must be asked, every concept of tradition must be challenged. Why is that sized pipe used and in that wall thickness? Will a smaller bore pipe be adequate even if it means daily irrigation rather than once in five days? If low pressure systems are in use why use high pressure pipe? Do we need the same safety factors for burst pressure of feed lines as for domestic water supply?

Plastics technology can also be utilized to reduce costs. Plastics raw material can be diluted with fillers, product dimensions can be changed, for example thinner walled pipes. Plastics products can be produced of less weight but still retaining strong mechanical performance by skilled use of mixed polymers. Recycled plastics have a place in agricultural applications. However, such programmes require a great deal of research and development effort as well as time in order to achieve satisfactory results. They also require a skilled team of trained investigators showing innovative skills and dedication to their task.

There has been little incentive for developed countries to pursue such lines of development since in their particular situation plastics are already economically satisfactory. It is therefore left to developing countries to solve these problems of

technology adaption for themselves. Within these five UNIDO projects three have a wide range of facilities which could be usefully utilised for this purpose. In addition it is possible to develop and build up the skilled multi-disciplinary teams that will be required, and coupled with the provision of international expertise will enable these countries to effectively tackle the problem of developing an appropriate adaptive technology.

6. Inter-Project Co-operation

Each of the five projects contain items of common interest in relation to the use of plastics in agricultural applications in semi-arid and arid conditions; as one example only, applications for water conservation, mulching and trickle irrigation. For this reason it would be advantageous for there to be some form of inter-project co-operation that could provide for an interchange of technical information and to investigate the feasibility of undertaking a jointly-operated development programme. This has the advantage that it would possibly shorten the normally long development time span that is required in this field of investigation. It would also maximise the use of resources to the benefit of all the countries concerned.

To date there has been no provision for such co-operation, and it is doubtful if the personnel involved in these projects are aware of the other related UNIDO projects outside their own countries. It is possible that the 8th International Congress for Plastics in Agriculture may form a meeting ground for the initiation of such discussion and consultation since it is understood that representatives from all five countries will probably be attending the Congress.

It is believed that this is an area which requires the attention of UNIDO, and subject to the agreement of all the countries involved would enable technical co-operation between developing countries to be given some practical and useful meaning.



