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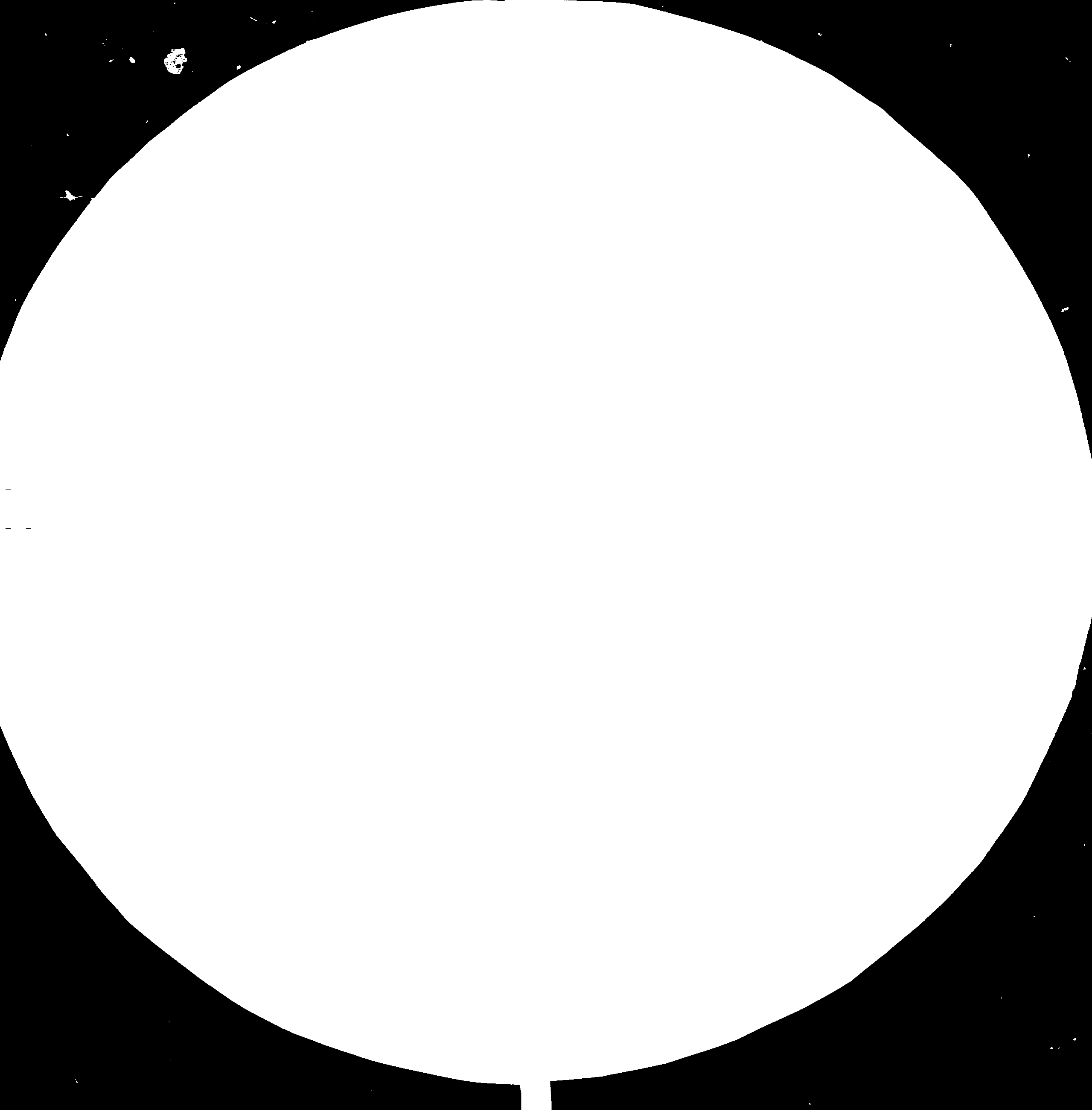

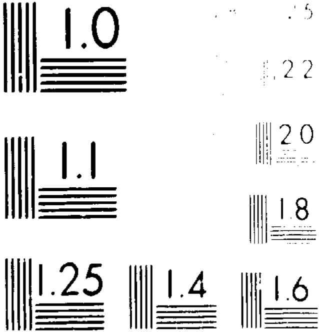
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PROJECT NO. DP/LIB/72/003

Libya. INDUSTRIAL RESEARCH CENTRE (Food industry).

SOCIALIST PEOPLE'S LIBYAN
ARAB JAMAHIRIYA

12216

FINAL REPORT

OF

A.G.M. SJOSTROM

EXPERT IN FOOD PROCESSING

December 1982

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## ABBREVIATIONS

| | |
|---|---|
| IRC | Industrial Research Centre, Tripoli |
| SLI | Secretariate of Light Industries |
| NASCO | National Supplies Corporation |

## ACKNOWLEDGEMENTS

The Expert would like to express his thanks for all cooperation and assistance received from the counterpart staff and the UNIDO Co-ordinator and the other international experts.

1. Introduction

This report is based on the work of Dr. G. Sjostrom, Expert in Food Processing, assigned by UNIDO to the project DP/LIB/77/001 "Industrial Research Centre, Tripoli, S.P.L.A.J.". The assignment was originally for one year: August 1979 to August 1980. It was extended twice : first to December 1981 and then to December 1982.

1.1. Terms of reference

At the outset of his assignment the Food Processing Expert was given the following terms of reference:

"The expert will be assigned to the Laboratory Section of the Technical and Economic Department where he will work in close co-operation with the national staff and other local specialists and experts, under the administrative guidance of the Project Co-ordinator. Specifically, the expert will be expected to:

1. Assist in the planning and co-ordination of the Centre's activities in his field of specialization.
2. Assist and actively take part in providing technical consultancy services to food processing industries in order to improve their operations and the quality of their products, with emphasis on (a) food processing hygienee (b) improvement of specific unit operations, (c) quality control of raw materials and finished products.

3. Assist and actively take part in the organization and the carrying out of laboratory experimentations at the Centre's laboratories aimed at directly assisting industry and supporting consultancy service activities.

4. Assist in and take active part in introducing modern quality control systems and techniques in the food processing industries.

5. Co-operate with and provide advice to other experts carrying out market and feasibility studies in the fields of processed foods and food processing industries.

6. Assist and take active part in the preparation of training programmes for and in the training of local staff in the above fields."

1.2. Food Laboratory of the Industrial Research Centre

The Expert worked during his assignment in the Food Laboratory. It is one of five laboratories belonging to the Laboratory Section, the others being the Microbiology, the Instrumental Analysis, the Chemical and the Textile Testing Laboratories.

The Laboratory Section forms together with the Building Materials, the Technical Studies and the Economics Sections, the Department of Techno-Economics. The latter and the Departments of Geology and Administration comprise the Industrial Research Centre.

1.2.1. Physicial facilities of the Food Laboratory

The Food Laboratory consists at present of three laborat... rooms with a total area of about 200 square meters. It is equipped for general food analysis, e.g. determination of protein, fat, carbohydrates, fiber, moisture and ash. There ... also a few instruments for special food analysis such as a flame-less atomic absorption spectrophotometer for mercury determinations and a farinograph and an extensograph for evaluation of wheat flour.

Lacking are a sensorial testing laboratory and any type ... pilot plant equipment.

The services of the Chemical Laboratory for water anal..., the Instrumental Analysis Laboratory for trace element and f... acid analyses and the Microbiology Laboratory for yeast, ... and bacteria counts are available when needed.

In short, the physical facilities at the disposal of the Food Laboratory are sufficient for general and some special f... analyses. They have also allowed limited work on product development in laboratory scale.

Due to the expected, but several times postponed, move to the new premises in Tajura the general up-keep of the Food Laboratory and its facilities has, understandably, been limited to the bare necessities during the period. Irregular water supply has noticeably had an effect on the laboratory activiti... especially during the last two years.

1.2.2. Personnel resources of the Food Laboratory

The Food Laboratory has been staffed with between six and nine agricultural engineers specialized in food technology and graduated from the Al Fatah University, Tripoli. The Head of the laboratory has a Master's Degree in Food Quality Control from the University of Reading, United Kingdom. Three of the other staff members have been on one year training courses in food analysis and technology at the Institute for Nutrition and Food Research, TNO, Holland.

One or two technicians have assisted in the laboratory work.

The Microbiology Laboratory, which mainly has worked in the field of food microbiology, has been staffed with two or three agricultural engineers specialized in microbiology.

1.2.3. Work Programme

Due to its proven capability in the field of food analysis the Food Laboratory had earlier mainly been carrying out determinations of the composition and quality of food stuffs for outside clients. It had also taken part in the work of foreign consultants in the food field and made certain industrial surveys. However, since the Food Control Laboratory of the Secretariate of Economy took over the control of imported foods in 1978 the IRC Food Laboratory was in need of new work activities.

A tentative work programme was proposed in October, 1979, see Appendix I. It was based on the Expert's terms of reference, findings made during preliminary factory visits and the previous experience of the staff of the Food Laboratory.

The main purpose of the proposed work programme was to gear the activities of the Food Laboratory to the needs of the food industry. Only if close cooperation could be established with this client would there be any guarantee that the results of the efforts were put to use.

The tentative work programme was accepted by IRC and was followed with minor modifications. Its most important parts proved to be:

- Technical assistance to the Food Manufacturing Industry
- Research and development
- Planning for the food industry and evaluation of food industry projects

## 2. Activities and outputs

### 2.1. General

In the following summary of activities and outputs of the Food Laboratory during the period August 1979 to December 1983 the headings of the Tentative Work Programme, Appendix I, are used.

Only those activities where the Food Processing Expert took part are mentioned. A certain amount of food analytical work for various government institutions was also performed during the same period by the counterpart staff with only occasional participation of the Expert. Examples of the latter type of activities are determinations of purity of olive and other vegetable oils, possible presence of animal fats in biscuits, quality of canned fruit and vegetable products and mercury in imported canned fish products.

2.2. Technical assistance to the food industry

After an experimental start in the spring of 1980 the IRJ decided on a broad technical assistance programme to the food industry in the fall of the same year. The Expert had suggested that the start should be made with only one branch of the industry, but in order to involve the whole staff of the Food and Microbiology Laboratories it was decided to cover almost the complete food industry.

Consequently, three committees were formed for the dairy, the cereal and the canning industries, the latter also including the soft drinks and confectionery branches. Each committee consisted of three or four staff members of the Food and Microbiology Laboratories, one economist from the Economics Section and the two UNIDO experts in Food Processing and Production Engineering/ Maintenance.

Work Plan

The work of the committees was planned to include two stages. In the first, "investigatory" stage all factories of the selected food industry branch would be visited. Discussions would be held with the factory staffs and also with the direction of the corresponding umbrella company set up by the SLI during the 1978-81 period. The main problems of the factories would be identified and a preliminary "investigative" report written and submitted to the SLI and the umbrella company.

After the reaction to the investigatory report had been obtained a second, "diagnostic" stage of the technical assistance programme would be started. In this one or more factories in each industrial branch should be selected for direct technical assistance through prolonged visits by IRC staff. During this period the recommendations included in the investigative report would be implemented. When the need arose UNIDO experts or other outside consultants would be called in.

In order to standardize the information on the individual factories a factory visit questionnaire of 8 pages covering technical and economic matters in a concentrated form was proposed to be used. However, the Economics Section requested a more detailed questionnaire. The finally adopted form had 27 pages and went into great detail.

Activities

The factory visit programme of the investigative study was started in the spring of 1981. Up to the fall of 1982 all dairies, cereal mills, fish canning factories, macaroni factories and soft drink factories in the country had been visited. The investigative reports on the first three branches were submitted in the first half of 1982. The reports on the soft drink and macaroni industries were still under elaboration in December of that year.

The preliminary reports cover efficiency of operations, the quality of products, the state of sanitation, quality control, maintenance, working conditions, etc. Deficiencies are pinpointed and recommendations for their elimination are given.

Serious problems were encountered in obtaining economic, financial and even production data. These areas had therefore sometimes to be treated only briefly in the reports.

Output : See Appendix II, refernces (1), (2), (3), (4) and (5).

2.3. Trouble Shooting

This type of technical assistance has been carried out on an ad hoc basis. The following examples can be mentioned.

- The bread flour mills were working with unsuitable raw material in 1980 - 81 due to unsatisfactory purchasing procedures. Recommendations on revised purchasing specifications for bread wheat were prepared for the General National Flour Company and the National Supply Corporation.
- A sardine factory was experiencing low keepability of part of its production. Possible causes were studied on the spot and recommendations for changing the processing operations and the sanitary procedures were given.

- A dairy was producing pasteurized milk with too short shelf-life. The main cause was found to be low quality of the raw milk. The situation was aggravated by the fact that the dairy could not reject sub-standard milk. Recommendations were given how to improve the quality of the raw milk and the processing operations.
- The mercury level in tuna fish was studied at several tuna canneries. The study led up to a wider study on the mercury contamination in the Libyan diet (mentioned under section 2.4.4.).

Outputs: Reports to the local Secretariates of Light Industry.

## 2.4. Research and Development

As explained in section 1.2.1. the laboratory facilities suffice for food analytical work, but only to a limited degree for research and development work on products and processes. This situation should be considerably improved when the IRC moves to the new premises in Tajura.

Still, some work has been carried out that can be classified as research and development activities.

### 2.4.1. Utilization of dry figs

There is at present over-production of about one thousand ton of dry figs per year in the Jeffren area. The local Secretariate of Light Industry requested a study on the best way to use this surplus.

Laboratory experiments were carried out during the 1979/80 and 1980/81 seasons. It was shown that consumer packed figs can be produced of a quality which can compete with imported dry figs. Out-graded figs can be transformed to fig paste for use in biscuit manufacture and for production of industrial alcohol.

A fact finding tour was made in April 1981 to Turkey and Italy by the Head of the Food Laboratory, the Secretary of Light Industry, Jeffren, and the Expert. Dry fig processing and manufacturing of fig processing machinery was studied in the two countries.

A detailed plan for a small factory including a pack house for cellophane packed dry figs and production of industrial fig paste was elaborated and presented to the Secretariate of Light Industry. With an input of 1100 ton semi-dry figs the following amounts would be produced:

| | |
|---|---|
| - 1st quality figs in 200 g cellophane packages | 200 t |
| - 2nd " " " " " " " | 400 t |
| - fig paste in 20 kg cartons | 300 t |
| - figs for industrial alcohol production yielding 35 t 95% fruit alcohol | 100 t |

Outputs: See Appendix II, references (6) and (7).

2.4.2. Utilization of Surplus Water Melon

Every year during the peak harvest season there is a surplus of water melon which goes to waste or is sold at a loss by the farmers.

Laboratory experiments on the production of juices and jellies based on water melon pulp were made. Literature studies and the experimental work indicated that the best way to decrease the excess of water melons was to make use of cold storage facilities, which are available and largely under-utilized. It was also recommended that large scale trials with the manufacture of water melon jelly and mixed water melon/orange juice should be made in cooperation with the Mamoura canning factory during the 1981 season.

Outputs: See Appendix II, reference (8).

2.4.3. Study on possible utilization of carob beans

There exists a small production of carob beans which could be expanded without need for irrigation water. Laboratory experiments indicate that a cold water extract of the pods can be used as a base for carbonated drinks. Other ways to utilize the beans are as energy ingredient in animal feeds and for glucose production. A gum can be produced from the seeds which has found wide use among other things as a thickening agent in food products.

A rough calculation showed that as little as 330 hectare non-irrigated land would suffice to produce the beans needed to cover 5% of the local carbonated drink market. Much development work in laboratory and pilot plant is however needed before the feasibility of such a project can be determined.

Outputs: See Appendix II, reference (9).

2.4.4. Mercury Contamination of the Libyan Diet

A survey of the mercury content of the Libyan diet with special regard to the fish component was carried out. It was found that the mercury content of the average diet gives no grounds for concern. The average mercury intake per capita and day was found to be 8.8 microgram which is far below the maximum permissible level of 42.8 microgram established by FAO/WHO. However, groups consuming large amounts of locally produced canned tuna may exceed the maximum permissible level. E.g., persons which consume ten times th[illegible]erage amount of fish in the form of locally caught tuna [illegible] a daily mercury intake of 103 microgram. In fact, the high mercury level in tuna caught in the Mediterranean Sea throws some doubts on the justification of the local tuna canning industry.

The findings of the survey were reported to the Secretariate of Light Industry in the summer of 1982. Short of closing down the tuna canneries we propose canning of imported frozen tuna with low mercury content combined with distribution of canned local tuna under strict control. The final recommendation was however left for the nutritional and toxicological expertise to make.

Outputs: See Appendix II, references (10A) and (10B).

## 2.5. Planning Industrial Development

### 2.5.1. 1980-85 Five-Year Plan for the Food Processing Industry

The Head of the Food Laboratory and the Food Processing Expert took part in the preparatory work for the 1981-85 national Five-Year Plan for the food industry. The working group set up by the Secretariate of Light Industry held weekly meetings from December 1979 to February 1980 and covered all fields of food processing. The IRC/UNIDO members were specially charged with the elaboration of a detailed plan for the carbonated beverages industry.

When the recommendations of the working group later were referred to the IRC for comments the Expert assisted the Economics Section with the evaluation.

Outputs: See Appendix II, reference (11).

2.5.2. Plan for Reactivation of the Tomato Paste Industry

The tomato paste industry was up to 1976 a rapidly expending branch of the Libyan food industry. The quality of industrial tomatoes grown was excellent as was the paste produced.

In view of the serious water supply situation in the Gefara plain area the production of industrial tomatoes was prohibited after 1976. This decision was based on the fact that tomato production requires large amounts of irrigation water. Industrial tomatoes were considered to be a low priority crop compared with cereals, vegetables and fruits.

As a consequence of the decision there was in 1980 at least 26 idle tomato processing lines in 9 factories.

A study was made to evaluate possible ways to make use of the idle capacity and to minimize the appreciable economic losses encountered.

Outputs: See Appendix II, reference (12).

2.5.3. Development Plans for the Food Industry to the Year 2000

In 1981 the Secretariate of Light Industry requested a series of industrial development plans to the year 2000 from different institutions. The Food Laboratory of IRC was asked to prepare two such plans: for the edible oils and fats industry and for the carbonated beverages industry.

2.5.3.1. Development Plan for the Edible Oils and Fats Industry to the Year 2000

The report contains a detailed study of past and present production, import and consumption of all edible oils and fats. The future demand for the various products is estimated using as a basis past trends and the development in other countries with comparable food habits and economic development. It was assumed that the consumption of all oils and fats would stabilize at 23 kg per capita and year and that the importance of olive oil should gradually diminish from the present 81% to about 70% in the year 2000.

A strategy to meet the demand up to the year 2000 was proposed. It was suggested that the import of consumer packed edible oils should be phased out and replaced by a combination of local production and import of raw oils in bulk,

A vast expansion of the vegetable oil refining and canning industry would be required. Taking into account the present agricultural plans the self-sufficiency in olive oil and other vegetable oils would be 48% and 30% respectively in the year 2000.

The necessary expansion of the local production of olives and oil seeds and the corresponding expansion of oil extraction and refining capacities for reaching complete self-sufficiency was also calculated.

Output : See Appendix II, reference (13)

2.5.3.2. Development Plan for the Carbonated Beverages Industry to the Year 2000

This study followed the same steps as the edible oils and fats study. The yearly per capita consumption of all carbonated beverages was estimated to reach 50 liter in the year 2000 from the present level of about 30 liter. The proportion of carbonated mineral water was assumed to remain at the present 10% level. The plan foresees a three-fold expansion of the carbonated beverages industry in the 20-year period.

Output: See Appendix II, reference (14).

2.6. Evaluation of Food Industry Projects

The Economics Section was assisted in evaluating regional planning studies and feasibility studies as far as food processing aspects goes.

Examples of studies where the contribution of the Food Laboratory was substantial are:

- The NIDC Regional Industrial Development Study for the Misurata-Sirte and Fezzan-Al Jufra Regions.
- The SODETEG feasibility studies on various packaging material industries.

Outputs: Included in evaluation reports of the Economics Section.

## 2.8. Other Activities

### Animal Feed Ingredients

Literature studies for the use of urea in feeds for ruminants and bird feathers and other chicken offall in broiler rations were made and reported to the IRC/Secretariate of Light Industry.

Outputs: References (16) and (17)

### Cold Storage Utilization

The Agricultural Production and Marketing Company, Tripoli, has established about 90 cold-storage units in various parts of the region in order to improve the marketing of farm produce. A number of these stores were visited by a team from the Food Laboratory. Only a small part of the stores was in use and then usually for imported products such as apples, bananas, cheese and meat. Sometimes wrong storage temperatures were used and incompatible products stored in the same room.

A report was submitted to the Company with recommendations for improved operations of the stores.

Output: Reference (18).

### Paper on Food Processing Industry

A short paper entitled "Food Processing Industry - past, present and future" was prepared for the Secretariate of Light Industry in connection with the 1 September celebrations in 1981.

Output: Reference (19).

Costs of Food Analyses

A formula for calculation of costs of analyses performed in the Food Laboratory was elaborated. A price list was later made for possible use with outside clients.

Cooperation with Nuclear Research Centre

A paper on "Possible areas of cooperation between the Nuclear Research Centre and the Food Laboratory, IRC" was prepared. Discussions were later held with staff from the Nuclear Research Centre.

The only activity of common interest for the two institutions was found to be radiation processing. Any future activity in this field should involve participation of the [redacted] Agency, Vienna.

Output: Reference (20).

Brine Shrimp Project Proposal

In connection with a duty trip to the Sebha area the Expert proposed a visit to some salt lakes in the desert where the population is known to harvest brine shrimps and use them as a protein source in their diet. A visit was seen as a possible first step in the elaboration of a project proposal for the utilization of brine shrimps for human and animal consumption.

Output: Reference (21).

Data Bank on the Libyan Food Industry

Information on all cereal mills, macaroni factories, dairies, fish canneries and carbonated beverages factories has been collected during the technical assistance programme described in Section 2.2. However, much work to present the data in a standardized form remains to be done if a "Data Bank on the Libyan Food Industry" is to be realized. Several branches of the food industry have still to be systematically visited and studied.

Training

Training of counterpart staff was done by working together on the various activities.

A few lectures were given on subjects such as:

- Information sources in the IRC library of interest for the Food Laboratory
- Food additives - their properties and uses
- Sanitation in the food industry

After the Technical Assistance Programme started in the beginning of 1981 the lecture programme was interrupted.

## 3. Utilization of the Project Results

There has been very little feed-back of information from the Secretariate of Light Industry to the Industrial Research Centre, at least as far as the Food Processing Expert is aware. It is consequently difficult to say with certainty which results of Project activities have been utilized.

It is known that the five-year plan for the carbonated drinks industry, Appendix II, reference 11, was included in the official version of the 1981-85 plan. It is may be significant that this work was done in a committee set up by the Secretariate of Light Industry.

Our other industrial development plans, research reports, etc. may or may not have been utilized by the Secretariate of Light Industry. Some of the more recent reports must still be under study.

4. Findings and recommendations

During the past three year period a great deal has been learnt about the operation of the food laboratory of the IRC and the problems of the local food industry. These findings and the ensueing recommendations will be presented in the following.

4.1. Food Laboratory, IRC

4.1.1. Physical resources of the food laboratory

Findings

As the Food Laboratory will be moving to the new IRC buildings at the beginning of 1983 it would be pointless to dwell on the state of the present laboratory facilities, which, as mentioned earlier in this report, have allowed work in the field of food analysis and some product development.

The new Food and Microbiology Laboratory will be situated on the ground floor of Building C3 in the new premises at Tajura. It will have at its disposal 1100 square meter laboratory and office space, as compared with the approximately 200 square meters now available. There will also be storage space set aside for the Food Laboratory in the underground floor of the same building. The laboratories and their furnishing are of the highest international standard.

Recommendations

The disposition of the various rooms should follow the proposal of the Consultants with the following modifications:

Room 2110 should be used as Dairy Products Laboratory

Room 2115 " " " " Fats and Oils Laboratory

Room 2307 " " " " Cereal Products Laboratory

Room 2417 " " " " Oven room

Half of the reserve area 2121 should be used as a Sensorial Testing Laboratory according to specifications given to the construction company.

The already existing laboratory equipment should be installed in the new laboratories and complemented with the equipment specified on the lists prepared for the food and microbiology laboratories in 1980, Appendices III and IV.

## 4.1.2. Food Workshop

### Findings

The small food pilot plant, called the Food Workshop, comprises half of Building E. It consists of an open hall of 144 square meters designed for food processing and equipped with a crane, capacity 3.2 ton and two refrigerated rooms of 18 square meters each, one for storage at -20°C and the other for storage at 4°C. There is also an office room and a dressing room with sanitary facilities.

The processing hall is equipped with a sufficient number of points for hot and cold water, compressed air and electric power and is provided with drains, all in accordance with modifications of the original proposal of the Consultants.

### Recommendations

The equipment listed in Appendix V should be acquired for the Food Workshop. As the area is comparatively small it will be possible to install permanently only one processing line, e.g., a line for experimental canning and a few other pieces of equipment which require steam and water supply.

The following items will have to be permanently installed on concrete plinths:

- Steam generator
- Steam-jacketed kettle
- Exhaust tunnel
- Water baths (2)
- Autoclave
- Vacuum evaporator
- Tray dryer

The rest of the processing equipment should be mounted on castors so that it easily can be moved into a processing line when required. There will be need for flexible hoses and fittings in order to connect equipment to the water main and for pumping fluid products from one processing unit to another.

Quality control in the pilot plant will need an about 2 meter long laboratory bench placed on the side of the wash basin at the outer well.

One way of arranging the equipment in the Food Workshop is shown in the layout sketch attached to Appendix V.

4.1.3. Personnel Resources of the Food Laboratory

Findings

The personnel resources of the Food and Microbiology Laboratories, as described in section 1.2.2., have been sufficient for the requirements of the work programme adopted. This refers both to the number of staff and their qualifications.

The ratio of academic staff to technicians is unusually high: about ten to one.

Recommendations

No need to expand the present staff is expected for the foreseeable future.

It is recommended that those staff members who have not yet received training abroad should be given that opportunity.

The senior staff should from time to time be sent to seminars, shorter training courses and congresses in the fields of food science and food technology in order to collect information on the latest developments in the food field, to create international contacts and in general to broaden their professional experience. This is quite important as it is probable that the IRC in the future will become the venue for regional conferences and congresses in its various fields of activity.

When the equipment for the Food Workshop is being installed and later taken into use there will be need for a technician assigned to the pilot plant. He should preferrably have been trained as an electrician and mechanic and should be responsible for the maintenance of pilot plant equipment.

4.1.4. <u>Work Programme of the Food Laboratory</u>

<u>Findings</u>

The work programme as outlined in Section 1.2.3. and Appendix I could be followed with only minor modifications. Certain work activities have taken much longer time than originally expected. The reason has been a combination of several factors: deficiencies in water and electric power supply in the IRC laboratories, problems with transport and communications, and a few times, financial difficulties.

The technical assistance programme was appreciably slowed down due to difficulties in obtaining information from the food factories under study.

Recommendations

The purpose of the IRC is two-fold: to assist the existing industry and to plan for the development of new industrial projects.

It seems to this Expert that in the field of food processing the main effort should now be on technical assistance. It would be wasteful to continue the rapid expansion of the food industry without first assuring that the existing factories are well utilized and work efficiently.

It is therefore recommended that the future work programme has as its main purpose the continuation of the technical assistance programme already started. It is hoped that the second phase of the programme can be entered into during 1983.

As a result of the industrial contacts certain problems and needs will appear. These should be formulated as research and development projects and be taken up in the work programme.

Examples of possible projects are:

- The development of a calory free carbonated beverage
- A survey of trace metals in processed foods
- A study of the potential for mineral water production in the Eastern area
- Evaluation of wheat varieties for bread flour and semolina milling in cooperation with the Agricultural Research Centre and the cereal industry.
- A survey of the purity of imported edible oils
- Development of new and improved canned fruit and vegetable products in cooperation with the Mamoura Canning Company
- Development of a soft drink based on carob bean extract
- Improved processing of pickled olives

4.1.5. Mode of Operation

Findings

Like most government institutes the world over the IRC has a budget management mode of operation. That is to say, the Government provides the IRC with a yearly budget and asks it to fulfil its responsibilities.

The risk with this mode of operation is that if not enough contacts are kept with the outside industrial reality the institute will develop into an "ivory tower" and its research and development efforts will seldom be made use of.

With the present work programme, however, this risk seems to be small, as far as the Food Laboratory goes.

For efficient working there must be some form of control from the sponsoring body. At IRC there are quarterly progress reports delivered to the Secretariate of Light Industry. These are prepared by the Economics Section and based on interviews with the staff.

There seems to be no regular internal reporting.

Recommendations

It is recommended that the work programme also in the future should be generated through contacts with the industry. So called "in house" activities can be started when the work load permits, but they should always be selected for their possible future use by the industry.

It is also recommended that monthly progress reporting should be started on an experimental basis. Each staff member should prepare a monthly progress report in longhand with two carbon copies. The original should be delivered to his closest supervisor and the first copy to the next higher person in the organizational structure.

Such reporting, which often is done on a weekly basis in commercial research institutes, is very useful for the participants as they are forced to evaluate their own work and have an opportunity to communicate difficulties and progress to their supervisors. In many companies these progress reports are circulated within the sections in order to keep all staff members informed of ongoing activities and improve the team spirit.

## 4.2. Food Industry

Through the technical assistance programme described in Section 2.2 and other factory visits the Food Processing Expert has got detailed knowledge of the nature and the operations of a large part of the Libyan food industry. In the following his findings and recommendations will be given first in a general section, covering matters common to most of the industry, and then in special sections, dealing with the special problems of each of the industrial branches studied.

Many of the problems afflicting the food industry are related to maintenance, spare part supply, production organization, quality of manpower and general management. These matters are dealt with by other Experts of the UNIDO team and are mentioned in this report only when they have a direct bearing on food processing and product quality.

Questions concerning location and size of factories fall outside the field of food processing but are touched upon here as the Expert became involved in several industrial planning activities, Section 2.5.

The Expert would like to stress at this point that it is in the nature of this kind of report that problems and deficiencies are high-lighted while trouble-free areas are not specially mentioned.

4.2.1. General Problems of the Food LIndustry

4.2.1.1. Findings

Location of factories

Some existing as well as planned factories are unsuitably located in respect of either raw material supply or the intended market or, sometimes, both.

As examples can be mentioned:

- The recently (June 1981) started dairy in El Beida which for a long time will receive only a very minor part of the needed raw milk due to a misjudgement of the number of milk cows in the area by a factor of ten. It is now exclusively processing imported skim milk powder.

- The new (January 1981) cereal mill in El Marj, which was equipped for soft wheat milling while the surrounding area is producing hard wheat. One of the two lines is now being converted to hard wheat milling.
- The sardine canning factory in Benghazi suffering from a complete lack of local raw material. During its four year of existence it has processed 23 ton locally caught sardines corresponding to 11 hours operation at nominal capacity. It is now working at 10 percent of its one-shift capacity with imported frozen sardines.
- The just finished big dairy in Souk el Chamis south of Homs, which will deliver milk to the Tripoli area over a distance of about 120 km and which is placed in an area not presently producing milk.
- A planned wheat flour mill in Sarir of the smallest commercial size. probably uneconomical, but with a capacity far greater than the demand in the Sarir and Kufra oases.

Size of Factories

Compared with the food industry in developed countries the Libyan one is characterized by small to middle size factories. This may be unavoidable in a country with a relatively small population and a very big area. Still, the greater Tripoli and Benghazi regions have sizable populations and should allow more middle size and even large size food processing factories.

The relatively small size of certain factories brings with it some disadvantages. These factories have difficulties in acquiring staff for certain services necessary in modern industry such as quality control and maintenance and even operation of the more sophisticated equipment. That small scale production always is less economical than large scale production is may be of less importance.

Among the small factories are several up to 50 years old, dating from the colonial time, e.g. the sardine and tuna canneries in Zuagha near Sabratha and in Zliten, some of the macaroni factories in Tripoli and Benghazi and a great number of small olive oil mills in the Tripoli-Gharian region. These factories are now rapidly disappearing, being replaced by modern processing lines, some times placed in the old buildings. A similar situation exists for some post-war, pre-revolution factories.

Maintenance of Equipment

In general it would seem that the life-time of food processing lines in S.P.L.A.J. is shorter than in European countries. E.g., a wheat milling unit is ready for complete over-haul already after 7.5 - 10 years, while the normal time in Europe is 15 - 20 years. The reason for this difference is usually unsatisfactory maintenance, sometimes compounded by incorrect use of the machinery. E.g., in the case of the milling line the wheat may not be of the type for which the line has been designed and it may not be tempered to the right moisture content before milling. The all pervading dust may also contribute to the short life of machinery.

Certain types of auxiliary equipment presents an even worse picture. Regrigeration machinery in many dairies and carbonated drinks factories has been out of working order since long periods of time. Sometimes replacement machinery has been installed, but in many cases refrigeration was simply not carried out with detrimental effect on quality and keepability of products.

The life-time of steam generators is generally quite short, in some cases less than five years. This is usually caused by faulty feed-water treatment. More often than not the various types of water treatment equipment are not used. Instead the water from the municipal line or the factory's own wells is fed directly to the boilers. As this water often has a high chloride content a rapid corrosion of boiler tubes, valves, steam lines and even processing equipment is to be expected. In several cases incrustations of salt could be collected from leaking steam fittings.

The reasons why feed water treatment equipment is left unused can be several. Many times there is lack of spare parts, chemicals, zeoliths and iron-exchange resin, sometimes there is a break-down of instruments, but more often there seems to be lack of instruction of boiler operators, who many times do not seem to appreciate the importance of feed water treatment.

There is no initial government control and certification of newly installed boilers and autoclaves nor any regular inspection. In many factories the safety velves on pressure equipment are out of order. There seems to be no awareness of the risks involved even among some factory managers.

## Quality Control

Most dairies and carbonated beverages factories have quality control laboratories staffed by one or two technicians. Other industry branches studied had no or only a very rudimentary form of quality control. One of the largest flour mills with a well equipped quality control laboratory abolished quality control after a 6 to 4 vote of the factory committee, but may now have reintroduced it after a near four year break.

Even in factories where quality control of a kind is performed it is not always properly made use of. E.g., in several dairies the fat content of the pasteurized milk is regularly found to be below the level stated on the cartons, but no correction is made by the production departments. In many carbonated beverage factories the carbonation is lower than what the factory standards prescribe, but no adjustment is made, probably due to technical difficulties (insufficient refrigeration).

Predictably, the erratic quality control results in many products with quality below the one prescribed by national or factory standards. Still, the quality of most processed foods can be classified as "acceptable".

Special quality problems with the different food products will be mentioned in later sections.

Sanitation

During the three year period in question no serious cases of hygienic nature has been observed with the produce of the Libyan food industry. The exception is the mercury contamination of local, canned tuna described in Section 2.4.4, but the cause was found to be natural contamination of the raw material. One can therefore say that the state of sanitation in the factories in general is satisfactory.

This does not, however, mean that the sanitation and general housekeeping in all factories is good. None of the factories visited had organized special sanitation crews and there seemed to be no rigid sanitation programmes. Cleaning of equipment and floors is usually done by the production personnel after the end of the days work. The method used is often flushing the lines with cold water. The dairies have of course by necessity a more intensive cleaning and desinfection programme.

In many factories birds could be seen flying freely in and out of production areas through open windows or broken screens. In many macaroni factories cockroaches was a fairly common sight. One of the large mills, the one that had abolished quality control, was heavily infested with flour beetles.

4.2.1.2. Recommendations

Location of factories

There is no doubt that the large majority of food factories in the country have been placed in suitable locations. Still, there are a number of newly established factories, mentioned earlier, for which it is difficult to find the rationale for the choice of location.

It is recommended that in choosing location for food industry projects above all the intended market and the availability of raw material are carefully considered.

Most factories for consumer packed foods should be located near population centres. This is particularly important for products with short shelf life such as pasteurized milk.

Another type of products which definitely should be produced close to the intended market is beverages where nearly 90% of the weight is packaging material and added water. Most food industries where the raw material is stable and easily stored, such as grain, should likewise be placed near the consuming public. Such locations have also the advantage that factory staff is easily available.

Only when the main raw materials are difficult to store and transport, as in the case of fresh fruits, vegetables and fish, are there good reasons to place the processing factory in the raw material producing area.

## Size of Factories

As pointed out above there is a tendency to modernize and refurbish outmoded small food factories in situ. That is to say, one is perpetuating the disadvantages of small scale production. Even if the new lines have an increased capacity the units are still small.

It is therefore recommended that the possibility of rationalizing the structure of the macaroni and carbonated beverages industries is taken up for study. It should for example be possible to bring down the number of macaroni factories within the Tripoli area from five to three or even two units. In Benghazi there is hardly any reason to continue production at the two nearly artesanal macaroni manufacturing units.

The advantages of such rationalization schemes are evident. It will be easier to find qualified manpower, the production economy will increase and valuable land in central parts of the cities can be used for housing. It should also be considered that the old factory sites are completely closed in without any space for future expansion.

A reorganization plan for the olive oil pressing industry is already in full swing along similar lines. A very large number of the more than 300 small oil presses which existed 10 years ago have now been closed and are being replaced by much larger units with up to 10 so called super-presses, installed in new buildings.

Justification of New Food Industry Projects

For geographical reasons and due to the high costs of investment and labour in Libya export of processed foods must be ruled out. The size of factories must therefore be based on the local market.

If the local market is smaller than half the smallest economic factory size and if the local demand does not show a strong positive trend of more than 10% per year it is highly doubtful if an industrial project should be implemented.

It is therefore recommended that two food factory projects included in the 1981-85 five year plan be reconsidered and if possible postponed to a later date.

- A factory for 4000 ton hydrogenated fat is already out for tender. The imports of hydrogenated fats have for the last ten years been stable at about 200 ton per year. There is no suitable indigenous raw material available at present. Refined olive oil and refined, residual olive oil have a higher value than hydrogenated fat and should not be used for hydrogenation. Even if locally produced soybean oil should become available at a later date the local market for hydrogenated fats will still be too small.

- A factory for 2500 ton chips, pop corn and french fried potatoes. These products are unknown to the majority of the Libyan population; they are generally considered as luxury foods or "junk" foods. It would definitely be advisable to carry out a marketing study for these products and then possibly commence with small, semi-industrial units in the two metropolitan areas before the industrial project is implemented.

Maintenance of Equipment

The problem of maintenance and spare part supply and how they can be solved is dealt with by another Expert of the UNIDO team. One of the recommendations concern the expansion of central maintenance services and spare part stores at the level of the various branch companies.

Due to the extreme importance of properly functioning refrigeration equipment, steam generators and autoclaves for the processing of food products an additional idea will be elaborated here in spite of the risk for overlapping recommendations.

Within the food sector refrigeration machinery is used to a very large extent for air conditioning and in cold storages for fresh products. There are e.g. about 90 cold storages in the Tripoli area established by the Agricultural Production and Marketing Company, see reference 18. The dairy, the carbonated beverages and the canning industries also use a large amount of refrigeration machinery. The maintenance of refrigeration and air conditioning equipment requires special training which many of the normal maintenance staff evidently have not received.

It is recommended that a study is made on the feasibility of setting up a service company for maintenance of air conditioning and refrigeration machinery within the food sector and possibly covering also other industrial sectors using refrigeration equipment.

This service company should service its clients on a contractual basis. Preventive maintenance should be carried out through regular visits according to a pre-determined schedule. An emergency group should be ready to take care of any break-downs which occured in spite of the regular maintenance programme.

Such a study could be carried out by the IRC with assistance of a consultant in servicing of refrigeration machinery. It should be mentioned that this type of service is usually provided by the manufacturers of refrigeration machinery or their sales agents in the European countries.

The situation is somewhat different for the maintenance and service of steam generators including their feed water treatment plants, autoclaves and other pressure equipment. The bigger factories with well equipped and staffed maintenance work shops should be able to take care of their own oil burners, water treatment plants, manometers, safety valves, etc. but most of the smaller factories have been experiencing difficulties in this field.

In this case there is a strong need for training courses for boiler and autoclave operators. It is recommended that such courses are organized by the Secretariate of Light Industry possibly in cooperation with IRC and a consultant. The courses should preferably be held in winter time when most factories operate at low capacity or not at all. The practical part of the courses could be held at the Mamoura Canning Factory.

Government Inspection of Boilers and Autoclaves

Due to the potential risks for human life and property all developed countries have a system for inspection, testing and certification of boilers and autoclaves (and in fact other types of machinery such as elevators, cranes, etc.) before they can be taken into use. These inspections are then repeated with regular intervals.

As far as the Food Processing Expert has been able to find out no such system is in operation in Libya. If it exists it must be only "on paper".

It is therefore recommended that a plan for a Government Bureau for Boiler Inspection is elaborated and later put into practice. This work could, again be started by IRC in cooperation with a consultant. The plan should cover boilers, autoclaves and other processing equipment working under pressure. It is believed that this work should be given high priority.

Quality Control

There is no doubt that the quality control in the Libyan food industry need to be improved. Before any recommendations are made the following facts should be considered.

- Properly working industrial quality control is independent of the factory production department. There must be a responsible quality control manager, usually with training in chemistry, who should report to the Production Department and to the general management. In a very small factory he could possibly be working alone, but usually he will need at least one technician for sampling, process control and routine tests. There is also need for a small laboratory equipped for the necessary tests. All this costs money and it has been estimated a that a small factory usually cannot afford a real quality control department. With a small factory is meant a factory with a yearly production of less than roughly 3000 ton. This means that one cannot reasonably expect the smaller macaroni factories, fish canneries and soft drink factories to set up a quality control department in the modern sense. Still, it is quite possible for such small factories to produce excellent products if the production leader or the forman takes an interest or even pride in the quality of the production. Usually he can perform certain simple tests on product quality in spite of his other duties.

- Secondly, it is a fact of industrial life in capitalist and probably also in socialist countries that the industrial quality control is only as strong as needed to meet the requirements of government control, enforced standards and regulations and the demands of the consumers.

In S.P.L.A.J. the Government is concentrating its food control efforts on the imported foods through the Food Control Laboratories in the ports. The locally produced food stuffs undergo a very lenient and not systematic control through the health authorities. The newly formed "umbrella" companies are starting an internal control of the quality of the products from their various production units but this control has only taken form in the soft drink sector.

There exist national standards for some foods such as wheat flour, semolina, carbonated drinks, olive oil, etc. Some of these standards contain impractical requirements and are in need of revision; as they are not enforced they seem to be completely disregarded by the food industry.

The consumers' demand for quality, finally, played a certain role as long as imported and locally produced products of the same kind were standing side by side on the shelves in the retail shops. This situation changed from January 1982 when import of products, which are or can be made locally, was stopped.

In this situation the first recommendation is that the official control of the quality of processed foods must be intensified. Before that is done there should be a revision of the national food standards. The standards should as much as possible be compatible with the FAO/WHO Codex Alimentarius Recommended International Standards and certain unreasonable requirements of the old standards should be changed in cooperation with representatives of the food industry.

Already before this work has been done, which may take several years, it is recommended that the different "umbrella" companies establish a system of internal product standards, sampling procedures and quality testing at a central laboratory. The possibility of rewarding those factories which consistently produce according to the internal standards should be considered.

At the same time it will be meaningful to improve the factory quality control in all the producing units. A Quality Control Manual should be prepared by the technical departments of the umbrella companies. This manual should contain:

- Factory standards for raw materials, packaging materials, processing parameters and finished products.
- Sampling plans and schedules for process control
- Methods of analysis
- Reporting rules
- Sanitation control procedures, etc.

The necessary personnel and laboratory resources must be provided to each producing unit.

Sanitation

In order to improve the sanitation in the various food factories the umbrella companies should issue regulations specifying that each plant must organize special sanitation and cleaning groups which should follow strict sanitation programmes. The use of cleaning and desinfection compounds should be mandatory. High pressure cleaning/desinfection machines should be acquired for each factory. Windows and screens must be mended in order to keep birds and insects out of production areas. (This will necessitate repair or installation of air conditioning equipment). The use of excessive amounts of insecticides should be discouraged the effort should instead be on the cleaning programme.

4.2.2. Dairy industry

Findings

The dairy industry sorting under the Secretariate of Light Industry consists (1982) of five units in the Tripoli area and four units in the Benghazi area. The total nominal capacity is about 320 000 liter per eight hour shift. There are also some units beloning to the Secretariate of Agriculture. The dairies in the Tripoli area belong to an umbrella company: General Dairy Establishment.

All the raw milk delivered to the dairies comes from state farms; the small amounts of milk produced by private farmers is usually sold directly to the households, although this practice now is discouraged by the authorities.

An increasing part of the dairy milk is based on imported skim milk powder and imported butter. Probably more than half the dairy milk presently produced is such recombined milk,.

The animals at the dairy farms are fed mainly factory made feeds based on imported products to at least 80 percent, The cows of the Friesian type produce comparatively small amounts of milk, around 10 liter per day, although the trend is slowly increasing. The temperature of the raw milk arriving at the dairies is often around 15°C or higher due to lack of or insufficient refrigeration at the dairy farms. The acidity of the milk is many times over 0.20 percent. Its fat content is very low; often around 2.5 percent.

Milk is usually pasteurized at 80-82°C for 15 seconds. The unusually high pasteurizing temperature is used to compensate for high bacteriological counts in the raw milk.

The dairies produce mainly pasteurized milk packed in one liter Purepak cartons and sterilized milk in half liter Tetrapak. The newest dairy in El Beida is using Brikpak. Many of the dairies are equipped for production of cheese, butter, yogurth and ice cream, but most have limited their production to pasteurized and sterilized milk and sometimes yogurth. Some p repacking of imported butter in portionpacks and larger consumer packages is also done.

The quality control performed is generally good but the results of the control are not used in the proper way. Raw milk with acidity over 0.20 percent or otherwise substandard cannot be rejected. Consumer packed milk with too low fat content is regularly delivered from the dairies without any corrective action being taken.

The quality of the products is generally acceptable; however, the keeping quality of the pasteurized milk is many times too short and few dairies are able to keep the fat content at the level stated on the packaging material.

The distribution of products is partly done in refrigerated vans, but too often open pick-up trucks are used with the packages loaded helter-skelter.

Recommendations

It is a declared national goal to make the country independent of imported basic foods before the year 2000.

With the present expansion of the dairy industry the per capita consumption of dairy products will certainly go up from the present level of approximately 75 liter milk equivalents. This is a laudable development as the dairy products provide the least expensive animal protein needed to complement the cereal products in the basic diet. However, the increasing production is largely based on imported milk powder. Also, the local milk production is based to a large extent on imported feed ingredients.

If this trend continues no real independence will be achieved. There is also a risk that the import of inexpensive milk powder (subsidized to a high degree in the producing countries) will hold back the local production of raw milk. It must be kept in mind that the subsidized export prices for milk powder from European countries could suddenly change, although that at the moment does not sound very probable..

- It is therefore recommended that the local production of raw milk be expanded and made more efficient. Also, the local production of animal feed ingredients must be improved so at least 50 percent of the protein and calory needs are covered as a first step.
- The programme for establishing dairy farms should be accelerated. A big effort to produce more green fodder at the farms is also needed.
- A coordinating committee with members from both the Agricultural and the Light Industries Secretariates should be set up to ensure that the establishment of new dairies is coordinated and supported by growth of milk production in a timely way.
- The reasons for the comparatively low yields of milk per cow at the dairy farms must be studied by specialists and an action programme developed (responsibility of the Secretariate of Agriculture).
- The dairies must have more control over their raw material supply. They must be allowed to reject substandard milk. A system of two or three different prices paid to the farms for the milk depending on acidity and fat content would also serve as an incentive for the farms to produce higher quality milk.
- The cooling of the raw milk at the farms must be improved. Combined with an improved cleaning of the transport tanks this will make it possible for the dairies to go down with the pasteurizing temperature to the internationally used 72°C.
- The main product from most dairies is labeled "Pasteurized milk. Fat content 3%". This is an incorrect name for the product. It should be labeled e.g. "Pasteurized milk made from fresh milk, milkpowder, water and butter. Fat content about 2.5%" or similar.

- There is too much waste of the expensive imported packaging material. This situation can be improved if the packaging material is kept in its original wrapping until the last possible moment and if it is stored in airconditioned rooms relative humidity about 30-40%, under the care of a store keeper.
- All dairies, and especially those producing sterilized milk, are very sensitive to breaks in the electric power supply. They should all be equipped with automatically started diesel generators. Those producing sterilized milk need a "no break" system as even a break of one second will necessitate complete production stop and hour-long cleaning and sterilizing procedures.
- All dairy products, except sterilized milk, need refrigerated transport and storage during distribution and sale. Several dairies need more refrigerated trucks and many retail stores do not have or are not using refrigerated storage and display boxes. A coordinating committee with members from the Secretariate of Light Industry, the dairy umbrella companies and the General Marketing Company should survey the distribution system and suggest improvements.

4.2.3. Cereal Mills

Findings

The wheat flour milling industry consists (1982) of six mills, belonging to the General National Company for Flour Mills and Fodder, Tripoli, and the Benina Mill, the main factory of the National Milling and Macaroni Company, Benghazi. The combined nominal capacity of the seven mills is 1450 ton soft wheat per 24 hours.

The combined storage capacity of the mills is about 140 000 ton soft wheat corresponding to about 4 months production at nominal capacity. There are moreover large silos being constructed in the ports of Tripoli, 40 000 ton capacity, and Benghazi. Some silos have also been built in the wheat producing areas by the Secretariate of Agriculture.

The total yearly nominal milling capacity is 406 000 ton wheat corresponding to 317 000 ton flour. Counting with an average utilization rate of 80% this corresponds to about 65% of the demand of bread flour. After four new mills, included in the 1981- 85 five-year plan, with a combined nominal capacity of 247 500 ton have been taken into use the country will have reached complete self-sufficiency in wheat flour milling capacity.

However, as the industry still is relying to about 75% on imported wheat the real self-sufficiency in wheat flour is only about 25% at present. If the agricultural expansion plans are successful this figure will reach 50% in 1990.

The mills are modern and automated to a high degree. Processing follows international practices with two exceptions:

- The normal procedure when producing bread flour is to mix a less expensive soft wheat, yielding weak flour, with a more expensive soft or semi-hard wheat from the U.S.A., Canada or Argentine, yielding a strong flour. In this way bread flour with good baking quality can be produced at the least cost.

  To carry out this procedure two conditions will have to be met: the mills must be able to mix the two wheat types and they must have the two types of grain available in desired proportions at all times. All flour mills are equipped for mixing grain. The second condition, however, is met only occasionally. The main reason is badly planned imports of grain forcing the mills to fill their storage silos with only one type of wheat when grain ships arrive. There seems to be insufficient cooperation between the importer, NASCO, and the mill industry.

  As a result the mills have at times been producing bread flour with low baking quality.

- The local wheat produced in desert areas, such as Sarir and Mourzuk, has such low moisture content, 6-7%, that the mills are unable to temper the grain to the desired moisture content. As a consequence this wheat is milled at about 11% moisture content resulting in decreased milling capacity and increased wear of the rollers. Another disadvantage is a very high breakage, up to 15% of the kernels, causing a low yield of flour.

Only a few mills carry out any kind of quality control. As a predictable result the wheat flour produced by most mills is not up to the national standards. In one survey made by the Food Laboratory, covering all five mills active at the time, only 2 out of 9 bread flours fulfilled the requirements for the flour grade claimed by the mill.

According to the General National Company for Flour Mills and Fodder the extraction rate for wheat flour should be 78% calculated on the basis of cleaned wheat before washing and tempering. As the grain usually is not weighed at this point in the processing it is necessary to determine the moisture content before and after washing/tempering in order to calculate the extraction rate. As most mills do not carry out the required moisture determinations they cannot calculate their extraction rates.

Recommendations

- In order to make it possible for the mills to produce a good flour of even quality they must be provided with the right amounts of grain of the right types and at the right times. For this purpose the whole import, storage and distribution system for wheat grain need to be studied.

  It is therefore recommended that a small study group, including two representatives for the milling industries in the Tripoli and Benghazi areas, one representative from the Secretariate of Agriculture, one representative from NASCO and, possibly, one consultant in grain handling and transport, should be set up in order to study the import, storage and distribution system for wheat grain. The group should not only define the needed storage and transport facilities but also propose a suitable management system

- The problem of the abnormally low moisture content of wheat produced in the desert areas should be studied. It is known that one foreign company has been asked to propose an enlarged tempering section for the mill in Sebha. However, it might be advantageous to study ways to increase the moisture content of the grain already before it is filled into the silos at the mill. Otherwise the losses due to breakage of kernels will not be decreased. Advice from countries with the same problem could be sought.
- Quality control should be reinforced at all mills. Without knowledge of moisture content at the different stages of the milling process it is impossible to optimize the production. Without ash determinations it is not possible to control the flour grade.
- It would be better to calculate the extraction rate on the basis of the total weight of edible products and mill feed. These weights are determined daily at all mills; it is also an advantage that the percentage figures add up to 100.

## 4.2.4. Semolina and Macaroni Industries

### Findings

The semolina and macaroni industries are organized under two umbrella companies, one for each of the two main regions of the country.

The National Establishment for Semolina and Semolina Products, Tripoli, covers the western and southern regions. It controls one semolina mill and five macaroni factories in Tripoli and one macaroni factory in Sebha. The combined nominal/actual capacity is about 60 000/40 000 ton hard wheat and 83 000/55 000 ton macaroni products per year. The yearly production of semolina and semolina flour is about 31 000 ton.

In Benghazi the National Milling and Macaroni Establishment controls one wheat mill producing both bread flour and semolina and one large and two small macaroni factories. The combined nominal/actual capacity of these units is 42 000/24 000 ton hard wheat and 28 000/23 000 ton macaroni products per year. The yearly production of semolina and semolina flour is about 19 000 ton.

Import of macaroni products has been stopped since 1980. The combined national production of about 78 000 ton is not sufficient to fill the demand, especially for spaghetti. For this reason many of the factories are being modernized and expanded through installation of new lines with increased capacities in place of the old lines.

The combined local production of semolina and semolina flour, 50 000 ton, corresponds to about 65% of the demand of the macaroni factories. There is also a large home consumption of semolina for kuskus. As a consequence NASCO has to import appreciable amounts of semolina each year.

The semolina mill in Tripoli operates sometimes with a 2/1 mixture of hard and soft wheat. The extraction rate for semolina is about 75%, while the normal figure should be less than 65%. The total extraction rate is about 80%, while the recommended value is 78%. As both the semolina and the semolina flour are used for macaroni production the result is large amounts of bran particles causing brown spots in the pasta products. Analyses made at the Food Laboratory show that semolina from this mill has both higher ash content and larger amounts of coarse particles than allowed by the Libyan standard. Large particles are known to cause white spots in the macaroni products.

The mill in Benghazi is also sometimes forced to mill a mixture of soft and hard wheat. Its extraction rate for semolina is around 66%, but the total extraction rate is as high as 81%. Again, the result is brown spots from bran particles in the macaroni products.

Except for some control of the purity of received grain at the Tripoli mill and occasional checks of package weights in the macaroni factories the industry is working without any quality control.

In the macaroni factories the water addition is regulated according to the pressure of the paste in the extruder; the drying parameters are seldom controlled but are generally not too far off the values recommended by the equipment manufacturer.

The macaroni products have a low, but acceptable quality. Brown and white spots are frequent; the boiling water extract is usually quite starchy.

Recommendations

The semolina mills should be supplied with enough Durum wheat, so that mixing with soft wheat can be avoided.

The mills must be instructed to start a quality control programme including determinations of moisture, ash and protein in raw material and products. Sieve analysis of the semolina should also be made.

Already before the quality control programme has been started the mills should be able to adjust their milling process to internationally accepted extraction rates, that is, less than 65% semolina and not more than 78% total edible products.

The macaroni factories should be encouraged to control their raw materials as to particle size, moisture and ash content. They should have the right to reject non-standard deliveries.

Due to the relatively small size of several of the present macaroni factories they will always have difficulties in applying the needed control of processing and quality of products. It is therefore recommended that the umbrella companies during the ongoing expansion of the industry strive to decrease the number of small units.

4.2.5. Fish Canning Industry

The fish canning industry is wholly controlled by the Libyan Fishing Company, LIFCO, which runs the tunnaras and all tuna and sardine canning factories.

4.2.5.1. Tuna Canning Industry

Findings

The local catch of tuna in tunnara traps has fallen from about 1200 ton per season in the period 1950 - 1970 to 200 - 400 ton at present.

During the last years a newly established deep sea fishing company, the Libyan Spanish Fishing Company, has started fishing in the Atlantic. In 1980 it landed about 1000 ton frozen fish in Libya. Of this amount 420 ton was decapitated and cleaned tuna, corresponding to 600 ton whole tuna which was used by the two tuna canneries at Zuagha and Zanzur.

There are at present (1982) four tuna canneries with a total capacity of 960 ton raw tuna, counting with 40 working days and one 8 hour shift. Only one of the factories, in Zanzur, is modern; the other three at Zuagha, Zliten and Misurata date from before the second world war.

Three modern lines, each with a capacity of 10 ton raw tuna per shift, will be established in Zliten, Zeregh and Zuagha. The combined capacity of these three lines will be 1200 ton raw fish

Assuming that the three old lines will be scrapped,the total capacity for canning of tuna after the planned expansion will be 1600 ton per 40 days season and one shift operation.

There are three newly established cold stores at Zanzur, 1000 ton, Zuagha, 250 ton, and Zliten, 250 ton. These are used for quick freezing of tuna and sardines and for storage of imported frozen fish. By using frozen fish for canning the season can be extended over the whole year.

Processing of tuna at the three old canneries is very labour intensive. The resulting product has a good taste but an appearance which would not be acceptable on the international market as it does not conform to any of the recognized packing styles. The processing on the modern line in Zanzur was not seen by this Expert.

The total production of canned tuna from local and imported fish in 1980 was 714 ton gross weight corresponding to about 1000 ton raw, whole fish.

Recommendations

The IRC report on the fish canning industry, Appendix II, reference 2, shows that all factories run with an appreciable loss. The expanded use of frozen storage and import of frozen tuna, which has been started recently should change this situation.

However, the local catch has stagnated an about 300 ton and the imports, now corresponding to 600 ton whole fish, are not easily increased as the exporting countries prefer to sell their tuna in canned form. This situation is further complicated by the question of mercury contamination in tuna, see Appendix II, reference 10. The Libyan import specifications stipulate not more than 0.5 ppm mercury in tuna (corresponding to 0.8 ppm in the canned product) and this quality is naturally preferred by all buyers.

Assuming that both the imports and the local catch can be doubled, the total supply of tuna, calculated as whole fish, would be 1800 ton. This amount can be handled by one canning line with a nominal capacity of 10 ton per 8 hour shift running at 72% of nominal capacity for 250 days, one shift.

Such a production could be done with the existing tuna line in Zanzur using e.g. two thirds of available cold storage capacity at Zanzur, Zliten and Zuagha and timing the imports so they do not coincide with the local season.

It is therefore recommended that the three, old tuna canneries in Zliten, Misurata and Zuagha are closed down and that all tuna canning is concentrated to Zanzur, which will work up to 250 days per year. The catches at Zuagha and Zliten/Misurata should be quick-frozen and stored at the local cold stores and later brought to Zanzur for processing. Imported frozen tuna can be directed to empty space in any of the three cold stores with preference for the one in Zanzur.

The three new lines being established at Zliten, Zeregh and Zuagha should be used only if imports of frozen tuna can be increased over 840 ton decapitated fish. Each of these lines will be able to process the same amount at the line in Zanzur, that is about 1800 ton whole or 1260 ton decapitated fish per year. They will each need a cold storage of about 500 ton capacity corresponding to 4 months operations.

It should be noted that the above calculations are all made on one shift basis.

4.2.5.2. Sardine Canning Industry

Findings

Sardine fishing, mainly with lamparas, brought in about 3000 ton in 1980 of which 1200 ton was used by the canneries.

There are 4 sardine canneries in the western region with a combined capacity of 2400 ton fresh sardines, counting with 80 working days and one shift operation.

One of these factories in Sabratha is about 50 years old but the other three, in Zuara, Zanzur and Homs have identical, modern lines with a capacity of 9 ton per 8 hour shift.

One modern sardine cannery in Benghazi, with a capacity 1200 ton fresh (or frozen) sardines, has been mentioned in Section 4.2.1.1. as an example of a misplaced factory.

Sardine processing in the modern lines at Zanzur and Benghazi results in a product of acceptable taste but with too many defects in appearance and style. The product can in no way compete with canned sardines imported from Portugal and Spain, which are available in the Libyan market.

The production in both factories is marred by heavy losses in the cutting and cleaning stage. In 1980, the average of these losses at the Zanzur factory, not counting cooking loss, ran up to 65%, while they normally should be between 30 and 35%.

The cause of this serious processing defect, which decreases the potential production nearly by half, was malfunctioning of the cutting machines from which a high percentage of fishes cut in halves and in one centimeter thick slices emerged. Either the machines were not adjusted to the fish size being processed or they are constructed for another type of sardine. The production management was not able to take any corrective action.

The canneries at Zanzur, Homs, Zuara and Benghazi are equipped for fish meal production. The combined capacity was said to be 420 ton dry product per season. The total production of fish meal at the three factories in the Tripoli area was 195 ton in 1980. No fish meal was produced at the Benghazi factory. Analysis at the Food Laboratory showed that the fish meal was of excellent quality.

Recommendations

Continued operation of the sardine factory in Benghazi cannot be justified. The present production at less than 10% of the one shift capacity using imported frozen sardines cannot be called even a stop-gap measure.

Operation of the old canning line at Sabratha has hardly any justification when a modern, under-used line is available at Zuara. Sardines landed at Sabratha should be quick-frozen and processed in other places.

If the three new lines in Zuara, Zanzur and Homs received eac one third of the 1980 catch of 1200 ton they would work only 45 days per season one shift operation. Unless the sardine catch can be at least doubled or the import of frozen sardines of the right size (25 - 30/kg) can be increased it is recommended that at least one of the three lines is closed down.

As it has already been proposed that the tuna canning should be concentrated to Zanzur it might be suitable to let the factories in Homs and Zuara divide all sardine canning between themselves.

It is also recommended that a consultant or a representative from the manufacturer of the sardine cutting machine is called in for investigation of the cause of the abnormal losses in Zanzur

4.2.6. Carbonated Beverages Industry

Findings

The major part of the carbonated beverages industry is organized into two umbrella companies based in Tripoli and Benghazi.

The Arabic Establishment for Manufacture and Bottling of Soft Drinks, Tripoli, controls the two Kawtar factories in Tripoli, one Kawtar factory in Sebha and the Bengashir Mineral Water Factory, the OEA Brewery (non-alcoholic beer), the National Beverages and the Local Beverages, all in Tripoli.

The combined nominal capacity of this group is presently (1982) about 150 million liters (300 days, 8 hours per day): the actual production is about 87 million liter. Ten percent of the production is in the form of mineral water. The group plans to expand its production capacity during the present five-year plan with seven new lines with a combined yearly capacity of about 130 million liters.

In the Benghazi area the General National Company for Soft Drinks controls the Kawtar factories in Benghazi and Derna, the Zuhur Bottling plant in Benghazi and one fruit juice bottling plant. The combined nominal capacity for carbonated drinks is about 67 million liters per year. (300 days, 8 hours per day). The actual production is about 22 million liters. The expansion plans up to 1985 include three new lines with a combined capacity of 76 million liters.

The most striking fact about the carbonated beverages industry is the dominance of the five Kawtar factories (formerly part of Pepsi Cola International, PCI). The Kawtar drinks represent 80% of the sweet carbonated beverages market. Kawtar obtains its flavour concentrates from the PCI and follows processing and product specifications from that organization. Samples of products are sent monthly to PCI for quality control.

The industry is depending on highly automated lines including very fast filling and capping machines. Consequently it suffers badly from maintenance problems, which is illustrated by the wide difference between nominal and actual capacities. This situation has been discussed in section 4.2.1. of this report.

Liquid carbon dioxide is presently produced in three units in Tripoli with a combined capacity of 455 kg per hour. A large unit is planned for the Kawtar factory in Benghazi· capacity 500 kg per hour and another unit for 100 kg per hour will be installed in an independent factory in Derna.

All plastic crates and most crown caps and glass bottles are imported. A national production of glass bottles has started in Azizia: the first experience with these bottles has not been good.

Recommendations

The development plans for the carbonated beverages industry prepared by the Food Laboratory for the 1981 - 85 five-year plan and up to the year 2000, Appendix II, references 5 and 11, contain our recommendations for this industry and are not repeated here.

In general, the close contact upheld by the industry with the PCI allows it to solve most problems with processes and products internally without the use of outside consultants. Still, we would here make two suggestions.

It is recommended that production of a calory free carbonated drink should be started, may be at one of the smaller factories in Tripoli. A cola flavour would probably be most suitable. The product development could be done in cooperation with the IRC and a consultant. It could also no doubt be done in cooperation with the PCI.

It is also recommended that a suitable source for mineral water bottling is located in the eastern region. The Bengashir factory has already great difficulties with its water supply and it must be costly to truck water from Tripoli to the eastern region. We believe that the natural spring near Derna might be of interest for this project. The requirements on a mineral water source are mainly that it has constant composition, has sufficient capacity and that the water has a clean taste. If necessary, mineral salts can be added before the carbonation. In this connection it can be mentioned that the Bengashir water, which is an excellent table water, has quite low total solids, 570 mg/1, mainly chlorides, and is weakly alkaline, pH 8.

The reasons for the unsatisfactory quality of bottles from the Azizia plant should be investigated. An outside consultant may be needed to identify the problems and introduce the necessary improvements.

## APPENDIX I

## TENTATIVE WORK PROGRAMME OF THE FOOD SECTION OF I.R.C.

Before a work programme is proposed a series of influencing factors have to be considered.

### Duties

The main duty of the food section is to render technical consulting services to the food processing industry. The purpose of these services should be to improve the efficiency of processing operations and the quality of products.

As a support to these consultancy services the food section should also carry out research and development activities in laboratories and pilot plant.

Another important duty of the food section is to take part in the planning and evaluation of new industrial projects in the food sector.

### Capability and Limitations

The food section is presently equipped and staffed mainly for work in the field of food analysis and laboratory aspects of quality control.

The staff has limited experience of industrial food production and must therefore be cautious when entering into the field of technical consultancy services.

There is no pilot plant and consequently it is not possible to carry out work on product and process development. This situation will be changed to the better when the Food Research Laboratory and the Food Pilot Plant will be taken into use at the new IRC premises in Tajura. This will only happen some time in 1981 as the necessary equipment is still to be ordered.

## Present Work Programme

Due to its proven capability in the field of food analysis the food section is presently carrying out determinations of composition and quality of foodstuffs for outside clients. However, since the new Food Control Laboratory of the Secretariate of Economy took over the control of imported foods in 1978 the IRC food section is in need of new work activities.

## Technical Assistance Working Methods

Experience in many countries have shown that technical assistance consisting of short visits to factories and advice given orally during the visits and/or in the form of trip reports usually leads to no tangible results. Even if the advice given is technically sound the following conditions must also be considered before any lasting results can be expected:

1. The proposed changes must be not only technically but also economically feasible under the local conditions.
2. The factory staff on all levels should be convinced about the usefullness and benefits of the proposed improvements.
3. There should be no misunderstandings about the nature of the proposed changes. The best way to avoid this pitfall is for the advisor(s) to take part in the introduction of the changes.
4. After changes have been implemented in a factory any differences between expected and real results should be observed and necessary adjustments made. This requires follow up visits by the original advisor(s).

## Present Situation in the Local Food Industry

During September-October 1979 staff from the food section and the UNIDO Expert in food processing visited a number of representative food factories in the Tripoli area in order to identify types of clients and work area where technical assistance was most likely to have impact and be successful. Although the factory managers not always directly admitted the difficulties they were encountering it was noticed that many factories were producing far below capacity often due to problems with raw materials supply and maintenance. The factory hygiene, the quality control and the processing operations could often be considerably improved. Most factories suffer from a series of bottle-necks and problems distributed between raw materials supply, processing, quality, hygiene, marketing and management in general. Technical assistance in one particular area even if successful, is therefore not likely to have a dramatic effect on the overall performance of a factory.

This fact should not discourage IRC to start technical consultancy activities in the food manufacturing industry. It should, however, be realised from the start that the problems of this industry very seldom are caused only, or even mainly, by deficiencies of technological nature.

An assistance programme to the food industry should ideally consist of expertise in raw material production, food manufacturing, marketing as well as economy, financing, and business administration.

## Tentative Work Programme

Taking the above into consideration the following work programme is proposed for the food section of I.R.C. for the period November 1979 to the date when the new premises of I.R.C. are operational.

1. Technical Assistance to the Food Manufacturing Industry

1.1. Technical Assistance to a selected industry

1.1.1. In consultation with the Secretariate of Light Industries the IRC should select one type of food industry, e.g. the cereal milling, the dairy, the fish canning, the fruit and vegetable canning, the olive oil or some other kind of food industry, which is known to be working under capacity and/or with low quality products.

1.1.2. The Food Section should study the operation and the problems of the selected industry in depth through interviews with factory personnel and prolonged visits to the factories.

1.1.3. A programme for improvements should be elaborated and thoroughly discussed with the factory management.

1.1.4. The improvement programme should be implemented at the factory which has proved itself the most interested in the project during the initial phase.

1.1.5. The operations of the factory should now be followed during a representative period by measuring the efficiency of the processing and the quality of the products. These values should be compared with those determined earlier; activity 1.1.2. above. Adjustments may have to be made to optimize the operations.

1.1.6. The factory management should continue the improvement programme (evolutionary operations). Contact with the factory should be continued for an undetermined time.

1.1.7. If the results are encouraging other factories within the same type of food industry should be informed of the results obtained and offered the same service.

It is estimated that the above project will have a duration of one to several years depending on the type of operations, continuous or seasonal, and if the proposed improvements involve time-consuming imports of equipment.

1.2. Trouble Shooting

In various ways the Food Section can become aware of technical problems of certain food factories. Most of the times it will be the question of the quality of a finished product. In such cases the section can offer its assistance in finding a solution to the problem. Examples of such problems encountered during preliminary contacts are: turbid apple and grape juice at a canning factory, pasteurized milk contaminated with E.coli at a dairy, excessive waste at a fish canning factory and uneven quality at a pasta factory.

This "trouble shooting" activity will be on an ad hoc basis and will often require minor laboratory investigations and experimental factory runs.

1.3. Research and Development Activities

During work on technical assistance (activity 1.1.) and trouble shooting (activity 1.2.) certain technical problems may appear which are not easily solved and which require special studies.

If sufficient physical and personnel resources are available and if the problem is considered of general importance research projects can then be elaborated and started.

Due to the lack of a pilot plant and a well equipped food research laboratory certain product and process development projects will have to be postponed to the time when the new facilities at Tajura are ready.

2. Data Bank on the Libyan Food Industry

In its future activities the food section will need up to date and well organized data of technical and economic nature on the Libyan food industry.

A standard format for the data should first be elaborated in cooperation with the Economic Section.

The collection of data will initially require a few man months of one staff member: later it will become a continuous activity involving all staff members in contact with the food industry.

The maintenance and the control of the data bank should be the responsibility of the head of the Section.

3. **Food Standards and Regulations**

To be able to give correct information and advice to the industry the Food Section must have access to all Libyan food standards and regulations in force. For this reason continuous contact must be established with the various government offices dealing with these matters.

The food section of IRC should be actively involved in the elaboration of the technical parts of any new food standards and regulations representing the view point of the food industry.

4. **Planning for the new IRC premises**

In connection with the moving to the new IRC premises in Tajura the following work activities have to be carried out:

4.1. Establish an organization plan for the food section and the microbiology section and preparation of work descriptions and personnel requirements.

4.2. Establish a plan for the use of the new facilities. In this connection to control that electric power, water and other facilities are sufficient as to quantity and well placed.

4.3. Select, order and install new equipment for the Food Research Laboratories and the Food Pilot Plant.

4.4. Plan and carry out the moving of existing equipment from the old to the new premises.

5. **Planning and Evaluation of Food Industry Projects**

5.1. Take part in work for the new 5-year plan for the food industry.

5.2. Evaluation of Food Industry Projects of consulting firms prepared for IRC.

29-10-1979

G. Sjostrom
UNIDO Expert

## APPENDIX II

List of reports of the Food Laboratory, Industrial Research Centre, prepared during the period August 1979 to December 1982 with participation of the Food Processing Expert.

(Reports nos. 6-13, 15-17 and 19-21 exist in a draft version in English and an edited and modified final version in Arabic).

1. Development study on the dairy industry
   Report from IRC to SLI (Dec.1981)
2. Development study on the fish canning industry.
   Report from IRC to SLI (1982)
3. Development study on the wheat milling industry.
   Report from IRC to SLI, 116 p. (May 1982)
4. Development study on the carbonated beverages industry.
   Report from IRC to SLI (under work Dec.1982)
5. Development study on the carbonated beverages industry.
   Report from IRC to SLI (under work Dec.1982)
6. Utilization of surplus dry figs from the Jeffren region.
   M. Baruni and G. Sjostrom
   Report to the SLI, 11 p. (Nov. 1980)
7. Processing of dry figs and manufacture of fig processing equipment in Turkey and Italy.
   M. Baruni and G. Sjostrom
   Trip report for IRC/SLI 8 p. (May 1981)

8A. Possible use of surplus water melon
   M. Baruni and G. Sjostrom
   Report to IRC (March 1981)

8B. Recommendations for continued work on water melon

M. Baruni and G. Sjostrom

Report to IRC, 2 p. (July 1981)

9. Experiments with carob bean extract as base for carbonated drinks

El Aghal, Shermit and G. Sjostrom

Preliminary report to IRC, 4 p. (August 1982)

10A. Mercury contamination of foods in S.P.L.A.J.

Abu Agrab and G. Sjostrom

Report to IRC, 12 p, (Jan. 1982)

10B. Problems of contamination of tuna fish by mercury (in Arabic)

Abu Agrab

Report of Techno-Economic Section, IRC 33 p. (July 1982)

11. Carbonated beverages industry. Tentative development programme for the 1981 - 85 five year plan.

M. Baruni and G. Sjostrom

Report prepared for the Food Industry Committee, SLI, 11 p.(Jan.1[illegible]

12. Study on ways to make use of the idle tomato paste industry

A. Keshem and G. Sjostrom

Report to the SLI, 6 p. (July 1980)

13. Plan for the development of the Libyan edible oil and fat industry to the year 2000.

Abu Agrab and G. Sjostrom

Report to SLI, 39 p. (Feb. 1982)

14. Plan for the development of the Libyan carbonated beverages industry to the year 2000.

El Aghal, M. Mounir and G. Sjostrom

Report to SLI (1982)

15. Evaluation of a feasibility study for two dairies in El Marj and Garabulli - TESCO/AGROBER

G. Sjostrom and M. Baruni

Report to SLI, 8 p. (1981)

16. Urea in animal feeds

G. Sjostrom

Literature study made for IRC/SLI, 5 p. (Apr. 1980)

17. Utilization of feathers and other chicken offall in broiler ration

G. Sjostrom

Literature study made for IRC/SLI, 5 p. (May 1980)

18. Report on cold storages in the Tripoli area

El Aghal and G. Sjostrom

Report to IRC, 5 p. (March 1980)

19. Food Processing industry - past, present and future.

G. Sjostrom

Paper prepared for SLI, 6 p. (Aug. 1981)

20. Possible areas of cooperation between the Nuclear Research Centre and the Food Laboratory, IRC.

G. Sjostrom

Working paper, 5 p. (July 1982)

21. Proposed visit to salt water lakes in the Sebha area

G. Sjostrom

Proposal to IRC, 4 p. (Nov. 1980)

APPENDIX III

Equipment to be accquired for the new IRC premises - Food Laboratory

NB : All electric equipment should be for 220/380 V AC,50 cycles. All equipment with recommended spare parts and lubricants for two years service.

| Description | No. of units | Appr. price (198.. US $ CIF Tripoli |
|---|---|---|
| A. To be ordered from general laboratory supplier such as: | | |
| - Karl Kolb KG, P.O.Box 102040, D-6072, West Germany | | |
| - Gallenkamp & Co., Ltd., Christopher Street, London EC2P 2ER, England | | |
| - Scientific Glass Apparatus Co., Inc., 735, Broad Street, Bloomfield, N.J., U.S.A. | | |
| 1. Top pan balance, 10 kg, tara possibilities several kg, readability 0.1 g, precision ± 0.05 g | 1 | 4000 |
| 2. Top pan balance, 1.2 kg, electronic, digital readout, taring range 1.2 kg, readability 0.01 g, precision ± 0.005 g | 2 | 5500 |
| 3. Top pan balance, about 160 g, tare about 160 g, readability 0.001 g, precision ± 0.001 g | 2 | 4400 |
| 4. Muffle furnace, up to at least 1000°C, muffle volume about 40 liter, automatic temp. control | 2 | 2400 |
| 5. Drying oven, mechanical convection, up to 350°C, volume about 215 liter, temp. regulation ± 1°C, recirculation of air in vertical direction | 1 | 3000 |
| 6. Water bath, thermostatic, about 26 liter, with 2 sets of 4 test tube racks with 12 and 18 mm openings respectively, and with ring sets and gabled cover. | 2 | 1400 |
| 7. Shaking water bath, thermostatic, volume c·a 14 liter with clamp plates for 50 ml and 200 ml flasks and 4 test tube racks each for 12 mm and 17 mm tubes. | 1 | 2200 |

| | | | |
|---|---|---|---|
| 8. | Thermostatic bath with heating and refrigeration, transparent sides, to be used with hand-operated Ubbelohde viscosimeters, temp. range 0 - 150°C, accuracy ± 0.01°C | 1 | 2800 |
| 9. | Viscosimeters, Ubbelohde, set of 9, range 0.5 to 30 000 centistokes, for manual operation, relative measurements | 1 set | 800 |
| 10. | Magnetic stirrer with hot-plate, 500 W, diam. 12.5 cm, stainless steel surface, stepless electric speed regulation, from 0 to 1100 rpm, with supporting rod and four magnetic bars. | 5 | 1900 |
| 11. | Sieves, stainless steel, diam. 20 cm, mesh 230, 140, 120, 100, 80, 60, 40, 30, 20, 16, 12, 10, 8, 6, 4 with cover and receiver, stainless steel, diam. 20 cm. | 15 | 900 |
| 12. | Emulsifying-stirring apparatus, ULTRA-TURRAX, 500 W, 2 speed, with container holder, table clamp and set of recommended spare parts and 2 extra rotor heads, 45 mm diam., for high viscosity emulsions and disintegration of coarse-grained substances. | 1 | 4000 |
| 13. | Mixer-blender, 3 speed, 1 liter capacity glass jar, with 2 extra jars and 2 extra cutters/sockets | 3 | 600 |
| 14. | pH meter, portable, range 0 to 14 pH, precision 0.05 pH, digital read-out | 1 | 1100 |
| 15. | pH meter, bench type, with temp. compensation and digital readout, range 0 to 14 pH, precision 0.01 pH | 2 | 3000 |
| 16. | Viscosimeter, falling ball type, range 0.5 to 10 000 cp | 1 | 1300 |
| 17. | Viscosimeter, rotation type, portable, with support stand and sensors for the range 0 to about $60 \times 10^6$ cP | 1 | 3500 |
| 18. | Stop watches, addition timer, 1/5 sec., interrupted performance with two hands, max. 60 min. | 2 | 150 |
| 19. | Stop watches, addition double timer, interrupted performance with two hands, one trailer hand, 1/100 min., max. 30 min. | 2 | 350 |
| 20. | Thermo-hygrograph, -35 to 45°C and 5 to 100% RH, for weekly and daily drum recording, with 3 sets of 100 weekly and 3 sets of 100 daily recording charts; plus set of 6 spare fibre tip pens | 1 | 1000 |

| | | | | |
|---|---|---|---|---|
| 21. | Aspiration psychrometer, Assmann type, -5 to 60°C, with set of spare thermometers | | 1 | 800 |
| 22. | Hydraulic tincture press, hand pump, capacity 2 liter, max. pressure about 450 bar, with manometer and recommended spare parts | | 1 | 2800 |
| 23. | Ice making machine, air cooled, storage bin capacity about 35 kg ice, production capacity about 100 kg per 24 hour | | 1 | 4000 |

NB: The balances, items 1,2 and 3, can be ordered also from : Mettler Instruments
CH-8606 Greifensee,
Switzerland

B. TO BE ORDERED FROM SPECIAL SUPPLIERS

| | | | | |
|---|---|---|---|---|
| 24. | Spectrophotometer, visible range, single beam, range about 340 to 950 nm, spectral slitwidth about 20 nm. Analog readout. About 12 mm round cells. Set of recommended spare parts | Beckman Spectronic Zeiss, etc. | 1 | 3000 |
| 25. | Spectrophotometer, visible-UV, single beam, range about 200 to 1000 nm, spectral slit-width about 2 nm, digital readout, 10x10 mm cells, set of recommended spare parts. | Beckman Spectronic Zeiss, etc. | 1 | 9000 |
| 26. | Tristimulus colour difference meter, for measurement on solid and liquid opaque materials, digital readout in L, a, and b values, about 10x10 cm cells and if possible also 5 cm diam round cells. With set of colour standards and all recommended spare parts and accessories. | Hunterlab Overseas Inc.,9529, LeeKwy 11 Fairfax, VA 22031,USA | | 13000 |
| 27. | Can testing set for control of double seam incl. pressure test and thickness of seams. | Metal Box.Ltd. 2 Queens House, Dorbury Road, Reading,Berks,England RG1 3[illegible] | | 500 |
| 28. | Brabender Amylograph | Johs. Rieckermann Hamburg, W.Germany | 1 | 3000 |
| 29. | Brabender Senior Automatic Mill | Ditto | 1 | 9000 |
| 30. | Brabender D-corder | Ditto | 1 | 5000 |
| 31. | Brabender 20 DN Measuring Extruder | Ditto | 1 | 7000 |

TOTAL FOR FOOD LABORATORIES 101400

## APPENDIX IV

**Equipment to be acquired for the new IRC premises - Microbiological Laboratory**

NB : All electric equipment should be for 220/380 V AC, 50 cycles. All equipment with recommended spare parts, lubricants for two years service.

| Description | No. of units | Appr.price (1980) US $ CIF Tripoli |
|---|---|---|
| A. To be ordered from a general laboratory supplier such as: | | |
| - Karl Kolb KG, P.O.Box 102040, D-6072, West Germany | | |
| - Gallenkamp & Co., Ltd., Christopher Street, London EC2P 2ER, England | | |
| - Scientific Glass Apparatus Co., Inc., 735 Broad Street, Bloomfield, N.J., U.S.A. | | |
| 1. Incubator, volume about 50 liter, temp. range from 5°C above room temp. to 70°C, with adjustable limit temp. controller, with inner glass door, shelves and thermometer, tem. accuracy ± 0.5°C | 2 | 1800 |
| 2. Waterbath, thermostatic, about 20 liter, with 5 test tube racks with 18 mm holes and with gabled cover, accuracy ± 0.5°C | 1 | 600 |
| 3. Waterbath, shaking, thermostatic, 10 to 200 oscillations per minute, load up to 10 kg, thermostate accuracy ± 0.5°C, with shaking inserts for about 15 conical 50 - 100 ml flasks, 8 conical 200 - 300 ml flasks and about 100 16 mm test tubes | 1 | 2700 |
| 4. Sterilizer, horizontal, max. working pressure 3 bar, volume about 60 liter, semi-automatic operation, with temp. indicator, time switch, water-jet pump, etc., incl. trays and sterilizing boxes. | 1 | 12700 |

| | | | |
|---|---|---|---|
| 5. | Test tube rotator, speed between 6 and 60 rev. per min., capacity about 26 test tubes of 16 mm diam. x 160 mm | 1 | 1000 |
| 6. | Turbidity meter for direct reading of cell concentration in culture tubes of about 17 mm diameter with turbidity standards | 1 | 2200 |
| 7. | Filter holder for membrane filtration, stainless steel, 47/50 mm filters, with 2 suction flasks, 1 liter, and 2 silicon stoppers | 1 set | 500 |
| 8. | Membrane filters, 50 mm diam, porosity 0.65 microns | 200 | 150 |
| 9. | Ditto 0.45 microns | 200 | 150 |
| 10. | Ditto 0.2 micron | 200 | 150 |

Total for Microbiology Laboratory 21050

## APPENDIX V

Equipment to be acquired for the new IRC premises - Food workshop

NB: All surfaces in contact with food of stainless steel· all electric equipment for 220/380 V AC, 50 cycles. Always with recommended spare parts and lubrican·

| Description | Possible suppliers | Number of units | Appr. pri· 1980 US $ & CIF |
|---|---|---|---|
| 1. Retort with automatic controls incl. thermograph, for experimental canning· volume about 70 liter; steam heated | Dixie Canner Equipment Co. P.O.B. 1348, Athens, Georgia 3060, U.S.A. | 1 | 7000 |
| 2. Exhaust tunnel, semi-automatic· adjustable for various speeds· taking cans up to 5 kg· with tables at ends· max. capacity about 800 1 kg cans per hour. | Dixie Canner... | 1 | 1000 |
| 3. Water bath, steam heated, for pasteurization/sterilization of cans and bottles, with baskets· approx. 100x60x80 cm (lxwxh)· stainless steel. | Dixie Canner...... | 1 | 500 |
| 4. Water bath for cooling of cans· with baskets· approx. 100x60x80 cm (lxwxh) | Dixie Canner.... | 1 | 500 |
| 5. Single effect vacuum evaporation pan with vacuum pump· equipped with sight glass, bottom valve, scraped surface stirrer, thermometer, vacuum-meter, and device for sampling· effective volume about 25 liter· evaporation capacity about 50 kg water per hour· steam-jacketed. | S.S. Bertuzzi Milan, Italy | 1 | 7000 |
| 6. Kettle, steam-jacketed, trunnion mounted, with stirrer, for cooking and mixing· gross volume about 100 liter; stainless steel interior. | Lee Metal Production Co. Philipsburg, Penn., USA<br>- Dixie Canner....<br>- Bertuzzi..... | 1 | 4000 |
| 7. Pulper-finisher for fruit/vegetable pulps, with 3 sets of sieves: 1.0, 0.7 and 0.4 mm holes; equipped with motor for variable speeds; capacity about 100 kg per hour. | F.H.Langsenkamp Co., 227 E South, Indianapolis 25, Ind., USA | 1 | 6000 |

| | | | | |
|---|---|---|---|---|
| 8. | Dinintegrator for pulping wet products: smallest commercial model (capacity approx. 1 t/h) | Rietz Mfg. Co.,<br>160 Rood Road,<br>Santa Rosa, Calif.,<br>U.S.A. | 1 | 1800 |
| 9. | Laboratory pasteurizer, plate type, electrically heated, capacity about 100 kg per hour for juices, nectars, purees. | Alfa-Laval AB,<br>22103 Lund,<br>Sweden | 1 | 8000 |
| 10. | Tray dryer, cabinet type, steam-heated, with automatic temperature and humidity control: max. load about 30 kg moist material; equipped for vertical and horizontal air flow. | Proctor & Schwarz.<br>Inc., 7th & Tabor Rd.,<br>Philadelphia, PA<br>19120, USA | 1 | 25000 |
| 11. | Colloid mill, toothed disk type, out-put about 50 kg per hour. | -Karl Kolb KG,<br>POB 102040, 6072<br>Dreieich, West Germany<br>-FRYMA, Switzerland | 1 | 4000 |
| 12. | Vacuum de-aerator for juices and purees: batch operation; capacity about 20 liter. | -FRYMA Maschinen AG<br>CH-4310 Rheinfelden<br>Switzerland | 1 | 5500 |
| 13. | Steam generator; 100-200 kg per hour, 3 $kg/cm^2$· including feed water tank and pump: heated by gas or electricity | Karl Kolb KG...... | 1 | 10000 |
| 14. | Platform scale· up to about 150 kg; 0.2 kg to 0.1 kg divisions; mounted on casters | Karl Kolb KG..... | 1 | 2500 |
| 15. | Electric can closer with change parts for several can sizes (European standard), hand operated, smallest type, with all recommended spare parts | -Dixie Canner......<br>-Metal Box Ltd.,<br>Queens House, Forbury Rd.<br>Reading, Berkshire,<br>England RG1 3JH<br>-LUBECA Maschinen u.<br>Anlagen GmbH, POB 1229<br>D-2400 Lubeck, Western<br>Germany | 1 | 1500 |
| 16. | Holding and blending tank, about 150 l with stirrer; jacketed for heating with steam and cooling with water | Alfa-Laval AB<br>22103 Lund<br>Sweden<br>-S.A.Bertuzzi, Milan, Italy | 1 | 1000 |

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|---|---|---|---|---|
| 17. | Inspection and trimming tables with stainless steel surface with edges turned up and equipped with drain; on wheels· about 200x90x90 cm (lxwxh) | Dixie Canner... | 2 | 800 |
| 18. | Bottle sealer for crown caps, hand operated, bench type. | Dixie Canners.... | 1 | ·300 |
| 19. | Vacuum sealer for plastic bags· about 30 cm width, hand operated | Multivac Export AG | 1 | 3800 |
| 20. | Platform trucks; about 60x40 cm | Dixie Canners.... | 2 | 400 |
| 21. | Stainless steel pots with lids; about 20 liter | Dixie Canners | 6 | 600 |
| 22. | Electric reamers for citrus fruits, hand operated | Karl Kolb... | 4 | 400 |
| 23. | Assorted pans, 2 to 5 liter of stainless steel | Karl Kolb. | 8 | 800 |
| | jugs, 2 liter " | " | 4 | 400 |
| | trays, about 70x60x7 cm " | " | 6 | 600 |
| 24. | Homogenizer, piston type, one step, max. pressure about 300 $kg/cm^2$ | -Gaulin Corp. USA<br>-Rannie, Denmark | 1 | 8000 |

Total for Food Workshop about 101900

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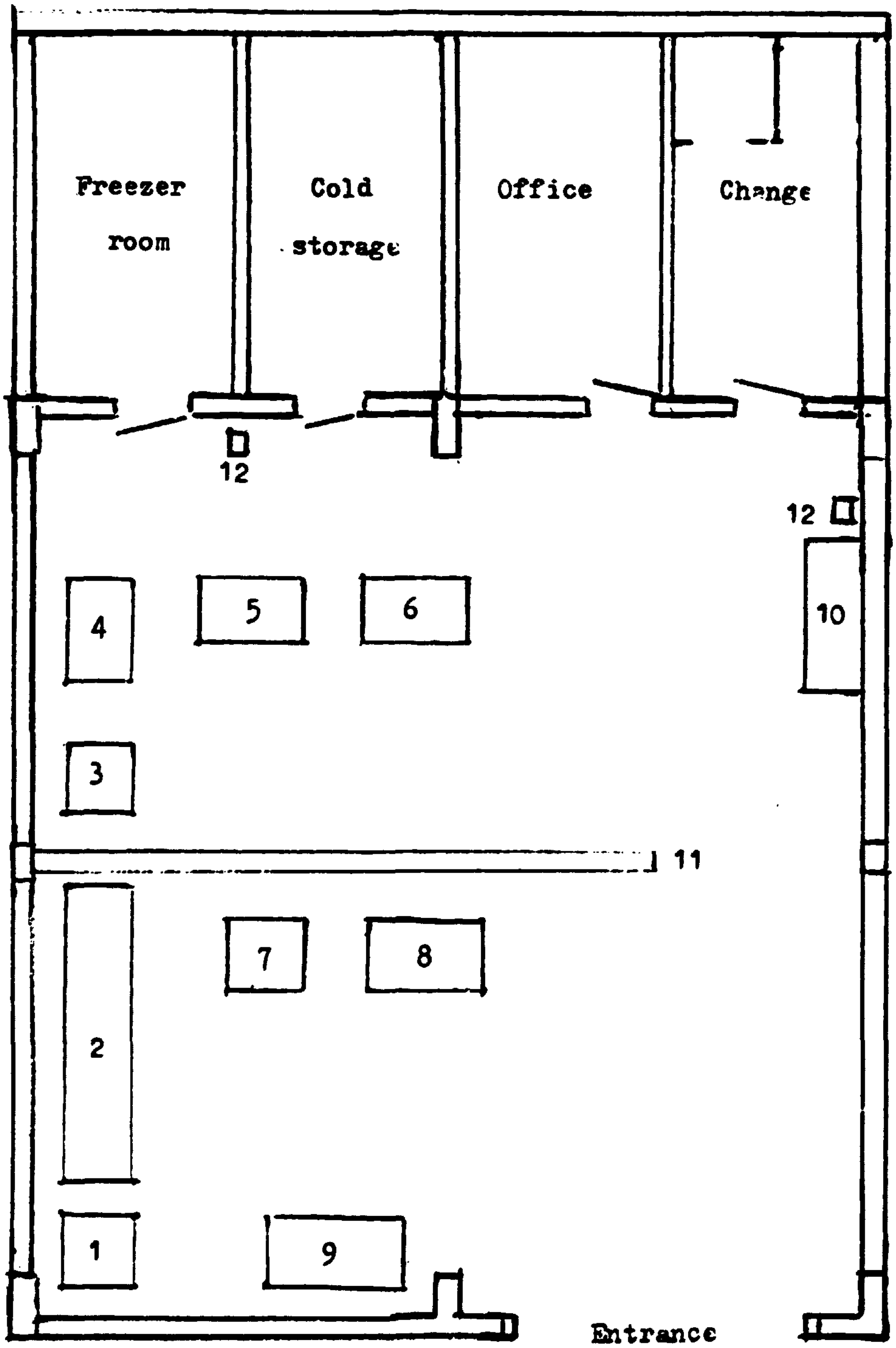
T/VOHRA

Possible arrangement of permanently installed equipment in the Food Workshop Scale 1:100




1 Steam generator
2 Exhaust tunnel
3 Seamer
4 Autoclave (retort)
5 Water bath, hot
6 Water bath, cold
7 Kettle, steam-jacketed
8 Vacuum evaporator
9 Tray dryer
10 Laboratory bench for QC
11 Floor drain
12 Sinks

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