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1. Architectural elements for the new wholesale market in Chimoio

The new wholesale market includes several complementary areas:

- a wholesale area for perishable products (commercial area);
- a refrigerated logistics area dedicated to the distribution and fractionation of products (logistics area);
- farmers' markets (e.g. in Daloa and Abengourou);
- a maintenance, processing and logistics service area (industrial area);
- offices for quality control, research, digital technologies, training, etc. (administrative area)
- an area dedicated to waste management.

The study of international examples provided inspiration and ideas, both in functional and constructive terms.

1.1. Function and users

The CAAM is the operational market dedicated to physically matching the demand and supply of products, a place where sellers meet buyers to present simple, raw, packaged, processed products and negotiate the price according to availability and quality criteria.

The physical market is the centre of CAAM, around which the other components will develop. It will consist of relocating and transferring all the city's atomised unloading platforms to the new site.

Vendor users:

- shippers of wholesalers,
- wholesalers on unloading platforms,
- collectors
- transformers
- importers.

Buyer customers:

- retailers in retail markets,
- food shops and supermarkets,
- restaurants and hotels
- catering companies
- large consumers (such as hospitals, schools, the army, large factories, mines, etc.).

1.2. Sale pavillions

To meet the needs of operators of different sizes, the building must be flexible and modular, to offer different types of stands, open and closed, responding to different needs (tiles, lorry sales, dry goods storage, perishable goods storage, processing).

Taking into account the location, where the sun and heat have a predominant relevance, especially for perishable

products, the best type of structure is the bioclimatic pavilion type. This concept has been developed, for example, in the new Rabat market offers a ventilated wholesale space. This concept allows

- to accommodate large lorries,
- to provide a central corridor with access for buyers' small vehicles (forklifts),
- to offer sales spaces, from simple tiles to compartmentalised shops,
- respect the wholesale trade from hauliers (large lorries) to small hauliers (supply of small lorries and vehicles).

Traders are protected from rain, sun and heat, and the cold stored by the structure overnight (due to the lower outside temperatures) is released in the morning, helping to keep the sales space cooler even outside the cold rooms. In addition, natural ventilation is ensured thanks to the ventilated roof and some specifically designed openings.

The main lighting is provided by LEDs under the beam. However, in future design phases, some translucent panels on the roof should be considered to ensure some natural light as well.

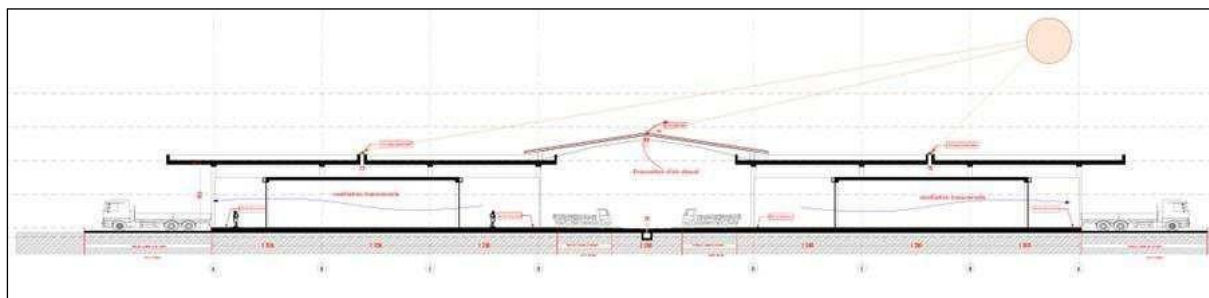


Figure 1 – Bioclimatic pavilion, example (Rabat market)

The sales halls offer total modularity and flexibility in the commissioning of roof tiles, warehouses and offices. Operators vary in size. To have a good chance of success, it is necessary to offer modular spaces adapted to each operator's needs and possibilities. The rear division of one or more tiles makes it possible to have refrigerated or non-refrigerated storage space for wholesale shops. A mixed-use pavilion combines tiled sales areas and individual shops.

Wholesalers must be able to access the following elements, depending on their needs:

- a tiled retail area for displaying products and presenting them to customers for sale during the day
- a private, closed warehouse for storing the product so that sales can be spread over two days. The closed warehouse can be ventilated or refrigerated, depending on the type of product being sold. These shops are also adapted to a clientele of artisanal processors (drying, cutting).

The sales halls are modular and flexible to accommodate both large and small retailers. For small wholesalers, modular spaces called 'tiles' are available. A tile is a simple space made available to wholesalers who only want sales areas coexisting with an exhibition area.

These buildings are inexpensive to build. Tiles can be as small as 25 m² and can be modularised to suit different needs. The tiles work as follows:.

- Wholesaler co-operatives can rent tile blocks to a group of members.
- Buyers can move through the main corridor of the building. Once they have made their purchases, they remove the products, either with the help of conveyors or with the help of trolleys that must be approved so as not to damage the floor.
- Disposal (the buyers' exit) takes place from the loading bays at the end of the building.

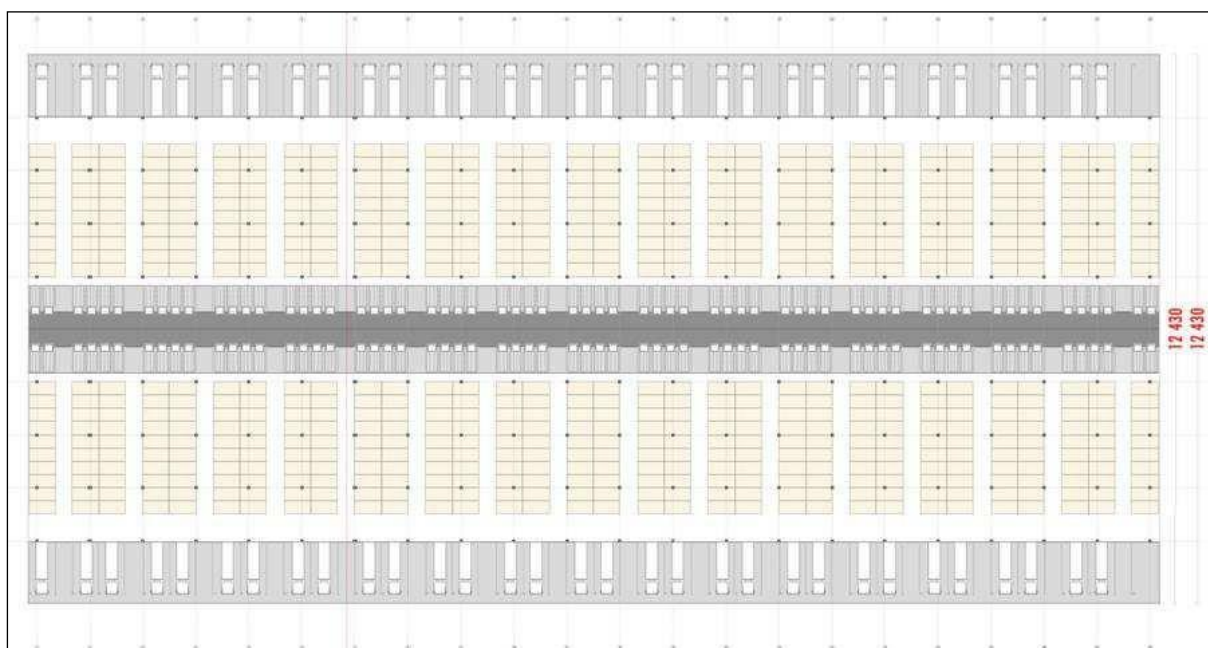


Figure 2 – Example of tiles division, example (Rabat market)

Some permanent wholesalers need a fixed location on the market and limited storage areas. The modular system of the sales pavilions can also be adapted to accommodate the shops of large permanent operators.

The building will have modular surfaces, direct access to the loading bays and dedicated exhibition space in the centre aisle. They will be equipped with partitions and can accommodate cold storage facilities.

These warehouses can also be used by artisanal processors who need small areas to receive goods, process and package an elaborate product. In fact, the warehouses could house small processing workshops. There could be traditional processing for cutting fruit and vegetables, filleting fish or cutting meat. The boxes will be equipped with all the characteristics that the products handled require. In fact, fish and meat have more restrictive operational and sanitary constraints (cold, water, sewage). O armazém logístico

O mercado grossista é dotado de armazéns frigoríficos modulares e adaptados a todos os tipos de pedidos. Estes armazéns destinam-se a , importadores, amadurecedores de bananas, cadeias de supermercados que pretendam centralizar os seus fornecimentos.

1.3. Producers' building

This building makes it possible to concentrate production to supply the consumption areas. Unloading is also carried out by small producers and collected for handling and then storage.

The building's users are wholesale shippers, producer co-operatives, collectors and wholesale collectors.

The reception area must be protected from the weather. The packaging company must have facilities for checking, weighing, labelling and recording the date and origin of delivery of the products. The reception area must be large enough to handle large quantities of products.

The products must be sorted to eliminate non-standard products and manually classified according to size and other different qualities.

Depending on the quantities, types of products and market demand, short-term temporary storage, such as a ventilated room, is required. For highly perishable products, such as vegetables, refrigerated storage (cold room) is the preferred option.

The dispatch area must be clean and spacious to allow for the temporary storage of packaged products and the free movement of loading staff and vehicles.

1.4. Process building

The sectors highlighted in the previous analysis (vegetables, fruit, poultry and eggs, dairy products) will be organised into related business units in the park, focusing on infrastructures and technologies for processing and cold chain management.

Packing plants are sheltered structures where, after harvesting, vegetables are cleaned, sorted, sized and generally packed for sale on the fresh market. Packing plants must have an orderly assembly and flow of produce, which is well managed and supervised.

The packaging company should be divided into three main areas of activity: reception, preparation/packaging and dispatch.

The dirty and clean passages must be clearly separated to avoid contamination of the packaged products, but also to facilitate the separation of incoming and outgoing vehicles. The despatch area must be fresh, clean and spacious, so as to allow for the temporary storage of packaged products and to facilitate the movement of loading staff and vehicles.

The operations carried out in the packing houses include the following: reception, cleaning, selection, sorting, packing, dispatch and storage.

Facilities to improve upstream (commercialisation) and downstream (value chain with the territory) connections are the park's horizontal actions.

The common services (quality laboratories, offices, marketing, technical services, etc.) are installed in a specific space close to the administration.

1.5. Mobile units for on-site semi-processing

The adoption of mobile product processing units could extend logistics to provide services to a larger agricultural area. The mobile units can be moved around and based in a different area each day, according to needs. In this way, producers far from the agro-park can benefit from the same facilities as nearby producers, reducing the time and transaction costs of logistics, with a direct benefit for agricultural products. Thus, the cold chain with processed products starts directly at the production centres that transport value-added products.

Amongst others, some of these mobile units may consist of:

- Chicken slaughter modules, which consist of two separate units for the dirty area (stunning, bleeding, skinning and evisceration) and the clean area (cutting, packing and cold cell).

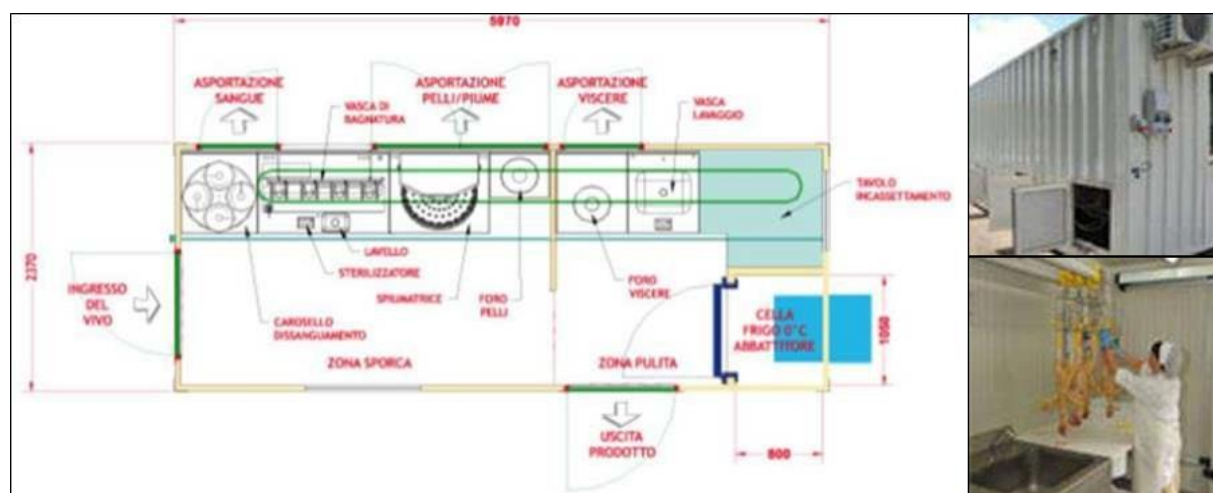


Figure 3– Layout of a slaughter module

- Milk/mini-milk processing plants, which include machines for pasteurising and bottling milk for direct sale or for processing to obtain dairy products and a refrigerated room.

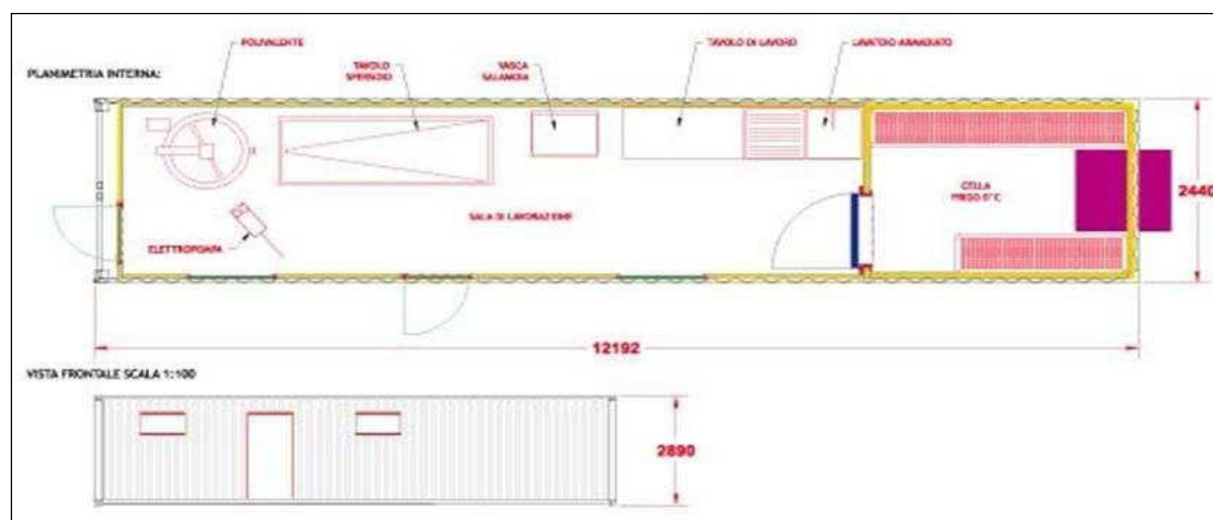


Figure 4 – Dairy processing unit

1.6. General installations

The business units identified in the previous sections need common facilities for energy supply, water management, quality control and food safety.

- Electricity

A regular supply of electricity from the mains or a back-up generator will be needed to provide good lighting. In addition, an energy reserve will be needed for the cold store's emergency power supply. It is envisaged that the energy will be supplied partly through the grid connection as a safety basis, but it could be supplied mainly through renewable sources, generating electricity without producing greenhouse gases, thus mitigating climate change.

One renewable energy option that can be easily implemented is solar panels. These are used to produce hot water and electricity (photovoltaic). Both systems have the advantage of being viable on both a small and large scale; however, production depends directly on solar irradiation (it only occurs during the day) and energy can only be stored with the addition of external devices (i.e. batteries).

Another natural source of renewable energy is wind. However, this is more complicated to install and requires larger systems to be able to utilise wind energy.

- Sanitising water for processing

Large quantities of drinking water are needed to wash the products and clean the packaging facilities after use. It is important that attention is paid to the sanitary quality of the water. Processing and handling facilities must be easily cleanable and must be designed and built in such a way as to prevent the entry or harbouring of parasites or other sources of contamination.

The provision of potable water, steam and ice is imperative for the hygienic processing and handling of food. Compliance with the appropriate regulations and standards must be verified through testing programmes. Water treatments (such as chlorination systems, ozonation, demineralisation, filtration, etc.), if applied, must be maintained. Appropriate water temperatures and pressures must be ensured in the processing areas.

The best solution for treating effluent water in food chain processing is biological, which provides the best results at the lowest operating cost. Depending on the loads and the need to reuse the water, we use a wide variety of specific techniques, such as biofiltration, filtration with special machines or physical-chemical treatments for incoming and effluent water.

- Waste disposal

Waste and rejected products from the fresh produce production line must be disposed of in a special area outside the packing house in order to prevent the spread of post-harvest pests and diseases. Waste must not accumulate in and around the packing house. The washing water used to clean the products must be drained into a designated area away from the packing house.

Biogas for anaerobic fermentation is useful for transforming organic waste into energy. Biogas can be

produced by anaerobic digestion with anaerobic bacteria, which digest the material in a closed system, or by fermentation of biodegradable materials. The waste management area should have a small biogas plant next to the composter. The release of energy resulting from these processes allows biogas to be used as a fuel for any heating purpose or as a gas engine to convert gas energy into electricity.

- **Quality system implementation laboratories**

An internal laboratory must fulfil the role of a facility for the application of quality systems and internal auditing, while external laboratories (provided by companies outside the CAAM) must serve as external control and certification. The presence of a laboratory is important in a CAAM to support the application of international food safety quality standards and GlobalGAP. The laboratory must obtain ISO 17025 Lab certification and Good Laboratory Practices (GLP).

With regard to food safety standards, Hazard Analysis and Critical Control Points (HACCP) is a preventive system designed to ensure that all food safety production is carried out in accordance with the Codex Alimentarius International Food Standards. The aim of the HACCP system is to prove that products are manufactured in a way that is suitable for the health and safety of consumers, avoiding three sources of danger: biological hazards (such as salmonella and e.coli), chemical hazards (such as chemicals used in agriculture or food additives) and physical hazards (foreign objects in food, such as pieces of glass or plastic).

- **Personell facilities**

All facilities for employees (canteen, changing rooms, communal spaces, etc.) can be located in the same building, but each unit must also include facilities for staff (changing rooms and washing facilities).

It is very important to keep clean areas separate from dirty paths in order to avoid contamination, especially in processing areas.

1.7. Marketing information system

A marketing information system (MkIS) is designed to support marketing decision-making and improve knowledge and transparency in the market. An MkIS is designed to bring together disparate data elements into a coherent body of information, providing methods for interpreting the information that the MkIS provides in order to help managers make decisions at all levels: strategic, control (or tactical) and operational. The internal records that have immediate value for marketing decisions are: orders received, stocks and sales invoices. This helps to control and categorise many parameters, such as product types, size, average value and/or sales volumes. As well as helping managers, an MkIS also helps to standardise prices and keep costs and volumes traded on the market under control.

1.8. Innovation

Weak extension and advisory services limit the ability to reach small farmers with agricultural innovations and

market opportunities. Extension and rural advisory services are crucial for putting farmers' needs at the centre of rural development, ensuring sustainable food security and poverty reduction, and dealing with risks and uncertainty. Knowledge-sharing mechanisms should focus on critical areas, including the protection of natural resources, productive agricultural processes, product development, marketing skills, nutritional needs and family health. Agricultural extension is the function of providing rural communities, in a systematic and participatory way, with knowledge about agronomic techniques and skills, according to needs and demand, with the aim of improving their production, their incomes and (implicitly) their quality of life. Extension is essentially educational and aims to bring about positive behavioural changes in farmers.

Agricultural extension consists of:

- the dissemination of useful and practical information related to agriculture, including improved seeds, fertilisers, implements, pesticides, improved cultural practices and livestock farming
- the practical application of useful knowledge to the farm and household.

Research institutions focus on the technical aspects of generating useful technologies, while extension focuses on the acceptance and adoption of these technologies by users. The two, research and extension, must be functionally linked.

Agricultural advisory services are part of a wider knowledge and innovation system and due attention is paid to the links between advisory services and other components of the knowledge and innovation system in the agricultural sector.

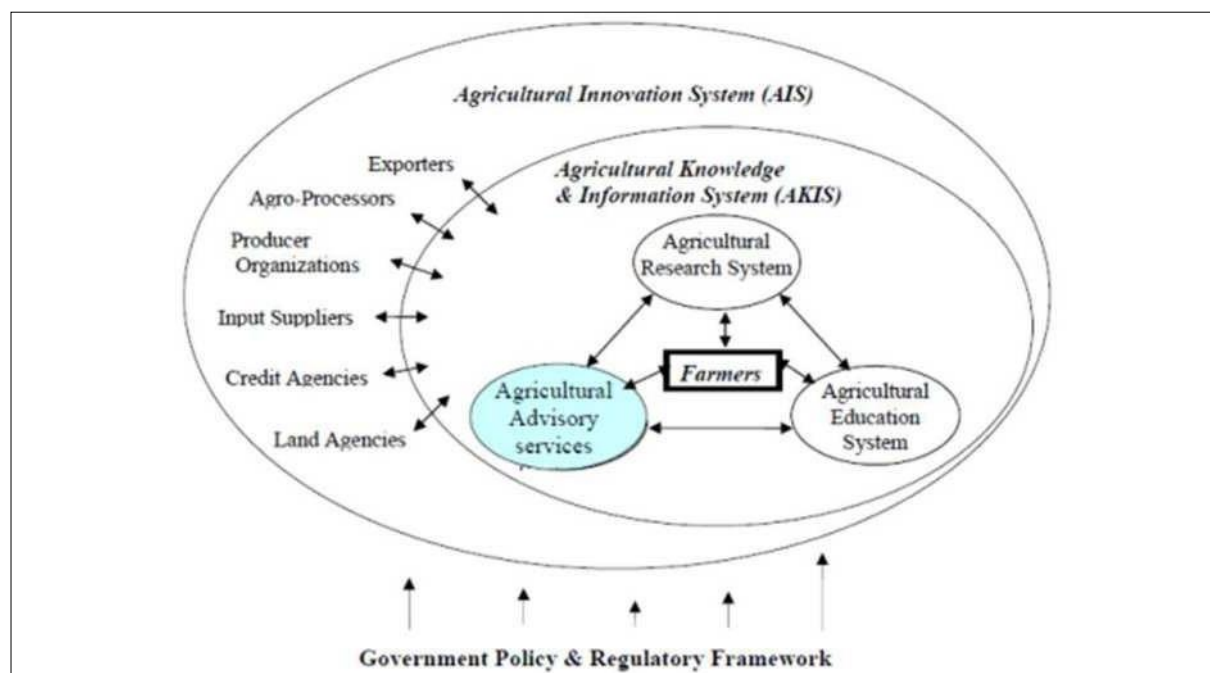


Figure 5 – Agricultural Counselling Services as a Component of an Agricultural Knowledge and Innovation System. Source: Adapted from Rivera et al. (2006)

1.9. Human resources

The AgroPark should also provide innovation to the rural area through the skills of operators, workers and farmers. The innovation systems framework views innovation in a more systematic, interactive and evolutionary way, through which networks or organisations, together with the institutions and policies that influence their innovative behaviour and performance, introduce new products and processes into economic and social use. Emphasis is placed on promoting active interaction between the various players and strengthening the human capacity to innovate continuously in order to adapt to changing social, economic and environmental conditions.

The park plays the role of innovation platforms for agricultural research in order to generate research results that respond directly to the needs of small farmers. Structure is conceptualised as the arrangement of individuals into groups and groups into networks, with special emphasis on the patterns of interaction and information exchange between these components.

Main human resource development activities:

- Workshop training: selected companies take part in workshops organised by the park.
- Distance learning: management modules suitable for the agri-food industry are provided according to the needs identified. *Visitas no terreno: visitas a empresas agro-alimentares num país à sua escolha para aprender sobre aspectos relevantes da produção e comercialização agro-alimentares e explorar oportunidades de negócio.*
- Field visits: visits to agri-food companies in a country of your choice to learn about relevant aspects of agri-food production and commercialisation and explore business opportunities.
- Agronomic forum: between the harvest and the next planting season, the park brings together managers from participating companies to establish contacts and explore trade opportunities and other collaborative initiatives.
- Student placements: the agropark, in collaboration with universities and research institutions, facilitates placements for university students to respond to specific management and commercialisation challenges.

2. Construction techniques and examples

At this stage, the buildings have not yet been designed in , however, some general notes can already be emphasised. In order to optimise costs and the construction schedule, the best option is to follow building techniques and choose materials typical of the area for structures similar to this project.

2.1. Administrative, directional and common buildings

The simplest and easiest way to build these structures <civil> is with brick walls, using mainly clay, wood and local laterite. Choosing this technique will ensure that you can build on a lower budget and, in the future, that it is easy to maintain. Taking into account the climate zone, it is good to build structures with a ventilated roof, to help keep the building cooler in the hot season and prevent damp inside the structure in cold periods. Together, these

mechanisms ensure better thermo-hygrometric behaviour of the roof, resulting in energy savings. The ventilated roof also guarantees better indoor comfort. An innovative example of this type of structure is the Opera Village school, built in Laongo (Burkina Faso) by Francis Kéré (Kéré Architecture).

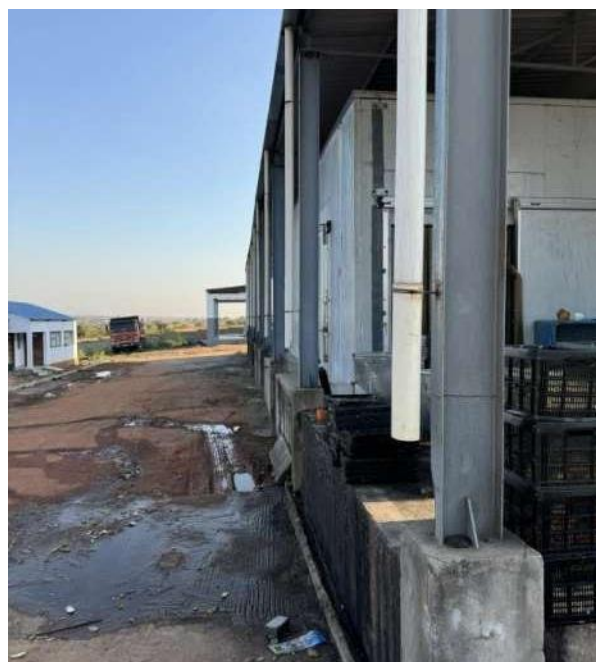


Figures 6 e 7 - School in Opera Village, Laongo (Burkina Faso), Kéré Architecture. Source: kerearchitecture.com

2.2. Process buildings and selling pavillions

These buildings form the core of the project, serving the main functions of the supply chain: collecting, storing, processing and selling agricultural products.

The key is to create modular buildings that can be extended when transaction volumes increase, with a flexible structure that can be divided up and adapted to different needs. A modular metal grid structure with sandwich panel infill is the best solution for achieving the desired results: it provides speed of construction on a reduced budget, allows flexibility over time and guarantees ease of maintenance and, if necessary, replacement. The metal grid structure allows internal partitions to be fitted as required, without compromising the stability of the building. The roof, built on a lattice grid, rests on the metal pillars and is independent of the walls.



Figures 8 e 9 – Pedro Paulino company, producers of fruit juice and pulp

When necessary (i.e. in cold rooms), the sandwich panels can be fitted with the necessary thermal insulation to guarantee the highest standards of fresh produce preservation. The metal surface of these panels, which is low-maintenance and easy to clean, makes it possible to achieve the required hygiene and sanitary standards.

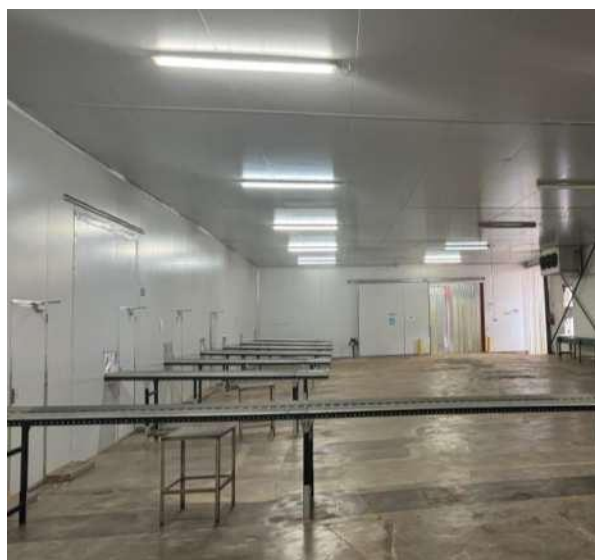
Garages, workshops and other public utility buildings (e.g. for waste disposal) can, with the same system, be built without walls, becoming, in effect, just roofs that protect from the elements.

2.3. Operative units, processing modules

The construction of processes included in the CAAM, as well as those that can be built locally in HUBS, where second quality products are not standardised, must be able to contain different operating units, according to the products treated. In addition, it should be borne in mind that it is extremely important that the different processing lines are separated from each other to avoid contamination.

Therefore, the best option is to build boxes within a box: install prefabricated modules inside the building in order to achieve segregation, modularity and flexibility.

These boxes are made up of sandwich panels to ensure proper climate control (the panels are insulated when necessary) and to maintain the hygiene and sanitation standards required for the health of the spaces and the preservation of the products.



Figures 10 e 11 – Westfalia Fruit, fruit wholesaler

2.4. Other spaces to be included for social activities

This project aims to serve the supply of agricultural products, reinforcing the strategic value chains already identified in previous reports, but also to improve the social life of the communities that will benefit from the existence of the wholesale market.

All of this translates into actions aimed at inclusion (jobs for women in the community), improving the entrepreneurial dynamics of small producers (easier access to credit, therefore banking), and social well-being (healthcare and

support spaces for workers' families), as well as areas with leisure facilities and outdoor activities. These spaces were seen as a potential for expansion beyond the functions more closely linked to the business activities of the agri-food supply chains. Therefore, the following three architectural sketches do not go into detail about these extra spaces, but consider them as part of the infrastructure to be planned.