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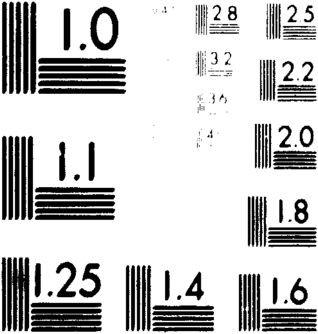
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STUDY ON SELECTION OF TECHNOLOGICAL PROCESSES IN SOME SUBSECTORS OF FOOD-PROCESSING INDUSTRY WITH RECOMMENDATIONS ON MAINTENANCE AND MANUFACTURING OF SIMPLE MACHINERY AND EQUIPMENT

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May 1982
Final report

INDEX

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ref.2 UNIDO - "Technological choice in the food processing industry in developing countries" by G.A. Nuti - April 1981 - English original

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INTRODUCTION AND AIM OF THIS STUDY

This study has been carried out with the purpose of being a general, but practical, tool for food processing technology selection in developing countries.

This study is intended for use by planners, managers, boards, decision makers in developing countries, as a guide for selecting adapted technologies in four main subsectors:

- -meat processing
- -fruit and vegetable processing
- -cereals processing
- -dairy products, particularly milk

These subsectors cover the large majority of food processing demand in developing countries.

Selected food processing systems cover the field of so-called "adapted" or "appropriate" technologies, with a simple or intermediate degree of complexity ,suitable to be operated in countries at the earliest stages in industrial development.

The technological complexity analysis has been carried out at system and machinery level.

The work done in this study is to be considered as the first phase of a detailed and exhaustive analysis of food processing technological complexity, which, in the second phase, will go down to component level.

In selecting technologies, potential development of local maintenance and manufacturing capability has been taken into account, industrial infrastructure and personnel qualification pointed out, as a general guide for workshop design and engineering.

SUMMARY AND CONCLUSIONS

The introductory part of this study (Chapter 1) is a general - and somewhat critical - review of the basic concepts of small-scale, adapted or appropriate technology for food processing.

In Chapter 2, the study explains the selection criteria followed in selecting food processing technologies for developing countries at the earliest stages in industrial development. On the basis of these criteria, a possible range of adapted technology systems, suitable to be operated in a developing so-

cio-economic environment, is described, with references to adapted machinery and equipment and recommandations on personnel, energy consumption, utility etc.
In chapter 3,basic concepts of maintenance and repairs are reviewed, introducing also general considerations about preventive maintenance .
The development of local manufacturing capability, following a sequence of industrial and techological stages, is discussed in Chapter 4, with practical recommendations on type of workshops infrastructures, personnel qualification and training.
Proposed lines, for further studies and research, are outlined in chapter 5.
As a conclusion, it can be stated that a large range of small-scale food processing projects, employing adapted technologies, can be economically feasible, if industrially opérated and managed.

These small-scale projects may prove to have, expecially in the less developed countries, a great potential in developing and sustaining capital goods maintenance and manufacturing capability.
There are many examples, both in developed and in developing countries, of family-or group-owned small and medium size industry ,that following a sequence of evolution stages,have developed a very steady social and industrial infrastructure.

This path should be taken into consideration by decision makers of developing countries,as a possible alternative for industrial development.

Summary and Conclusions

In this study, only simple and less complex technologies are taken into consideration.

This choice was made, because food processing systems selected must be suitable, or adapted, for less developed countries socio-economic conditions.

In the study, when talking about adapted or appropriate technology, reference is made to industrially-operated small-to medium-size plants.

It is well known that many factors influence technological choices, that, in turn, influences the operational and economical life of the food processing projects.

1. The adaptation of food processing technologies to the less developed countries conditions, can be obtained basically in three ways: "down grading" currently employed technologies; "up-grading" local artisanal techniques; transferrig from developed countries specially developed technologies, designed on the basis of machinery, currently considered in developed countries as "obsolete", (not technically), due to high wages and/or high market competion pressure.

2. If the technological complexity is too high, maintenance and machinery manufacturing will depend completely on the supplier's technical assistance.

3. Technological choice, that matches with the average grade of complexity that a certain environment can "assimilate", will allow an induced process of development of local maintenance and manufacturing capability

Three main stages of development of such a capability can be identified; the stage of "copying", when simple mechanical parts are reproduced and changed; the stage of "adapting", when mechanical and electrical components of machinery are produced and modified to better match with local technological adaptation needs; the stage of "innovating", when a certain engineering and design capability allows the establishment of an independent machinery manufacturing capability.

At each stage, a corresponding level of technical infrastructure is to be provided, in terms of personnel qualification, manufacturing machinery and equipment, energy supplies, etc.

A possible way of developing such infrastructure is to give technical and financial assistance to family-owned, or co-operative types of small mechanical workshops to evolve from mainly maintenance activities towards manufacturing of simple to more complex parts.

This process has created, in the past, a very steady and efficient industrial infrastructure in some developed countries; it could be an alternative path in industrial development, when adequately accelerated and sustained, for some less developed countries.

Particular stress has been put on maintenance and repair of food processing machinery and equipment.

An effective maintenance is a key factor for the operational life of a plant and has a great influence on long-term profitability of a project.

If food processing machinery has simple or intermediate complexity, an almost independent mechanical maintenance capability can be reached at the first development stage ("copying" stage); this will also accelerate the technology "assimilation" process, needed to develop a local manufacturing capability.

As a very general guide for policy makers in developing countries, a selection is made of simple to more complex processes, in the four mentioned subsectors.

The food processing technologies have been selected on the basis of the criteria that an adapted technology should not include any sophisticated parts or machinery, should be manually or semi-manually operated, should possibly be labour-intensive and should be suitable for a low-to medium-wage environment.

The complexity grade analysis includes the processing system and the related machinery and equipment; no complexity analysis has been performed at a component level.

The selection made is very general, but many possibilities exist for small-scale food processing plants to be economically and technically feasible and profitable.

This study aims only to be a general, but practical introduction to the problem; further studies and research are to be carried out to define detailed aspects of technological adaptation and/or capital goods manufacturing capability.

Some recommendations for further studies are outlined at the end of the study.

CHAPTER 1

CHOICE OF FOOD PROCESSING TECHNOLOGIES , STAGES,ALTERNATIVES AND OTHER TECHNO-ECONOMIC ASPECTS.

1.1 IMPLICATIONS OF TECHNOLOGICAL CHOICE

In a previous study (1) main qualitative characteristics of what "appropriate", or "adapted", technology for a developing country should be, have been pointed out, and possible technological choice implications have been described.

Making reference to the previous studv for a more detailed analysis, it could be useful to resume some leading points on appropriate technology and its impact on socio-economic enviroment in a developing country.
"Appropriate" system technology will be referred to industrial processes for food-processing, using simple, or more complex machinery, but industrially operated in a small - or medium-scale plant.
"Appropriate" technology does not imply, in this study, artisanal or village-level self-subsistence processes to procure food.
An appropriate technological choice is one of the key factors to promote industrial and social development in the less developed countries; particularly when development of industrial capability of maintenance and/or components and machinery construction are concerned.
In a primary sector, as food-processing industry should be considered, the development of industrialization should be strictly connected with the capacity of fulfilling basic needs for a given population.
A wrong technological choice, in this sector, could cause long delays, or otherwise stop, the industrialization process in a given region, or originate undue responses in the socio-economic enviroment.
In fact, if, on one hand, high rates of increase in population and inurbation processes, give origin to very urgent needs, in terms of food quality and quantities, that certain

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(1) See ref.no.2 - "Technological choice in the food processing industry in developing countries".

ly cannot be solved by village-level artisanal technologies, on the other hand, the use, without any control, of international transfer of technology, with any regard to its impact on socio-economic enviroments, has already proved (1) to be, in many cases, a wrong policy.
It would be preferable to investigate and find out an "intermediate" industrialization path, that should be "adapted" to local environment, in such a way as to stimulate follow-up processes of technological improvement, adaptation, research and development and, finally, innovation.

In other words, an equilibrate technological choice in the food processing sector could give great contribution in creating conditions for diffused industrialization of a given region in developing countries.
It goes without saying, that any social and economic development process has its basis on the choice of a certain socio-economic policy.
Once defined such a policy,a technology will result appropriate, if its grade of complexity matches, in a dynamic sense, with the potential level of industrialization (2) of the area where it is going to be installed.
A detailed analysis of the socio-economic situation can give data to select the relevant grade of technological complexity to start with, apt to stimulate a development process of the sector.
An appropriate technology plant has to be, in this sector,economically feasible and profitable, not only - or not necessarily - at single plant level, but as a whole with all directly induces industrial and/or artisanal activities .(3)

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(1) It is to be pointed out that very few analytic data exist on real operational rentability of agro-food projects on the long run.

(2) Level of industrialization is here intended in a general sense, but it is referred maninly to the case of food industry; more detailed analysis will be carried out in the next paragraph.

(3) Such as maintenance and reapir workshop,spare parts and pre-assembly small enterprises etc.,as it will be discussed in the next chapters.

Many socio-economic conditions, along with general policies established, play a relevant role in defining a certain "scenario", within which a given agro-food project is to be installed, but a key factor is obviously the destination market specifications.
In the agro-food sector, in general, and in some subsectors in particular (such as milk, fruit and vegetable), the destination market, and the relevant distribution and retail system, rigidly determines food-processing systems and related technologies.
A priority item, to be defined for an agro-food industry in a developing country, is the final destination of products: whether for domestic market or for export to the international market.
It is of very scarse significance to perform a technology adaptation study, if the food-processing system must match so tightly international food standards, that this is pratically possible only with the use of sophisticated technologies, available only on the international market.

In the present study, only food-processing systems for domestic market will be taken into consideration. (4)
Within domestic market boundaries, three main factors have implications, at different grades, on technological complexity of a given food-processing line, which is normally intended as the whole range of transformations food has to be submitted to, from raw material state to maketable item.
The three main factors are:

a) phisycal transformations, intended mainly for conservation, cleaness or other modifications connected with taste, consumer's habits, etc.

b) paking and similar activities, intended for destination market preparation of output products

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(4) It is not to be forgotten that food-processing for export market could be a great resource for foreign currency procurement to many developing countries.

c) operations along the processing line, intended for selection, manipulation, transport, etc. of food items, that can be automatically or manually operated.

When analyzing technological complexity of a food-processing line, these three factors should be considered as conceptually separated, because of their different relative weight in determining the technology systems, even if in practice they are tightly interconnected.

Factor "a", in fact, defines the quality standards of food, that are to be fixed (5) within guaranteed wealth criteria, on the basis of people and market needs, regardless of how complex a given technology could be.

In other words, factor "a" is a "mandatory" factor, whose implications on technological complexity are to be accepted if given quality results are to be achieved; otherwise quality standards are to be lowered and the process re-started.

Completely different aspects are shown by the other two factors.
Factor "b" depends (6) mostly on market characterícts, such as type of distribution, size of retail shops etc.; a wide range of possible changes can be studied in order to optimize packing and market preparation to the real basic needs of developing countries, that might be entirely different

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(5) regardless to the destination market, hygienical conditions are to be kept within fixed limits, but quality standards depend also on nutritional habits, obviously different in different countries; there is a trend to standardize tastes and quality to international standards, that are improperly considered as the best.

(6) in many cases, factors "a" and "b" are strictly connected, because conservation system and packing system are the same thing (such as in canning); but also in these cases some adjustaments to local conditions can be made (type of materials, sizes, external finishing details etc.).

from those of the international market.
Factor "c" depends only on a careful economic rentability analysis, depending on wage level in each country and general policy as far as employment creation is concerned.

Probably, the evidence of different roles of these three factor is quite obvious, but it is worth being remembered how international manufacturer tend to offer food-processing systems as "packages", and how, as a consequence, normally such differentiated factor analysis is not performed.(7)
It goes without saying that, in some subsectors, all three factors are so strictly connected to influence deastically each other; this is the case of milk, where the choice of the packaging system rigidly determines the whole processing system complexity.
In other sub-sectors, on the contrary, factors are mostly independent, such as in the meat or fruit and vegetable processing.

It can be said that tecnological choice is, or may be, higly influenced by general food procurement policies in a given country (or, better, region within a country) and that this choice will in turn influence, at a very grat extent, the creation and the development of an induced maintenance and manufacturing capability, in the same socio-economic enviroment.

If, on one hand, this statement seems quite obvious, it is, on the contrary, common experience in developing countries that implications of technological choice, for many reasons (8), are not taken into account and complexity analysis ver-

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(7) some processing systems, imported with technology transfer "turn-key" procedure, possibly responding to the country's needs in terms of food quality, includes line, or ancillary, equipments, such as automatic packaging or wrapping machinery, highly sophisticated and economically unadapted in a medium-wage environment.

(8) Main reason is obviously that more than 80% of total manifacturing capability, as far as capital goods for food processing is concerned, is concentrated in a half dozen most industrialized countries.

sus socio-economic impact is not performed at any level.

Few operational data exist so far, but probably a very wide range of "adaptations" of existing food processing techhologies is possible and a "re-styling" of obsolete (but not for quality reasons) technologies, normally in use in developed countries until a few years ago, should be studied.
Results could allow some country to match urgentfood needs and, at the same time, stimulate local industrial capability, much better than up-to-date international technology transfer has proved to do.

Some proposal, followwuing this line, will be made on chapter 2. (9)

(9) see ref.no.2 : op.cit.

1.2 STAGES IN DEVELOPMENT OF INDUSTRIAL CAPABILITY OF A GIVEN AREA

The tentative analysis, carried out in this paragraph, will try to define a very schematic sequence of possible stages in the development of industrial capability to manufacture capital goods in some sub-sectors of the food processing industry in developing countries.

Obviously, this capability will have a high degree of interconnection with general industrial development of a given region or country, but here only typical aspects of the food technology and industry will be taken into account.

In a previous study ,(1) different degrees of food processing technology were compared to different stages in general industrial development of a given area.

In other words, each stage of industrial development of a country will admit the corresponding degree of technological complexity in machinery and equipment, to be put in service for food processing plants.

It has been pointed out in these studies, how this systematic approach could be a very useful tool in defining technology adaptation criteria and how it cou[illegible] p in chosing appropriate technology systems.

A great deal of feed-back analysis is reque[illegible] to check pratical operational results.

In this capter, an effort will be made to extend this concept to possible stages in the development of an induced in-

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(1) see reference n.1: Analisis de maquinaria para la industria agro-alimentaria" by INITEC - (spanish original) and also ref.n.2: op.cit . , chap.,3.

dustrial capability to maintain and manufacture parts or complete machines for food processing system locally. Three main stages (2) and objectives may be identified as follows:

<u>First stage</u>

<u>Objective</u>: development of local capability of maintenance, repairs and manufacturing of spare parts and simple components.

At this stage, two joint programmes should be implemented to initiate the process of industrial development in the sector.

The first programme requires the use of international technology transfer, at complete system level or, if possible, at single machinery level.

The technological choice has to be made on the basis of accurate analyses (see par. 1.1.) and it is a very delicate and determining factor.

The capability to "assimilate" and production systems, within a limited period of time, from operational and cultural points of view, is a key factor in stimulating the take-off of an indipendent innovative process.

This implies that technology should be simple and operated in small - to medium - scale industrial plants.

Since no intervention at system level is probably possible at this stage, the technological process should be selected as a whole.

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(2) having to be very schematic, this analysis cannot take into account important differences between different developint countries; the three stages are then to be considered merely as first approach items, their objective could be expressed by the following simplified correspondance:

1st stage = copying
2nd " = assimilating/adapting
3rd " = innovating

If intermediate, or "down-graded" technologies, with a certain content of obsolescence (3), with respect to developed countries' standards, are imported, this could allow machinery and components to be copied , repaired, reproduced and modified without restrictions from the original manufacturer and/or patent limitations.
This possibility normally stimulates local entrepreneurial or artisanal capabilities in such a sector as mechanical and electrical repairs and maintenance,iron charpentry, sheet and plate forming, welding, small castings, simple machining etc.

The creation of diffused industrial infrastructures, privately owned and/or operated, will be of great help in the food sector, due to scattering of processing plants around in the country (4).
The second programme, to be started simultaneously with the first one , should catalogate and analyze local, artisanal food processes and technologies , strictly connected with local food resources. A forced process of development of these local systems could bring them, in a relatively limited amount of time, to a grade of industrial efficiency (5)

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(3) Obsolete, for non technical reasons, does not mean,or imply, in whatever extent, "second-hand technology" transfer. In the very dynamic competition context of industrialized countries, obsolescence is rarely cause, in the food processing sector, by a merely technical inadequacy.

(4) This is one of the characteristics that diversify agro-food sector; also in the DCs the majority of food processing plants are of small/medium size and scattered in location (see ref.n.1 op.cit. chap.4 for more details)

(5) similar programmes are at the pre-feasibility study phase, sponsored by UNIDO , for ASEAN and ANDEAN PACT countries.

(6) some results have been obtained,for example,in the sugar industry, with the OPS method.

Second stage

Objective : creation of the industrial infrastructures needed to manufacture machinery; improvement and adaptation capability at component level.

At this stage, upgrading of traditional technologies or "down-graded" imported technologies are completely "assimilated" by the industrial infrastructure.
This means that maintenance and repairs, as well as construction of parts and components, can normally be achieved without problems.
At this stage, with adequate personnel training programmes and with investiments on mechanical and electromechanical industrial equipments (boring machines, copying machinery, high-precision milling, grinding and lapping machines, high-precision machining, pre-assembly and assembly benches etc.), construction of modified food processing machinery should be started , obtaining improvement in system performance, with respect to previous stage technology.
No intervention is foreseenable in the field of system engineering, but a certain amount of self-adaptation of simpler processes to the changing socio-economic enviroment is possible, and should be stimulated by finalized R&D projects.

A more qualified access to the international food processing technology market could be tryed, using the license or the "joint-venture" tool to improve manufacturing capacity of single machinery or very specialized equipments for auxiliary operations (such as packaging, wrapping, selection etc.), whose limited domestic market would never justify a completely indipendent manufacturing capability.
At the end of this stage the industrial infrastructures have technical and potential capability to cover the internal market needs in terms of adapted single machines, components and equipments.
More sophisticated spare parts, or components, could be produced under license, if economically feasible, for domestic market or under a certain associate market agreement.

Third stage

Objective: creation of capacity in research, development and food processing systems engineering.
In the majority of food processing sub-sectors, the overall technological complexity of the processes employed, also in the most developed countries, is not at a very high level.
Other characteristics of the food industry are:
except a few "food giants", scattered small-and medium size firms; relatively low investment/labour coefficient; rapid implementation of food processing capability in a given area, provided a minimum of environmental conditions; strict liasons with agriculture (7).
All these factors justify the definition of food processing industry, as light industry.
Innovative processes within this field are normally more intended to respond to industrialized countries'market competition needs, than to substantially improve food quality or introduce completely new processing systems.
Given these characteristics it is much easier than in other sectors,either to create basic research and development, or to make possible the beginning of a local innovation process.
All background conditions exist, to allow many developing countries to reach the third stage in development, at least in many subsectors in the food processing industry, with adequate domestic and international policies and use of resources.
It is to be remembered that many of the abovesaid considerations can be applied only to basic food industry for domestic market; export food industry has to be tackled with a different approach that is not on the purpose of the present study.

(7) for a more detailed definition of food processing industry characteristics, see ref.n.1 op.cit., chap.3,4 and 5.

1.3 DIFFERENT NEEDS AT DIFFERENT STAGES IN THE LOWER RANGE

Generally speaking, the establishment of an adequate industrial development programme in the food processing sector, originated by political decisions, is highly influenced by the rate of change of socio-economic environmental conditions of the area.
Among them, three main conditions are to be taken in account: labour, industrial infrastructure, general infrastructure (with particular reference to energy supplies).

In a recent study (1), professional profiles of personnel to be employed in food processing capital goods industry are described in details. Three types of personnel functions could be identified:

- production
- supervision
- support and service, including sales and market assistance

In the food industry, the general trend for a progressive shifting of personnel needs toward tertiary tasks, is more evident , since technology is relatively simple and basic direct labour needs are easily saturated.

In the first stage of development, only artisanal or small workshop skills are requested, mainly intended to reproduce parts and components, by simple mechanical work, hand operated.
A basic skill in assembling and disassembling mechanical and electro-mechanical devices is requested for maintenance and repairs.

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(1) see ref.no.1 : op.cit. , chapter 9.4, pag.535 and following

Manufacturing of parts and components, and machinery assembling, which is the main objective of the second stage, requires more specialized workmanship (2) in some mechanical sub-sectors; personnel training normally allows also the manufacturing of more complex machinery and equipment.
As far as supervisory personnel is concerned, its function becomes determinant at the second stage, where management capability and know-how are the key factor of a successful evolution from first into second development stage.
Personnel training and creation of knowledges in the support and service sector (such as engineering services, planning, quality control, etc.) allows entering into the third stage.
Basic personnel training needs, during the three stages, to be supported by assistance programmes, mainly are:

first stage - basic training of workmanship and artisans on simple mechanical works and on disassembly/assembly of simple to more complex machines and equipment.

second stage - specialized training of mechanical and electro-mechanical workmanship, more complex machining, metal treatments and welding.
- specialized training on assembly works
- basic training of supervision personnel for work organization, plant management, administrative work etc. for small-and medium-size enterprises.

third stage - specialized training programmes for more complex plant management and supervision.
- basic training for specialized personnel, such as engineers and technicians, to be employed in basic research and development of engineering services.

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(2) see ref.nó.1 op.cit.: chapt.4.2 para. A,b

In chapter 4 some highlights of training programmes and methodologies will be pointed out.
As far as is industrial infrastructure is concerned, a very complete list of basic needs, in terms of machinery and equipment, is described in the mentioned study (3)

It is to be pointed out that this type of infrastructure is quite simple and does not require great economic(4) and technical resources to be fully established. Main workshops are:

a) stainless steal boilermaking
b) steel carpentry and walding
c) machining and mechanical work in general
d) medium size casting
e) metal surface heat and chemical treatments
f) pre-assembling for elecrical and electronic components

Within these sectors, machinery and equipment could be more or less comple and/or automatized, depending on the development stage.
As far as general infrastructure is concerned reference is made mainly to:

- transport facilities
- energy supplies

Raw materials for food processing are normally rapidly perishable items and collection is made during limited periods. Transports between collection site and processing plant must be as quick as possible; this, first of all, means that plant location studies should be raw material - oriented, but also that a minimum transport infrastructure is needed, in terms of practicable roads and/or special vehicles.

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(3) ref.no.1 :op.cit. para.7.1, pag.462
(4) The evaluation of investment costs for a basic infrastructure is not difficult; normally these workshops are labour-intensive.

The industrialization process,for capital goods manufacturing, does not require great modification of general infrastructure, form that required for the agrofood industry.

It should be of some interest to try to investigate possible connections between vehicle maintenance and agrofood machinery maintenance, to find out possible common aspects.

For what concerns energy sources,the need for thermal treatments, often very intense and adjustable within very narrow limits,is a typical characteristic of agro-food processes. At the moment, no systematic data is available on the variation of specific consumption of thermal energy per unit of finished product, when varying technological complexity.(5) Some scattered value gives the impression of a specific consumption decreasing with the growth of technological complexity because of the more efficient processing systems employed. If this is confirmed by experimental data, the high energy costs will oblige to very accurate analyses of simpler technologies before making any choice.

Also a qualitative analysis is to be performed, in order to find out the tolerance limits and reliability of energy supplies, because this is a very important point in defining technological complexity of energy sources.

Generally speaking, food industry requires high absolute quantities of thermal energies and medium quantities of electrical energy.

Energy sources for food industry will be considered in details in chapter 2.3. -

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(5) It could be a very interesting study, because of the importance of energy consumption as a factor of technology "appropriateness".

1.4. NOTES ON THE DEVELOPMENT OF FOOD PROCESSING MACHINERY MAINTENANCE AND MANUFACTURING CAPABILITY.

It is common experience that most developing countries employ resources in trying to establish food processing capability, using the sole instrument of international technology transfer.

Apart from how appropriate a technology will result, from the point of view of food processing, normally few attention is put on how the technology maintenance and manufacturing capabilities can be developed.

In some cases, development of such capabilities is in fact impossible, because of the enormous technological gap with the existing conditions; in other cases, development could be possible, but it is not stimulated with adequate credit or incentivation.

When maintenance is taken into consideration (1), it normally comes out as an appendix to the food processing plant, as an internal workshop, fully depending on plant management.

In the food processing industry, it is not the content of innovation of an imported technology that stimulates induced maintenance and manufacturing capability, but the content of "assimilability" by the environment.

In this sense, there are different "levels of insertion" in the industrialization process, instead of "alternatives" in development.

The development trend is different, depending on local socio-economic, and mostly cultural (2), conditions and on resources employed to stimulate it.

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(1) This is the case of some "turn-key" contract, where machinery and equipment for maintenance workshop is included, with a fixed spare parts stock.

(2) a very important factor is the human factor: to start the first development phase, it is necessary that direct production personnel, employed in the food processing industry, or elsewhere, has assimilated technologies, before a creation of skills in maintenance and manufacturing of parts could be possible.

CHAPTER 2

ADAPTED SYSTEMS OF TECHNOLOGY IN SELECTED SUBSECTORS OF FOOD-PROCESSING INDUSTRIES

2.1 Selection criteria

2.2 Adapted technologies in subsectors:

- 2.2.1 Meat processing
- 2.2.2 Fruit and vegetable processing
- 2.2.3 Cereals processing
- 2.2.4 Dairy products, particularly milk

2.3 Basic operational needs and recommandations for adapted technologies in terms of utilities, labour, energy consumption etc.

2.1 SELECTION CRITERIA

It is quite impossible to establish an unique technological selection criterium, given the enormous diversification of food processing industry.
As a general rule, the selections made in this chapter take into account mainly the potential "assimilability", with reference to the environmental condition of less developed countries.
This will ease, as mentioned in the introduction, the creation of a development process that will lead to the establishment of local maintenance and manufacturing capability in the selected subsectors of food processing industry.

But, of course , a general rule has its own exceptions, such as processing lines in cereals and fruit and vegetable subsectors, where some operation is performed by very specialized machinery; the limited market, also in developed countries,has generated a semi-monopolistic manufacturing by very few firms in the world.
In this case, of course, if there is a technological need along the line to employ such machinery, no manufacturing capability is to be envisaged, at short or long period.
Further-more, it is very important to distinguish between processing system and processing machinery.
In some subsectors processing systems have not substantially changed after very long periods, while machinery has been periodically up-dated.
In these cases (cereals, meat, some fruits etc.) it is relatively simple to select adapted technologies, that mantain food quality and characteristics, but have a lower degree of automation, or a different type of packaging, or a different size, and so on.
In these cases, technological "down-grading" is also possible.
In other words, systems have not to be adapted; only machinery has to.
In other cases, such as for example frozen foods, the process itself has been developed in the last years and technological complexity is not adaptable: the system itself, if too compli-

cate, is to be rejected.
Finally, in the case of developed countries market conditions determining factors, like packing, that in turn determines the complexity level of the whole processing line, (see the case of milk processing) no adaptation is possible without a previous profound change of market conditions.
Another aspect of technological adaptation is the selection of different grades of automation in some operation, which has a great influence on technological complexity of machinery and often on the whole processing system.
The technological choice is, in this case, influenced at a great extent by general occupational policies as well as wage costs.
The technology systems selected in this chapter normally have a low degree of automation and, when techincally convenient, or possible, manual or semi-automatic operations are preferred.

Being very general adaptation criteria, those adopted in this chapter cannot surely fulfill all different needs of different developing countries: more detailed adaptation to each country's conditions should be performed for food processing projects implementation purposes.
As far as machinery complexity level is concerned, the selection made on this chapter is very indicative, no detailed study being available on food processing machinery at the component level (1).
In fact, if a given machinery can be quoted as a simple one, this does not imply that every component can be manufactured locally.
For example, ball bearings, electrical motors, switches etc., are normal components of the simpler machinery, but the majority of developing countries have to rely on import goods or on license agreement manufacturing.
The same problem has to be tackled when raw materials are concerned, because it is very unrealistic to foresee special steel sheet (2) production capability within most developing countri-

(1) this could be the scope of further studies as outlined in chap. 5
(2) including for example stainless steel and can tin for preserves packing.

es.
In these cases, adaptation of technology can be made by changing the original machinery design, in order to reduce the quantities of certain raw materials to be employed , or by following a different commercialization path, in order to reduce or eliminate certain packing raw materials (this is the case of can preserves and milk commercialization).
When such a possibility exists, mention will be made and past experience, if any, indicated.
No mention will be made, in this chapter, to possible econoical unfeasibility of some machinery, due to limited domestic market, more than to technical difficulties.
It has already been outlined that, in general, food processing machinery is simple, with some more complex units.
In principle, higher complexity grades come out from the need for mechanization or from special market requirements.
Selection and comments indicate two different grades of complexity: simple and intermediate.
The selection will take advantage of a classification of food processing machinery by subsectors made in a recent study (3)
Machinery not mentioned, in the present selection, is reputed to be too complex or sophisticate for adapted technology applications. In special cases, isolated advanced machines could be used in adapted technology environment, but their integration is to be carefully studied.

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(3) Initec's study (see ref.n.1 op.cit.), chap.IV and VII.

2.2. ADAPTED TECHNOLOGIES AND MACHINERY IN SUBSECTORS

2.2.1 MEAT PROCESSING

In principle, meat processing technology is simple and assimilation is possible, at various grades, in developing countries.

The process is a sequence of mechanical operations to be performed on raw materials; only in case of meat conservation process, a thermal treatment is necessary, normally obtained by autoclaves.
All operations are carried out with the use of manually operated machinery, whose grade of complexity is normally low. Complexity, in this subsector, comes out as a consequence of mechanization or automation of some operation,with the scope of increasing production efficiency versus labour employed.

In many developed countries, completely manual processes are still in operation.
Some problem is to be envisaged at complete system level,as it will be pointed out later, as far as management and operational know-how are concerned, as well as ancillary equipments duty cycles and utilization procedures.
Some ancillary equipments (such as refrigerating systems) are of great importance on system working cycle and on finished products quality standards.
Hygienical conditions, as well as ambient conditioning, have to be kept within narrow limits to guarantee products quality and consumer's wealth.
Generally speaking, ancillary equipment also has a relatively low degree of technological complexity, with the exception of some single component within the machinery, whose grade of complexity requires sophisticated technology to be produced.
Food freezing for meat conservation over the long period is a medium-grade technology system in itself,but it is probably unachievable by the majority of developing countries because of enormous amount of investments requested to provide distribution and retail systems with very low temperature storing capacity.
System technology (1) can be oriented toward two different

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(1) the same subdivision as in Initec's study (see. ref.no.l. op.cit. ch.III,3) has been used, for ease of consultation of process details.

market requirements:

a) - fresh meat consumption (primary processing)

b) - preserved meat (secondary processing)

The complete processing system includes the following phases:

Primary processing

A- cattle, pig, sheep

- Slaughtering
- Refrigerated storage
- Butchery and preparation
- Freezing of meat

B - Poultry

- Poultry slaughtering and processing line
- Freezing of chicken

Secondary processing

Cattle, pig

- Preservation process : - salting
  - smoking
  - thermal treatments
  - spice adn additive treatments
- Preservation packing : - sausages
  - canned meat
  - others
- Residues recuperation: - fats and meals
  - meat residues

At system level, technological complexity comes out from the integration between different processing stations and is connected with the overall plant dimension.
Large scale plants have to be carefully engineered and very complex designing phase is necessary to integrate different components (machinery, equipments, transport systems, refrigerating system, buildings etc.).
Large and medium scale plants require skilled management and a great amount of operational know-how, to keep system in good hygienical and maintenance conditions and to assure economic rentability over the long period.

Small scale plants can probably be installed and managed in the majority of developing countries without great problems and relevant technology assimilated in a limited amount of time.
An auxiliary equipment of great importance all along the primary processing line, is the overhead conveyor,which is practically the only mechanization of the entire process widely employed. The overhead conveyor allows a good improvement in processing efficiency, from the point of view of labour and overall organization.
Its technology is well assimilated and within limited complexity range, with the exception of some component.
Its installation supposes a high degree of integration with building frames,with high investments, and its use implies a medium level of operational organization.
Its use in very small processing plants in less developed countries probably results to be unconvenient.

2.2.1.1 Primary processing

All different phases of primary processing will be analyzed (2) , pointing out different system technology complexity and possible adaptations.

2.2.1.1.1. - A.Slaughtering

As already pointed out, this phase consists of mechanical operations on animals; various technologies exist, with various complexities, all in the lower range.
The only mechanization feasible is the semi-automatic deskinning machine, whose complexity is higher and therefore not to

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(2) a very detailed description of meat processing phases is reported in Initec's study (ref.n.1 op.cit.), chap.III pages 96 to 139.

be suggested for low developed countries.
An adapted technology system should perform the following operations in a manual way:

- slaughtering, in the sacrifice box
- suspension to overhead conveyor (if applicable)
- blood drainage
- de-skinning
- head and feet removal
- evisceration
- carcass splitting into two or four parts
- washing
- weighing

Quality of raw materials employed for the construction of machinery and overdimensioning of parts and components are the key factors for long duration and low maintenance of machinery and equipment.
The described process can be used for cattle, pig and sheep. Animal slaughtering has different procedure depending on the type of animal: for cattle, slaughtering is made by pistol devices in a stall; for pig and sheep, a previous stunning is requested.
Some differences also occur for deskinning : sheep carcasses are inflated to easy skin removal ; pig carcasses are scalded, depilated and accurately cleaned. All these operations are normally manually operated.

2.2.1.1.2-A. Refrigerated storage

Traditional municipal slaugtherhouses were normally not equipped with refrigerated storage and fresh meat was directed to the market.
This system obviosly does not cause any problem, but better meat quality and hygienic conditions, as well as improvements in slaughterhouse's management, suggest the use of refrigerated storage also for small scale plants for fresh meat consumption. Refrigerating system technology is in fact well assimilated and does not present aspects of high complexity, except some special component or equipment that should be imported.
If the technology itself is simple, economical operation of refrigerated stores causes some managerial problem, because

slaughtering should be made only 2/3 times per week. The design of refrigerate storages (with minimum temperature of -5C) supposes engineering and knohow capabilities and the precise definition of fresh meat market needs.
The design of refrigerating medium distribution system is a difficult job, that implies some engineering skill. Some difficulties can also come out from the design and the construction of the refrigeratedchambers, whose building materials and techniques are not normally available (3) in less developed countries.
Building costs for refrigerated storage are quite high and economic feasibility must be carefully analyzed,when operating in limited market environment.

A solution often used is to install prefabricated cool chambers; this system has the advantage of solving quick installation needs, but no assimilation process can be started, because the production of highly sophisticate plastic and metal panels is not possible in the majority of developing countries.

Refrigerated storing suggests the use of refrigerated trucks for market delivery and integrated cool storage capacity in the retail system. All these items must be carefully analyzed, from commercialization policy point of view for fresh meat consumption, because of the subsequent high investment concerned.
Another important point in determining type of slaughterhouse is its location with respect to rearing centres.(4)

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(3) a very interesting field for future research is the investigation on the use of local materials for heat insulation and industrial walling.

(4) scattering slaughterhouses in the vicinity of rearing centres and reducing their sizes seems to be the most economic solution, when considering total operational costs from animal rearing down to commercialization of meat.

2.2.1.1.3 - A.Butchery halls

Dimensioning, and type of operations to be performed in butcheries, have to be established depending on meat processing plant production planning.
Basic processing is made out of operations (cutting and selection) to prepare meat for fresh comsumption, or, more frequently, for secondary processing. No technological complexity exists in this type of equipment; all operations can be only manually-operated.
A great influence on butchery operations is obviously due to commercialization habits and policies.
Also in many developed countries, the fresh meat market is based on small butcheries, where all cutting and packaging for retail is performed; the method of cutting big pieces, to be packed in plastic bags under vacuum, needs the use of sophisticated equipments and is scarcely diffused also in many developed countries.
Probably, for less developed countries, a centralized cutting and packaging system is not the more convenient solution, apart from the fact that this would imply supermarket-type commercialization, not possible everywhere, short period meat preservation is much easier when large pieces (such as halves) are concerned, than pre-packed small portions.
In the case of slaughtering at service of secondary processing, butchery will be designed on the basis of this processing requirements.

2.2.1.1.4 - A.Freezing of meat

Very low temperature refrigeration (down to -18° C or -30° C) is probably the best way to preserve meat over a long period, keeping the most of nutritional value and product quality.
Normally employed technologies are based on continuous tunnels with belt or chain conveyors and counter-current refrigerated air.
Other methods employ metal plate freezing.

In both cases, freezing tunnels have medium technological complexity, particularly as far as type of materials are concerned, and stringent hygienical specifications.
Very low temperature refrigerated stores have a medium level of complexity, as far as cool generating system is concerned.
Machinery and equipment are similar to those described for low temperature stores (down to -5° C), but some more experience is requested in design and distribution system engineering.

Much more complicated is the design and construction of buildings and refrigerated cells for very low temperature; they also require the use of costly materials, normally unavailable on developing countries.
All these considerations put freezing system, for long period preservation, in the medium complexity range where some engineering and know-how capability for design and management is requested. But what really makes this system unproposable as a possible widely imployed system for food preservation in developing countries, is the very great amount of investments needed to create and to manage the related commercialization system equipment with frozen food transporting, storing and selling capability.
Specific energy consumption remains at a high level during the whole life of the product, while, in all other preserving systems, the specific energy consumption is lower and is consumed in a limited and well controlled amount of time, during the preservation process.
Furthermore, a very limited period at higher temperature (due to black-outs, repairs , maintenance, etc of the cooling equipments) could cause an irreversible damage of food.
All these considerations, along with technological complexities induced by the absolute need for dependable energy supply suggest that the freezing system is to be considered as an unadaptable preservation system for many developing countries.

2.2.1.1.1. - B - Poultry slaughtering and processing lines.

The Poultry processing lines have been developed in the last years from semi-automatic lines for 50 to 100 chicken/ man-hour to the almost fully automatic lines that process 400 to 500 chicken/man-hour.
Consequently, technological complexity has risen from medium-grade complexity to higher grade technologies.
Primary need was to reduce labour employed and to increase line productivity.
A chicken processing line of intermediate complexity operates through the following main phases:

- high-voltage stunning
- aerial conveying belts
- pre-scalding tanks
- de-plucking
- evisceration
- washing
- refrigeration

All operations need the operator intervention and can be classified as semi-automatic.
Higher automatization is justified only in a very high wage enviroment.
In many industrialized countries, these medium-grade complexity lines (about 100:150 chicken/man-hour) are considered technically obsolete and are available, on request at a relatively low price; in a low or medium wage costs enviroment, their use could prove to be economically convenient.

At the end of the processing line, chicken is normally refrigerate down to -5°C and put into refrigerated stores for distribution.
Modern processing lines include automatic packaging equipment of very high complexity.

2.2.1.1.2 - B - Poultry freezing

The considerations pointed out at point 2.2.1.1.4.-A- are valid also in this case.
The use of counter-current air freezing tunnels at the end of processing increases chicken meat quality and allows a better and longer preservation also in low temperature storing facilities.
System technology is at a high degree of complexity just as materials and construction techniques to be used.

2.2.1.2. Secondary Processing

Secondary processing is intended for long term preservation of meats, with systems different from freezing. Traditionally, many ancient processes exist. But, to preserve meat, the processes suitable to be industrialized are basically:

- salting
- smoking
- thermal treatment
- spice and additive curing

More or less, each preservation system include a final packing, to keep products in the same conditions they had at the end of the processing.
More widely used systems are:

- canning of meats
- sausages making
- plastic vacuum bags for cured meats

Generally speaking, with the exception of some isolated machines alla machinery employed is at a low grade of technological complexity, suitable to be operated without problems in many developing countries.
In this secondary processing, good quality results are much more dependent on personnel operational know-how and skill, than on machinery employed, which is very often manually operated.

Salting and smoking have a very limited diffusion and have never reached the full industrial operation, because of the changes they induce on aspect, taste and quality of food. Technologies emplcyed are almost artisanal and very simple; it is probably a subsector to be fully investigated in order to find out possible system performance and product quality improvement. Thermal treatment remains one of the most widely used; meat is treated at high temperature in autoclaves, then cans are filled by means of filling machines. The canning operation is not performed in a sterile enviroment and cans are to be sterilized with their content in a sterilizer. The use of batch sterilizers is easy to be operated.

The entire cycle is very simple and machinery employed has a limited degree of complexity.

Complex techniques are normally induced by the need of mechanizing operations.Complexity may arise also from quality and production procedures needed for can metal sheets; only a few firms in the world have the production know-how and the very sophisticated machinery needed to produce good quality metal sheet currently employed in developed countries (1).

The problem could be tackled by reducing the number of can sizes and increasing quantity per can (family cans instead of individual portions common in developed countries supermarkets), thus reducing the consumption of imported metal sheet.

Another possible way could be the use of other type of sheets (different internal surface preparation or different materials, like aluminium or different materials, like aluminium or plastic), but researches have given dubious quality results or high unity costs.

Technologies for metal sheet can forming are very sophisticated and unachievable by many developed countries, also because of the limited domestic market.

Spice and additive curing for sausages making is the most widerspread system for meat preservation.

(1) the problem is common to fruit and vegetable processing.
(2) with the exception of sealing machines, as it will be seen on chap.4.

Some sausage making includes also cooking.
So many varieties of sausage making process exist that a general rule for technology complexity cannot be found;processes from very simple manual systems to semi-automatic or automatic sausage machines.
In most cases machinery used is simple and performs two basic operations:

- cutting and spice/additive adding and/or curing
- synthetic or natural skin packing

Key factors in obtaining good quality results are the operator's skill and know-how, and perfect hygienical conditions of the curing plant.
Simple auxialiary equipment, like drying chambers and refrigerated storing chambers, are necessary during the final curing phase.
Another preservation system performs meat pasteurization and plastic bag packing under vacuum condition; it is a quite complicated machinery and the product has the inconvenience of having to be kept in a refrigerated store for long period preservation.

2.2.1.3 Residues recuperation

Different technolgies have been developed to recovery meat residues and to process them to obtain by-products for animal feed and human consumption.
Those intended for human consumption are very complicated processes and become economically viable only for very large slaughtering plants.
Different may be the case of production of fats and bonemeal for animal feed, which contributes to integral utilization of resources and to reduction of meat wastes.

The use of very specialized machinery, whose grade of complexity may also be very high, suggests a careful economic analysis of residues recuperation and processing facilities.
For small scattered plants , residues recuperation and processing is probably not feasible.

2.2.1.4 - Meat processing machinery

Generally speaking , machinery for this subsector is simple; some more complex machinery has to be used to make automatic operations.
Equipment of intermediate complexity is needed for refrigeration.
A over-head conveyor, basic equipment to carry out alla internal transport operations in slaughterhouse as welle as in refrigerated stores, has simple mechanical technology, with some more complex components.

a) Slaughtering: simple machinery, for cattle:
killer, slaughtering stalls, hooks, electromechanical skinning knives, horn remover, discontinuous weighing-machine
Intermesiate complexity machinery for cattle:
carcasse raising and lowerign devices, pneumatical skinning knives , balanced saws, vertical silicing saws pneumatic disposals remover, continuous weighing machines, hydraulic skinners.
Simple machinery for pig and sheep: stunning stalls, killers, hooks, pig scalders, hair removers, pig scrapers, electromech.knives, pig flayers.
Intermediate complexity machines for pig and sheep : pneumatic skinning knives, vertical slicers, singeing blow lamps, sheep inflators, raising and lowering devices, continuous weighing machines.
For poultry abattoirs, the complete line is normally manufactured as a whole; complexity arises from automatic operation. A semi-automatic line could be defined as an intermediate complexity machinery. Simple machinery could be obtained by building up a processing line with manually, or quasi-manually operated machines for washing, killing, plucking, cutting and eviscerating.

b) Quartering room: machinery is normally simple,
because the majority of operations are done manually: circular adn rotary saws, quartering tables, trucks, overhead-con-

veyors, mincers, knives, bone removers.etc.
Very complex machinery is that used for automatic and semi-automatic packing and wrapping of meat.

c) refrigerate stores ; cool - generatin equipment is normally manufactured as a "package"; that equipment, with evaporators and distribution systems and related control devices, can be quoted as intermediate complexity apparatus.
Very complex equipment and machinery are to be used for freezing tunnels and very low temperature storage.

d) pork meat secondary processing: very many processing systems can be used for obtaining a very wide range of products; in general , cutters, grinding machines, mixers and filling machines are simple.

e) meat preserves : sterilization and cooking drum autoclaves, can filling machines, semi-automatic can sealers, sterilization autoclaves and labelling machines are simple to intermediate complexity machines.
Complex machines are: rotating autoclaves, automatic can sealer, sterilization tunnels.

2.2.2. FRUIT AND VEGETABLE PROCESSING

This subsector is perhaps the most important from the point of view of the enormous variety of raw material that can be processed, and of finished products , that can be obtained.
Furthermore, this subsector is quoted as one of the more rapidly increasing in the next years in the developing countries.
In general it can be said that fruit and vegetable processing systems are not very complex.
Technology, in this subsector, has increased its complexity when the need to automatize some operations has arisen.
Normally , due also to the great variety of fruit and vegetables, processing systems are made up of a series of isolated machines (many of them superspecialized in the treatment of one or few types of fruits and vegetables), that have been more or less developed by specialized firms.
The majority of firms, in this subsector , do not manufacture the entire system, but integrate and assemble lines on client's request, on the basis of acquired experiènce and operational know-how, using different machinery from their own other's production.
Consequently, a very vast range of possible technology systems can be build up, having different characteristics of complexity, depending on how automatized a selected machinery is.
"Down-grading" of existing technologies is possible and should be investigated.
A brief description (1) of adapted technologies will be held,

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(1) For a very detailed description of technology systems for fruit and vegetable proccessing see ref.no.1 op.cit., chap.III, 4, pag.141.

in the following fields:

- tomato concetrate and preserves
- green vegetable processing
- canned fruit processing
- juice and pulps extraction
- fruit and vegetable dehydration

Freezing for fruit and vegetable long-term preservation is not taken into consideration, because of complexities in the commercialization system.(2)

2.2.2.1 Tomato concentrate and preserves

Tomato is normally processed to obtain two types of canned preserves, tomato concentrate and peeled tomatoes in natural state. Both products are widely diffused in the world. In the last few years, tomato processing systems have been subjected to intense improvement, mainly directed to eliminate labour from peeling and handling of tomatoes (for tomato preserves) and to improve concentration (for tomato concentrate). For peeled tomatoes, an adapted technology could be:

- washing
- scalding
- peeling with mechanical or manual operation
- can filling and sealing
- sterilization
- storage for fifteen days for inspection

Higher complexity can be found in mechanical peeling and handling.
At a very low level of complexity, hand-peeling and batch-operation of the whole line allows this system to be used in the less developed countries with intense labour employment.
At higher grades, mechanical peeling (soda bath system is to be avoided, because of the large water consumption and/or recuperation) can be used.
Filling and sealing are key operations common to almost all fruit and vegetable processing systems . Apart from metal

(2) see Para. 2.2.1.1.4 - A freezing of meat

sheets procurement problems (4) , filling does not imply a complex system, while sealing machinery is much more delicate; for very low complexity grades manual sealing is suggested.

In a higher wage environment, mechanical sealing can be operated, with some precaution.

Sterilization performed in batch-operated autoclaves shows no problem, while a much higher complexity grade is in rotating sterilizers and continuous tunnel systems.

For tomato concentrate, the processing system is:

- washing
- fruit crushing
- pulp refining and residues separation
- concentration
- packing operations

Depending on final market destinations, concentration and packing can be made in different ways.

When tomato pulp for further processing is to be obtained, the tomato is crushed and concentrated in drum concentrators, and then packed in 200 Kg. sealed containers with preserving additives. The processing system includes some complex machinery only in the concentration phase.

More widely employed, the concentrate tomato processing obtains finished high - quality tomato paste.

The grade of complexity is the same of peeled tomato (machinery is common in the first phase), except concentration. Modern continous concentrators, operating at low temperature in vacuum environment, are very sophisticated equipments,with very little adaptation potential.

Intermediate technology could be obtained by using batch-operated drum concentrators, with lower quality finished products, because of higher concentration temperatures.

As far as filling and sealing is concerned, the considerations made before are still valid. A very important point to be investigated is the possibility to commercialize (3) bigger cans

(3) a similar system was in use in the European countries some years ago.

(1 to 5 Kgs., for instance) with manual portioning at retail shop, in order to save costly tin with respect to normal international packing standards (individual portion cans, from 50 to 500 grams).

2.2.2.2. Green vegetables processing

There is a great variety of green vegetable processing systems, which depend on vegetable availability and local market habits. Most widely used processe are:

- preserves of green vegetables in natural state
- canned peas and beans

Machinery for green vegetable preserves is to be studied specifically, taking into account physical characteristics of each product (in terms of shape, weight, heat treatment resistance, qualities etc.).
Generally speaking, technological systems for this type of processed foods run along this sequence of operations:

- pre-washing and selection
- final washing
- scalding in hot water or steam
- can filling
- preserving liquid adding
- sealing
- sterilization

For peas, beans, and other pod-contained beans, a pre-washing is performed, followed by a threshing operation to separate pods.
After the size selction is performed, the rest of the process is the same as for other green vegetables. Sometimes a pre-cooking or a more intense scaldind is performed.
Pre-washing and washing machinery are normally simple and can be modified for use with special vegetable without any complexity problems. Selection can be made manually, for big crops, but must be done in a automatic way for peas and beans; quite simple pneumatic separators are normally used.
Scalding is a very delicate operation, in order to preserve taste and quality of the products, but machinery is simple and can be easily adjusted.
Can filling is of the same type described for other products

and consists normally on a calibrated hopper, mechanically operated.
Preserving liquid adding (normally salted hot water) is performed by sprayng hot water until overflows from the can. This is a very efficient but simple system; at higher complexity grades, vacuum units can be used.
The final part of the process is common to all fruit and vegetable preserving.
Depending on season and product harvesting, it is common practice to integrate processing lines for different products, in order to harvest and to process, at times, different products on the same line, just adjusting or changing some special machine.
Generally speaking, green vegetable processing is a simple technology, whose grade of adaptation can be very high.

2.2.2.3 Fruit processing

Much more than in the vegetable field, fruit processing can cover such a variety of type, processes, preservation methods etc., that are hard to be defined in a brief description. As far as adapted technologies are concerned, some basic selection can be made, among different fruits, to find out those of more interest for less developed countries.
First, and more widely used, method for fruit preservation is canning under syrup. But this system, with the important exception of pineapple, is suitable for pears, peaches, apricots, cherries, plums ets., which are, in general, fruits of scarse diffusion in the majority of less developed countries, most of them with a tropical climate. Moreover, technology for fruits preparation, pelling, cutting and stoning operations, vacuum volumetric liquid filling, etc. imply the use of quite complex machinery or have to be completely andoperated, with great labour involvement and low quality level.
International pineapple market is dominated by few multinationals, using very sophisticated plants it would be very hard to compete with.
The sector of siruf preserved fruit is therefore a field where technological adaptation is scarse and of little interest for less developed countries.

Much more interesting are citrus fruits and juice and pulp processing in general; tropical fruits are in fact suitable for these processing systems.
All fruit juice and pulp extraction are normally intended to obtain semi-finished products, to be stored and re-processed to obtain beverages, nectares, jams and/or other special products.
A typical process for citrus fruit juice extraction is as follows :

- fruit washing and brushing
- cutting in halves
- fruit squeezing for juice extraction
- juice concentration
- pasteurization, cooling, tanks filling
- tanks refrigeration for storing

Washing machinery is very similar to that used for tomatoes and can be used for every fruit; its technology is simple.
Also cutting and squeezing is made in mechanical machines, that are very simple or can be simplified.
The only complex operation of this process is concentration, when continuos double-effect vacuum concentrators are used; this allows very low temperature concentration and very good quality results.
Being this big and complex machinery not adaptable, the only alternatives are: no concentration (1) or employment of batch-operated drum concentrators, with possible quality troubles coming out from higher concentration temperatures.
Pasteurization, cooling and tank filling can be operated in a simple way using-manual batch-operated machinery.
As far as tanks refrigeration is concerned, general considerations on refrigerating systems (2) are still valid.

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(1) for the internal market of beverages, the no-concentration way should be carefully investigated to test economic feasibility.

(2) See para. 2.2.1.

Pulp and juice processing for fruits, other than citrus, involves the following operations :

- fruit washing and brushing (if applicable)
- crushing and stoning
- pulp heating
- juice and/or pulp pressing and filtering
- (centrifuge second juice extraction)
- de-aereation and homogenization
- pasteurization
- cans packing and sealing

If jams are to be obtained, after de-aereation, pulp is sent to boilers; during boiler concentration, glucose is added; jams are then packed, sealed and often sealed cans are sterilized, ad in the other types of preserves.
Process technology is, in general, at intermediate complexity level; while first operations are very simple, pressing, filtering and particularly centrifuge juice extraction (when needed) can cause some technologicall complexity problem, being all machinery to be manufactured with good corrosion-resistant materials (mainly stainless steel), because of aggressive components in juice.
Pulps, to be re-used for later processing, are normally canned and sealed in 5 to 50 Kg. cans.
It is to be pointed out that nectares processing (natural juice beverages), to be obtained from pulps, is a quite complicated technology; with very specialized continuos-process machinery and very stringent specifications for product quality standards.
As far as jams are concerned, technology is simple and normally iams are apcked into glass containers, whose quality standards, in terms of rim and air - tight caps, are very hard to be obtained in small glass factories. (3)

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(3) glass containers and bottles manufacturing within developing countries is a very important problem, where further research and studies are necessary, to find out a possible adaption in manufacturing technology.

2.2.2.4 Fruit and vegetable dehydration

Dehydration has been for centuries the main preservation systems for many products: a content of moisture less than 15% allows the product to be easily preserved at normal temperature conditions.
Various technologies exist to dehydrate fruits and vegetables, ranging from artisanal dehydrators to industrial dehydrating plants.
This is a very simple and interesting process, whose major advantage is that it does not need any sealed can or container for preservation.
Apart from energy consumption evaluations, this system should be extended to many products, provided an adequate domestic market is stimulated.
Basic process is :

- washing
- cutting and stoning (if needed)
- dehydration in sealed chambers

The first two operations have already been mentioned above and are very simple; in a very low developed environment, cutting and stoning can be operated manually.
Dehydration can be kept at the complexity degree chosen, the only problem being the handling of products from each dehydration stage to the following (normally six to eight stages are used).
Semi-automatic belt systems are simple and can be operated by non-specialized labour.
An ancillary equipment, to be carefully investigated, is the heat plant; heat exchangers, whose technology grade has normally implications on specific fuel consumption, is very important in this process.
Normally, a hot water system is employed, with simple technology; steam system is better, but more complex.

4.2.2. Fruit and vegetable processing machinery

Generally speaking, fruit and vegetable processing can be made with simple to intermediate complexity machinery . Complex machinery is needed for automatic selection, automatic fruit processing, low temperature continuous concentration and fruit and vegetable freezing.

a) <u>vegetable processing</u>; <u>simple machinery</u> can be: inspection and weighing, washing-machines, deshelling machines, manually operated selection and preparation tables, scalding machines, simple cans fillers, grinders, preserving liquid fillers, semi-automatic can sealers, sterilizing autoclaves, labelling machines.
<u>Intermediate complexity machinery</u>: automatic selection machines, trimers, tunnel scalders and blanchers, volumetric filling machines, continuous sterilizers, automatic sealing machinery..

b) <u>fruit processing</u>: <u>simple machinery</u> is similar to that used for vegetanle processing, except cutting, stoning and peeling machines, which are simple machines, if semi-manually operated. Automatic fruit selection machines, stoning and peeling machines, cutters, fruit manipulating equipment, continuous sterilizers, volumetric fruit and liquid fillers, automatic sealing machines are of intermediate complexity.
<u>For fruit pulps and juice</u>,machinery is intermediate for grinding machines, pulp extractors, centrifuges, sterilizing autoclaves, presses and level fillers; complex and very complex for vacuum operated continuous concentrators homogenizers, plàte pateurizing machines, volumetric fillers and automatic packing machines.
For citrus fruit simple to intermediate machinery can be used for squeezing, grinding, washing, juice extraction and de-aereation, juice refining and processing, filtering; while complex machinery is needed for low-temperature vacuum-operation continuous concentration, homogeneization and pasteurization.

c) <u>dehydration</u> can be obtained by simple equipment such as dehydratation chamber or small dryers.

d) freezing requires the use of complex machinery, such as airflox-freezing tunnels, plate-freezing machines, very low temperature cells, automatic packing machines, packaged refrigeratoring equipments, cooling medium distribution and control system.

2.2.3 CEREALS PROCESSING

All possible technology processes exists in this subsector, since it has been in operation for centuries.
From village-level manual process, to very sophisticated large plants, it is possible to obtain different products in many ways. Processing of cereals covers a broad range, from post-harvest operations, to storage and milling, down to flour processing to obtain bread, pastas etc.
Many varieties of cereals exist, but here only wheat, rice and maize will be taken into consideration, due to their greater importance in food processing for human consumption.
As far as technology is concerned, the consideration made for these cereals will be valid also for other kernels such as oat, sorghum, etc.
The field of cereal processing, considered here, are:

- milling
- Bread and pasta making

All post-harvest and long term storing of cereals are a very important field, but technology depends on different habits, quantities to be treated, harvesting season, etc., that are typical of each developing country. Most of them have to import part of their cereals needs.
Therefore, storing techniques depend on adaptation factors of such a nature (nutritional policies, strategic silos, etc.), that single cases are to be analyzed.
Furthermore, examples of appropriate storage technology and silos/warehouses building are very common in all developing countries.
As a general rule, it can be said that small-and medium-size storage units, locally built with local materials are more appropriate than high-investment concrete silos at regional level.
Thus, the tendency should be to scatter grain storages at town or small district level, using small-capacity silos or even bagged storage in warehouses, that has proven to be a very economic and flexible way.

2.2.3.1. Wheat milling

Many plants,with various options of technological complexity and procuctions scales, are currently in operation in de-

veloped and developing countries.
Huge plants use very complex technologies, whose develop - ment is continuously updated by very few large firms, which dominate the field.
Very little adaption is possible on this wheat milling technology: the entire plant is designed and engineering by these firms, which manufacture or subcontract all machinery, except some very specialized packing unit.

Investments are very high and the centralization of wheat milling capability has proven not to be the best economic solution.

If small and medium size district plants are taken into consideration, many different adjustements are currently in use to perform the basic process of wheat pre-conditioning (heating and moisture equalization), kernel crushing at various levels , intermediate sifting and separation for recycling, final sifting and packing.
The most widely used kernel crushing machinery is the grooved and/or flat roller (in different stages).

Sifting is obtained by flat sieves ("plansichters") of different size and material, operated by air or by gravity, to separate flour fractions for recycling and to separate bran from flour. Probably the best packing method for small plants in developing countries is bag filling. Bag filling plants can be operated pneumatically or by gravity (or combined) methods.
Those, operated by gravity, are of simpler technology and use hoppers and mechanical weighing.

In this field, "down-grading" of existing developed countries small plants can give good adaptation results.

2.2.3.2. Rice milling

Being rice the most widely used cereal in developing countries, many efforts on the last years have been spent in technology adaptation of rice milling, to find out an optimal solution for small and medium industrially operated rice mills.

From one side, huge plants have a very complex technology, with high rice yields and qualities; on the other, village-level hand pounding or artisanally semi-mechanized (1) mills have less efficiency, but strongly contribute to poorest countries' economy and employment creation.

Basic process has to perform the following stages:

- paddy cleaning and weighing
- (parboiling)
- de-husking
- whitening (bran-removal)

Parboiling (hydrothermal treatment of paddy) is sometimes added, to obtain a greater yield of milled rice and to sterilise rice for better storage.

Cleaning is obtained by gravity, followed by sieving and magnet iron objects removing.

Technology is normally very simple.
De-hulling, or de-husking, can be performed by different friction or impact techniques; the technology claimed to be the most adapted is the revolving rubber roller system, that gives good quality results.
Husk are removed by aspiration and can be used as fuel when parboiling is added.

Parboiling can be obtained by open metal pans, when very simple technology is requested, or by pressurized tanks of intermediate technology.

Whitening of rice is obtained by steel roll whitener, whose technology is the same as for de-husking.

A mechanically operated bagging and weighing system completes the rice processing system.

2.2.3.3. Bread and pasta making

These two wheat flour processing system are mentioned together, because of the similarity in flour treatment (with or without yeast), but their technologies normally differ as far as grade of complexity and machinery is concerned.
Bread technology has a wide variety of options, from hand-operated mud ovens, to completely automatic plants.

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(1) a very peculiar example is the bike-operated rice mill, developed by TPI.

In this field, good result can be obtained using economically obsolete technologies, operated until a few years ago in the Europan countries, or "down-grading" continuous ovens.

Baking process can be very different, depending on type of bread to be obtained, but basic operations are:

- ingredients weighing and mixing
- kneading
- fermentation
- baking

Weighing and mixing are normally performed, in small plants, by hand or by hand-operated balance and hoppers.

Kneading takes place in an open pan machine, whose technology is simple.

Fermentation takes place in a chamber at controlled climate conditions; normally, raster-type chariots are used, manually positioned. A possible alternative is the use of continuous belt chambers of higher complex technology.

Baking is the main operation of the process and that where a possible adaptation can take place.

Discontinuous process is claimed to be the most adapted system for low and medium wage countries. This baking takes place in multiple deck ovens or rotary peel ovens, where temperature control can be more easily obtained and production quantities better controlled.

Continuous tunnel baking is a complex and higher-scale production technology, whose machinery can be manufactured only by a few firms, specialized in the field.

For pasta making, several options exist.

The market of complete large-scale plants is dominated by few firms in the world, whose technology has been developed during years of research and improvement.

Machinery is normally manufactured entirely by the firm or under license. But many small factories, in some European countries, are still using simpler technologies, that give goog quality out-put.

It is within this type of small plants that pastamaking adapted technologies should be seeked, after having well defined type and quantities of pasta to be produced..

In fact, the many possible types of pasta make difficult to define a unique criterium for technological adaptation, since, for instance , processes to obtain long or short pastas are quite different.

Basically, operations for pasta processing are:

- ingredients weighing and mixing
- kneading
- press extrusion
- drying

The first two operations are very similar to the corresponding ones for bread making and can be operated by the same machinery.

The screw press extruder can be a complex machinery, depending on output rates, reliability, output quality etc.; simpler alternatives exist on the market for small output rates.

Type of handling of fresh pasta and drying depends mostly on the type of pasta and can be operated manually with special chariots, or semi-automatically, with intermediate complexity machinery.

2.2.3.4. Maize milling

The main product obtained by maize milling is cornflour (meal) which is the basic nutrition for many people in developing countries.

Technology problem are very silimar to those for other cereals milling.

Cleaning process takes place by aspiration.

The problema of maize kernel grinding to be obtain meal is to be considered also from a nutritional point of view: in fact "wholemeal" (endosperm with bran and germ) has a higher nutritional value, due to germ and bran oil content, but is of coarser consistence and has a shelf life of few weeks.

To improve smoothness and shelf life, bran and germ are to be removed (this loosing weight and oil content) with a sifting operation, after having grounded maize in smaller particles.

If sieving is to be obtained, roller grinder is to be used, followed by gravity or pneumatic shifting and coarse particles recycling.

This technology is at an intermediate level.

For poorest enviroments, hammer mill can be used, obtaining "wholemeal" with a much simpler technology.

4.2.3. Cereals processing machinery

Generally speaking, small and medium-scale cereals processing plants require simple to intermediate complexity machinery. Only for complete automatic and large-scale processing plants, complex and very complex machinery and equipment is necessary.

Intermediate to complex machines are to be used when automatic packaging and transport system are requested.

a) cereals preparation and cleaning: machinery is normally simple, such as intake hoppers, semiautomatic weighing machines, bucket elevators, cleaning and trimming devices, sieves, grain selection machines, stone removers, magnetic separators. Intermediate complexity is requested when auto weighing, selection, disinfection, sieving, bagging and silo filling is requested.

b) wheat milling: small-scale plants can be operated with simple machinery, such as pre-conditioner, roll crushers, plane gravity sieves, blowers, manual baggers.
Intermediate complexity machinery could be needed when semi-automatic operations are requested by grooved roller crushers, plansichters, pneumatic shifting, semi-automatic agging systems, cyclones, aspirators.

c) rice milling: small scale plants can be operated with simple machinery, such as grain dier, winnowers, rubber roll huller, steel roll whitener, open-pan parboilers.
When intermediate complexity machinery is used, the rice mill is completed with intake magnetic separator, paddy sieve, elevators, screw conveyors, whitening-cone machine, rice aspirator, rice-grading sieve, bagging hoppers.

d) bread making: simple machinery can be used, such as kneading machines with manual emptying manual mixers, fermentation chambers with chariots, multiple-deck ovens, brick ovens.

For intermediate complexityoperations these machines can be use: kneading machines with semi-automatic emptying, weigher-mixers, fermentation chambers with conveyor belts, rotary pell ovens, cooling belts.

e) pasta making: intermediate complexity machinery is requested for long and short pasta lines, to be built on order, basically including components silos weighing -mixing machines,, kneading machines, extrusion screw presses, pasta cutters, pasta driers, cooling and drying chambers with special hanging belts, semi-automatic packaging machines.

2.2.4. DAIRY PRODUCTS

There is a very wide variety of products, that can be obtained by milk processing.
Processing systemsare very different, depending on country's market, nutritional habits etc.; it would be very hard to define adapted technologies in such a variety of contexts. Further more, any diary product can be seen as processed "by-product" of the milk industry, because no developing country or region would obviously create or maintain a milk-producing ranch structure only for cheese, butter or whatever dairy production.
Milk commercialization is therefore the basis of any dairy industry in developing, as in developed, countries.
Since milk transformation costs are the major portion in milk industry economic balance, in the last years a very sophisticated technology has been developed, to fully automatise milk processing.
This technology is continuosly updated and dominated by few huge multinationals, producing sophisticated equipment.
Milk technology is perhaps the most complex technology in the food processing industry; it needs the use of special materials, to match very stringent hygienical specifications, and of complex equipment to control, within very narrow limits, physical parameters (such as temperature) to avoid milk nutritional or taste characteristics to be altered.
In the milk commercialization, three possible ways can be followed:

- direct distribution to consumers of fresh milk from the ranches
- pasteurization of milk and specialized distribution within one/two days
- long term sterilization (UHT) and distribution by normal market channels.

Direct distribution is now being reintroduced in some industrialized countries, but it is a common practice in many rural areas.
In developing countries (as in some developed ones) it is very hard to rely on an efficient system and to guarantee aseptic milk conditions.

This system is therefore not be suggested in tropical or poorest enviroment conditions.
The other two systems are widely used in developed countries, where significant evolution has taken place as far as type of container and packing technology are concerned.
The use of cartoon packing (tetrapck, tetrabrik, etc.) has almost superseded the glass bottle, completely changing filling and sterilizing technology.
Packing is formed, in a sterile condition, at the same time milk is filled in with volumetric fillers: all technology is so sophisticated, that only three or four firms in the world can afford the manufacturing of these equipments.
The UHT sterilization is even more a complex technology and "flash" sterilization is to be controlled within two or three degrees in temperature to prevent milk protein content change.
No adaptation is possible and therefore milk technology cannot be afforded by the large majority of developing countries.
Few alternatives remain, if milk is to be put into the nutritional programme for a given country (1): some possible suggestion is mentioned in the nex paragraph, but no data is currently available.

2.2.4.1. A tentative approach to adapted technologies for milk processing.

Following the "down-grading" line, this approach takes origin by noting that some developing countries (or at least some regions within them) have nowadays a socio-economic enviroment, similar to that some currently developed countries used to have some decades ago.
To "restyle" milk distribution system and relevant technologies in use there at those times , and to propose them to developing countries, might be a possible approach in giving adapted technologies and keeping investment costs at an acceptable level.

(1) many authors consider milk as a luxury item for many developing countries (see UNIDO monograph no.7 on appropriate industrial technology)

A possible adapted technology should consider the glass bottle as the basis of a daily distribution system, with empty bottle return delivering the full one on the following day (or every two days, or whichever combination) (2).
This would give the possibility of using intermediate technolgies for pasteurization of milk in batch-operated (or continuos, depending on scale), autoclaves, with bottle level-filling machinery, whose technology is simpler.
Bottles should be treated in steam-operated bottle washer, which would give out clean, but not sterile, bottles.
Capping of bottles could be obtained by aluminium capsules, that ensures a hygienic sealing.
This adapted technologiy would not be labour-intensive and should be operated in small-scale plants, to serve a limited area distribution system.
Any milk processing (except UHT sterilization) implies the provision of an adequate refrigerated store capacity along the commercialization line.
Obviously this "down-graded" system needs the establishment of a definite milk-supply policy and adequate techno-economic feasibility studies to verify what here is only very roughly outlined.

2.2.4.2. Dairy Products

Few could be envisaged as milk processing "by-products" (3) between the vaste range of dairy products usually obtained in milk-producing countries.
Cheese, yoghurt and butter can all be processed with a wide range of technologies, from completely manual operation to fully automatised plants.

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(2) this would also have the advantage of employment creation in very low wage services.

(3) in the sense that main economic goal of a dairy industry in a developing country should be fresh milk distribution; tests have proved no substantial difference in economic balance for small firms between sole milk processing and milk plus other dairy products processing.

It is impossible to define in general processing technologies because each kind implies small processing variants.
For butter and yoghurt processing, possible complexity arises when packing systems are considered, depending on the automatization grade requested.
Generally speaking, a small plant for dairy products with batch-operated open-pan processing is very simple.
Low production rates are achived and labour-intensive operational system are required, but many firms of this type still exist also in industrialized countries.
The main problem is that of materials to be used for machinery (only stainless steel, in practice, can assure long-lasting equipment and hygienical conditions), whose cost and manufacturing skill must be carefully taken into account, when the economic feasibility and development potential of dairy industry is considered.

4.2.4. Dairy products machinery

As mentioned before in chapter 2, no simple machinery is suitable for milk processing.
If glass or level-filling containers are to be used, intermediate complexity machinery can be employed.
If tetrapack, or similar, carton container are to be used, only very complex lines have to be employed.

a) milk processing: intermediate complexity machinery, (with some single simple equipment, such as pails, tanks, pumping equipments, pail washers, conveyor belts), such as refrigerating reception tanks, continuous weighing machines volume meters, de-areators, homogenizers, filters, tubular heat exchangers, cooling equipments, refrigerated tanks, pasteurizers, storage tanks, bottle washing machines, level fillers, capping machines.

b) cheese processing: simple machinery could be used, batch-operated, such as heaters, curdling pans, sieves, presses, filters.

2.3. BASIC OPERATIONAL NEEDS AND RECOMMANDATIONS FOR ADAPTED TECHNOLOGIES IN TERMS OF UTILITIES, LABOUR, ENERGY CONSUMPTION, ETC.

2.3.1. Electrical power

All processing systems, whichever industrial technology is used, need reliable electric power supply.
In the food processing, due to very rapidly perishable products, power brown-outs or black-outs can irreversibly damage enormous food quantities.
If any doubt exists on main supply reliability, an emergency generator is to be taken into consideration.
This will, of course, add some technological complexity factor to plant, but this is a risk worth being ran.
In terms of voltage and frequency specs, needs are not very stringent, since adapted technologies in this sector employ normallu only electric motors and transformers.
Slight changes in voltage and frequency could induce less efficient operations, but normally would not stop the factory. Electric contorls, if any, should be protected against overshotts and voltage lowering.

2.3.2. Water

Normally, big quantities of water are requested to operate food processing plants.
Washing is requested all over; a proper washing of raw materials, as well as a proper cleaning of processing equipment, are key factors in assuring requested hygienical and process conditions.
Water is requested also for fast cooling operations in some processes.
In all cases, water must be clean, aseptic and in some cases thats to have low mineral content; this could be a problem in countries where water supplies are scarse. In cases where the need for proper water is mandatory, possible complexity factors can arise from imput water purifyng equipment, whose technology is often very sophisticate, and should be very carefully investigated.
Also investment costs can increase.

As far as waste water is concerned, normally food processing industry cause no pollution, except in some identified cases, where special waste water depuration equipment are to be used.
Washing waters are normally conveniently used for irrigation, because of their content of organic residues.
In case of scarsity, washing waters are to be purified and recycled; the purifying system can be a complex and costly item.
Cooling waters are normally recycled with simple to more complex (depending on scale) equipment.
Water consumption is a very important criterium in defining technology adaptation.

2.3.3. Heat generation

The majority of food processing technologies require heat treatment and therefore a more or less important heat generation plant is requested.
Steam is the heat transport medium normally employed as the most efficient system. Relevant technolgy is at an intermediate complexity level and should be very carefully operated for security and reliability in operation.
When steam system result to be too complex, hot water should be used, much simpler in technology and in operation.
Other systems can be used in special cases.
As far as fuel is concerned, the maximum effort should be put on using burnable residues of processing, such as husks, hulls, stones, etc.
This gives the double result of diminishing waste residues pollution and energy costs.
Since fuel costs are going higher and higher, thermal energy balance is a key factor in defining profitability of a given technology.
Electrically operated heater are to be avoided, except in some very special case.

2.3.4. Labour

In principle, when speaking about adapted technologies, no mandatory labour-intensive operations, nor employment crea-

tion policies, are implied. In practice, adapted technologies are normally more labour-intensive than corresponding developed ones, whose major feature is the automatization intended for labour costs elimination.
On the other hand, labour qualification requiremts are lower in adapted techologies giving a sort of compensation in low- and medium-wage enviroment.
When establishing food industry general polices, global area employment creation should be considered, instead of making simple single plant labour-intensity economic convenience calculations.
If generation of maintenance and repairs capability, as well as an induced artisanal and small workshop manufacturing capability, are taken into account (see ch. 1.1.), the technological choice implications could results in less labour emloyed in a given plant, but more employment opportunities in the induced industrial or service infrastructure.
This is a key factor, when capital goods manufacturing capability development is considered as a secondary goal, while installing primary food processing capabilities (see ch.1.2). Personnel training requirements are very different, depending on technological choice and related implications: some highlights will be discussed in ch.5.4.

2.3.5. Energy consumption

It goes without saying, that energy consumption for a given food processing system should be kept to the minimum.
What should be pointed out is that, sometimes, an adapted technolgy choice has to be made, even if specific consumption is higher than the corresponding developed one, because other adaption factors have a "heavier" weight.
Furthermore, great attention should be put not only on energy consumption quantities, but also on energy source qualities. Availability of "softer" energy sources could suggest modifications on a given technology, to match local requirements, even if efficiency is lowered and specific consumption becomes higher.

CHAPTER 3 - MAINTENANCE AND REPAIR IN FOOD PROCESSING INDUSTRY

3.1. Basic aspects at different stages of technological complexity

3.2. Industrial infrastructure for maintenance and repair

3.3. Common and uncommon aspects of maintenance and repair in the considered subsectors.

3.1. BASIC ASPECTS AT DIFFERENT STAGES OF TECHNOLOGICAL COMPLEXITY

In the common sense, maintenance involves a regular care, intended for full serviceability of machinery, equipment, etc. Repair involves, on the contrary, a specific intervention, intended for remedying an unexpected breakdown, which has rendered the machine out of service.
Maintenance and repair have common aspects but, in general, while maintenance implies a programmed activity (at least a certain extent), repair is normally an unplanned activity.
Planned activities range form daily maintenance, carried out by the machine operator, to major interventions, carried out by specialist, aimed to remove important wear effects and to bring the machine to a predetermined original status.
Unplanned activities range from minor periodical repairs, carried out by maintenance staff, to major repairs, caused by unexpected breakdown for lack of maintenance or undue operational conditions (common cases in developing countries).
The development of maintenance and repair procedures has been aiming at the reduction of unplanned activities.
Maintenance procedures can be listed, per increasing level of complexity, as follows:

a) repairs to remedy faults
b) general preventive maintenance
c) differentiated preventive maintenance
d) self-diagnostic fault protection systems on machinery and equipment.

The increasing level of complexity is to be justified by an economic balance analysis, to compare maintenance procedures with plant needs.
Also, the relative position of machines and equipments in the production process plays an important role in establishing the type of maintenance procedure to be used (1).

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(1) See ref. n0.3, op. cit., para 2.1.1., for more details

Some key machinery must be protected against breakdown much better than auxiliary equipment because a failure may stop the entire production cycle.
In the food processing industry in developing countries, level b) only is normally acheved, because higher levels require management and planning staff, the majority of small plants cannot afford.
A simple, but efficient, programme of general preventive maintenance should be the goal of any food processing factory, also for those equipped with ver simple machinery.
A full understanding of the working principle of a given system is possible only when the system technology is fully "assimilated".
A full indipendent local maintenance and repair capability is therefore possible only when technological complexity level is compatible, or "adapted", with the best local level of cultural and social environment (4).
In the food processing machinery and equipment the following groups of parts can be identified:

- mechanical parts, such as supporting frames, metal sheets, pipes, gears, rolls, chains , belts, etc., normally made by steel, stainless steel or cast iron.
- electrical parts, such as motors, switches, relays, cables, etc.
- electronic and process control devices, such as meters, transducers , electronic process controls, computing devices, etc.

Generally speaking, simple machinery are mainly composed of mechanical parts, with some electrical driving and supply; process control is manual.
More complex machinery has more electrical components and some process control device.

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(4) This point has been discussed on para.12

Sophisticated machinery is almost automatically operated and therefore process control components are of key importance for a ccrrect working cycle.
Since the functional aspects of a mechanical system are almost intuitive, a short training is sufficient to reach simple machinery trouble-shooting capability.
When technology becomes more complex, trouble-shooting requires a specialized training,based on checking and testing procedures, normally edited by system manufactruer.
For driving and supply electrical systems, testing procedures are very simple and trouble-shooting skill can be afforded by many developing countries.
Process control system maintenance and tuning (electric or electronic) normally require complex test equipment; a certain dependance on manufacturer's technical assistance service is to be envisaged.
Once the origin of the failure has been located, changing of defective parts is a question of assembling/disassembling skill.
This capability can probably be obtained, with adequate motivation and intelligence, by almost every good artisan if enough time is left to him to acquire the necessary pratical experience.
This is probably a determining factor of the "assimilation" process of a given technology, and should be stimulated by technical assistence and training programmes.
The central problem remains the availability of spare parts.
This problem can be tackled with two different approaches:

- spare parts stockage
- spare parts manufacturing

Spare parts stock management is a basic aspect of an effective maintenance programme; at any level of manufacturing capability, a certain quantity of spare parts must be kept in stock.
The majority of developing countries has, in fact, a limited market that will not justify, for many years in the future, The creation of electrical and electronic components manufactu-

ring capability, as well as special mechanical parts, such as roll bearings, rubber belts and rolls, plastic items etc.
To optimize spare parts quantities and types to be kept in stock, is a very difficult and risky job, that can be successfully carried out only when a very good knowledge of processing technology has been acquired.
Manufacturer's advise is important, but working experience is the determining factor.
Spare parts manufacturing is only a partial aspect of capital goods manufacturing , but its peculiarity is that only copying " or "reproducing" skills are needed.
This is, of course, only the first step in the development of manufacturing capability, as it will be discussed in the next chapter, but it is very important because it can involve small workshops in the industrial development process.
Once this process is initiated , the development of manifacturing capability will evolve toward more complex parts and sub-assemblies, if small workshops are adequately stimulated by technical and financial assistance.

Manufacturing can involve almost alla mechanical components in steel and cast iron, if welding , boilermaking, machining and casting facilities (5) are provided; some difficulties will be encountered on stainless steel working, which needs a deeper welder's training.
As far as electrical components is concerned, it is believed that development of manufacturing capability could not be envisaged and dependance on import goods, at component level, will continue.
A certain pre-assembly and electro-mechanical components integration capability will take place, but this is properly to be considered as part of assembly/disassembly work, mentioned above.
At process controlling device level, no manifacturing intervention is to be envisaged, being totally dependent on import goods and foreign assistance services, at least until a much higher degree of development is achieved.

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(5) See next paragraph for a more detailed list of facilities.

3.2 TECHNICAL INFRASTRUCTURE FOR MAINTENANCE AND REPAIR

Basic needs for maintenance and repair capability of simple and intermediate technology machinery and equipment are:

a - electrical , special mechanical , electronic and control system spare parts, in carefully managed stock quantities.

b - steel and stainless steel welding and forming capability.

c - medium complexity mechanical machining capability

d - trouble-shooting skill and maintenance programmes management

The management of stock quantities of various spare parts is a very difficult job; very carefull attention is to be put on establishing type and quantities of spare parts to be kept in stock, the manufacturer (local or international) can give useful suggestions, but the best ways are experience and other user's advises (1)

The spare parts department has to be subjected to the plant management.

On the contrary, manufacturing facilities can be located in different workshops or small plants, where artisanal work could be made.

These workshops could work as maintenance infrastructure for many plants in the area, within or outside the food processing field (2).

A typical workshop should be equipped with this type of machinery:

- copying lathes
- mechanical presses up to 20 tons
- reciprocating saws
- portable electrical welding machines

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(1) a good solution should be to establish maintenance training programmes in other more advanced food processing plants, instead of manufacturer-sponsored training programmes.

(2) there are interrelations between food processing and agricultural and transport machinery, that can help in creating common maintenance facilities. These interrelations mainly in the mechanical working, should be studied in detail.

- boring machines
- gear cutters
- milling machines
- drilling machines
- surface flattening bench
- oxyacetilene welding sets
- flexible polishing machines
- small casting and/or forging ovens and shells
- various mechanical tools and instruments
- miscellaneous accessories for a mechanical workshop.

Dimensioning and machine type definition could be easily done on the basis of maintenance needs (3) in a given area.
With the above described workshop the majority of food processing machinery mechanical parts can be manufactured, by "copying" original parts.
The "reproducing" skill can be the first step in "assimilating" simple technologies to stimulate the development of more complex components manufacturing capability.

(3) depending on number of food processing plants and interrelated equipments to be served

3.2 COMMON AND UNCOMMON ASPECTS OF MAINTENANCE AND REPAIRS IN THE CONSIDERED SUBSECTORS.

Generally speaking , food processing machinery and equipment has a certain degree of commonality, as far as typology and construction methods are concerned.
When adapted technologies are taken into account, the common aspects are even more, because mechanical component prevail.
On the considered subsectors, the following considerations can be made:

- preserving technology is the same in fruit and vegetables, as in meat, processing.
- meat processing first phase has only rough mechanics, and shows common aspects with fruit, vegetable and cereals first preparation and cleaning process , as far as steel frames and main mechanical components are concerned
- milk technology , whichever the grade of complexity,has a very poor similarity with other processing
- cereals processing machinery has some similarity with other grain processing subsectors (such as coffe and cocoa)

From the point of view mechanical repair, problems are the same in all subsectors: welding of steel and stainless steel.

Main electrical components, such as motors, switches, relays, supplies etc. are very similar and, with some design care, a certain degree of standardization (1) can be obtained, reducing the need for spare parts stock quantities and types and therefore a great deal of foreign currency investments. Very little, if any, similarity is shown by electronic and, in general, process control devices, whose function and design are very specific. It can be summarized that, within adapted technology range, maintenance and repair of machi-

(1) This may be an interesting study at component level.

nery and equipment, in the considered subsectors, have many common aspects, for mechanical interventions, and that a certain standardization could be possible in the electrical components, to reduce spare parts stock quantities.

CHAPTER 4 - TECNICAL INFRASTRUCTURE NEEDED FOR MANUFACTURING OF SELECTED FOOD PRO CESSING SYSTEMS

4.1 Technical infrastructure for manufa cturing

4.2 Possible ways of development of in- frastructural capability

4.3 Highlichts of an implementation and personnel training programme

4.1 TECHNICAL INFRASTRUCTURE FOR MANUFACTURING

From the point of view of mechanical components the same type of machinery, described at para.3.2, should be used.
Some other equipment and machinery have to be added to reach full operational capability (1). Machinery added to the previous list could be of the following types:

- hydraulic presses up to 200 tons
- hydraulic guillotine sheet cutters
- oxygen plasma cutters
- steel disc cutting machines
- shear disc cutters
- roller forming presses
- sheet folding presses
- electrical continuous - wire welding machines
- eletrode-type step-welding machines
- various measuring instruments
- various dimensioning benches
- special tools

With this machinery (to be added to that described in ch.3.2) a mechanical workshop can be able to produce food processing machinery, on order and/or in small series, for special and general purposes.
To assure food processing machinery manufacturing capability, a pre-assembling and assembling skill of electro-mechanical and electronic components must be developed, using imported semifinisched or finished components.
Another point, to be carefully analyzed , is how to supply raw materials, where dependance from import goods is normally very high.

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(1) a full list of machinery needed, with dimensional specifications, is reported on chap.VII of INITEC's study (see ref.no.1 : op.cit.) A list is also reported in Appendix III.

In particular , it is quite obvious that the following raw materials are to be imported:

- steel sheets
- stainless steel sheets
- large castings
- special metal alloy parts

This means that adequate stocking facilities and management are to be provided.

Finally, a certain metal surface treatment capability is to be envisaged, such as:

- thermal treatment
- metal sheets/bars galvanizing
- surface sanding and coating

4.2 POSSIBLE WAYS OF DEVELOPMENT OF INFRASTRUCTURAL CAPABILITY

In the very first development stage, the maintenance and manufacturing capability is fully dependent from the food processing industry, from economical and operational points of view.

Possible interrelations with other industrial sectors, such as agricultural and transport machinery and equipment,have to be studied, in order to accelerate industrial development process for a given area.

In this first stage, location of the small workshops can be in the same building or in the vicinity of served industry/ies.

Very low management capability is requested in this phase, since workshops work directly on orders, coming from served industry.

Adequate aids should be provided to stimulate skilled workers to create their own maintenance workshops. The gradual assimilation of technologies, obtained by maintenance and repair interventions, is one of the most efficient training systems for creating future manufacturing capabilities.

In a more developed stage, the different needs originated by prototype or small series manufacturing, may suggest a different organization into artisanal or small-scale factories.(1)

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(1) many examples of this type of organization still exist in industrialized countries; for instance, in northern Italy, more than 80% of mechanical workshops are family-owned with less than 10 workers, working only on specific orders.

These small factories, if adequately sustained, could become economically indipendent, while working still on orders from the food processing industry within the area.
The choice of a very specialized single machinery and/or components subsector could be the takeoff opportunity for these small manufacturers to enter the local market (2) with their own products.
At this stage, training of direct production workers has been almost completed, needing only some very specialized adjustment; on the contrary, trained management personnel begins to be of decisive importance.
If these small firms can be adequately sustained, by financing and technical assistance programmes, and the internal market develops, a certain technological adaptation and innovation takes place, and engineering capability begins to be part of infrastructural capability.
From this moment on, local food processing industrial environment can accept higher complexity technology transfer with a self - adaptation capability. At this stage, joint-ventures and/or license agreement could be of great help in accelerating industrial development process.
Of course, the sequence of the above mentioned steps in development is only theoretical , the actual development being greatly influenced by a wide range of disturbing factors, due to interrelations between sectors and to international technology market pressure.
It is also to be pointed out that this "small - scale workshop-based" development of manufacturing capability is a long-lasting process, particularly suitable for less developed countries with few resources.
Furthermore , starting conditions, as far as socio-economic and political factors are concerned , could suggest modifications of the stage sequence.

(2) if local market is very limited, possible export toward other developing countries may be seeked.

4.3 HIGHLIGHTS OF AN IMPLEMENTATION AND PERSONNEL TRAINING PROGRAMME

It has already been pointed out that needs, in terms of qualified personnel, vary during the industrial development process (see ch.1.3).
Therefore, personnel training programmes should be "tailored" to different stage needs.
In other words, technology complexity and level of personnel training should match.
It is often seen how high-level training of personnel from developing countries, that normally takes place at manufacturer's headquarters or in a much more developed environment, has the only effect to stimulate emigration.
Generally speaking, training , as technologies, should be "adapted" to development stage needs, in order to avoid the difficulties encountered by more qualified personnel to find a job at their qualification level in a socio-economic environment with different needs.
In the first stage of food processing industrial development the following direct production personnel qualifications are requested:

- welding (steel and iron)
- welding (stainless steel)
- small-pieces casting
- small-pieces forging
- simple mechanical machining
- metal sheet cutting
- metal sheet cutting and folding
- pre-assembling and assembling of electro-mechanical parts
- trouble-shooting and repairs of simple electro mechanical machinery
- maintenance scheduling
- spare-parts stock management

The training courses should be held in a socioeconomic environment possibly similar to that where workers are going to get their job; for example in other developing countries, or in their own country's more developed regions, or by programming technical assistance courses with foreign teachers, working with people in workshops, small firms etc.
To organize "stages" at foreign manufacturer's headquarters

and/or at foreign food industry's plants may be of some help in some case, but normally the impact with a so different social environment causes great diffulties to the learning process.

Furthermore, pratical working conditions will be so different, that training has a very scarce significance, if compared with the local working practice.

In the second stage, direct production personnel training is requested also in the following qualifications:

- stainless steel continuons welding
- non-ferrous metal welding
- medium-pieces casting
- " " forging
- mechanical machining (particularly lathe, boring machines, milling machines, planers, gear cutting, drilling machines, grinding machines etc.)
- metal sheet forming
- large-piece sheet folding
- dimensional measurements and quality control
- electrical, electronic and hydraulic assembling
- heat and surface treatment specialists
- utilities and supplies maintenance and repairs
- raw-materials stock management

In the second stage, supervision personnel training should be programmed for the following qualifications:

- workshop supervision
- production scheduling
- production organization and control
- preventive maintenance scheduling
- clerks of various qualifications
- client technical assistance managing
- technicians with intermediate education (high - school or equivalent) for staff jobs
- workshop and small firm management
- quality control planning
- preventive maintenance planning and management

In this stage, training programmes could include educational periods to be spent in more developed countries, but within small-and medium-scale firms.

It may be of great interest to implement knowhow acquisition "courses" at food processing machinery user's plants. Food processing methods and detailed operational know-how can be more easily learned, than at machinery manufacturer's plants.

In the third stage, all the above mentioned training courses must be intensified , with higher qualification request in the following fields:

- university and high-school graduates in sciences and management
- university and high-school graduates, in engineering
- system analysts
- planning methods specialists
- food processing technologists
- sales and technical assistance management sales agents
- sales planning and marketing

In this phase, being the assimilation process of simple and intermediate technologies almost completed, joint training and assistance programmes (with other developing and developed countries) should be studied and contacts with universities and official learning institutions intensified.

CHAPTER 6 - PROPOSED LINES OF FURTHER ACTIONS IN RESEARCH AND STUDIES

6 - PROPOSED LINES OF FURTHER ACTIONS IN RESEARCH AND STUDIES

General research

a) It has been pointed out that there is a lack of feed-back informations on operational (economical and technical) data on long-run economical "adapation" conditions of many "transferred" technologies for food processing projects. To collect long-run data for some project may be a pratical help an appropriate technology choice.

b) correspondance between infrastrucural development stage and maintenance and manufacturing capability should be verified in practice for some developing country.

c) further and deeper analysis should be performed on possible ways of development of industrial manufacturing potential in food processing machinery.

d) a more precise and detailed definition of technology "approrpiateness" factors should be made, with case studies.

e) level of educational needs, and related training programmes, should be analyzed for different industrial development stages.

Operational studies proposals

a) study on specific and qualitative energy consumptions for different grades of technological complexity in the food processing industry.

b) study on possibility of interrelations in maintenance and repair between agricultural, food processing and transport machinery and equipment.

c) study on "economically obsolete" technologies in industrialized countries, but still in use in intermediate development countries.

d) study on "down-grading" of some complex technology to match lower complexity requirements, without changing processing system principle and industrial feasibility.

e) study on "up-grading", or "up-dating",of local technologies to convert them into industrial operations for small-scale plants.

f) study on distribution and commercialization system, in use in many industrialized countries until some years ago, suitable for modification and adaptation to developing countries present environment .

g) study on medium-size metal containers and packing systems to be employed for market distribution of processed foods to be retailed by weight in small shops.

h) study on possible standardization of electrical components in some simple to more complex food processing machinery

i) analysis on grade of complexity of mechanical, electrical, electronic, pneumo-hydraulic components in the machinery of some selected subsector of food processing.

l) "roster" of adapted technologies in various subsectors, with the definition of complexity grades for system, machinery and components.

m) definition of maximum grade of technological complexity for some less developed countries, to allow technological "assimilation" process.

n) "prototype" projects, at feasibility study level, for investigation of possible alternatives in technological choice in a selected subsector of food processing; in a given country. The study should take in account an integrated approach with agricultural production and infrastructure of the same area, to suggest possible common implementation or intervention programmes.

o) study on the use of local raw materials for manufacturing of insulation panels and industrial walling for refrigerated stores.

p) packing systems and techniques adaptation, for a more efficient locally based packing industry (glass, plastics, cans etc.)

APPENDIX 1

LIST OF SIMPLE AND MORE COMPLEX MACHINERY AND EQUIPMENT FOR FOOD PROCESSING INDUSTRY.

SUBSECTORS:

* Meat processing
* Fruit and vegetable processing
* Cereals processing
* Dairy products

Note : this list makes reference to notes pointed out on chapter 4

1 - MEAT PROCESSING

<u>Simple machinery</u>

Slaughtering stalls

Stunners

Killers

Overhead conveyors

Transporting chariots and trucks

Hooks

Bleeding stalls

Pig scalders

Hair removers

Pig scrapers

Horn and hooves remover

Weighing machines

Washing pools

Central conveyors

Circular and belt saws

Bone saws

Quartering tables

Quartering room equipment

Electromechanical knives

Semi - manual poultry shughtering lines

Civingind machines

Cutters

Cutter - mixers

Sausage

Filling machines

Drum cooking and sterilization autoclaves

Can filling machine

Semi-automatic can sealers

Drum can sterilizers

Intermediate-technology machinery

Raising and lowering elevators

Pig flayers

Sheep inflators

Pneumatic skinning machines

Pneumatic skinning knives

Balanced saws

Vertical slicers

Continuous weighing machine

Continuous bone remover

Automatic skinners

Air-conditioning system

Semi-automatic poultry slaughtering lines

Poultry central conveyors

Automatic pluckers

Automatic killing machine

Poultry eviscerators

Refrigerated stores

Refrigerating system and equipment

Air cooling tunnels

Hydraulic mincing and cutting machines for frozen products

Sooking and smoking ovens

Rotating autoclaves

Vacuum filling machines

Continuos filling machines

Pressure-cooking sterilizers

Drying chambers

Complex machinery

Automatic skinners

Automatic meat wrappers

Continuos automatic weighing machines

Automatic poultry slaughtering and preparation lines

Cage depalletizers

Air-flow freezers

Plate freezers

Continuos counter-current freeezers

Freezing chambers

Very low temperature refrigerated rooms

Freezing equipment and distribution systems

Automatic can sealing machines

Continuos tunnel sterilizers

2 - FRUIT AND VEGETABLE PROCESSING

Simple machinery

Vertical and horizontal drum autoclaves

Weighing machines

Soda tanks

Blanching machines

Pumps

Manually operated calibrators

Brushing machines

Washing machines

Manual sealing machines

Belts, conveyors, selectors

Dryers

Mechanical elevators

Can filling machines

Overflow preserving liquid fillers

Batch sterilizers

Juice extractors

Squeezing machines

Filter presses

Ispection tables

Tube heaters and pre-heaters

Water sprayers

Pulp refiners

Silos

Hoppers

Fruit crushing machines

Motor fan units

Ventilation units

Forced ventilation dryers

Drying chambers

Intermediate complexity machinery

Rotating autoclaves

Peeling machines

Semi-automatic calibration and selection machines

Centring-cutting machines

Automatic sealing machines

Peeling cylinders

Concentrators

Peeling-cutting machines

Cutting-stoning machines

Core removing machines

Top-tail removers (automatic)

Cooling tunnels

De-areating cooling tunnels

Tubular scalding machines

Labelling machines

Homogenizer

Centrifuges

Rotating fillers

Plate pasteurizers

Centrifugal filter presses

Refrigerating equipment

Semi-automatic selection rows

Threshing machines

Refrigerating chambers and tunnels

Freezing chambers

Cooking tunnels

Re-heating tunnels

Air conditioning system

Drying tunnels

Complex machinery

Continuos calibration machines

Continuos concentrators (under vaccum)

Automatic peeling machines

Cutting-centring-stoning lines

Tunnel scalders

Continuos rotating sterilizers

Tunnel sterilizers

Multiple-effect evaporators

Volumetric filling machines

Tubular cooler-pasteurizers

Flow-freezing tunnels

Freezer equipment

Automatic cutting machines

3 - CEREAL PRCESSING

Simple machinery

Spiral feeders

Suction pumps

Maire threshing machines

Rice parboiling pans

Small rubber roll rice de-huller

Friction-type de-huller

Smooth cylinder rice whiteners

Small silos and grain storage units

Flat gravity sieves

Small stone removers

Belt conveyors

Magnetic stone removers

Germ removers

Track elevators

Chain and belt transporters

Small grooved cylinder grinders

Small smooth cylinder grinders

Hammer grinders

Ventilation and air circulation equipment

Intake and outlet hoppers

Steam treatment tower

Kneading machines

Beating-mixing machines

Weighing balances

Flour storage silos and containers

Fermentation chambers

Belt conveyors

Small pasta extruders

Discountinous ovens for bread baking

Cooling chambers

Drying chambers

Intermediate complexity machinery

Vacuum pumps

Input weighing machines

Bag weighing machines

Larger rubber roll rice de-hullers

Larger sooth rolle rice whiteners

Rice polishing cones machines

Rice parboiling autoclaves

Pneumatic sitting machines

Larger grooved cylinder grinders

Larger smooth cylinder grinders

Flour and cleaning plansichters

Temperature and humidity control chambers

Drum sifters

Bag sealers

Disinfection lines

Bagging machines (semi-automatic)

Polishers

Flake dryers

Temperature control transducers

Graders

Pneumatic transport system

Automatic empting kneaders

Weighing-mixing machines

Mixer-beaters with automatic operation

Cooling and fermentation chain operated chambers

Wire mesh belts

Dough shapers and dividers (automatic)

Shaper-rounder machines

Homogenizer-mixers

Multiple deck ovens

Rotating peel ovens

Larger pasta extrusion presses

Long pasta conveyor belts

Long pasta automatic cutters

Long pasta dryers

Complex machinery

Large and integrated wheat mills

Large and integrated rice mills

Conditioned silos and containers

Automatic and continuous weighing machines

Pneumatic transport (automatically switched)

Automatic bagging system

Continuous tunnel ovens

Automatic weighing-mixing devices

Automatix kneading-beating machines

Large long-pasta production lines

Automatic pasta packaging machines

Automatic long pasta hangers and dryers

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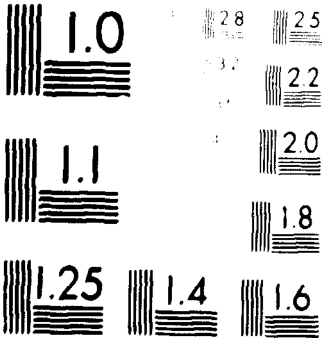

MICROCOPY RESOLUTION TEST CHART

4 - DAIRY PRODUCTS

Simple machinery

Pails and tanks

Tankers

Pumping equipment

Discontinuos weighing systems

Pail washing machines

Tanker unloading pumps

Container tanks

Storage tanks

Water cooled refrigerators

Level filler

Bottle washing machines (hot-water)

Capping machines

Conveyor belts

Skinner pans

Beaters

Curdling pans

Cheese presses

Cheese drying chambers

Intermediate complexity machinery

Cleaning centrifuges

Milk refrigeration tanks

Refrigerated tankers

Pumping-measuring equipment

Weigh bridges

Analysers

Pail-washing continuous tunnels

Refrigerated tankers equipment

Volumetric meters

Air-removing machines

Homogenizing centrifuges

Plate heat exchangers

Coolers

Refrigerated tank stirrers

Plate pasteurizers

Batch horizontal sterilizers

Higher performance level fillers

Heat-sealing machines

Water tightness testers

Glass bottle sterilizers

Glass bottle tunnel washer

Labellinh machines

High-speed conveyors

Centrifuge skinners

Cream pasteurizers

Vacuum deodorizers

Cream refrigerators

Continuous beaters

Mixing-beating machines

Butter cutting-packing system

Curdling pans with heat exchangers

Whey removing systems

Metering system

Parafine wax applicators

Viscous products fillers

Air-conditioned incubators

Complex machinery

Automatic continuous milk weighing machines

Tubular heat exchangers

High-pressure tubular sterilizers

Countinuous vertical sterilizers

Ultra-violet sterilizers

UHT processing lines

Volumetric fillers

Tetrapack shaper-fillers

Tetrapack stackers

Multiple-effect evaporators

Powder dryers and fluidizers

Automatic packing machines

High-temperature pasteurizers

APPENDIX 2

LIST OF POSSIBLE MANUFACTURES OF FOOD PROCESSING MACHINERY AND EQUIPMENT.

Note: this is an indicative list of italian small and medium enterprises, able to build simple and intermediate complexity machinery for food processing.

A - MEAT PROCESSING MACHINERY

Sausage

- DRUSIANI RINO
  Via Asiago, 14 - CALSTELFRANCO EMILIA (MO)
- F.LLI PARMEGGIANI S.n.c.
  Via Loda,5 - CASTELFRANCO EMILIA (MO)
- PALTRINIERI ENNIO
  Via Provinciale, 54 - MEDOLLA (MO)
- S.M. S.a.S.
  Via A. Buozzi,10 - NONANTOLA (MO)
- R.A.S. S.n.c.
  Albinea (RE)
- GISTAR SG S.n.c.
  Via di Vittorio - FORNOVO di TARO (PR)
- C.G.M. S.n.c.
  Via Are 2/A - SALA BAGANZA (PR)
- C.G.Z. Alimec S.r.l.
  Str. Prov. Sala - Collecchio - SALA BAGANZA (PR)
- IFM S.r.l.
  Via Buozzi, 15 - SALSOMAGGIORE T. (PR)

Slaughtering

- DI NARDO P.
  Viale Storchi, 347 - MODENA -

  ITALCOSMOS S.r.l.
  Via dell'Artigianato,35 - PIANORO (BO)

  BARONCINI EDMONDO
  Via Bentivoglio, 21/I - LUGO (RA)

  I.B. di Bertoli e Corradini
  Via S. Marco, 38/A - GUASTALLA (RE)

  OFF. MECCANICA ZIVERI
  Pilastro - LANGHIRANO (PR)

  BRECO
  Str. Golese, 30 - PARMA -

<u>Meat processing</u>

- I.M.A.S. Snc
  Via Che Guevara, 5 - MODENA -
- N.S.V. S.n.c.
  Via Bernini, 97 - MODENA -
- UNION S.n.c.
  Via Colombo, 29 - MODENA -
- AMB S.n.c.
  Via della Tecnica,19 -S.LAZZARO (BO)
- COSTRUZIONI MECC. ROVANI
  S.S. n.62 Km. 161 - LUZZARA (RE)
- AL. MA. Levati S.r.l.
  Torricella - SISSA (PR)

B - FRUIT AND VEGETABLE PROCESSING MACHINERY

Canned Products

- OFFICINE MECCANICHE BARALDI F.
  Via Radici, 308 - Corlo - FORMIGINE (MO)
- R. LEVATI S.p.A.
  Via Nazionale Est, 2 - Collecchio (PR)
- La Parmigiana S.r.l.
  Via del Porro, 2 - FIDENZA (PR)

Fresh fruits

- BIONDINI G.
  Case Murate, 339 - Forlì -
- COMPAGNONI FELICE
  Via Emilia, 1165 - SAN CESARIO SUL PANARO (MO)
- DALLE VACCHE e F.LLI
  Via della Resistenza, 14 - MASSALOMBARDA (RA)
- TECNOFRUTTA S.r.l.
  Via Corriera, 51 - COTIGNOLA (RA)
- GUARDIGLI L.
  Via Amendola, 21 - CONSELICE (RA)

Dehydration

- Rodexport S.r.l.
  Via Calzavecchio,23 - CASALECCHIO (BO)

C - CEREALS PROCESSING MACHINERY

Bread

- LATINI PIERO
  Via F. Rosselli, 23 - 41012 CARPI (MO)
- BREVIGLIERI LIVIO
  Viale delle Nazioni, 86 - MODENA -
- FORNI-ZENITH S.r.l.
  Strada S.Anna 581 - MODENA -
- AVONI DANTE
  Via Matteotti, 16 - VILLANOVA DI CASTENASO (BO)
- FOLLI G.& D.
  Via Bedeschi, 5 - CONSELICE (RA)
- VICTUSFORNI S.Coop.r.l.
  Via Romagnoli, - S.paolo - TORRILE (PR)

Pasta

- C.M.P.
  Via della Suora, 237 - MODENA -
- MALAGUTI ANGELO
  Via B. Corti, 45 - MODENA -
- S.I.M. BIANCA S.p.A.
  Via Marescalca - CENTO (FE)
- BRIZZI ORLANDO
  Via Porta di Castello, 3 - BOLOGNA -
- OMAR S.n.c.
  Via Caduti di Casteldebole,3 -BOLOGNA-
- SENZANI BREVETTI S.p.A.
  Viale Risorgimento, 13 - FAENZA (FO)
- SIMPLA S.n.c.
  Via Torrette Cagnona - SAVIGNANO S.R. (FO)
- LAMPA
  Via Milano, 8 - GATTEO (FO)

Milling

- MALAGUTI NERIO
  Via B. Corti, 41 - MODENA -
- OFFICINE RONCAGLIA S.p.A.
  Via R. Araldi, 100 - MODENA -
- MOLITECNICA ARDUINI S.n.c.
  Via Caduti di Amola, - BOLOGNA -

D - DIARY PRODUCTS PROCESSING MACHINERY

Cheese and butter

- PANINI S.r.l.
  Via D.Ferrari, 49 - MARANELLO (MO)
- NUOVA OFFICINA MECCANICO F.lli FILIPPINI
  Corte Tegge - CAVRIAGO (RE)
- Ing. FERRETTI S.r.l.
  Via Pellico, 5 - Quattro castella (RE)
- I.M.A. S.r.l.
  Via Guerrazzi, 5 - REGGIO EMILIA -
- ARFA S.n.c.
  Via Marconi, 3 - NOCETO (PR)
- BOSELLI G. e Figlio
  P.zza Partigiani, 15 - NOCETO (PR)
- CASEARTECNICA
  Via Bertini, 26 - PARMA -
- S.M.
  Via Ortles, 4 - PARMA -
- TECNOINOX
  Via di Vittorio - S.PANCRAZIO- PARMA -

Creamery

- CARPIGIANI S.p.A.
  Via Emilia, 45 - ANZOLA EMILIA (BO)

E - GENERAL FOOD PROCESSING MACHINERY

(Built on special order)

General

- Costruzione Complessi Alimentari S.r.l.
  Via Gazzotti, 297 - MODENA -
- Delver S.n.n.
  Via O. Respighi, 92 - MODENA -
- F.T.P. ITALIA S.p.A.
  Via G. Pepe, 15 - BOLOGNA -
- M.E.C. INOX S.r.l.
  Via S.Allende, 60 - MODENA -
- SPECIAL INOX S.n.c.
  Via Di Capua, 21/1 - MODENA -
- Ing. MACCARI
  Via del Papa, 126 -Casella di Crevalcore (BO)
- SELL - MECC. S.r.l.
  Via Nazionale, 73 -Fornovo di Taro (PR)
- COSMINOX S.n.c.
  Via S.Martino, 16 -Ramiola -MEDASANO (PR)
- C.M.P.E.G. S.n.c.
  Via G.di Vittorio- MEDASANO (PR)
- C.M.A.
  Via Frassinara -MEZZANI (PR)
- O.C.M. S.n.c.
  Via Martiri della Libertà,77 -MEZZANI (PR)
- ADORNI C.
  Via di Vittorio,7 - S.PANCRAZIO - PARMA -
- A.S.I.
  Via Marconi,7 - S.LAZZARO - PARMA
- A.& G.
  Via Trieste, 5 - PARMA -
- BARANTANI F.
  Via Pellico, 6 - PARMA -
- BERTOLINI S.n.c.
  Strada Argini, 60 - MARIANO - PARMA-
- C. MIGLIAVACCA & C.
  Strada Alessandria, 5 - PARMA -

- BONGRANI G. e V. S.d.f.
  Beneceto - PARMA -
- COSTR. MECC. DALL'ASTA
  Via Gramsci, 20 - PARMA -
- DANTI e NICOLI S.n.c.
  Str. Martinella, 119 -Vigatto- PARMA -
- ERRE-BI-ZETA S.n.c.
  Via Baganza, 35 - PARMA -
- FOOD MACHINERY ITALY S.p.A.
  Via Mantova, 127 - PARMA -
- FAVA GIANFRANCO
  Str. Martinella, 154 - ALBERI - PARMA -
- F.LLI MELEGARI S.r.l.
  Str. Martinella, 154 - PARMA -
- F.LLI MENOZZI S.n.c.
  Via Baganza, 57 - PARMA -
- GHIRRONI S.n.c.
  Pannocchia - PARMA -
- LONDON-pack S.r.l.
  Via Londra, 5 - PARMA -
- MA.PI.BI. S.n.c.
  Str. Martinella, 154 - PARMA -
- M.R.M.
  Str. Manara, 9 - MARINELLI - PARMA -
- NILMA
  Via Zacconi,24 - PARMA -
- NIM INOX S.n.c.
  Str. Montanara,104 - Carignano - PARMA -
- OFF. MECC. SOAVI S.p.A.
  Via M. da Erba Edoari, 29/A - PARMA -
- OFF. MECC. SAVI S.p.A.
  Via Ravasini,13 - PARMA -
- PARMASEI S.r.l.
  Str. Martinella, 154/C - Fontanini - PARMA -
- PEDRELLI & BELLICHHI S.n.c.
  Via Naviglio -S.LAZZARO - PARMA -
- PIAZZA ALDO e C. S.n.c.
  Str. Martinella, 150/9 - PARMA -
- PNEL - MEC S.n.c.
  Via Scarabelli Zunti, 9 - PARMA -

- VEMIA
  Str. Golese, 24 - PARMA -
- ZANICHELLI MECCANICA S.p.A.
  Via Mantova,139 - PARMA -

F - COMPLETE FOOD PROCESSING SYSTEMS

(for larger plants of intermediate and complex technology)

- TITO MANZINI e FIGLI S.p.A.
  Via Tonale, 11 - PARMA -
- OFF. MECCANICHE Ing. Rossi e Catelli S.n.c.
  Str. Zarotto, 114 - PARMA -
- VETTORI MANGHI S.p.A.
  Via Spezia,56 - PARMA -

APPENDIX III

LIST OF MACHINERY AND EQUIPMENT FOR A MECHANICAL WORKSHOP FOR FOOD PROCESSING CAPITAL GOODS MANUFACTURING

List of workshop machinery

- no. 1 1500 mn copying lathe
- no. 1 2000 - mn " lathe
- no. 1 200 - ton hydraulic presse
- no. 1 reciprocating saw, for metal bars up to 5 mn. hydraulic guillotine press, 3-mt long ,sheet 8 mm thick
- no. 1 20 - KW plasma cutting machine
- no. 1 continuous -wire 0,8 to 1.2 - mn welding machine
- no. 2 argon welders 300 A
- no. 3 portable electric welding sets 300 A
- no. 3 oxyacetilene welding sets
- no. 1 high-frequency welder for aluminium
- no. 3 shear disc cutting machine
- no. 3 portable shear disc cutters
- no. 1 abrasive disc machine
- no. 1 folding press for metal sheets, 2,5 mt long, sheet up to 5-mm thick
- no. 1 110-mn boring mill with two- coord. visual display
- no. 1 radial drilling machine, dia.60-mm, 1500-mm arm
- no. 1 universal milling machine
- no. 1 universal grinding machine
- no. 1 precision drilling machine, dia. 15-mm.
- no. 1 electrode - type step-welding machine
- no. 1 surface flattering bench
- no. 5 flexible polishing postable machines
- no. 1 small casting shell, with related equipment
- no. 1 small forging oven, with related equipment
- no. 1 belt polishing machine
- no. 3 portable deburring machines
- no. 1 roller forming presse, 5- mm thickness, 2,5 mt. long
- no. 5 portable drilling machines, dia. 13 - mm.
- no. 1 3,5 - mt. dia. turntable, 7-ton load
- no. 1 3,5 - mt dia. turntable, 3-ton load
- no. 1 10-ton crane
- no. 1 5- ton crane
- various dimensioning and composing benches
- miscellaneous hand and machine tools
- no. 1 tool sharpener
- miscellaneous measuring instruments
- " accessories