MALI TRIP REPORT

TRANSFORMATION OF MANGO FRUIT

Submitted to the Centre Agro-Entreprise (CAE)

Mali Sustainable Economic Growth

December 7 - 15, 1999

USAID Contract No. 624-C-00-98-00012-00

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MR. EO/NM/657.99

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Summary

The design of a CAE strategy to support mango fruit transformation in Mali is built on an in-depth analysis of this sector with national production exceeding 100,000 tons. The objective of this consultation is therefore to analyze the current status of fruit transformation in Mali, to examine various transformation options which may be adapted to local conditions and to make a series of recommendations regarding the main lines of activity to be supported.

It is worth noting that the agro-food transformation sector in general, particularly fruit and vegetable transformation (and even more particularly the transformation of mango which is one of main raw materials) currently receives **very little attention**. Making a fruit transformation sector a dynamic one requires adequacy of the products to local and export market demands.

At the local market level, numerous international consultants working for various international institutions frequently work on the fruit and vegetable sector while privileging the informal sector (women's groups, regions, various projects). Numerous and diversified transformation activities are thus carried-out which help a few people produce dried goods, jams or juice with uncertain marketing opportunities. We do not believe it worth working in this sector if there are no accompanying measures for these projects through access to credit (providing funds for fruit purchase, packaging and basic production equipment). Better utilization of Training Centers, such as the center of the "Laboratoire de Technologie Alimentaire - LTA" (food technology laboratory) financed by CAE, by small entrepreneurs in the form of equipment leasing, would improve the effectiveness of small businesses.

However, there are no operating facilities in Mali for the production of mango juice or other fruit juice: the Yanfolila factory is out of operation, SOMACO is being liquidated. The country imports most of its fruit juice form neighboring countries. **Support to a private entrepreneur who wishes to set-up a juice production facility is recommendable**: a minimum of 150 liters of juice per hour from mango, but also tamarin, orange, bissap and ginger. Packaging for local consumers may be done with aluminum bags (the Doypack type), or with Variopack type boxes, as both packages tolerate hot filling.

The requirements to reach the **international market**, include uninterrupted supply of constantly good quality products at competitive prices. The production of concentrated mango juice and frozen pulps is faced with the following constraints:

- a severe lack of technical skills (concentration technique by membrane and coupling to enzyme liquefaction, for example),

- a competitive cost price (considering the fact that the market for mango pulp is a narrow one in Europe which is dominated by Indian exports), which relies on the establishment of an uncertain cold chain, if mango pulp is to be exported via Abidjan.

- too many varieties of mangoes with different characteristics in terms of color, aroma and fiber content, which does not help ensure uniform quality for large scale pulp production.

Likewise, it is difficult to envisage exportation of finished goods (juice, jam) in the **sub-regional market** due to packaging constraints (price and availability).

Considering the lack of transformation industry, we think that dried mango is the only good which has export potentials because of the demand in the international market, but also because of economic, financial and technical (low technical level) constraints. Considering the stake in the market, the critical size of such a facility should allow for a minimum production of 50 to 60 tons of dried fruit per year.

Based on our visits during this mission, two options may be considered. Production may be achieved within a group, which would operated like the Dryers' Circle in Burkina-Faso: a GIE, the "Groupement des Sécheurs du Mali" (the Dryers' Group of Mali), was established. It should be noted that such an enterprise will take 3 to 4 years to become fully productive, due to the size (very small) of individual enterprises, poor organization, the personal character of members and difficulties in setting-up such an organization to ensure homogenous product quality.

Therefore, it is rather recommended to support an industrial facility which can process about 5 to 6 tons of fresh fruit a day (or 200 kg of dried fruit). Mangoes may be processed during 3 to 4 months, depending on production areas, or even 5 months if early or tardy varieties are taken into account, or if a cold room is utilized. The Kent variety is the most recommendable because of its high "brix" content, however, the grading gaps for the Amelie variety may be valued. The amount of funds needed for such a facility urges to envisage year round operation, which would require other products: okra, onion, bissap, etc. As for papaya, only the Solo variety may be considered: the current local variety is of little interest for drying activities.

Dried mangoes may be packaged into 10-15 kg bags for European importers (Worlee, Mister Mango, Navimpex, Boyere, etc.) first, before envisaging packaging into 100 g bags for the local market.

Installation should be planned with gaz heating and located in an electrified place to facilitate conservation. Identification of a serious enterpreneur, establishment of such a facility involving work place hygiene issues and staff training, are imperative requirements to obtain quality products. These are aspects for CAE intervention, with more potentials for success.

The following step should concern the identification of local partners who would be likely to overcome the above mentioned constraints, and technical and economic feasibility of such facilities, for both juice and dried fruit.

1. Introduction

The Centre Agro-Entreprise (CAE), being seriously involved in the development of transformation sectors, mainly for mango in Mali, wished to carry-out further reflection on assistance to be envisaged in the mango transformation sector.

A first mission carried by J.Y. Rey for Cirad-Flhor on June 2 to 6, through field observations and interviews with various actors, helped propose action in the fresh mango sector in Mali, in order to develop sustainable processing of this fruit.

Consolidation of this sector requires an agro-industrial approach which helps value grading gaps on the one hand, and on the other hand, agro-industries which respond to local and export market demand.

Therefore, the purpose of the mission carried-out in December 1999 was to analyze the local agro-industry component and to propose forms of support that would help set-up local agro-industries adapted to targeted markets and to local mango production and eventually other fruit and vegetable.

2. Current status

2.1. Mango and the production of fruit and vegetable in Mali

2.1.1. Mango

With a production level of about 200,000 tons of natural mangoes and 50 to 60,000 tons of grafted mangoes, Mali is far behind India (9 million tons), Pakistan or Thailand (more than 600,000 tons each), or Brazil which produces more 700,000 tons of mangoes.

For non-grafted mangoes, the main variety identified are the "Sabre", Mangotine" and "Mango vert" varieties, which are generally small fruit weighing 120 to 150 grams with fibrous pulp and skin containing high rates of terebenthine oil.

In general, they are produced early (March/April) and consumed locally and therefore offer little commercial transaction opportunities. Physical characteristics of these fruit and their diversity make them most appropriate for juice production for the local market.

For grafted mangoes, production is estimated at 50,000 tons and mainly includes the following varieties:

- Zill and Irwin which are early varieties (March/April) with medium grade fruit (250 to 300 g);
- Amélie, Smith, which medium grade fruit (200 to 300 g) and may be harvested in April/May/June;
- Kent which ripens in May/June with 600 to 700 g fruit;
- Palmer which is a semi-tardy variety (June/July);
- Keit and Brooks which are tardy varieties and respectively yield large and medium size fruit.

Other varieties such as Valencia, Divine and Maya, which were characterized by the LTA, seem to be very interesting both in terms of taste and color.

Therefore, it may be noted that, all varieties combined, mangoes may be harvested from March to August, or for about 6 months. Of course, maturity and harvesting periods are slightly different, depending of the production place (Bamako/Sikasso for example with a gap of 15 days to 1 month).

The IER (Institute of Rural Economy) reports that there are more than 80 varieties in the control-nurseries of the local research institution.

Export marketing concerns part of grafted mangoes, mainly the Amélie and Kent varieties.

Exportation of these fruit require a whole set of logistics for collection from small producers, grading within various packaging centers, the main one we visited is the AOM facility in Sikasso.

It is obvious that any grading for exportation results in important grading gaps estimated at about 15% per ton.

Valuing at the industrial level should therefore take into account these main grafted varieties, closeness of fields and existing logistics in order to reduce the operating costs as much as possible.

In fact, traditional harvesting and transportation methods (often in bulk) do not allow for long time conservation of the product, which urges farmers to harvest unripe fruit. Because of this, it has often been noted that post-harvest losses are generally high, which makes us believe that an industrial facility will rely only on fruit harvested in a maximum of 50 km radius.

2.1.2. Other fruit and vegetable

We deemed it necessary to point out the need to establish industrial facilities which may process both mangoes and other fruit and vegetable that are likely to be economically interesting. These include mainly:

- Onion:
  Onion consumption is high and there is demand within the sub-region and in the Sahel. Onion drying (as the demand concerns dry onion) may perfectly be done with facilities designed for mangoes.

- Okra:
  There is a high demand for dried okra within the sub-region to be used as ingredient for sauces.

- Bissap:
  Very widely used in the beverage industry at the regional level, dried bissap may prove to be an interesting crop.

- Papaya:
  The currently available variety is not much recommended for dried papaya production: there is market demand only for the Solo variey with red flesh.

2.2 Mango Transformation

2.2.1. General information

Before getting to the heart of the matter, it is important discuss mango ripening and conservation issues after harvest.

If the fruit are to be consumed fresh and on the spot, the ripening may continue while they are not harvested. On the other hand if they are to be exported or transformed, it is essential to know the harvesting point which allows the fruit to ripe properly.

The maturity degree at harvest will have impact on the quality of transformed products and the quality of fresh mangoes in export markets.

4 stages are considered around the harvesting point:

* Stage A: the shoulders of the fruit are at the same level as the insertion point of the peduncle and the color is olive-green.

* Stage B: the shoulders are higher than the insertion point of the peduncle and the skin is olive-green.

* Stage C: the shoulders are higher than the insertion point of the peduncle and the skin color lightens.

* Stage D: the flesh softens and coloring develops.

Fruit harvested at these four stages ripens normally. However, stages B and C yield fruit with more perfumed flesh and better taste. Stage B is most appropriate for long distance shipments.

In fact, these stages are mostly useful for Indian varieties.

Three physico-chemical characteristics are to be noted and adjusted to the relevant variety and region:

* The dry soluble extract: between 12 and 15^{o} Brix,
* Density: between 1.010 and 1.020,
* Resistance of the flesh to pressure: between 1.75 and 2 kg/cm*

Once harvested, the mango should be conserved so as to guarantee proper maturation until it reaches foreign markets or the transformation workshop.

For the storage and ripening of mangoes designed for transformation, a conservation period of 2 weeks is recommended at 12^{o}C for green fruit and 4 weeks under temperatures ranging between 1 and 3^{o}C for ripe fruit. It appears that although the skin darkens rapidly at these temperatures, the

pulp keeps its quality.

In order to avoid weight losses, it is necessary to maintain a high level of relative humidity: 90-95%. A 30°C temperature is optimum and the usage of ethylene helps maintain uniformity of this temperature.

Thus, knowledge and monitoring of the ripening stage and conservation parameters of mangoes are crucial for optimization of technological processes for transformation and final product quality.

Fruit that have reached a proper ripening stage will be submitted to various processes, depending on their quality, while green (unripe) fruit may be utilized in a specific way, (see the functional schema below).

1. Transformation of green mangoes

They are essentially used in the preparation of condiments which are well-appreciated in English-speaking countries: chutneys and pickles.

- **Chutneys**
  There are various types of chutneys, ranging from the softest to the strongest; the soft one is mostly exported, the strong one contains more hot pepper.
- **Pickles**
  There are 4 kinds: with oil, with salt, with lemon juice and with vinegar.

2. Transformation of ripen mangoes (reference to the summary report on this subject by Mrs. Champ, in relation with Cirad-Flhor).

* **Frozen cheeks and mumps**
  These are obtained after slicing very high quality ripen mangoes.

* **Slices, cheeks, syrup pearls**
  This operation requires quite firm fruit and adapted varieties: among Indian varieties, the best ones for export canned mango include the Alphonso, Banganpalili and Dashri varieties.

* **Candied, semi-candied and dehydrated mangoes**
  Some definitions and processes:

* **Candied fruit**
  These are obtained after soaking quarters or entire fruit in more and more concentrated syrups (the water within the fruit is progressively replaced by sugar syrup). The sugar concentration in the final sugar syrup should vary between 66 and 67%.

* **Semi-candied fruit**
  The process is the same as for candied fruit, i.e., it corresponds to enriching the fruit with sugar by soaking it in concentrated solutions, however, the final dry extract is 55-65%.

The objective is to obtain fruit that are less sweet than candied fruit. Therefore, the immersion time in the sugar syrup is shorter.

Drying at 60-70°C for 20 hours up to a final humidity rate of 16% is necessary.

* **Dehydrated fruit**

  Recently, a new range of fruit with lower sugar content than semi-candied fruit has appeared in the market upon request of certain clients such as Germany and Japan. These fruit are more tasty but have less soft texture.

  The process used to prepare them is either dehydration or hot air, by convection system (dryer with prunes), at low temperature (with, if possible, air dehumidification) or by osmotic dehydration or dehydration through differential diffusion. This operation essentially aims at extracting water from the product through immersion in concentrated solutions. The concentrated solution is not compulsorily sugar, it may also be NaCI, sorbitol, or glycerol.

  This last variant, associated with supplemental moderate drying helps obtain intermediate humidity products which may be conserved for several months at the ambient temperature.

  The interest for these dehydrated products is that they keep a good taste and color, without any alteration, because they were not exposed to high temperatures for long periods, such as in the case of other traditional water elimination processes.

* **Pulp (or purée)**

  The pulp yield exceeds 50%. For later uses, pulp may be frozen, pasteurized, concentrated or dried. The pulp is well conserved with 0.1% of ascorbic acid, 0.5% of critic acid (which helps monitor browning) and 5% of sugar. The addition of 0.1% of monosodium glutamate is reported to significantly improve the taste of slices and pulps. The presence of air is bad for product quality.

  Commercial standards in the USA include:

Brix	15 to 18
pH	4 to 4.5
Color	orange-yellow
Flavor	good, without bad taste or smell
Flaws	almost without flaws
Total flora	50,000/g maximum frozen
Salmonella	0
Moistures	less than 10% (through Howard counting).

A European standard for mango pulp is being finalized.

* **Frozen pulp**

  Freezing helps conserve the pulps for the preparation of sorbets, nectars, beverages, yogurts and eventually jam and marmalades. It has the advantage of conserving the aroma. Rapid

freezing and storage at 18°C or less are required to obtain quality products.

The pulp may be concentrated by cold or by evaporation with reservation of the final aromatic quality. Concentration is easier with lightened juice or in the liquid phase of the enzymatic macerated pulp. Stability of the pulp depends on the final concentration degree which, in turn, depends much on the variety.

* **Dried pulp**
It is also called "mango skin". In this case, mango drying requires an optimal drying temperature of 70°C or 70°C at the beginning and 55°C at the end of the drying process. It is desirable to treat the pulp prior to drying.

* **Jams and marmalades**
Jams are made of entire or sliced fruit, cooked in sugar; marmalades are made of mashed fruit which is cooked with sugar. There are several recipes depending on the variety used, each variety having different sugar, pectin and acid contents. In general, the disadvantage with mango is its low acidity.

* **Nectars - juice and beverages**
They are made of mashed fruit or thin pulp mashed while fresh or frozen.

- **original juice**, this is homogenized pulp which yields an
undrinkable cream, as it is too pulpy and tasteless if sugar and acid are not added.

- **Nectar** is obtained by adding water, sugar and original juice acid. It may contain 50% of pulp: typical nectar: 25% of mashed fruit, 15° Brix, 3.5 pH.

Current techniques for obtaining mango pulps may utilize liquefaction with pectolytic enzyms. Treatment with enzym does not cause major changes in the aromatic profile of the Amélie variety. The interest of this treatment lies in its high yields (yields increase by 20 to 70%), less thermal treatment requirements and simplicity of necessary installations (pulpers and vats).

* **Juice/lightened juice**
One may include original juice in the composition of numerous tropical mixtures which have naturally acid taste (pomelos, lemon juice, etc.). In this case, it is useless to dilute with water, as pure fruit juice is obtained. To obtain clarified juice, part or all of the pulp should be eliminated. Preparation of a lightened juice is achieved adding enzym to mashed mango pulps.

* **Fizzy drinks**
Sweet acidified water saturated with CO2 (at 2 kg) is added to the original juice.

* **Fermented drinks** (mango wine and vinegar)
A mango wine may be prepared by culturing the mashed fruit with yeast obtained from the pulp recuperated from the nucleus and remains of too much ripen tropical fruit. To produce vinegar, it is necessary to distil the ethanol obtained from alcohol fermentation. One may

obtain crude alcohol at 80^{o} and then a rectified alcohol at 93^{o} after centrifugation and distillation of wine and mire.

* **Mango powder**
May be obtained after lyophilization or by drying through atomization. Various processes are used to reduce viscosity of to help obtain a final product that has approximately 1% water content.

* **Sub-products:**

*** Utilization of the almond**: relative volume of the nucleus varies a lot. Depending on the varieties, it may range from 6 to 25%. The almond contains:
- 8.5% of protein
- 8 to 12% of fat
- 73% of carbon hydrates (mainly starch).

The nucleus may have several usages: oil is extracted from the almond and utilized in soap making. The starch is also extracted: dry almond has sufficiently starch and protein contents to serve as animal food.

Butter contained in the nucleus seems to have a promising future and might even compete cocoa in the preparation of chocolate.

Dried, powdered and softened nuclei mixed with wheat is reported to be used in the composition of bread.

*** The skin**: it represents approximately 10% of the weight of fresh mango. When dried, it may be used as animal food.

Conclusion

There is a wide range of transformation goods made with mango, however, it should be noted that 1,000 varieties with different composition, maturation and behavior may disturb knowledge which helps determine adequacy of the variety to the product selected.

Based on the technological process adopted for transformation of mangoes, it is of paramount importance to know both the variety to be processed, the ripening stage at harvest and conservation conditions.

Controlling these parameters is essential to optimize yields and obtain quality products. The establishment of comprehensive and systematic "identification sheets" including the composition and reaction to conservation conditions as well as different processing technologies is usually recommended to help mango transformation facilities.

2.2.2. Some economical data

In the international market, mango pulp is sold at about US$1,300 per ton in aseptic or frozen form. For the local market, factory delivered fruit should be sold at a maximum of 30 CFA.

For dried mangoes, the FOB price delivered in Europe varies between CFA 3,500 and 4,000 CFA per kg and between 4,000 and 4,500 FCFA per kg when marketing is done by bound organisms. Currently, data from Burkina-Faso, where producers, organized into a "Dryers' Circle", perform marketing under the aegis of CLARO, under the bound market agreement.

From Togo, dried good sales (about 100 tons per year) produced at an industrial scale are performed with the "bio" label and seem to be designed for "Mister Mango", an importer who is specializing in the dried mango sector and is settling in Burkina-Faso.

In both cases, the price of factory delivered fruit does not exceed 35 CFA which, considering yields, which results in a raw material "cost" of: 35 X 15 = 595 CFA, considering yields (17 kg of fresh mangoes for 1 kg of dried mango).

2.3. Local agro-industry

2.3.1. The facilities

To meet local market needs, i.e., consumption in big cities, there are no factories operating currently. In fact, industrial factories should be closer to production places, either by preparing semi-transformed goods to be re-processed (packaging) near consumption areas, or by preparing and marketing edible goods that are affordable to the low purchase power of targeted consumers. Only two factories were planned for in this context:

* **SOMACO-S.A.** ("Société Malienne de Conserve"), in Baguineda (40 km away from Bamako). The company has:

- a line of fruit juice and concentrated juice capable of processing 2.5 tons/hour for tomatoes, making about 400 kg of double-concentrated (at 28%),
- a juice and nectar preparation line (500 liters/hour) packaged into "Doypack" bags (the cheapest package in the current market...).

This line may also process goyava, tamarin, mango and papaya. This factory, with reach a production record of 200 tons per year, experienced serious problem with row material supply (especially tomatoes).

Currently out of operation, it may be difficult to repair and made functional, considering the positions of various shareholders.

* **COOTRAVA** ("Coopérative de Transformation des Produits Végétaux et Animaux") whose trademark is "Yanfojus", seems to be well-known by consumers.

This factory, located in Yanfolila (100 km away from Bamako) and established in 1996 with support from ADF and CDI in Brussels, is currently not working due to a lack of electrical connection. It is capable of producing 500 "Doypack" bags with a capacity of 25 cl of orange juice per hour. Additional equipment needs to be secured in order to peel mangoes (5 million CFA).

2.3.2. The handicraft sector and projects

We deem it essential to briefly present various projects targeted in order to draw some conclusions on this type of operation, which is in the informal and crafts sectors.

* **The handicraft sector: Jam making: "Le Verger", "La Maraîchère"**

These are facilities which prepare various local fruit jams by cooking with unprotected fire in difficult conditions:

- lack of running water and electricity at the workshops,
- packaging in glasses recuperated in the market,
- strong imagination to conserve pulps and thus extend preparation periods,
- no access to credit, inadequate investments.

However, one should recognize the strong motivation of these two craftsmen who are operating in difficult conditions while keeping a certain level of hygienic practice. Sometimes, they may produce as much as 400 bottles weighing 450 g per day. In fact, it is impossible to obtain smaller recipients in Mali and no individual craftsman alone has the means to import a container of pots and leads, as is frequently the case in Abidjan.

Therefore, competition is very strong with goods imported from other countries in the sub-region.

However, it would be useful to allow these craftsmen to use the pilot/demonstration equipment located at the LTA, this would improve the quality of their products.

* **The projects**

The USSIS project, which started with GTZ (Germany) cooperation, mainly dries meat with a solar dryer installed on the roof of a building in Bamako. This project is faced with inadequate hygiene issues and lack of facilities to develop and process mangoes in a rational fashion. The ISCOS/UNTM project, located in Koutiala (near Sikasso) and established as a result of cooperation between Italian and Malian workers' unions, was supposed to produce dried fruit, which it did only as a sample due to inadequacy of the drying device that would rather fit for university students.

It is a pitty that this installation cannot be repaired and re-started.

2.4. Local supports opportunities

In order to envisage establishment of agro-industries, it is usually necessary to have local support opportunities, in terms of quality control laboratory, testing halls and staff with food industry engineering profile.

Such staff should be able to bring a certain logic in the resolution of problems that arise when setting-up facilities and exporting food products; mainly those made of fruit (diversity of raw materials, evolution of standards and schedule of conditions, etc.).

2.4.1. Public institutions

The CAPES report, "a study on the fruit and vegetable sector", dated July 1986 and the UNIDOA report dated May 1997 on "designing an action program for the transformation sector" mention the following:

- the Ministry of Rural Development,
- the Minister of Industry,
- the Ministry of Finance and Commerce
- the Prime Minister's Office/Prime Minister
- professional organizations:
    - . the fruit and vegetable exporters' group,
    - . the agricultural product transformers' group,
    - . the regional chambers of agriculture.

We will not mention the details on the types of support such institutions may provide to the private sector, **as this is very limited.**

2.4.2. Other supports

Mainly this concerns the **Food Technology Laboratory**, located in Bamako, which has low technical level testing equipment and which organizes training sessions. Although it continues to respond to transformers' needs, it needs laboratory equipment, technical staff and operating budgets in order to be able to meet various promoters' needs.

3. Recommendations

3.1. Priority action lines in the local market

3.1.1. The products

As already mentioned (paragraph 2-3-2), various craftsmen (groups of craftsmen) transform fruit or vegetable for the local market. The main products made from fruit are jams, syrups, juice or nectar and dry fruit.

There is almost no outlet in the local market for dry fruit because of their taste and the fact that they are not part of local food habits and are expensive. Probably, jams are not widely consumed products at the local level either and are expensive too (FCFA 950/50 g in the supermarkets).

On the other hand, drinks made of fruit, mainly nectars in the case of mango, are certainly the main transformation aspect to be privileged, especially in Moslem-dominated countries, despite failures recorded in this sector.

Calculating on the basis of 35 CFA per kilo of mango, a pulp yield of 50% and 35% of nectar (according to European norms), one obtains approximately 23/25 FCFA as raw material cost for one liter of nectar, in addition to the price of sugar (and water).

One may roughly estimate a cost of 75 CFA per liter for the equipment depreciation, and the cost of energy, making a total of 100 FCFA/liter, excluding salaries and packaging.

It is obvious that the cost of packaging is primarily important for the sustainability of this type of project. An accurate feasibility study should help calculate a cost price based on the type of packaging adapted to the clients.

For comparison, the costs of rare drinks or nectars made from mango observed in supermarkets were 590 CFA/200 ml (originating from Spain), 315 CFA/250 ml (from Arab countries) and 200 FCFA/250 ml (from Mali?).

3.1.2. Types of enterprises

The production of fruit juice requires a minimum of equipment and infrastructure; as an example, various fruit juice workshops which we know well represent an investment of about 50 million CFA, and have production capacities of about 150 liters/hour.

There it is necessary to identify promoters who are able to successfully implement such a project, on both financial and technical sides as well as in management.

This excludes right away those craftsmen we met with and who, despite evident motivation, cannot manage this type of project. On the other hand, among various promoters we met during our stay, some have already contacted equipment manufacturers, have already thought about packaging issues, etc., and **may be supported by CAE in their efforts.**

3.2. Priority action lines at the international level

3.2.1. The products

*** Dried products**

We believe these are the main products to be privileged, as there is considerable demand for dried mangoes in the market. These are generally dried mango strips for which there are tentative standards in order to guarantee an internationally recognized quality standard.

The "bio" label is an improvement, but imposes constraints for certification at both production and drying levels: it is not advised to dry "bio" products and non-bio products later which may contaminate "safe" products. The "bio labeling" seems to be difficult to set-up at the production level due to the lack of "contractual plot" cadastre and location .

The price of biological dry mangoes varied between 60 FF (6,000 FCFA) and 85 FF (8,500 CFA), FOB delivered at European ports, as of early 1999, for products imported from Honduras and Guinea. The quantities varied between 30 and 50 tons in Germany and the Netherlands in 1998.

For traditional dried mangoes, based on the development of dried mango in Burkina-Faso, the final cost price was estimated at 3,500 FCFA/kg maximum as the raw material cost amount to about 15/20% of this price (estimating 35 CFA/kg of mango and an average transformation yield of 17: 17 kg of fresh mangoes yield 1 kg of dried mangoes!).

The sale price in the international market varies between 4,000 and 4,500 CFA/kg while the proposed volume is important for pricing and client loyalty: one may estimate at 50 tons the minimum quantity of dried fruit to be produced each campaign.

* **Juice, pulps and concentrates**

Considering the low level of production (compared to India for example) and the diversified varieties, juice, pulps and concentrates are not recommended.

In addition to this fact, there are constraints related to the landlocked status of Mali: cold chain to be set-up without discontinuity in order to transport pulps or concentrates at -20^{o}C with required perfect homogeneity and regular transportation, etc.

* **Jams and fruit pastes**

These products are highly taxed because of:

. the high packaging cost,
. high cost of raw materials: sugar and fruit.

There is considerable competition with products from Ivory Coast, Mauritius, etc. which, in addition benefit from skilled labor and transformation standards that respond to international market needs.

* **Other products made of mangoes**

For us, this includes powders and others which we do not think competitive in Mali because of:

- too expensive raw materials,
- the high cost and unreliability of electricity,
- high level of basic investment requiring considerable credits.

3.2.2. Types of enterprises

Establishing a facility that is capable of supplying the export market requires a minimum level of capacity and therefore investment.

As for dried goods, for example, a dried mango production capacity of 50 ton/year would require an investment of about 200 million CFA.
This figure will need to be revised through a feasibility study to be carried-out contacting various industrial businessmen capable of proposing fully equipped drying facilities.

Therefore, one may think that ideally, **a transformation unit** capable of processing between 850 and 1,700 tons of mangoes per year (or 50 to 100 tons of dried products) would be most appropriate to supply the international market, in terms of homogeneous quality and regular supply.

The main "problem" lies in the selection of the support type for a promoter capable of operating such levels of investment and who has access to campaign credits, even if it may be envisaged to seek support from the importer (if a partnership is established in a sustainable fashion) who may pre-finance part of the campaign.

We are taking the liberty to mention the remarkable success of drying facilities in Burkina Faso, **organized into the "Cercle des Sécheurs du Burkina-Faso"**. In fact, a strong association helped bring uniformity among ten "small" dryers, each producing between 1 and 5 tons of dried product per year.

For importers, there should be only one representative for dryers and only one quality. About this last point, it should be noted that a 3 to 5 year period is necessary to synchronize various dryers and stop personal activities by certain actors. The advantage of such an organization is the low level of investment for individual facilities.

In the case of Mali, we are confused about the success of such an organization but which will in any case take time to become successful.

3.3. Work to be done and developed

Feasibility studies

Providing specific support to mango transformation industry and fruit transformation in general, in our opinion, requires a comprehensive feasibility study options we are privileging:

*** for a dried fruit facility** oriented toward exportation of dried mango slices.

Terms of reference:

. analysis of the conditions for establishment of a factory facility for dried fruit, processing about 3 tons of fresh mangoes per day,

. analysis of the conditions for establishment and operation, mainly for current infrastructure issues or not.
. cost price estimates for products, mainly taking into account the influence of energy costs: recommendations for the type of dryer, power source to be utilized, etc.

. proposing appropriate equipment, in terms of fruit preparation and in terms of packaging;

. establishing the operating account taking into account current market prices applied by importers;

. identification of a promoter who would be likely to set-up such a facility.

* **For a fruit juice production facility targeting the local market**

We met with several promoters with more or less advanced projects. In this case, the remaining work would be the selection of the most serious promoter, providing him with technical assistance to complete his project, both technically and economically.

The terms of reference for such an intervention would be as follows:

. to verify technical data of the project, by providing or not providing supporting arguments for modifications in the technology selected,

. to look into packaging issues,

. to prepare a provisional operating account for such a project.

Training activities

This essentially concerns two-level training:

* at the level of local crafts workshops:

    . participating in training cycles through theoretical courses on various existing techniques,

* at the level of industrial facilities (juice or dried fruit)

    . training in Montpellier, in the testing laboratories and halls, for factory managers and technicians: the aspects of "quality control, technical monitoring, mastery of additional processing (ripening, etc.),

    . intervention mission at the local level:
        - start-up of facilities,
        - staff training,
        - product formulation,
        - organizing visits to similar factories (Togo, Burkina-Faso, Cameroun).

4. Annexes

1. Mission program and persons contacted

Wednesday 12/8/99

16:15 MM. Odoux and Reynes arrive in Bamako
Welcome by CAE

Thursday 12/9/99

9:00 Meeting with CAE Management:
MM. Lambert, Linvingstone, Boukenem

10:00 Visit to LTA laboratories (Laboratoire de Technologie Alimentaire)
Discussions with Mr. Djibril Dramé, Mrs. Cissé Traoré

11:00 Visit to "La Maraichere", a small enterprise
Discussions with Mrs. Bocoum Nana

14:00 Visit to the DEFSAM,
Discussions with Mrs. Konté Binta

16:00 Visit to exporters:
Discussions with Mrs. Touré

Friday 12/10/99

8:00/10:00 Visit to ITRAC (Ministry of Industry, Commerce and Crafts)
Discussions with Mrs. Niang Emma Kourouma, National Director of the "Multifunctional Plat-form" Project

10:00-11:00 Mr. A. Niang, GPTA ("Groupement des Sécheurs"), visit to facilities

11:00/12:00 Mr. Mallé, visit to jam making workshop

14:00/15:00 USSIS project (GTZ cooperation)
Discussions with Mr. Bamba Coulibaly

15:00/18:00 Visit to SOMACO company
Discussions with Mr. Traoré, Technical Director

Saturday 12/11/99

8:00 Departure for Sikasso, arrival at 12:30

13:00 Meeting with Mr. Lambert Boukenem, Y. Rey
Visit to packaging units/facilities for AOM mangoes
Discussions with Mr. Tapon

Sunday 12/12/99

9:00/11:00 "Cooperative Mali Irrigué: discussions with managers

11:00/12:00 Meeting with Mr. Tapon (AOM)

13:00/18:00 Visit to the ICSOS project (Italian cooperative)
Koutiala (2h from Sikasso)

Monday 12/13/99

9:00/10:00 Visit to APROFA
Discussions with Mr. Sanogo

10:00 Visit to IER (Research), fruit and vegetable department
Discussions with Mr. Koné

16:00 Arrival in Bamako

Tuesday 12/14/99

8:00 Discussions with Mr. Djigué (promoter)

9:30 Discussions with Mr. Yattasaye (promoter)

10:30 Debriefing with CAE

14:00 ADF, discussions with Mr. Dianka (representative): re: factory in Yanfolila

15:00 CNPI (Centre de Promotion des Investissements): Mrs. Ouedraogo

16:00 NIPAL (Mr. Doumbia)

16:30 Mr. Sekou Oumar Tall (fruit producer and promoter)

17:30 Mrs. Touré, SONATAM
Discussions about a fruit juice factory project

20:00 Departure to the airport

Wednesday 12/12/99

6:00 Arrival to Paris

14:00 Arrival in Montpellier

4.2. Terms of reference

4.3 Mango transformation schema