2.1 Introduction
Agriculture inevitably affects the land and, in many cases, shapes the landscape itself. Natural processes, including the immensely complicated run-off patterns of surface waters, can be disrupted by agricultural activities. The ability of a river system to satisfy all annual water supply needs can be compromised by the impact of agriculture. Natural vegetation acts as a slow sponge, releasing water to streams over relatively long periods following major rainfall events. The removal of vegetation, the development of formalised drainage systems and adjustments to ground levels can seriously affect how quickly water enters the river.

Furthermore, the use of fertilisers, herbicides and pesticides can contaminate surface waters and groundwaters to levels that breach water quality standards. The waste from agriculture can pollute surface and groundwaters to such a degree that subsequent use for potable supplies is compromised. Never benign, agricultural activities should ideally be sanctioned on the basis of the acceptability of potential effect upon the use of raw water sources for potable supplies - but this rarely happens.

Agro-industries are those industries whose raw materials come from agricultural production. The size of these enterprises varies widely from home-based activities to small-scale cottage industries to large-scale factories. Such industries are not limited to the rural areas where the raw materials may originate; they are also to be found in urban and developing urban areas. Agro-industries cover a wide range of technical levels, employ many thousands of people worldwide and make use of both simple and sophisticated processes. This may be as basic as solar drying to remove moisture prior to storing foodstuffs, or the use of the most advanced methods and equipment required for the new or emerging technologies such as food irradiation, high pressure processing, pulse light treatments and similar.

Not only are agro-industries diverse in scale, they are also diverse in nature. In Sonora Mexico, for example, technically advanced agro-industries include the production of low cholesterol oil, frozen processed meats, farm implements, canned sardines, spicy fruit snacks, beer, canned vegetables and corrugated cardboard boxes. Because they are so diverse it is difficult to classify agro-industries, however, the majority can be considered to come within one of the following categories:

- Storage
- Pre- and post-distribution
- Packaging and marketing
- Food and beverage industries
- Fibres and textiles
- Abattoirs, and associated
meat processing and leathers industries
• Transport
• Farm and agro-industrial machinery
• Animal feeds
• Farm chemicals, including pesticides and fertilisers

The supply of farm and agro-industrial machinery manufacture deserves particular attention, as it is essentially different from other agro-industries and provides the services, products and equipment required for supporting the many other industries within the food chain. A wide spectrum of machinery is available for both agriculture and agro-industries, from simple hand tools to highly sophisticated machinery that may require skilled operation and maintenance. In many industrialised countries, the results of research in agricultural sciences have made it possible for agricultural production to exceed national food requirements, and parallel advances in engineering have made this a technical reality. However, the situation in many developing countries is the reverse of this, and millions of impoverished people labour at near subsistence level – and produce nothing for sale outside the needs of the family. For reasons that remain numerous and complex the improved designs of cultivation equipment, tool carriers, dryers, threshers, pumps and other agricultural machines - with the various new or improved hand/pedal, biogas, wind, solar, animal and petro-chemical power options - have not always been received and adopted for use by farmers and small-scale industries in developing countries.

The use of water by these industries – for processing - and the subsequent impact on water quality varies widely from industry to industry. The use and impact of water by industries of which the only function is to store foods will be small, but the same is not true of the food processing industries. These industries may use large quantities of water in production and may require (but not always have available) access to high quality water for the processes used. Almost inevitably these industries will contaminate the water that is used with organic, chemical and microbiological material that will have the potential to adversely affect the receiving water.

Table 2.1 provides estimates of how much water is used by a variety of agro-industries. Although the ranges shown vary widely, in situations where there is insufficient water available necessity may reduce use. Other agro-industries that use more advanced equipment may have more modest process water requirements, but this is not always the case. As water becomes more expensive, so efficiency of use becomes more important.

2.2 Impact of agriculture and agro-industries on water supplies
In general, agro-industries are capable of using large amounts of freshwater and, as a result, can concentrate sources of physical, biological and chemical contamination within surface water and groundwater catchments in sensitive areas. These industries may impact on the quality of the raw water available for potable water supplies. The fundamental factors that relate to the production and distribution of potable water supplies are summarised in descending order of importance as:
Relegation of “quality” to the fourth level within the model may come as a considerable surprise, but it should be remembered that the presence of water, the quantity available and its availability for 365 days a year are fundamental pre-requisites for supporting stable communities; thus the priority ratings as shown.

The potential impacts of agriculture and agro-industries on these factors are summarised in Table 2.2. Agriculture and agro-industries clearly have the potential to adversely affect water supplies not only in terms of competition for scarce water resources, but also in terms of their effect on water quality, the cost of water and impact on the environment. See Figure 2.1, which shows intensive pig farming in the United Kingdom. Stringent waste control is undertaken at the farm to prevent waste from the pigs polluting a nearby stream which forms the source of a small tributary within the catchment of the River Thames. An agreement allows liquid waste to be discharged to the local community sewerage system, and solid waste disposal is by controlled composting with bed litter.

### Table 2.1 Typical Rates of Water Use for Selected Agro-Industries

<table>
<thead>
<tr>
<th>Industry</th>
<th>Range of Water Use (m³/tonne)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Canneries</strong></td>
<td></td>
</tr>
<tr>
<td>Green beans</td>
<td>50 - 71</td>
</tr>
<tr>
<td>Peaches and pears</td>
<td>15 - 20</td>
</tr>
<tr>
<td>Other fruits and vegetables</td>
<td>4 - 35</td>
</tr>
<tr>
<td><strong>Food and beverages</strong></td>
<td></td>
</tr>
<tr>
<td>Beer</td>
<td>10 - 16</td>
</tr>
<tr>
<td>Bread</td>
<td>2 - 4</td>
</tr>
<tr>
<td>Meat packing</td>
<td>15 - 20</td>
</tr>
<tr>
<td>Milk products</td>
<td>10 - 20</td>
</tr>
<tr>
<td><strong>Pulp and paper</strong></td>
<td></td>
</tr>
<tr>
<td>Pulp</td>
<td>250 - 800</td>
</tr>
<tr>
<td>Paper</td>
<td>120 - 160</td>
</tr>
<tr>
<td><strong>Textiles</strong></td>
<td></td>
</tr>
<tr>
<td>Bleaching</td>
<td>200 - 300</td>
</tr>
<tr>
<td>Dyeing</td>
<td>30 - 60</td>
</tr>
</tbody>
</table>

2.3 Case study: livestock slaughter and the processing of hides and skins

The industrial-scale preparation of hides and skins provides one example of a key agro-industry in many countries that has enormous potential to impact adversely on the quality of the receiving water.

Most countries use livestock principally to provide meat, milk, draught power or wool; most of the animals involved are eventually slaughtered and the hides and skins produced are destined mainly for the tanning industry (for manufacturing leather). Hides and skins from designated slaughtering operations may originate from any one of a range of places including street and backyard killing, slaughter slabs, slaughter houses and abattoirs. The facilities, and therefore the potential impact on the environment, vary enormously from place to place and are frequently uncontrolled and unregulated in many developing countries. Animals are often killed without any special facilities available, and with use of the most basic knives or tools. By contrast, a purpose -built killing works or abattoir may be available with full mains services.
Table 2.2 Impact of Agriculture and Agro-Industries on Water

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Context</th>
<th>Potential Impact of Agriculture and Agro-industries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage</td>
<td>Water must be available locally to support life.</td>
<td>• Point over-abstraction can cause related sources to dry up.</td>
</tr>
<tr>
<td>Quantity</td>
<td>Personal water allocation must be at least 20 l/h/d.</td>
<td>• Abstraction can deplete downstream or related sources or compete for use.</td>
</tr>
<tr>
<td>Continuity</td>
<td>Supplies must be available daily.</td>
<td>• Abstraction in dry seasons can cause sources to run dry.</td>
</tr>
<tr>
<td>Quality</td>
<td>Physical, biological and chemical contamination must be below health related quality target levels to control water borne disease or illness.</td>
<td>• Large-scale agriculture can affect rainfall and run-off patterns.</td>
</tr>
<tr>
<td>Cost</td>
<td>Running costs of water treatment and supply must be affordable for all the community to use.</td>
<td>• Agricultural activities and industry can result in the discharge of microbial pathogens that cause water borne disease.</td>
</tr>
</tbody>
</table>

Figure 2.1  Intensive pig farming in the United Kingdom. More than 3 000 pigs are reared in an enclosed area of 3 ha on this farm, and care with waste disposal is essential.
(viz. electricity, steam, water, effluent treatment and equipment) and highly trained staff. Irrespective of the size of the establishment, the slaughter facilities should conform to certain minimum standards in terms of being of an appropriate design, properly sited, well maintained and well managed. In all aspects of operation irrespective of scale, however, the killing works should not impact adversely on the surrounding environment, and particularly on local watercourses. Unfortunately, this is not always the case. In many countries slaughtering is seen as an unsavoury activity and it is often hidden away, and not given the attention it warrants on the grounds of animal and human welfare, public health and environmental impact – issues that are often ignored. There are considerable health risks with neglect of this kind. Livestock can carry and transmit a range of diseases that can be fatal to both animals and people. One of the most threatening is anthrax - the associated pathogen can persist in hides, skins and many other animal products and can be contracted by workers at the killing works or the tannery.

The preparation work required of hides and skins is atypical of agro-industries in general, in that the amount of water needed to actually prepare the skins is relatively small. The use of water in the preparation of the animals before slaughter should be limited (despite being frequently recommended) as this can be of questionable value. With very hairy or dense woollen skins, for example, it is best avoided and skins of this kind should not be rinsed under any circumstances. Rinsing freshly flayed skins and hides in cold water will cool the skin, but will not prevent microbiological contamination if fleshing has been inadequate. In many isolated rural areas there may be little or no water available for rinsing hides and skins. Since washing provides no major benefits and is often impractical, it can be omitted. One instance when rinsing is desirable, however, is when the hides are heavily soiled or when the skins have dried too much for efficient preservation. The salt used for preservation effectively limits the action of the micro-organisms, no matter that water may be present, and thus prevents proliferation and skin damage.

Although water itself is not an essential part of the skinning process it is essential for maintaining hygiene in the killing works and particularly in the killing and skinning rooms, where constant washing down helps to removed wastes in solution from floors and walls. Workers should have access to water at all times, to enable them to maintain high levels of personal hygiene. There is, therefore, a considerable wastewater flow at certain times and from some sectors of the killing works. The organic loading from the blood in the wastewater will be considerable and, in conjunction with the risk to public health from microbiological contamination present on the animal, makes the safe disposal of wastewater a priority. Water which is used to wash down the area where the hides are salted will contain high levels of dissolved salts, which has implications not only for the final disposal point but also for any waste treatment system that is used. Because this is often done in an uncontrolled and indiscriminate fashion, the effect on public health and the water quality of the receiving water can be significant. Notwithstanding the difficulties involved with organised killing of stock, the potential impact of this agro-industry - which is often viewed as a dirty and objectionable trade - is significant in terms of its...
perceived adverse impact on the environment, but also because of its highly beneficial socio-economic returns to the community. The production of hides and skins is a resource that is often under-valued and frequently under-exploited for its real value to domestic livestock industries in producer countries.

2.4 Economic value of agriculture and agro-industries

The economies of many developing countries are based on the exploitation of agriculture and agro-industries that are correspondingly important in relation to the economic stability of many villages, towns, cities and regions. Agro-industries contribute to the economic strength of an area by increasing the value of the raw materials, either by extending the “product life” of the materials or by converting them into more desirable commodities. In this way they stabilise the economy by rendering the primary products of a region into a more marketable form. Such products can be sold more steadily, consistently and reliably over a period, whereas the primary products of agriculture may normally sustain only a limited storage period and are generally seasonal in nature.

In developing countries post-production operations and agro-industries contribute more than 50 percent of the added value to the manufacturing sector. Even if the products are only partly processed and sold in bulk, they can still make an essential contribution to the economy of a nation. In Italy, for example, INEA (1998) reported that the domestic agro-industrial system was estimated to be worth ItLire 289 000 billion (US$160 billion) in 1997, equivalent to 14.8 percent of the gross domestic product (GDP). In this case, agro-industries systems are defined as the series of activities in which agriculture interacts with other associated sectors such as fertilisers, pesticides, animal feed and food, catering and distribution industries.

The contribution made in Italy by agriculture and, by implication agro-industries, is higher than in other industrialised countries, especially in terms of employment. Nevertheless, this example illustrates the importance of agro-industries within a major industrialised European country. Agriculture and agro-industries (together called the agricultural sector) have important direct and indirect roles in generating economic and socio-economic growth. The importance of the agricultural sector can be demonstrated in three ways:

• It provides food to consumers, and fibres and other raw materials for domestic industry.
• It is a source of foreign exchange earnings.
• It provides a market for industrial goods.

In Pakistan, the agricultural sector contributes approximately 24 percent to GDP and employs about 47 percent of the domestic labour force. It follows that a significant part of the economy remains dependent on farming - through production, processing and distribution of the main agricultural commodities. Again, with foreign trade, the agricultural sector dominates through the exports of raw materials such as rice and cotton, and semi-processed and processed goods such as cotton yarn, carpets and leather products.

In Pakistan, as with many other
developing countries, a buoyant agricultural sector is essential for making sustainable improvements to the external and internal economy. The share of primary commodities, primary processes and semi-processed products constitute almost 60 percent of the total exports earnings. In addition, the agricultural sector plays an important part in the economy of the country by providing food to a population of 130 million people. Agriculture is the main source of livelihood for the rural population; it provides raw materials for many domestic industries and provides the market for many locally produced industrial products.

Table 2.3 clearly shows that when the income of a country increases – that is, when it become richer - then the percentage of the total water used for agriculture declines and the percentage used for industry increases - sometimes dramatically. The proportion withdrawn for domestic use appears not to increase after the middle income group is reached, although overall the amount of water used increases of the order two to three times.

It follows that the processes associated with the development of agriculture and agro-industries and their requirement for water and their effect upon the environment are matters of great consequence. Difficult choices have to be made, for example, for the availability of water between investments in rural development and for urban growth. Choices of this kind become more confused when issues of pollution and/or global warming are considered, and when exploitation of raw water sources leads to lowering of quality.

2.5 Agro-industries as the engine of development

The development of agro-industries is seen by many as an engine that drives development, allowing for the additional and consequential development of other industries that lead, in turn, to overall growth of the community and the country. Attempts have been made in the past to apply the rules of general industrial development to agriculture, when what may be needed is a new approach that takes into account the special features of the industry.

Three main factors differentiate the development of agro-industries from general industry, viz.

- The nature factor.
- Paths to industrialisation.
- Locality.

Agriculture and, to some extent, agro-industries operate under the constraints of the natural world - best described as the nature factor. Nature dictates the productivity limit of labour and effectively restricts capital investment. There is no substitute (yet) for soil and solar radiation on large-scale, and no way to speed up agricultural processes beyond a certain limit; agriculture must operate with what the natural world offers on a day-to-day basis. Available labour cannot always be employed effectively because of the seasonal nature of the industry, and this creates difficulties for rural communities and particularly for those who may be landless. There is limited continuity with supplies of crops, which adversely affects local processing industries. The seasonal production base that nature provides affects the circulation of capital, as the production rate is not constant throughout the year.

One certain way to expand production in an agricultural area is to bring more
land into productive use, select complementary crops and varieties and extend the growing and harvesting seasons, but even then seasonal factors will continue to apply. It is not possible to apply more capital at a single site to expand or intensify production. It is difficult to react to market forces quickly in the agricultural sphere as land is a fixed, limited and heavily marketed resource. These markets are further affected by local social conditions. Small family units are flexible within a limited number of constraints. Families are able to adapt to uneven labour demands because non-commodity relations prevail in production. In Italy, for example, 83 percent of the members of farm families work on the family farm and/or in off-farm activities (INEA, 1998). Of this percentage, over two-thirds work full-time on the farm, while 31 percent have an off-farm remunerative activity which is either their sole or main occupation. Family units are also able to adjust consumption to subsistence level during times of low market values and prices. The impact of agriculture conducted by small family units on the local environment is generally limited. However, under exceptional circumstances, such activities can cause problems and the water cycle can be adversely affected. For example, even on small-scale the use of agrochemicals in an uncontrolled manner can lead to the chemical contamination of surface waters and groundwaters in surrounding areas.

In industrialised countries there are firm trends underway to reduce the amount of pesticides and fertilisers used, partly because of regulations and partly due to public pressure. For example in Italy in 1997, the use of fertilisers dropped by 3.5 percent compared with the previous year, and the use of pesticides fell by three percent (INEA, 1998). However, the use of agricultural chemicals continues and it is likely to remain stable at current levels of use, or to decline only marginally.

In the shift from farm production to agro-industries there are two main stages on the path to industrialisation. Firstly, farm processes are gradually assimilated into factory based industries. The processes are rationalised, mechanised and intensified beyond what is possible on the farm. Secondly, traders and manufacturers attempt to reduce farm products to more simple and controlled industrial inputs. As the pace of industrialisation gathers momentum, manufacturers eventually seek to replace agricultural products with industrially produced alternatives.

The agricultural sector (including agriculture and agro-industries) is diverse in both its products and the areas from which the products originate. Because of the inherent variability produced by biological processes, it is practically impossible
Part 2: Agriculture and agro-industries

for industrial capital to categorise and standardise agricultural production. In addition, household producers vary enormously in terms of use of external labour markets, strategic behaviour, gender relations and inter-generation relationships. In Italy in 1995, the average number of days for employing external labour on a farm was four days (INEA, 1998). The number of days of external labour employment is dependent on the size of the farm with larger farms – as expected - employing more labour.

Each commodity chain has its own industrial sector with its own policies and practices and, it follows, that each industry has its own policies and practices. State policies affect the path to industrialisation through influence over land use patterns, choice of crop, production techniques, technological advances, trade policies and environmental legislation. Despite a general trend towards labour division and the dominance of larger firms, there is no single route to industrialisation. Market-driven development moves in many directions at different speeds to produce an heterogeneous agricultural landscape typical of an area or region.

Pakistan is a striking example of a country where the development of water resources gave rise to the development of the agricultural sector. In 1947, the Indus Basin was irrigated with an extensive system of canals, cultivated land was sown with low-yielding traditional seed varieties, fertilised mainly with animal manure and cultivated by means of animal draught power and by hand. In the early 1960s conditions that favoured rapid growth were put in place, the Indus Waters Agreement was signed and the Indus Basin Development Fund established, and tube wells became a viable investment. This encouraged rapid intensification of crop production and the expansion of associated agro-industries.

The development of water resources has been critical in the development of agriculture and agro-industries in Pakistan (FAO, 1998). Since the 1960s the development of Pakistan’s agricultural sector has had a somewhat chequered career, and some important structural changes have taken place. Livestock, forestry and fishing are increasing in importance and cotton has become as important as wheat in terms of value added earnings. The acknowledgement of the importance of water as being crucial to long term development is recognised in future plans for the country. Water has been designated a most important area of concern for Pakistan in the development of the agricultural sector. Issues such as water-logging and salinity in irrigated areas, inequality of water distribution, loss of water storage capacity in existing reservoirs, drainage programmes and their evaluation and an increasing reliance on groundwater are crucial factors. The economy of the country is based on agricultural production, and access to sufficient water remains a decisive factor in all decision-making.

Many factors should be taken into account when planning development projects. In many countries women are in a comparatively disadvantaged position regarding access to food, health education and economic resources. Besides working in the agricultural sector they also bear the main responsibilities for family welfare, housekeeping and home management. The role of women in cottage industries and small-scale enterprise development is also important, for they normally comprise the greater proportion of the (low paid) labour force. Much depends on traditions in
the community but, generally, rural women are responsible for collecting fodder, fuelwood and water, vegetable production, poultry and livestock rearing and agricultural activities such as weeding, crop harvesting, and pre- and post-harvest activities. In Pakistan, processing of fruit is also women’s activity. The use of a participatory approach in development projects helps to empower women by helping them to raise their consciousness - as well as their collective voice - about their needs, rights and capabilities, which is essential to ensure the long term viability of the community.

In an illuminating example from a poverty alleviation project in Schag, Egypt when villagers from different socio-economic strata were interviewed, the Egyptian Government became aware that the priorities of women and the poorest were not the same as that of the village leaders (FAO, 1998). Initially the leaders emphasised activities mainly of interest to themselves, whereas the top priorities for women and the landless were small livestock and off-farm income generating activities. When developing rural projects it is essential that the interests of women and the poor are included from the outset. Failure to do so will jeopardise the success of the project longterm.

The sporadic development patterns of agriculture are not subject to the usual industrial dynamics, but also to the function of these dynamics within the constraints of the locality. People create localised differences in farming practices, social relations, land tenure patterns, agro-industrial links, labour markets and state policies. Capital deployment in agriculture is geographically specific and local conditions erect powerful barriers to industrial transformation.

The Midwest region of the USA provides a graphic illustration of the dynamics of agro-industrial growth in an industrial country (Gates, 1962). During the nineteenth century the farm

![Figure 2.2](image-url)
sector was rapidly expanding and economically healthy with rising investment in manufacturing. Farmers were highly commercialised and were integrated into the economy through land acquisition. Farmers were eager to compete and expand and, consequently, productivity rose along with total output to keep prices depressed. This depression sent farmers into debt as they struggled to keep pace with the need to buy the newest and best equipment or more productive breeding stock.

Family-run concerns acted as the epicentre of a rapidly expanding division of labour surrounding this buoyant resource utilisation. Markets were standardised, for example, by the formation of the Chicago Board of Trade, and this led to an increase in trade. This was further fuelled by the railroad network expanding throughout the Midwest, the centralisation of stockyards and the development of a grain storage system that rationalised the movement of goods from rural to urban areas.

These developments ensured that the conditions favourable for industrialisation took hold. This process was further aided by numerous technical innovations of that time, including roller mills, mechanical slaughtering, pasteurisation and refrigeration. Farm success and expansion created many new markets for manufactured goods, which in turn created a huge number of links between agriculture and industry. The dynamic relationship between agriculture and agro-industries fuelled the engine of market development and placed new products on the shelves of retail outlets.

In the twentieth century farm inputs to industry were shaped by the use of technology. The driving force for this came from the manufacturers who researched and developed many biological, chemical and mechanical innovations including the use of hybrid varieties, fertilisers, pesticides and antibiotics. Total output and productivity rocketed and agriculture came to be dependent heavily upon

![Small-scale banana cultivation in new settlements near Nyabwishongwezi, Rwanda.](image-url)
these technical innovations.

Food manufacturers and retailers increased the importance of their role through the introduction of branded high value foods, food wholesaling and retailing in large supermarket chains - and by the growth of corporate fast food chains. Farmers are now caught in a persistent cost/price squeeze associated with this technological cycle of dependency, leading to widespread consolidation and to a decline in rural populations. There has been a rise in pollution, groundwater depletion and use of chemicals. Many key urban farm-related industries such as equipment and implement manufacturing and packing have been restructured, leading to rationalisation, job losses and relocation. Other farm-related industries have expanded, such as seed production and pesticide manufacture. A key element in the process of rural industrialisation is the ever-changing links between agriculture and industry, and the need to consider flexibility within the different investment opportunities that may arise within a community or an economy. (See Figure 2.2).

2.6 Agro-industries and urbanisation

Urbanisation is the process of increasing the urban area, that is the area covered by, and dependent upon, the town or city. Urbanisation is generally linked to migration from rural areas to urban areas. There is a lag between the reproduction rate of a rural labour force and the growth of opportunities for work in the agricultural sector. This has been the driving force for migration in the developing world. For instance in the 1970s in Brazil, over 15 million people migrated from rural to urban areas (Chase, 1999). The tempo of these mass migrations was not simply due to poverty in rural areas, but was also a function of the introduction of modern agricultural techniques and the shift from subsistence farming to commercial production. Subsistence farming in many regions is no longer tenable, and is being replaced by modern capital intensive systems that require a smaller labour force for the area of land farmed. Accordingly, people are encouraged to shift and to find work in the cities. Much of this work is on agro-industries, with the farm worker becoming the agro-industrial worker.

As populations grow the search for employment becomes more widespread, especially when linked to the introduction of techniques that reduce the size of the rural workforce. In most industrial countries the proportion of the workforce employed in agriculture is 10 percent or less, whilst in developing countries this proportion is often significantly higher at 60-70 percent. Population growth leads to a reduction in the land-to-person ratio, reduced access to land and an increased incidence of poverty. If the available land can be increased then the problems of a decline in land-to-person ratios can be avoided. An approach of this kind has successfully been employed in the Philippines and Thailand, but in many countries land is scarce.

Rapid industrialisation that leads to stable or declining numbers employed in agriculture and/or dependent on agriculture will also help to avoid the problems of uncontrolled population expansion. Taiwan and South Korea are example of countries that have successfully used this strategy. However, developments of this kind in the industrial geography of a country will rarely entail a significant increase in agro-industries, as the area of land
available to agriculture cannot normally be increased.

Certain food plants such as plantains, tubers and roots are typically grown in the developing world (Figure 2.3). For example, in sub-Saharan Africa these foods make up 40 percent of the diet for approximately half of the population. Other areas in Africa, the Caribbean and Latin America also depend mainly on these types of food, which are highly perishable and labour intensive – for production, preservation, transformation and use. On small-scale constraints of labour in rural communities can be easily overcome but, as urbanisation increases, people have neither the time nor the physical resources to accommodate these needs – and problems of food security become greater.

Production of traditional staple foods can reasonably be expected to increase as populations expand (and thus markets grow and demand expands) with rate of production matching that of demand. However, if urbanisation increases dramatically the increase in demand for these foods cannot be met. This may be due to a decrease in land availability and the inability of the processing procedures to develop to maintain adequate processing before the foods perish. This leads to a decrease in the rate of consumption per capita of these foods and an increase in reliance on other foods, such as imported grains. However, in the medium term the demand for tubers, roots and plantains will remain high, as imported grains are unlikely to be available in sufficient quantities to allow them to become a major food group. Care is needed to avoid policy reforms causing prices to rise or limiting the amount of imported food aid available if a decline in consumption rates is to be avoided.

2.7 Alternative sources of water for agro-industries

It is not always technically or economically feasible to exploit previously untapped sources of water to supply the rising demands of developing agro-industries, and other sources must be considered.

Wastewater has been used for agriculture in the industrialised countries for many years, in particular in dry areas with high water consumption such as California in the USA. Uses included agricultural irrigation (including pasture, orchards, vineyards and harvested feed, fibre and seed crops), landscape irrigation (schools, playgrounds and parks), wildlife habitat enhancement, industrial use (cooling water and, where applicable, processing water) and groundwater recharge. Similarly, wastewater use in Tunisia has been practised for many decades and is now an integral part of the national water resources strategy. Use of the water is seasonal in Tunisia (spring and summer) and the effluent is often mixed with groundwater before being applied to irrigate citrus and olive trees, forage crops, cotton, golf courses and hotel lawns. Wastewater irrigation of vegetables that are eaten raw is prohibited. Similar practices are followed in Kuwait and Mexico. Wastewater is used in aquaculture in Calcutta, and India is the largest user of wastewaters for aquaculture in the world. Ownership of the ponds in Calcutta is in the hands of about 160 city dwellers, who employ nearly 400 families.

In all these cases the protection and promotion of public health remains a priority. Stringent measures are taken to avoid microbial contamination of the agricultural products and the agricultural workers. This protection of public health is of paramount
importance in the development of potential sources of used water, and in
the disposal of wastewater from agro-
industries.

2.8 Watershed management and agro-
industries
The importance of agro-industries
in national development planning is
firm. The need for adequate water
resources, either from scarce new
resources or from re-use of wastewater
is apparent throughout the world
across a range of economic, climatic
and political situations. Two examples
of exceptional projects from Pakistan
confirm that the development of agro-
industries rests on the development
of water resources - the success of
which rests on the participation and
motivation of the communities
involved.

In the Mithawan Watershed
Management Project, the main
objective was to introduce the concept
of integrated watershed management
with the direct participation of local
communities (FAO, 1998). The project
aimed to change attitudes through
social mobilisation in order to improve
the living conditions of the local
people. In this participatory approach,
more emphasis was given to involving
the local people in all phases of
the development process from
identification of problems and
characterisation to implementation.
Grassroots institutions such as village
organizations and women’s
organizations were strengthened.
There was a change in the attitudes
of local people towards sustainable
use and conservation of natural
resources, including water. An
important result was recognition that
local people were quick to take
advantage of the appropriate
technologies that best exploited natural
resources in a sustainable manner.

The Balochistan Watershed Planning
and Management Project was started in
1993 with the aim one of developing
the technical capabilities of the
Provincial Forest Department for
watershed planning and management,
for the preparation of a management
plan for the Quetta Valley, and for
beginning a watershed rehabilitation
programme in the vulnerable and
important watersheds of north-western

Balochistan Province has a hyper-arid
to dry climate with limited surface
water resources. Groundwater is the
main source of domestic water as
well as providing for irrigation
requirements. However in the past,
continuous overgrazing and cutting of
natural vegetation for fuelwood by the
local population and nomads resulted
in the denudation of the catchment
areas. The watershed rehabilitation
activities of the project involved:

• construction of small earth dams,
  ponds and check dams;
• establishment of plantations,
  adopting water harvesting and
  conservation techniques; and
• establishment of rural forests.

This resulted in the recharging of the
ground water aquifer, control of flash
floods and an increased productivity of
fuelwood and fodder.