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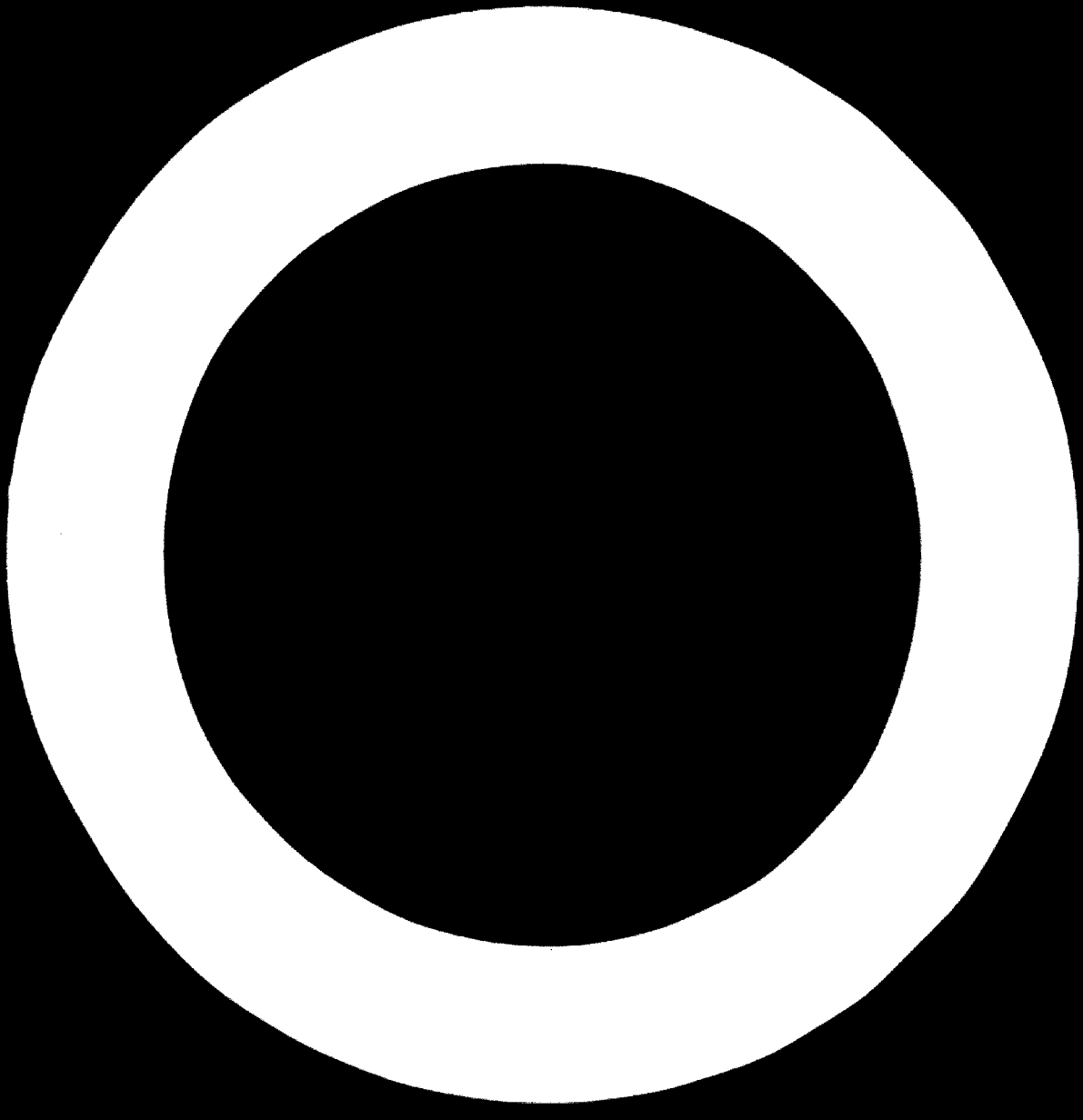
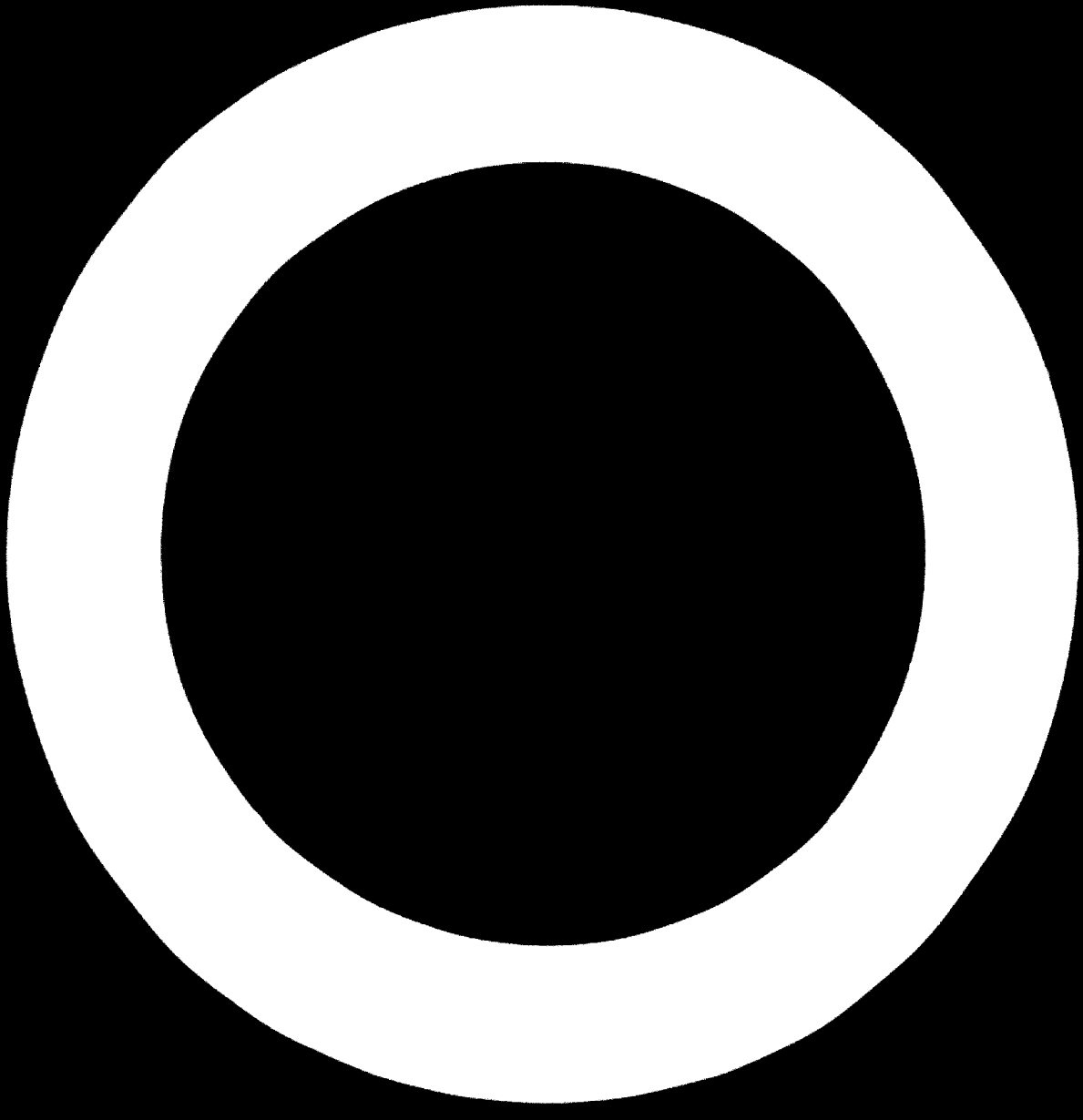
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

DEVELOPMENT OF THE PLASTICS INDUSTRY IN LATIN AMERICA

Report of a Symposium

Buenos Aires
8 - 17 September 1974





CONTENTS

Explanatory notes

Reference to "tons" indicates metric tons, unless otherwise stated.

Reference to "dollars" ($) indicates United States dollars, unless otherwise stated.

Reference to "fabrication", in the context of this report, includes plastics processing.

The following abbreviations are used:

ARGENPLAS '74	ARGENPLAS '74 - International Plastics Exhibition
CALIP	Cámara Argentina de la Industria Plástica (Argentine Chamber of the Plastics Industry)
CACM	Central American Common Market
CIPA	Comité International des Plastiques en Agriculture (International Committee on Plastics in Agriculture)
ICP	Industry Co-operative Programme of FAO
ILAP	Instituto Latinoamericano del Plástico (Latin American Institute for Plastics)
INSTIPLAST	Instituto Técnico Argentina de la Industria Plástica (Argentine Technical Institute for the Plastics Industry)
ABS	Polyacrylobutadienestyrene
PE	Polyethylene
PE-LD	Polyethylene - low density
PE-HD	Polyethylene - high density
PP	Polypropylene
PS	Polystyrene
PVC	Polyvinyl chloride
UV	Ultra-violet

INTRODUCTION

The Symposium on the Development of the Plastics Industry in Latin America, held at Buenos Aires, Argentina, from 9 to 17 September 1974, was the second in a regional series of symposia on plastics. It was organized by the United Nations Industrial Development Organization (UNIDO) in co-operation with the International Committee on Plastics in Agriculture (CIPA), the Cámara Argentina de la Industria Plástica (CALIP) and the Instituto Latinoamericano del Plástico (ILAP).

The Symposium was held concurrently and in conjunction with the Sixth International Colloquium on Plastics in Agriculture. Since the principal objective was to assist the plastics industry in the Latin American region to expand and diversify, a wide range of agricultural applications of plastics was discussed, covering crop protection, mulching and soil treatment, harvest protection, water management, harvest packing, baling, transport, rural buildings, machinery and attachments, special applications, new developments and economic aspects. A list of the papers presented is given in annex I.

In addition, time was made available for participants to visit the International Plastics Exhibition (ARGENPLAS '74). Both processing machinery and a wide range of fabrication products were displayed at this first international plastics exhibition held in Buenos Aires. Argentine applications of plastics in agriculture were further observed during field trips. These visits to areas near Buenos Aires are described in annex II.

Investment promotion activities took place during the Symposium as well as at ARGENPLAS '74, where UNIDO had a stand. These activities were established not only to stimulate investment opportunities in the plastics industry but also to plan new projects and expansion schemes, new technologies, to identify areas of joint ventures and to obtain the necessary foreign technical co-operation and financing.

Direct contact between participants, experts, government officials and businessmen from international organizations was encouraged. The promotional activities stretched beyond discussions of investments. Business contacts were established that may lead to further transfer of technology, joint ventures, licensing agreements, supply of equipment etc. An outstanding feature of the Symposium was the establishment of industrial and business contacts between resource-offering and resource-seeking parties within the Latin American region as well as those from Latin American and other countries with established plastics industries.

The role of UNIDO in investment promotion was to identify the interested parties and to organize meetings between them. A large number of project proposals were identified, and the appropriate parties brought together. Follow-up contacts, as well as contacts with other parties not present at the Symposium, have been established not only for immediate needs but also on a continuing basis for the future. The investment promotion activities were prepared and handled by the UNIDO investment promotion staff in close co-operation with CALIP.

Following the Symposium, the First Training Programme in Plastics Technology for Latin American countries, was started at the Instituto Técnico Argentino de la Industria Plástica (INSTIPLAST).

CONCLUSIONS AND RECOMMENDATIONS

1. Follow-up action by UNIDO on recommendations of the Symposium on the Development of the Plastics Industry in Latin America, Bogotá, Colombia, 1972

Referring to the Bogotá recommendations, the Symposium expressed its satisfaction concerning the following:

(a) The UNIDO Symposium held concurrently at Buenos Aires with the Sixth International Colloquium on Plastics in Agriculture and ARGENPLAS '74 in co-operation with the Government of Argentina, CALIP, CIPA and the Instituto Latinoamericano del Plástico (ILAP);

(b) The organization of the First Training Programme in Plastics Technology for Latin American countries beginning 23 September and ending 15 November 1974 in co-operation with ILAP and INSTIPLAST at Buenos Aires;

(c) UNIDO technical assistance projects in plastics already completed or under implementation covering feasibility and market studies, polymer synthesis, plastics processing and fabrication, quality control, testing and standardization, applications, mould design and mould making for countries including Argentina, Bolivia, Colombia, Ecuador, Nicaragua, Paraguay, Peru, Trinidad and Tobago and Uruguay;

(d) The initiative of UNIDO in studying the possibility of production of plastics components for housing using industrialized systems; special reference being made to the draft resolution by Colombia, Brazil, Guatemala, Panama, Spain, Trinidad and Tobago and Tunisia at the eighth session of the Committee on Housing, Building and Planning at Geneva in October 1973.

2. Areas of concentration

In view of the importance of the potential contribution of plastics in agriculture, it was recommended that UNIDO assist and promote the further development of the plastics industry to produce the following: shelters for animals, greenhouses, tunnels and mulching for vegetables and crops, water reservoirs and conservation, irrigation and drainage, weather protection, hardware for farming and transplants, silage and storage, and packaging, harvesting and transport.

The contribution of UNIDO in these areas would be the provision of expert advice including the organization of advisory teams for demonstration and discussion; the establishment of training facilities including quality control and establishment of plastics technology centres; promotion of contacts; and attraction of investment.

3. Assistance to Sudano-Sahelian countries

In response to General Assembly resolution 3054 (XXVIII) and the Permanent Inter-State Committee on Drought Control in Sahel for assistance, it was recommended that since the first immediate need is water for human needs, animals and crops, UNIDO could assist in the production and application of plastics film and pipe for water conservation, reservoir storage and distribution systems.

It was also recommended that UNIDO should study the desirability of setting up one or more experimental demonstration stations for production and use of plastics materials in desert agriculture. The following activities are suggested:

(a) Preparatory mission for site selection and feasibility study based on information already gained by UNIDO expert mission in September 1974;

(b) Expert services through the consultants present at the Symposium and from other sources;

(c) Training and visits abroad of local personnel prior to the establishment of the project.

4. International co-operation

Since the successful introduction of plastics in agriculture depends on both plastics production and the application of technology and techniques on an international level, it was recommended that continuous co-operation between UNIDO, the Food and Agriculture Organization of the United Nations (FAO) and CIPA should be maintained to encourage and promote plastics utilization. A co-ordinating committee of these bodies should be established for this purpose.

The Symposium expressed its appreciation to the Government of Argentina and the Government of the Province of Buenos Aires for a very generous offer through UNIDO to make the facilities of the demonstration and experimental station of plastics in agriculture available to all developing countries once the station is established and fully functioning.

I. OPENING OF THE COLLOQUIUM: PAPERS PRESENTED BY CIPA AND REGIONAL STUDIES

The Sixth International Colloquium on Plastics in Agriculture was inaugurated by the Under-Secretary of State for Industrial Development, Leopoldo Romero and by the Under-Secretary of National Agriculture, Armando Palau. A message from the Executive Director of UNIDO was read by Wilfred Pflucker, Resident Representative of the United Nations Development Programme (UNDP) in Argentina. It was attended by some 400 participants from 40 countries, of which 16 were Latin American countries. They included some 25 participants selected from the developing countries by the United Nations Industrial Development Organization (UNIDO), representatives of private industry, government agencies, consulting organisations, institutions of higher education and supporting trade and professional organizations; observers from private industry; and UNIDO staff, experts and consultants.

The papers presented provided a general review of use and developments of plastics in agriculture from CIPA member countries, while the general situation of plastics production, fabrication and use in agriculture in Latin America was presented by the country participants, with the exception of Brazil and Cuba whose representatives were not present. Other topics covered included high prices and shortage of raw materials, technical assistance and investment promotion.

The first ten years of activities by CIPA were described in a paper which indicated that there were now 10 member countries, and it was expected that 4 more countries would soon be joining. Plasticulture now went to 39 countries and was the only publication on the subject of plastics in agriculture.

CIPA was now recognized as a non-governmental body with consultative status at UNIDO. Co-operation with UNIDO on the problems posed by the Sudano-Sahelian drought in the Sudano-Sahelian zone was already in action.

CIPA intended to set up some new technical commissions to extend further the activities and assistance of the organization; but this would take time because of the lack of adequate funds.

In examining the world usage of plastics in agriculture, data from 16 countries were presented for 1963 and 1973. World consumption in 1973 was estimated to be about 900,000 tons, which at an average annual growth rate of 13 per cent would give for 1984 a tonnage of 2.6 million tons.

The report from Argentina noted that 1973 was characterized by a raw-material shortage and an increase in demand. Protected cultivations were dominant with some 250 hectares of greenhouses and 600 hectares of tunnels covered with polyethylene (PE) film. Structures were simple to keep costs low. A major development was noted in the protection of grain and forage (silage), and this market was expected to rapidly expand, with current consumption 1,500 tons per annum. Interest was growing in the use of PE film for water reservoirs and canal linings. The use of both rigid and flexible polyvinyl chloride (PVC) pipes for spray and trickle irrigation had expanded.

From Spain, it was reported that there had been a considerable increase in the use of plastics in agriculture during the past few years. The area of protective cultivations (greenhouses, tunnels etc.) had an annual increase of 59 per cent since 1971. Increased consumption of plastics also resulted from new applications in the cultivation of cotton and pimentos, as well as expansion of the trickle-irrigation systems to citrus fruit orchards and vineyards. A detailed list of statistics was presented and analysed covering many variants.

In the paper from France, it was reported that there were three main areas of application - mulch, tunnels and greenhouses. It was predicted that a new expansion of consumption would arise from developments of irrigation and drainage, windscreens, anti-hail nets, silage and containers. The important role played by the French Committee for Plastics in Agriculture in animating and co-ordinating these developments was stressed.

A report from Hungary noted the rapid expansion which had taken place since 1971 in plastics applications in agriculture. The per capita consumption in 1973 was 17 kg. Current consumption was in excess of 16,000 tons and mostly used in horticulture. The use of plastics for water conservation and pipes was increasing, and mulching and soil conditioning were now being introduced. The planned growth of agriculture would indicate that the ultimate usage would be three times the existing figure.

The production of plastics film and sheeting was to be expanded, as well as polyester for equipment application. It was intended to examine the potential and possible application for photo-degradable plastics. Finally, it was noted that the realization of these plans could be affected by possible changes in the price of petroleum and other basic chemicals.

From Japan it was reported that plastics-covered greenhouses were becoming widely used in agriculture. With 19,000 hectares of plastics-covered greenhouses, the Ministry of Agriculture had launched a scheme of joint operation to increase the size of holdings to achieve better efficiency. The operation was subsidized by about 50 per cent of the costs involved. Japan had been lagging behind in basic research for the greenhouse industry, but a five-year comprehensive plan from 1974 was now being implemented.

In a paper from Portugal, it was reported that the world demand for food products favoured conditions of rapid development of plastics in agricultural applications in that country. The raw-material shortage should eventually be resolved by the proposed local petrochemical plant, which would have a capacity in excess of the country's total requirements.

Apart from the normal applications of plastics films for crop protection and pipes for irrigation, some other applications were now developing. These included windscreens for rice, soil covering for fumigation, small boxes for produce and transport of fruit, reservoirs and trickle irrigation. Despite the economic difficulties, the development of plastics in agriculture had a favourable influence on the food-processing industries, such as tomato concentrate and purée, and the freezing of strawberries.

In a final paper from the United Kingdom of Great Britain and Northern Ireland on plastics in agriculture in some developing countries, a review was made of the various areas of applications which had been developed. It covered rubber, tea, palm-oil and rice as well as horticultural and floricultural crops. Technical factors which could influence the quality of the plastics product during processing and its relationship to the agricultural application were discussed. It was noted that the technological development necessary to establish the successful application of plastics in agriculture in developing countries was often lacking, since there were no facilities available to the plastics industry for this purpose. UNIDO technical assistance could be rendered in this area.

II. OPENING OF THE UNIDO SYMPOSIUM

A message from the Executive Director of UNIDO was read by H. May (UNIDO), Officer-in-charge of the Symposium, expressing gratitude to the Government of Argentina as hosts to the meeting. Thanks were also expressed to CIPA, ILAP and CALIP for their co-operation and efforts in organizing the Symposium.

Participants from Latin America and from other regions were welcomed. It was noted that UNDP and UNIDO support for this meeting had been in recognition of the outstanding success achieved by the Bogotá Symposium in 1972. The opportunities presented for personal contacts and exchange of views would help towards achievement of the Symposium's purpose, which was to promote development of the plastics industry in the region.

The attention of the participants was drawn to the problems arising from the prolonged drought in the Sudano-Sahelian countries for which international and bilateral efforts were still continuing. A request was therefore made for offers of assistance and suggestions since several papers to be presented to the Symposium were to deal with the subject of agriculture in arid areas.

In a short paper on the activities of ILAP, it was stressed that this organization could be the instrument for integrating the needs of the plastics industry in Latin America. The creation of one Latin American training centre had the advantage that it was not only within relatively easy travelling distance for Latin Americans but would specifically be tailored to their needs and requirements.

ILAP had now been granted consultative status as a non-governmental body with UNIDO. ILAP had knowledge of Latin American experts who could not only assist in the development of the Latin American plastics industry but also in other developing countries.

In a paper dealing with the activities of the Industry Co-operative Programme (ICP) of FAO, the basic objectives were detailed. The plastics working group of ICP had a mission to serve developing countries by studying the state of the market, to make project proposals and to ensure industrial collaboration. ICP together with both UNIDO and FAO could achieve better co-ordination.

A paper on UNIDO assistance and programmes for industrial development in developing countries outlined the instruments of action that were available; namely provision of experts, training by fellowships or group training programmes and establishing and fostering contacts between countries. The present state of achievement of UNIDO activity following the Bogotá recommendations was detailed, and operational projects in hand described. Details were also given of the specific areas of concentration involving UNIDO at the present time.

The final paper of the opening session dealt with the activities of the UNIDO programme on industrial investment promotion. These activities not only gave assistance in strengthening the investment promotion institutions of developing countries, but also gave assistance to Governments and industries in promoting specific projects. Various instruments of action included investment promotion meetings at both multisectoral and sectoral levels, such as were being promoted for plastics during the course of the Symposium and the ARGENPLAS '74 exhibition. Past experiences were described. This was the third such activity in support of the plastics sector following the Bogotá and London meetings of 1972 and 1973, respectively.

III. SUMMARIES OF COUNTRY PAPERS

Argentina

Many of the 1,500 plastics companies in Argentina were small-scale units. Employing 50,000 persons, they achieved a turnover of 300 million pesos.

The consumption of raw materials in 1973 was as follows (in tons):

PE-LD	60,000
PE-HD	7,000
PVC	42,000
PP	7,000
PS	30,000

Some 30,000 tons of PE-LD, 28,000 tons of PS and 36,200 tons of PVC were produced locally. With a per capita consumption of from 10 to 12 kg, it was expected to reach 25 kg by the year 2000. Although growth had been restricted by the world raw-material shortage, better economic prospects were in view.

During the past five years, the production of plastics-processing machinery and accessories had been developed. It included extruders, blow extrusion, vacuum formers, presses, preheaters etc. During this period, 150 injection moulding machines had been exported, in addition to many dies and moulds. The mould-making sector was highly sophisticated and produced many complex moulds such as those required for products in the automotive industry where accuracy of dimension was of major importance. The various plastics processes covered a broad range of operations and were continuing to expand.

Technical training was carried out by INSTIPLAST, where regular courses were held for technicians and workers.

New petrochemical projects were currently being studied as further support for the industry.

Applications of plastics in agriculture covered a wide range as reported in other papers presented to the Symposium, among which were PE film tunnels and greenhouses, mulching, overhead and trickle irrigation, water storage and canal linings.

Bolivia

Although having only 0.43 kg consumption of plastics per capita, the industry was expecting to maintain a growth rate of 43 per cent. During 1974, it was estimated that 7,568 tons of plastics will have been processed.

While 90 per cent of the plastics industry was located around La Paz, it was expected that with the development of agriculture and agricultural applications, expansion would take place in the areas of Santa Cruz and Beni.

Although primarily a mining country, agricultural development was taking place in three areas:

(a) The Altiplano region, with a dry and cold climate (average 9.1°C), 4,000 m above sea level, provided potatoes, vegetables, barley, oats, quinua and other cereals;

(b) The central region of Cochabamba, Tarija and Chuquisaca, 2,600 m above sea level, provided corn, wheat, oats, fruits and vegetables in a climate with average temperature of 17°C;

(c) The tropical region of Santa Cruz, Beni and Pando, 500 m above sea level, where the principal crops were cotton, cane sugar, tobacco, peanuts, soya, cocoa, cereals, yucca and sweet potatoes.

The application of plastics in agriculture was only just beginning, and the market was completely undeveloped. In the tropical zone, some experiments had been undertaken with PVC and PE pipes for irrigation, while in the Altiplano zone, experiments with tunnel covers had been very satisfactory increasing yields by 25 per cent. However, there were problems in persuading the local growers to change their age-old techniques of growing.

It was suggested that some of the 14 research centres in agriculture might be utilized to develop the applications of plastics to agriculture. However, Bolivia concluded that it will need technical assistance to improve both the fabrication of plastics and to develop the technology of application to agriculture. Additionally, help was requested for training Bolivian technicians to establish a realistic agricultural-industrial development.

Chile

In Chile, some 220 plastics-fabrication factories produced a wide range of products for many end-uses. Although there was a world shortage of plastics raw materials, Chile had sufficient domestic production to export fabricated items such as PE film and tubes. Successful applications of plastics in agriculture in several areas included PE film-covered tunnels and greenhouses for flowers, tomatoes, melons and peppers, mulching, silos and irrigation, which were all functioning adequately.

However, much work remained to be done in Chile; and there was need for joint action. One obstacle was lack of capital for publicity and promotion, and another was lack of credit facilities for farmers.

Chile still imported foodstuffs for its 10 million population, despite the fact that it has sufficient agricultural land to feed 80 million people. However, a start had now been made to reorganize the agriculture of the country which could provide many opportunities for plastics applications. Nevertheless, there was a lack of any real co-ordination by which the knowledge of plastics applications could be diffused.

The fundamental problem currently facing the country was a lack of financing necessary for restructuring the agricultural industry. It was within these limitations that plastics in agriculture in Chile was currently developing.

Colombia

The continuing world shortage of plastics raw materials maintained prices at an extremely high level without precedent. In some cases, the increase was as much as 1,000 per cent. Even so, there was still a shortage of materials for the plastics-fabrication industry, which in 1973 utilized some 20,000 tons of plastics. With an annual growth rate of 20 per cent, it was expected that the shortage would be further compounded, and its effect on prices was beyond calculation.

Of all plastics raw materials used by the fabrication industry, PE-LD, PE-HD, PP, PS and PVC represented about 85 per cent of the total. It was estimated that for 1974 the percentage of increase in consumption of these plastics raw materials would be as follows:

PE-LD	18.8
PE-HD	117.5
PP	29.7
PS	82.9
PVC suspension	82.9
PVC emulsion	8.4

These considerably high figures were the result of the present abnormal difficulties of supply, which, if the shortage continued, could lead to a reduction in the raw materials used in 1975.

Agriculture was of some importance in Colombia contributing 27 per cent to the gross national product. For this reason, the use of plastics in agriculture was an area that had already received some attention, particularly in

the packaging of agricultural produce. PE bags and woven PP sacks were used for these purposes; while PVC pipes were used for irrigation systems. PE films were used for greenhouses both for flower growing and vegetables, as well as for lining of canals and reservoirs. However, consumption was still low, and there was a specific requirement for better diffusion of technical information on the applications of plastics in agriculture.

It was later announced that Colombia would join CIPA and would thus be enabled to promote and encourage the development of plastics in agriculture in Colombia.

Costa Rica

Costa Rica, with only 1.9 million inhabitants, has a modern and highly developed plastics industry geared to exporting its finished products to the Central American Common Market (CACM) and to Panama.

At the present rate of export, the 1974 figure would be about $9 million representing some 7.5 per cent of the total industrial exports (excluding agricultural products).

The output of 30 factories covered a wide range of products, such as acrylic and PS sheet, PE film, polyurethane sheets, toys, pipe and conduit, electric cable, PP woven bags and plastics shoes. The raw-material crisis forced various factories to reduce their rate of production, but no factory was completely paralysed despite the fact that prices to the consumer rose between 200 and 350 per cent compared with prices before October 1973.

A good development of plastics in agriculture was reported with the largest use in banana growing. PE film was used for covering the growing fruit and for packaging. A new development in this area was the incorporation of the insecticide into the PE compound so that the bag did not require insecticide powder dusting before being applied to the fruit.

Although PVC pipes had been officially accepted for use in piping potable water supplies, drainage and ventilation, few had been used in irrigation. It was hoped to introduce drip-irrigation techniques, and this was expected to have a large market. However, Costa Rica required technical assistance in this development, as it does not have enough experience in the technology of application.

PE film was being used experimentally for tunnels, primarily for vegetable production in areas of high rainfall. The use of PE film-covered greenhouses for flower production covered some 60 hectares. Experiments with shading, using Saran (polyvinylidene) and PP nets had been undertaken without reaching satisfactory results.

PE film for mulching of strawberries covered some 28 hectares with excellent results, and it has also been successfully used for tobacco and vegetables. PE film had also been used with methylbromide for soil fumigation of mushroom beds as well as for disinfecting areas in banana plantations. In cultivating and transplanting, plastics planting bags were used for nursery stock of coffee plants, fruits and ornamental plants.

PE film was used in the tropical lowland of Costa Rica to trench silos and also as covers for bales of hay in open fields.

In harvesting, packaging and transportation, plastics played an important role. Almost all fertilizers were packed in PP woven bags having an inner PE film liner. In the banana industry, large quantities of plastics were used in packaging and transportation.

In rural areas, plastic pipes were used to bring water to homes and to cattle feeding troughs. Plastics were also used to construct storerooms to protect agricultural products and equipment.

Ecuador

Ecuador, with a population of 6.5 million people, entered the plastics industry through the need to provide PE film bags for banana fruit covers in the late 1950s. The plastics fabricators soon diversified into the much wider domestic market area, and there were now more than 50 factories. They covered a wide range of processing and biaxially oriented film.

While PVC was imported from Chile, the remaining raw materials were purchased outside Latin America. The estimated demand for 1975 was (in tons):

PE-LD	10,000
PE-HD	2,500
PVC	4,500
PS	2,000
PP	2,000
ABS	500

The past few years had seen a growth rate of some 25 per cent, which was expected to continue. Growth was limited only by the economic situation of the country which looked promising at the present level of export prices for petroleum and under a Government which was successfully upgrading the living level of the population where the annual per capita income is now approximately $700.

If packaging was included, then about 35 per cent of the PE was used for agricultural applications. Ultra-violet (UV) screened PE film had been recently used for covering of greenhouses for carnations in Quito, and flexible tubing in PE-HD had been used for irrigation. On the coastal area, there had been no development of plastics in agriculture, but the prospects appeared promising and were limited only by the raw-material prices of plastics and their impact on the economics of the potential applications.

Honduras

Honduras is an agricultural country with many small farms. Technical knowledge, economic financing and the spirit required to modify and update the farming techniques are absent. These factors had affected the development of plastics in agriculture. However, the banana plantations used plastics products, and most of the plastics-processing plants were originally created to supply them. For bananas, there were three applications:

(a) PE film to protect the banana fruit on the tree from attack of birds, insects and fungus;

(b) PP twine or rope to tie the banana tree for more resistance to the wind, and the weight of the banana cluster that tends to bend the tree;

(c) Perforated PE film for packing of bananas in cardboard boxes.

For other farms, both PVC and PE pipes were used for water supplies and for irrigation. Planting bags of black PE film were used for young trees, while woven PP sacks were used for transport and storage of grains. They were also used to pack tobacco leaves.

A small quantity of PE film had been used for lining irrigation channels and for water reservoirs.

For the future, the current high price and scarcity of raw materials had reduced the appeal of plastics products. Nevertheless, the development of plastics in agriculture could be further encouraged by continuing with this series of symposia and ensuring the presence of representatives of co-operatives, agro-business and directors of agricultural development programmes.

Jamaica

The Jamaican plastics industry was a viable and rapidly developing industry with some 25 fabrication factories in production. The recent raw-materials shortage and price increases of up to 300 per cent for some items had meant a cutback in production with some processing factories operating only three days per week. Because of this situation, no producer was prepared to disclose production figures. The development of the industry had been aided by government policy in three areas; incentives, restrictions on competing imports and duty-free raw materials.

Exports were limited to member countries of the Caribbean Community Secretariat (CARICOM) and included gramophone records, PVC pipes and fittings, PE packaging film, rigid and flexible polyurethane foams, spectacle frames and a wide range of domestic consumer goods.

The development of applications of plastics in agriculture was assuming an increasing degree of importance. An active expansion of the nursery-plant and flower industry was expected to reflect a 500 per cent increase in PE-film planting bags. Some 600 tons of PE film was used for packaging of fruits, vegetables and fertilizers, of which 80 per cent was accounted for by banana plantations.

Because of a failure of PVC pipe fittings under high-water pressure, the use of plastic tubes for pressure irrigation had not been widely accepted. Irrigation was limited to PVC pipes, garden hose and syphon tubes for flood-irrigation systems. PE film was increasingly used for silage making and was of economic benefit, particularly to the small farmer.

For poultry production, plastics were used for egg-setting trays, transport trays and protective packing of fertile eggs. This transition from more conventional materials has improved sanitation, and because of their longer life had been found to be more economic. Egg containers were produced from PS as well as catching crates, watering devices and packages for dressed poultry.

In the dairy industry, plastics were used as containers for yoghurt, ice cream and transport cases for boxes of milk. While plastics bottles had not yet been developed for whole milk, the prospects appeared promising.

The fishing industry used a wide range of plastics products only in small quantities, such as nets, ropes, lines and fibre-glass boats.

Some Saran and PP nets had been used for horticultural shading and protection from rain, while 50 acres of greenhouses were covered with PE film. However, the design of the houses had been limited due to the rather narrow widths of film that were available. If larger widths were produced, different greenhouse designs could result as well as the application of the film for lining of reservoirs.

Mexico

Mexico, with a population of 52 million inhabitants, had a plastics consumption of 5.5 kg per capita. The plastics industry was dynamic with an annual growth rate of 27 per cent. Currently, it produced some 89 per cent of the national requirement in polymers and had expansion plans to increase both polymer and processing production.

Monomer production was also being expanded. For ethylene, the present capacity of five plants was 253,000 tons/yr, while a plant under construction would add another 182,000 tons/yr, and a projected plant of 500,000 tons/yr would provide a total future capacity of 933,000 tons/yr. In 1973, exports of ethylene earned $6.3 million.

Propylene was utilized for the production of dodecyl benzene and acrylonitrile, which was in turn used for production of acrylic fibres with a small quantity being utilized for production of ABS. Consequently, all PP polymer had to be imported.

Some 35,000 tons/yr of styrene were currently produced and this would be supplemented with a new projected unit of 100,000 tons/yr to give a total 135,000 tons/yr capacity, made necessary by a 22 per cent growth rate. This monomer was used for production of both synthetic rubber and of PS.

Vinyl chloride production from two plants produced some 89,000 tons/yr and a new projected plant of 150,000 tons/yr would provide a total capacity of 239,500 tons/yr. Vinyl acetate monomer production has an installed capacity of 13,200 tons/yr.

Although there was no current production of methyl methacrylate, a new plant of 10,000 tons per annum capacity was proposed for 1975. The 1972 production of synthetic resins (plastics polymers) amounted to 206,590 tons and was in the following percentages:

PE-LD	31.6
PVC	25
PS	12.8

representing 69.4 per cent of the total resins produced.

The 61,900 tons of polymers imported in 1973 represented a 12 per cent decrease on the 1972 figures. Of these imports, PE-HD and PP represented some 66 per cent. On the other hand, 3,976 tons of polymers were exported in 1972, of which 1,340 tons were PVC.

It was projected that by 1980 the per capita consumption could be increased to 15 kg, but this would require the development of markets and the promotion and co-operation of all parties and institutions to achieve this aim.

Plastics in agriculture in Mexico covered a number of uses: they included PVC pipes and syphons for irrigation, liquid ammonia injectors for soil cultivation and as seed drills. PE film was used for covering of greenhouses and tunnels, while PE-HD fibrillated film was used for woven sacks for packaging of onions and peppers.

Woven PE sacks were also used for packing of fertilizers and sugar; while reinforced glass-fibre sheets were used for portable buildings and roofing of grain stores, and for the construction of water containers and feeding troughs for poultry. Expanded PS was used as an insulation material in rural buildings, and PP was used as raffia and also for woven sacks.

Nicaragua, Guatemala and El Salvador

A combined paper from Nicaragua, Guatemala and El Salvador was presented at the Symposium. These countries with a total population of 12 million inhabitants were basically agricultural and had a common Pacific coast.

The main agricultural products were coffee, cotton, sugar and meat. The plastics industries had developed quickly since 1950, and this was assisted by bilateral exchange. Plastics production in 1968 was 19,000 tons/yr, and at the present rate of growth would reach 78,000 tons in 1975. The

average per capita consumption was 1.9 kg, and this was expected to increase to 4.7 kg in 1975. The figure was somewhat distorted because El Salvador has a per capita figure of 6 kg.

PVC was produced in Nicaragua with a capacity of 6,000 tons per annum, and this was supplied to CACM. However, complaints had been voiced at the relatively high cost of this polymer which made it impossible to compete in the international market. Difficulties in obtaining imported raw materials and at high cost were also reported.

The largest part of the plastics fabrication industry was concentrated on packaging and construction applications. Its future growth rate was expected to be 20 per cent.

Plastics in agricultural applications had not been greatly developed in these countries through lack of knowledge and the necessary technological skills. PE bags were used for banana fruit growing and for packing. Planting bags were also used for coffee, while transparent PE film was used for shading of tobacco plants and for greenhouse covering. The main crops of the countries presented possible applications for plastics, particularly by irrigation, but few reservoirs appeared to have been constructed. Some 5,000 tons per annum of PP woven sacks were used for packaging of fertilizers and for frozen meat. Packaging of chickens, eggs, milk products and cheese all utilized plastics materials.

The establishment of a plastics technology centre to serve the needs of the area was stressed, and Nicaragua specifically pointed out that such a UNIDO proposal was included in their country programme. All three countries highlighted processing problems, equipment selection, moulds and small markets as areas requiring UNIDO technical assistance. Guatemala also stressed the need for technical assistance to establish a plastics technology centre and outlined the need for an information centre on technology, new techniques of production and for quality control of plastics products to enable them to penetrate wider markets.

Panama

Panama had a small but diverse plastics industry covering the basic processes of extrusion, injection and blow-moulding. Sophisticated equipment was not justified to meet the small demand (population 1.2 million). Nevertheless, the 10 factories had a total annual production of some 12,000 tons.

All raw materials were imported, and both the world shortage and the higher prices have forced previous users of plastics to turn to cheaper substitutes like paper to replace PE film and asbestos cement pipe to replace PVC pipe.

In Panama, it became necessary for plastics processors to hold up to a one-year supply of raw material in stock, and this coupled with both the high cost of labour, electricity and transport and the lack of experienced technical management have all made the market difficult with a resulting market decrease in the use of plastics products. If prices continued to increase, production would eventually cease; however, if this factor was removed the growth potential was good.

Exports to CACM countries had been slowly progressing through bilateral agreements, supplemented by the banking system in the country, which provided low-cost financing and investment.

Since agricultural development in Panama had been one of the smallest in the world, applications of plastics in agriculture had therefore been limited. PE film was used in banana plantations as a fruit cover as well as for packing. It was also used as a mulch for tomatoes and as tunnel covers for tobacco seedlings. PP baler twine was used to secure banana trees from wind damage.

Tests on the use of PE film for grain silos for small farmers had been undertaken by the University of Panama, and preliminary results appeared promising. PVC pipe was used for irrigation but limited in extent due to increasing price and low allocation of raw materials. Drip irrigation presented good potential for the future, and growers of tomatoes, cane sugar and apples were interested in this technique.

UNIDO was requested to continue assistance in training technical personnel in the techniques of applying plastics for water management and agriculture.

Paraguay

Although the plastics industry was only 12 years old, the country had now reached a *per capita* consumption of 1.2 kg per annum and an estimated 20 per cent growth rate. For 1974, the consumption of plastics raw materials was calculated at 2,002 tons/yr, 13 factories used a mixture of extrusion, blow-extrusion, injection, foam and laminating processes. All raw

materials were imported, mostly from Europe because of better payment conditions than could currently be obtained from their industrial neighbours Argentina and Brazil. Processing equipment likewise was of European origin, although financial credits had now been arranged with both Argentina and Brazil, which would influence future purchases of equipment.

The use of PE-HD pipes for potable water supplies has just begun in Asunción and in the interior of the country, while pipes for telecommunications have also been adopted as ducts for underground telephone cables. These applications would ensure full production for the next few years. There was no mention of any plastics in agricultural applications.

The plastics sector was also affected by lack of import protection, but recent reductions on raw-material import taxes have eased the present problem. The plastics industry in Paraguay was not seeking economic help or operational capital for its future, since there are sufficient lines of credit. However, it did lack experienced entrepreneurs, skilled labour and personnel specialized in handling equipment and moulds. Technical assistance from UNIDO was requested to advise on rationalizing the manufacturing processes and also scholarships for training of plant personnel at all levels.

Peru

The plastics industry was based on imported raw materials, which included both thermoplastic and thermosetting resin. In 1973, 18,000 tons were imported. PVC, however, was produced locally, based on alcohol from molasses. The 1973 production of 5,543 tons represented 75 per cent of the over-all consumption. In 200 factories, manufacturing operations used a wide range of processing equipment; injection, extrusion, compression, blow moulding, vacuum forming and rotational moulding. New machinery was to be of higher throughput rates with a view to increasing exports within the Andean Group. Exports in 1973 amounted to $800,000 million in pipes and joints, floor tiles, toys and PP woven sacks.

A petrochemical complex was planned for 1979-1980 utilizing the local petroleum supply. Apart from a 250,000 tons per annum ethylene unit, the complex would have a total capacity of 350,000 tons of plastics and elastomers.

In order to rationalize the plastics-processing industry, the Government was proposing that all small companies become associated into larger groups with a minimum $250,000 capital investment. Additionally, incentives were to be provided to establish new industries outside the Lima area.

To support the new capacity, it was proposed to start a prefeasibility study for the use of plastics in agriculture in 1975, and the Government would apply to UNIDO for technical assistance in the field of plasticulture. PVC pipes and fittings were being used in a new irrigation project at La Jaya Arequipa, and apart from PE film for packing, this represented the only large use of plastics in agriculture.

It was proposed to establish a centre for research in Peruvian plastics materials which would co-operate with the Instituto de Investigación tecnológica y de Normas Técnicas to control the quality of Peruvian plastics products.

Uruguay

Starting with thermoset mouldings in 1940, the plastics industry had developed, particularly from 1962 to 1972, to 170 plastics companies. During this period, consumption rose from 2,500 to 15,000 tons. Since then, the industry has stagnated. However, new government regulations would permit the possibility of renewing obsolete machinery and of incorporating the latest technological developments. New lines of medium- and long-term credit had been opened in an attempt to revitalize the industry, and this also meant developing export markets. An agreement had been completed with Argentina and another was being negotiated with Brazil. It was hoped that this new effort would raise the per capita consumption beyond the present 5 kg.

The industry covered a very broad range of processing technology, of which injection moulding consumed the largest share of raw materials, and a wide range of products from domestic wares to intricate industrial mouldings. The industry had been supported by a very good mould-making industry whose quality of product enabled it to export moulds to many countries.

Thermoset moulding had been decreasing due to high labour costs and delivery of the first labour-saving, thermoset, injection-moulding machines was expected soon. All extrusion processes were represented, with the exception of co-extrusion, and blown containers up to 50 litres were produced.

Apart from the normal range of other processes available, it was noted that both polyester and acrylic sheets were also produced and utilized for buttons and decorative craftsmanship.

With the exception of phenol and urea formaldehyde moulding powders and some plastics, all raw materials were imported.

There are many areas for development by the plastics industry, particularly in building applications. Despite the fact that Uruguay was an agricultural country, very little had been achieved in the field of plastics in agriculture. To support the new period of expansion and modernization, there were requirements of capital investment for equipment, know-how, training, investigation and development which exceeded the possibilities both of local enterprises and national resources, and for which UNIDO assistance would be requested.

It was later announced that Uruguay intended to organize a national committee for plastics in agriculture with a view to promoting this area of application. It would then apply for membership in CIPA.

IV. TECHNICAL PAPERS ON PLASTICS APPLICATIONS

A total of 45 papers was presented on applications of plastics grouped under 6 headings namely, crop protection, mulching and soil treatment, harvest, packing and transport, rural constructions, water management and finally, special applications, new developments and economic aspects.

Crop protection

Eight papers were presented on crop protection.

A paper on the use of woven plastics in Argentina described initial difficulties in convincing the growers of the advantages of using such material for protection against cold winds and birds as well as a means of providing shading. The use of plastics anti-hail nets for vineyard protection had been well demonstrated. Despite the apparent high capital cost, the benefits more than justified its use. This point was further emphasized

In a second paper which dealt with nets made of PE-HD. Additionally, the nets provided a microclimate for the vine, and temperatures 2°C warmer below the net had been observed during cold periods.

In a paper describing a series of trials utilizing tunnels covered with different combinations of clear and reflective PE film, it was shown that earlier ripening of a crop was realized with pumpkins and pimentos, while early colour development in pimentos and tomatoes was noted when using a low tunnel partly covered with reflective PE film.

A further paper dealt with the various forms of plastics-covered structures used for semi-forcing of crops grown in the eastern part of Spain.

The use of plastics for the protection of crops against disease caused by weather conditions was described in another paper. Various economic studies were being undertaken to evaluate the effect of plastics for crop protection against adverse weather conditions such as wind, cold and hail.

Continuing on the subject of adverse weather conditions was a paper outlining the work carried out in Patagonia, Argentina. Under adverse conditions of wind and cold, it had been possible to produce in plastics-covered walk-in tunnels not only an earlier cropping of tomatoes but three crops against only one crop in the open air in the same period.

In a paper on plastics for growing of vegetable crops in Portugal, it was noted that there had been an increasing use of plastics for this application in the past few years. The objective of plastics-covered greenhouses was to achieve earliness of cropping. A study had been made of various Portuguese geographic zones to ascertain where the climatic characteristics which were most appropriate to developing early vegetable cropping were located. It was concluded that the coast of the Algarve in southern Portugal and the littoral regionel south of Lisbon were most suited for intensification of this type of growing.

The different applications of plastics materials for the controlled cultivation of chrysanthemums were described in another paper. Plastics film as a mulch controlled the water evaporation from the soil and also reduced or eliminated certain disease problems that occurred when the mulch was not present. Irrigation of the crop with fertilizer dissolved in the water by

means of plastics pipes under the mulch reduced labour and made significant economic savings in distribution, while producing more important and immediate effects upon the crop.

By using black PE film, it was possible to totally exclude daylight from the plant thus artifically controlling the photoperiodic cycle which determined when the plant would flower. Thus the technique permitted chrysanthemums to be grown during the entire year, although in certain periods of the year, it was necessary to use both supplementary heating and artificial illumination.

Mulching and soil treatment

Six papers were presented on mulching and soil treatment.

Two papers on the use of PE film for soil fumigation in the United States of America indicated that the techniques had now spread from the strawberry growers, where the entire area was fumigated ahead of each crop, to use in orchards and vineyards. After use, the film was dumped and not reclaimed, though it was thought recycling would be employed in the future. Experiments with 25 µm PE film as a fumigation sheet (tarp) showed that the dosage could be significantly reduced with gel formulations of fumigants.

In a paper on growing pineapples in Brazil, it was stated that large areas of land were poorly cultivated and produced low yields and consequently low returns. In an attempt to raise the production of pineapple cultivation, trials with black PE mulch were undertaken. The results were outstanding. With one variety, yields have been nearly doubled, less work was needed on cultivating the soil, and the economics had appeared sufficiently interesting that an area of 50 hectares had now been mulched.

Trials with mulching of tomatoes grown outdoors with black PE film was the subject of a paper from Argentina. Different techniques for supporting the tomatoes were also tested, and the initial results indicated that higher yields and better quality fruit were obtained from the mulched area.

Black PE film mulching of vineyards was now widely practiced in the south of France. A paper dealt with the advantages which had been observed there. Mulching decreased the labour necessary for grape production, increased yields of up to 150 per cent had been noted in some cases, as well as improvement in

the quality of the grape. The film dimensions which had been found most satisfactory were described. It was stated that there might be some problems in using a plastics mulch in wet soil areas.

In contrast, a paper from Algeria reported experiments in various climatic zones of that country on the effect of mulching with PE film. Its effect on several parameters was being examined. It was noted that mulching could play a most important role in the economy of water, particularly in semi-arid areas.

White, perforated PE film, plus herbicide soil treatment, had been examined as a means of overcoming the heat build-up experienced with black PE in the semi-arid areas. Yields had been markedly improved as well as the quality of produce. On the basis of results obtained, it was now intended to extend the trials to examine the use of a woven plastics mulch.

Harvest protection, packing and transport

Five papers were presented dealing with silage, grain, peppers and flowers.

Two papers dealt with the subject of silage, which is a method of preserving fodder crops. One described a technique used in the Federal Republic of Germany that employed a double layer of PE film to pneumatically seal the completed silo. It also stressed the need of correct processing to produce high-quality, black PE film of specified minimum thickness to ensure that the silage did not puncture the film and thus, through air leakage, spoil the quality of the final silage. This same theme of quality of plastics film was emphasized in a second paper which also dealt with plastics-film applications in different types of silage clamps and also techniques of making air-tight joints in plastics sheeting on the farm.

The factors affecting grain storage were discussed in another paper. It indicated that although grain-storage problems differed according to the climatic conditions, nevertheless if grain was harvested with a moisture content as high as 17 per cent, then such grain had either to be artificially dried, stored in sealed (air-tight) containers or kept at very low temperatures. Of these methods, air-tight storage could be achieved with plastics films either by storing in sacks or enclosing the grain in an unbroken membrane of plastic. All organisms responsible for spoilage of grain required oxygen

for survival, and the principle of air-tight storage was to exclude oxygen. While the oxygen permeability of PE film was sufficiently low to be irrelevant, every precaution was required to avoid puncturing the sheeting.

Low-cost sacks of 100-µm thick PE film provided useful small storage units, while large tonnages of grain were satisfactorily stored in sealed clamps and silos lined and sealed with PE film. Techniques for sealing the film in the field were also discussed.

In a paper on storage of citrus fruit, it was pointed out that modification of the atmosphere in an enclosed space as used for the storage of apples and pears, together with refrigeration, prolonged the useful storage period of these fruits. Using this known technique and selecting from various plastics used for storage of apples and pears, tests for their suitability for storage of citrus fruits was undertaken. The initial results suggested that PE film of 25-µm thickness was a satisfactory material.

In another paper, a new technique for the packaging of fresh cut flower buds for retail sales was described which permitted wholesale storage at 0°C for up to eight weeks; or displayed at the retail shop at 5°C for three to four weeks while still providing the consumer with a vase life of 7 to 14 days. The technique consisted in treating the stem of the flower bud with silver nitrate solution and packing bunches of flower buds in a 75-mm wide, 150-µm thick PE bag. The consumer could obtain additional vase life by placing the opening buds in a sucrose solution.

Rural constructions (greenhouses and sheds)

Five of seven papers on rural construction concerned greenhouses. One paper was devoted to tobacco drying and one to livestock housing.

In the paper on low-cost farm buildings for livestock housing, it was stated that there was considerable expertise already existing on how to secure plastics to timber and metal frameworks from experience with plastics-covered greenhouses. Film-clad structures could vary from the simplest rain shelter for cattle and sheep to insulated, controlled environmental buildings for poultry and for mushroom growing. To reduce the temperature in buildings clad with black PE film (for longest life), it was customary to paint the outside of the film with white or aluminium paint.

When two seamless sheets of PE were used to sandwich an insulating material, such as fibre glass, a very well-insulated layer resulted. This type of covering provided good, low-cost structures with excellent insulation properties. This justified heating in a cold climate and artificial cooling in hot climates. Such an insulated poultry house had been erected in Kuwait and was cooled by fans and wet pads, while similar structures had been used for mushroom growing in Europe, but utilizing heating systems for temperature control.

A paper from Argentina on tobacco drying, described a simple construction using locally available materials and covered with 200-µm thick, clear PE film. Controlled trials were conducted comparing this structure with the traditional methods of tobacco drying. The results showed significant benefits and better-quality tobacco by drying under the plastics structure.

The subject of low-cost greenhouses was covered in a paper from Spain where the large scale cultivation of vegetables and table grapes under low, plastics-covered tunnels required so much work during the cultivation period that an alternative system had become necessary. As the region concerned was an area where the growing was performed by people of modest means, it was necessary that any greenhouse structure should be capable of being built by their own labour. The structure that was developed consisted of wooden posts set at regular intervals, the top of which supported a series of galvanized wires such as to make an overhead lattice pattern. PE film was threaded under and over the various overhead tensioned wires to form a large covered roof. The system provided a means of covering large areas under one roof, and it followed the natural contours of the land. Many such structures were now being used for both vegetable and table grape production to produce both early crops and better-quality produce.

A Japanese study pointed out that fibre-reinforced plastics panels had been used for greenhouse construction in that country for 10 years. However, new improved qualities of panels were now being produced that had greater light transmission and superior weathering properties. The consumption of this type of panel for greenhouse construction had increased considerably in the past few years. It had been shown that labour was saved in the erection of such a greenhouse, and that plant response had been satisfactory in the diffused light conditions. This type of structure had been successfully used for tobacco-leaf drying and paddy-rice seedlings.

In two papers on double-layer plastics greenhouses for fuel conservation, it was noted that in the Federal Republic of Germany, commercial growers were using this type of covered structure. Work carried out in the United States of America compared two types of double-layer plastics, one with a static air space and the other with two layers separated by forced air. Three greenhouses were compared: one, the control, being covered with a single PE film, and the two others with the double layer of PE film. The results showed a 40 per cent reduction in fuel consumption for both types of double-layer insulation.

In another paper concerned with greenhouse heating, it was shown that the principle of a heat pump could be satisfactorily utilized to extract the heat from underground (spring) water supplies. In the normal method of heating a greenhouse, hot water was circulated through pipes at temperatures of 60° to 70°C. In the heat-pump method, a water temperature of 33°C only was reached, but by circulating the heat under a black PE mulch, it was possible to ensure that the heat was taken to the soil. Using this technique, it had been demonstrated in a reinforced-PVC, covered greenhouse that an inside temperature of 9°C could be maintained against an outside temperature of -11°C. With this prototype installation, it would be possible to examine the possibility of recovering useful energy from waste hot water from electricity-generating stations and from other water sources.

Agronomically, the new system permitted the soil to be rapidly heated, which was important for the development of vegetative growth following the period of planting. In this system of heating, the heat pump was more economic than heating by the hot-water boiler method.

Water management

Water management was discussed in 13 papers on irrigation and 4 papers on reservoirs.

In a paper on PVC pipes, it was indicated that these could be used for water distribution, irrigation, drainage and tube wells. The production requirements of a PVC pipe plant were discussed, and cost comparisons made with other pipe systems. The advantages of PVC pipe were: resistance to soil corrosion; light weight compared to metal pipes; and simple systems of joining.

In a paper from Argentina, it was noted that plastics for irrigation had been developed there since 1969, and satisfactory sprinkler and spray systems used plastics pipes and components. With large areas of potentially cultivatable land, where the rainfall was less than 500 mm per annum, the future market looked attractive. There was a lack of work on trickle-irrigation systems; and there was a need to predetermine the economic factors for their use after deciding which cultivations would be used for local and export consumer markets.

Experimental work on irrigation systems was described in a paper presented by a French participant. For three years, comparisons have been made between sprinkler and flood irrigation. Trickle irrigation had been evaluated, with and without the use of plastics mulch, as well as the addition of fertilizer in both spray and trickle systems, with and without plastics mulch. The results indicated that trickle irrigation with fertilizer and plastics mulch gave not only an earliness of crop but also increased yields. It was suggested that large-scale commercial growing trials should be undertaken to confirm these results.

It was reported in a paper from Greece that development trials with a special, trickle-irrigation system were now continuing for the third year. On the other hand, it was noted in another paper that trickle irrigation had been in widespread commercial use in Spain for four years. It had several advantages over other systems. It was effective for saving water and especially high-cost water. It could be used with slightly salty water, since the salt permeated to the outer perimeter of the wetted area. The system was adaptable to many different locations and it also reduced the labour requirement. The system utilized filtered water and mostly consisted of microtube or helicial emitters. These latter types were used for citrus fruits, avocado-pear orchards and vineyards and were particularly useful for young trees.

A paper from Italy described the use of a plastics, trickle-irrigation, flexible pipe below a plastics mulch for growing crops, where up to 80 per cent water saving had been observed. The same system could also carry the plant fertilizer requirement and thus effected additional labour savings.

Three papers from the United States of America also related to this subject. In irrigating flowers in a greenhouse with water distributed through two plastics irrigation pipes along either side of the flower-bed, it was

noted that the sides were wetter than the centre. The introduction of a third irrigating plastics pipe into the centre of the bed enabled a 20 per cent reduction of applied water to be made while still maintaining the same flower production and quality.

Large acreages of land had only been used for trickle-irrigation systems since the early 1970s. For permanent crops such as orchards and vineyards, longer-lasting plastics emitters were used, while for annual or biannual crops, inexpensive plastics trickle-irrigation systems were used. These were discarded after cropping, and the cost saving in both labour and water offset the costs compared to normal, furrow-irrigation techniques. The improvement of crop yield and quality also effected further savings. There were problems of frequency and longevity to be solved in relation to the growth demands of each crop and the type of soil utilized. Nevertheless, it was predicted that there would be an increasing use of these irrigation techniques as the technology and management improved with each crop.

In utilizing plastics trickle-irrigation systems under PE mulched strawberry beds in California, it had been observed that increases of yield were 50 to 70 per cent higher. Additionally, the system permitted the use of marginal land which would otherwise not have been brought into production. Water requirements were some 50 per cent less, thus achieving an effective cost saving, while salt accumulations had been reduced. The formation of algae and more effective filtration of the water were the current major obstacles that had to be overcome.

The effects of surface air pressure differentials that can occur over reservoirs, canals and water-catchment aprons under high-wind conditions were described in a paper from the United States. Some of the design considerations that were obtained from the study indicated that in order to minimize the area of a reservoir or canal that could be subjected to adverse pressures, the slopes should be as flat as possible. Where existing canals were to be lined with flexible plastics membranes, the expected pressure coefficient and area of influence could be predetermined. This enabled both the extent and the degree of lift control measures that had to be employed to be assessed.

In a paper from Portugal, an account was given of the use of black PE film for the lining of ornamental lakes in a tourist area. Several such lakes had been installed with surface areas up to 15,000 m^2. A paper from Spain

[illegible] stressed the need to conserve water in specific areas of that country where the annual rainfall was less than 200 mm. The high salt content of underground water supplies also made it necessary to conserve rain water. After 1960, a number of very large reservoirs had been constructed so that large-scale, mechanized irrigation systems could be utilized. These reservoirs were constructed using PE film and the established buried membrane technique.

By this means, reservoirs of up to 500,000 m^3 of water had been successfully constructed. While PE film was the preferred material, butyl rubber and PVC sheeting could also be used.

A paper from the United Kingdom of Great Britain and Northern Ireland described the technique to be used when installing reservoirs in termite areas. To avoid attack by several species of subterranean termites, the excavated site was first pretreated with an insecticide of low mammalian toxicity.

Two separate sheets of PE were then used. The first was laid over the pretreated ground and then covered with a slurry, made by mixing local soil with water and a specific amount of the insecticide. This would normally have a thickness of 75 to 150 mm. The second PE sheet was then installed in the normal manner on top of this, and the whole reservoir back-filled with earth. By this means, there was provided a second line of defence should the pretreated ground area become ineffective for any reason. Reservoirs of this type had been successfully installed in Nigeria, the Sudan and Zambia.

New developments and economic aspects

Six papers were presented on special applications, new developments and economic aspects. Three of them dealt specifically with possible applications of plastics in agriculture in the Sudano-Sahelian zone.

An Argentine paper described the initial experiments of using black PE film wrapped around the buried portion of a eucalyptus post as a means of protecting the wood against the destructive action of soil fungi. Annual inspections were to be made, and ultimately a microbiological examination of the wood would be carried out. The trial started in September 1973.

In a paper outlining the consequences of employing plastics materials on the evolution of vegetable-production systems both in France and in countries around the Mediterranean basin, it was noted that there had been a progressive

development in techniques as well as in the economic aspects of growing. However, with the new problems realized by the energy crisis and the general rise in production costs, it was necessary to re-examine how this would affect the future development in the area of plastics in agriculture. It was concluded that if plastics were to continue to play a dominant role in the evolution of horticultural production systems, then much greater attention would have to be paid to the new costs of investments, which weighed heavily on the price received for the produce.

Another paper describing French experience noted that new developments with PE film for agriculture included a mulching film which was transparent to infra-red radiation but still sufficiently opaque to suppress weed growth. This would fill a mulching need in specific cases. Another modified PE film had improved far infra-red opacity, while still retaining transmission in the near infra-red region. In practice, this meant that it had characteristics more like glass and PVC in retaining heat within a greenhouse.

In the papers dealing with problems of the use of plastics in desert areas, the first emphasized that plastics had contributed much to the development of agriculture in desert regions of the world. Trickle-irrigation systems and plastics-lined reservoirs had helped to conserve and utilize water to its maximum. Food factories such as those developed by the University of Arizona in the United States, provided controlled environmental conditions under which it was possible to produce high-quality vegetables in far higher yields than in out-door production. Facilities of this kind had been installed in Abu Dhabi, Iran, and the United States. High-quality vegetables were now made available to the consumer all the year round. Without plastics for trickle irrigation, greenhouse covers, liners for growing beds etc., such vegetable production would have been prohibitively costly.

The second paper detailed a range of potential applications of plastics in agriculture which might feasibly be utilized in the Sudano-Sahelian zone and indicated that the way by which these applications could be introduced to the area would be by establishing one or more experimental demonstration stations. It was emphasized that each application had to be skilfully and technically developed to the specific needs of the country concerned. Established application techniques in other countries could only be regarded as guidelines.

The method by which such an experiemental station should be developed was the subject of a paper presented by a French expert. Being currently and strongly aware of the grave problems posed to the population of the Sudano-Sahelian zone, he warmly welcomed the UNIDO initiative. In establishing an experimental station, it was necessary to have careful selection and adequate pretraining of counterpart staff, since the satisfactory long-term performance and reputation of the station would ultimately depend on such personnel. The possible staffing needs of the station were outlined as well as accommodation, machinery requirements and the functions of the station. It was strongly emphasized that the station should be carefully planned in detail and built-up steadily rather than attempt a rapid growth.

At a meeting of UNIDO experts held during the course of the Symposium, it was agreed that at least one and preferably more experimental demonstration stations should be established. Although it was not possible to obtain detailed costs for establishing such a station, comparisons of the costs of established experimental stations in France, Italy and the United States indicated that $3 million would be a figure of the correct order of magnitude to establish such a unit at today's prices. The experts considered that after an exploratory fact-finding mission to the Sudano-Sahelian zone, it would be necessary for a second mission to visit the area to outline the needs of such a station, to locate and identify existing agricultural stations in the area and to recommend an agricultural station to which the proposed experimental demonstration station should be attached. For the second mission, it was strongly suggested to include experts in agriculture or horticulture with particular reference to desert agriculture, animal husbandry, and also plastics production as well as plastics in agricultural applications.

Stress was also laid on the need to carefully select potential counterpart (local) personnel for early and adequate training. At least 12 months training was envisaged as the absolute minimum requirement.

It was considered that water management was of first priority, both for human needs as well as for agriculture. It was thought that the time-table envisaged in the UNIDO secretariat paper was too ambitious, and the development of plastics in agricultural applications was more likely to take four to five years for new applications to be practised by local growers.

All the experts attending the Symposium offered their services for future Sudano-Sahelian operations within the limitations of their existing commitments.

Annex I

LIST OF PAPERS PRESENTED AT THE SYMPOSIUM

ID/WG.184/1	Ideas for potential application of plastics in agriculture in the Sudano-Sahelian countries UNIDO secretariat
ID/WG.184/2	Plastics processing and applications in agriculture in developing countries A. D. Clarke, United Kingdom of Great Britain and Northern Ireland
ID/WG.184/3	Introduction to UNIDO investment promotion programme UNIDO secretariat
ID/WG.184/4	UNIDO technical assistance and training programmes for the plastics industry in developing countries UNIDO secretariat
ID/WG.184/5	Plastics in Colombia - Acoplásticos I. Chiappe Lemos and R. Rubio Martinez, Colombia
ID/WG.184/6	List of participants
ID/WG.184/7	Low-cost farm buildings clad with polyethylene film H. R. Spice, United Kingdom of Great Britain and Northern Ireland
ID/WG.184/8	The use of plastics in the controlled cultivation of chrysanthemums V. Ravelli and M. Guariento, Italy
ID/WG.184/9	Mulching and fertilizing irrigation: economy of water in horticulture V. Ravelli and M. Guariento, Italy
ID/WG.184/10	Ten years of CIPA activities F. Buclon, France
ID/WG.184/11	The use of plastics to help farmers in the Southern Sahel R. Brun, France
ID/WG.184/12	The development of irrigation and fertilization systems in the protected growing of vegetables R. Brun, France
ID/WG.184/13	Soil fumigation in California B. J. Hall, United States of America
ID/WG.184/14	Drip irrigation in California B. J. Hall, United States of America

ID/WG.184/15 Plastic pipes in agriculture
D. Rowlands, United Kingdom of Great Britain and Northern Ireland

ID/WG.184/16 Development of plastics application in French agriculture
R. Brun, France

ID/WG.184/17 Estado actual y futuro de las industrias plásticas guatemaltecas en el campo de la agricultura y la asistencia que requieren para su mejor desarrollo
G. A. Argueta, Guatemala

ID/WG.184/18 Sobre la industria de los materiales plásticos en la Republica oriental del Uruguay
F. Lilienthal Fuchs, Uruguay

ID/WG.184/19 The development of the plastics industry in Honduras
M. V. Matute Zepeda, Honduras

ID/WG.184/20 The plastics industry in Panama
H. Stahl, Panama

ID/WG.184/21 Actual situation and plans for the future of the plastic industry in Paraguay
J. L. Pecci, Paraguay

ID/WG.184/22 Industria de los plásticos en México 1974
M. T. Osalde Rivera, Mexico

ID/WG.184/23 Plástico y agricultura en Chile
A. Reuter Ripp, Chile

ID/WG.184/24 Application of plastics in Bolivian agriculture
M. A. Carrasco Imaña, Bolivia

ID/WG.184/25 The plastics industry in Ecuador
R. S. Cheing, Ecuador

ID/WG.184/26 The plastic industry and its plans in Peru
M. Farfán Ch., J. Escajadillo P. and R. Miranda S., Peru

ID/WG.184/27 Situacion actual y planes y perspectivas futuras de la industria de los plásticos en Nicaragua
B. Cuadra M., Nicaragua

ID/WG.184/28 The use of plastics in agriculture in Jamaica
J. Ward, Jamaica

ID/WG.184/29 The plastic industry situation in Costa Rica
M. T. Elizondo M. and O. Sauter F., Costa Rica

Papers presented to the Colloquium

A-1 Situación actual de la plasticultura en la República Argentina
E. Sagalovsky, Argentina

A-3 Uses of plastics in Czechoslovak vegetable gardening and their results
B. Jasa, Czechoslovakia

A-4 Aplicaciones de los plásticos en la agricultura española - estadísticas, analisis y perspectivas
F. Robledo de Pedro, Spain

A-6 Employment of plastics in Hungarian agriculture
A. Somos, Hungary

A-7 Some attempts for joint operation for greenhouse agriculture in Japan in the future
S. Shimizu, Japan

A-9 L'évolution de l'emploi des plastiques en agriculture au Portugal et son influence sur l'industrie des conserves des légumes
P. Febrer, Portugal

B-1 Cultivos protegidos en el sur del país
J. Lesjak, Argentina

B-2 Aplicaciones de los tejidos plásticos en la República Argentina
L. Méndez, Argentina

B-3 Protección contra agentes climáticos. Granizo (red antigranizo)
O. Mesplet, Argentina

B-4 Ensayos de maduración anticipada con el empleo de polietileno reflectante en acolchado y túnel bajo
A. Arenillas Asin, Spain

B-5 Protección de cultivos con materiales plásticos contra fisiopatías por agentes meteorológicos
M. Davila Zurita, Spain

B-6 Semiforzado de los cultivos hortícolas en el Levante español
M. García Morato, Spain

B-8 Le plastique agricole dans l'évolution des cultures légumières - cas Portugais
R. M. Monjardino, Portugal

C-1 De quelques expériences complementaires sur le paillage par film plastique en Algérie
M. Hamadi, Algeria

F-13 Réserves d'eau en polièthylene noir. Son intégration dans le paysage
C. M. Bugalho Semedo, Portugal

F-1 Use of polyethylene tubing for packaging fresh flowers buds for retail sales
S. T. Besemer, United States of America

G-1 Plastics application to warmth isolation in greenhouses
P. Stickler, Federal Republic of Germany

G-2 Nuevo sistema de curado en tabaco (Nicotiana Tabacum L.) tipocriollo correntino mediante la aplicación de cobertura plástica
I. L. Gnoatto, Argentina

G-3 Restructuras de invernáculos de bajo coste, especialmente para hortalizas y uva de mesa, en España
M. Mendizábal, Spain

G-4 Utilization of F.R.P. panel in agriculture
M. Hayashi, Japan

G-5 Static and forced-air-separated double-layer plastic greenhouses for fuel conservation
S. T. Besemer, D. S. Axlund and A. Brown, Jr., United States of America

G-6 Expérimentation perspectives d'utilisation de la pompe à chaleur dans le chauffage des serres
M. Bollinger, Y. Dalle, M. Dumont, M. de Cachard, A. Fourcy, A. Freychet and A. Gouzy, France

H-1 Ensayo de aplicación de película plástica en el revestimiento protector de postes de eucalipto
D. Cozza, Argentina

H-2 Survey of plastics uses in desert areas
M. H. Jensen, United States of America

H-3 Consequences du développement de l'emploi des matériaux plastiques sur l'evolution de nos systèmes de production legumière en France et dans les pays du bassin Mediterrannéen
A. Bry, France

H-4 Les films plastiques spéciaux pour l'agriculture
J. Hanras, France

H-5 Quelques résultats récents de la coopération entre l'agriculture et l'industrie de plastiques en Hongrie
H. Macskasy, Hungary

Annex II

VISITS BY PARTICIPANTS, EXPERTS AND CONSULTANTS

During the course of the Symposium two days of visits were arranged for the participants to see the developments of plastics in agriculture near Buenos Aires.

The first visit was a trip to see the four hectares of land donated by the Argentine Government to PLAPLAS, which will become the future demonstration and experimental centre for applications of plastics in agriculture. This station will be jointly operated by the Government and PLAPLAS. It is conveniently situated within an existing Ministry of Agriculture experimental station at Morina. In his speech to participants visiting the centre, the Director of Agriculture for the Province of Buenos Aires, speaking on behalf of the Ministry of Agriculture, announced that the results of the work of the centre would be made freely available to all Latin American countries, and that at a later stage of development the facilities of the centre would also be made available to them.

A visit was then made to growers in Florencio Varela in the southern part of Gran Buenos Aires province. It was an important vegetable-growing area and was also developing flower growing. At the growers visited, PE-covered greenhouses were examined. These were of wooden "chapel" style construction utilizing 3 m wide (UV) screened PE film of 150 µm thickness. Inside the greenhouses, strawberries were mulched with black PE film of 60 µm thickness. Small tunnels for beans were utilizing 80 µm thick film. Of interest, as a new application, was the use of PE film tightly wrapped around part of the trunks of young trees and sealed with adhesive tape. The purpose was to protect the bark from attack by "scissor-cutting" ants, which were unable to crawl up the slippery PE film surface.

A demonstration of a spray irrigation system utilizing 100 mm diameter PE-HD pipe was observed. It was unusual to see PE-HD being used for this purpose. A life of from 7 to 10 years was expected. It had already been in service for some five years. Some 40 different types of vegetables were grown in the area, and the use of plastics was gradually developing.

A visit to Escobar and Pitar in the northern section of Gran Buenos Aires province covered the predominantly flower-growing area of the country. Most growers oriented their production to cut flowers of roses, carnations and chrysanthemums as well as the production of indoor plants such as ficus and sansevieria. In this area, about 70 per cent of the small-scale holdings were covered with greenhouses. The wooden structure of some houses had a curved roof which assisted better the long-term performance of the PE film covering, by eliminating stresses at a point source and thus reducing the risk of tearing. There were also some greenhouses made of glass-reinforced plastics though the light transmission was unsatisfactory, suggesting that a better quality product was required for the application. In this area, some 5 per cent of the growers commercialized their production through the floriculturists co-operative.

An excellent display of orchids was also seen at a large nursery in which PE film was used for soil isolation on some benches, while some of the structures had been roofed with glass-reinforced plastics sheets. All the growers using glass-reinforced plastics seemed pleased with the quality of their flower production (carnations, orchids etc.).

The main points arising from these visits were:

(a) The use of perforated PE film in order to eliminate excess condensation. The perforations had been made by the growers. This showed that local growers had both ingenuity and a feeling how to operate with plastics indicating that they could be valuable members of the Argentine plastics in agriculture committee, if they were recruited. It was noted also that one grower exported his production to Europe, which was additional evidence of the high quality of the blooms produced;

(b) A film thickness of 100 µm was used because, it was explained by one grower, both the film and the wooden structure (willow) were destroyed at about the same time (between six months to one year).

Technological development of special agricultural films was needed because of the high cost of the product in Argentina. At a price of about $2.20 per kilo, the PE film represented about two thirds of the total greenhouse cost. (The other third represented the structure and labour costs.) This high price for a low-quality PE film explained the great difficulty to develop, at the moment, plastics agricultural applications in Argentina.

At the request of the Argentine Government, six UNIDO experts and consultants visited the growers in the northern part of the country to give technical assistance on applications of plastics in agriculture. These visits were also

[illegible] representatives of the manufacturing and [illegible] industries.

[illegible] was made to the Tucuman Agricultural Experimental Station, one [illegible] in the country having been established in 1909. The party was [illegible] welcomed by the vice president in the absence of the station director [illegible]. After a briefing of the station activities, visits were [illegible] selection of the various sections where individual discussions with [illegible] and consultants took place on possible applications of plastics, [illegible] assistance rendered in relation to various problems that were [illegible].

Before visiting some selected growers in the area, a visit was also made [illegible] office of the Secretary of the Ministry of Agriculture and Graineries, [illegible]. In his briefing of the party, the Secretary of the Ministry outlined [illegible] problems that had been experienced in attempted applications of plastics [illegible] agriculture in that area.

There were few plastics greenhouses because high winds had destroyed the [illegible]. The structural problems had not been resolved. Mulching was not [illegible] practised since the presence of a tough variety of weed, and the hot [illegible] climate made it necessary to use a PE film of 100 to 150 µm thickness compared to the more normal 30 µm thickness. It was considered that the [illegible] market was too far away (1,200 km) to be competitive. Crops [illegible] in the area were cereals, cotton, soya bean, citrus (22,000 hectares), [illegible] (2[illegible] hectares), pepper, tomatoes and potatoes; the total vegetable [illegible] was 5[illegible],000 hectares of which 20,000 hectares were for potatoes, while the [illegible] crop was sugar-cane (200,000 hectares equivalent to 900,000 tons in [illegible]).

Visits were made to a co-operative unit of some 84 members with 350 hectares where packing operations were seen, and to two growers where tomatoes [illegible] per cent), peppers and strawberries were grown. The only application of plastics was as a black PE mulch on strawberries. The thickness of film was [illegible] µm. All strawberry production in the province was mulched. Past failures of plastics application (tunnels, greenhouses and mulching) were discussed at length, and advice was given on new approaches to resolve the problems. There is no doubt that properly designed and supervised trials using high-quality

plastics products produced with the correct strength characteristics could resolve many of the past failures. Taking into account the actual prices of vegetables in Argentina, it was understandable that only strawberry growers could afford to pay for the plastics mulching. The strawberry price was 20 pesos per kg, paid at the co-operative, and freight charges of 200 pesos per ton to Buenos Aires (1,200 km away) made it almost impossible to compete in that market so they were grown mainly for the local trade.

A visit was made to a vineyard of 220 hectares producing 80 hectalitres of wine per hectare at Cafayate, where the party was received by the owner, Senor Torino. In this particular valley, only 10 per cent (1,000 hectares) of the soil had been found suitable for grape production, and some of the vines were 100 years old and still producing successfully. In a newer part of the vineyard, a plastics-pipe trickle-irrigation system had been in operation for some five years. The experts were surprised at the actual technique which had been developed, and a detailed interchange of technical information and discussion took place. This type of irrigation was only in practice half the time, otherwise irrigation was by flood technique (each type 15 days).

The final visit, near Salta, was to a tobacco plantation. In the Salta Provincia area, 3,000 hectares were devoted to tobacco growing. At this time of the year, the seed-beds had only recently been prepared and were protected with simple, PE-film covered tunnels. The PE film was first used for fumigating purposes and afterwards used for these tunnel coverings. The quality of film was such that it could not be used in the following year. Irrigation was by flood technique. The design of alternative tunnels and their advantages were discussed together with technical information on trickle-irrigation and mulching systems.

In all visits, the growers were appreciative of the technical assistance that had been given, but it was self-evident that organized field trials under expert guidance were required if the use of plastics in agriculture is to be widely and successfully developed in the area.

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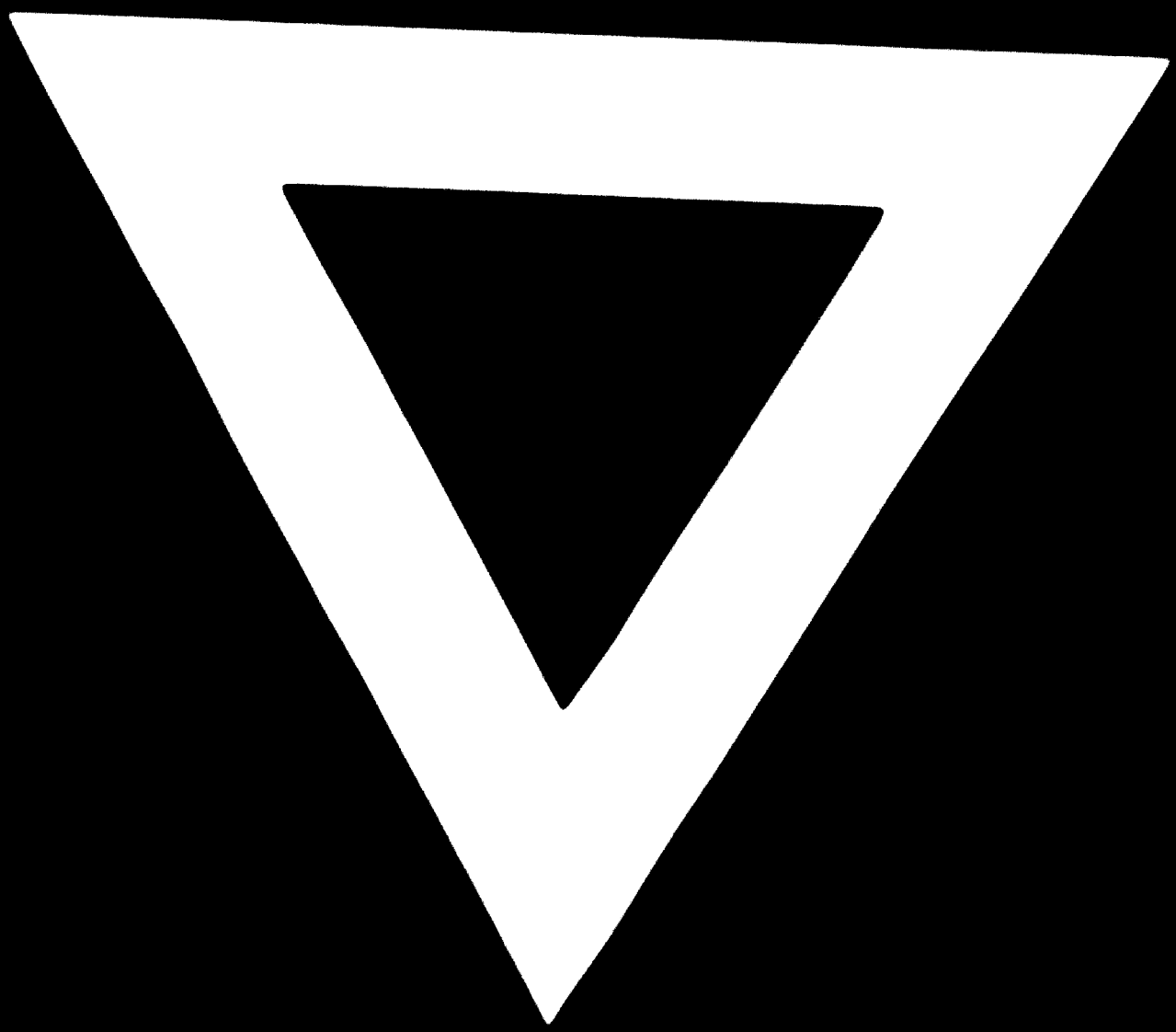

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