Promoting Indigenous Fruit in Namibia

Report on Phase One

and

Proposal for Phase Two

of the

Marula Juice and Pulp Pilot Project (MJP^3)

submitted to the

Indigenous Fruit Task Team

IPTT

by

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February 2005

1) Background

The *Strategy and Action Plan for Promoting Indigenous Fruit in Namibia* envisaged that Phase 2 of PIF would include pilot processing projects aimed at commercial opportunities identified during Phase 1. The marula (*Sclerocarya birrea*) fruit resource in the NCRs was identified in the *PIF Phase One Final Report* as the top priority for such pilot-scale processing, because:

- Marula is abundant in the NCRs and fairly common in some other parts of northern Namibia; an uncertain quantity of surplus fruit is known to be available, even in relatively bad years, in the peak season, from people who own many trees
- In the NCRs recruitment of marula trees is controlled by people and resource sustainability is not an issue (in fact there is clear evidence that marula oil commercialisation has stimulated increased interest in planting marula trees)
- Ownership and management of the resource are largely unproblematic (in the NCRs)
- In the NCRs there are organised producer groups (i.e. the marula kernel production associations organised by the Eudafano Women's Cooperative, EWC) to work with
- Locally manufactured processing technology of proven efficiency is available
- There is confirmed market interest (for different products) from potential commercial partners in the South African juice industry and the European cosmetics industry[1]
- There is good reason to believe that Namibia's production of marula fruit could be scaled up rapidly by targeting the production of other northern regions, and/or through selection and vegetative propagation of superior genotypes
- There is a need to do larger-scale juice and pulp preservation trials, and larger-scale processing trials with jams, jellies etc.

By its very nature, pilot processing involves experimentation. In the case of marula there were and are still some major unknown and/or unquantified factors that must be resolved before such an endeavour can be placed on a commercial footing. Many of these issues involve the scale of the operation, and can therefore only really be solved in practice.

In March 2003 the IPTT therefore authorised a budget of N$701334 for Phase One of the Marula Juice and Pulp Pilot Production (MJP^3) project, primarily to answer major outstanding questions related to commercially viable production of marula juice and pulp. For an overview of the available knowledge and unanswered questions used to design MJP^3 Phase One, see Appendix A.

2) Summary of MJP^3 Phase One results

The key results and outputs of MJP^3 Phase One were verbally reported to the IPTT at its 24th meeting on 17 April 2003 and can briefly be summarised as follows:

a) Due to the cumulative effects of two dry years the 2003 marula harvest was the worst in many years. By mid-March, when MJP^3 had been mobilised and started buying

[1] Namibia's small national market, as well as the growing importance of marula processing for informal markets as a source of household income, suggest that promotion efforts aim at export markets

fruit, the main harvest was substantially over (in 2002, by contrast, the annual marula festival was held on Independence Day and abundant fruits were still available). To further complicate matters, the bad season had resulted in sharply higher *omaongo* prices (up to N$5/litre in local NCR markets, and up to N$15/litre in Windhoek and points further South) while an abundance of family labour (that would otherwise have been occupied in farming activities) was available for *omaongo* processing.

b) These factors combined to make producers absolutely unwilling to sell marula fruits at the trial price of 25c/kg (to which the anticipation of a bad cropping season and reduced agricultural income later in the year no doubt also contributed). Although the acceptability of this price in the NCRs had never been sure, it was considered worth trying so as to maintain a competitive position relative to South African producers (who mobilise around 3 000 tons a year at that price).

c) Even when the price was increased to 50c/kg (plus 25c/kg transport for fruit delivered to COSDEC in Ondangwa), and repeatedly advertised on the Oshiwambo service of NBC Radio, the project could only buy 11 205.4 kg of fruit (out of a target of 334 tons). The total amount spent on fruit purchases was N$7 021.30 (out of a budget of N$101 500) – an average fruit price of 63c/kg. In general these prices (50c/kg farm-gate and 75c/kg factory-gate) appeared to be broadly acceptable to most producers and should therefore be used in 2005.

d) Even at quite low volumes, weighing the fruit is too time-consuming and not trusted by many producers. A better solution is to calculate quantities and payments using a volumetric system (a heaped bucket of marula fruits weighs about 10 kg, making calculations easier). At a larger scale such a volumetric system can use standard-sized wooden crates

e) In total 894 batches of fruit with a combined weight of 9 834 kg were processed and 2598 kg juice produced, for an overall average extraction rate of 26.41%. This figure is slightly misleading, however, because it includes some really bad (over-ripe) batches of fruit that were processed simply for comparison and yielded as little as 3.43% juice. The average juice yield for reasonable quality fruit was 27.5%.

f) Depending on the quality of the fruit, one person can sort about 90-100 kg of fruit an hour (more if the quality is consistently high, less if it is a very mixed batch). Around 12% of the fruits purchased were rejected as sub-standard during washing and sorting.

g) Even at the low volumes actually processed in 2003, deep-freezing appeared not to be a viable preservation option, or at least not viable as the only preservation option, especially given the frequent and prolonged power failures that are common in the NCRs. The 12m refrigerated container used to store the juice took at least 18 hours to freeze a daily production of 250 kg of juice, and then only when the bags were spread out in a single layer on the floor. While an investment in more efficient refrigeration technology (e.g. a pre-chilling radiator, a bigger, faster freezer with substantial holdover capacity and a back-up generator) might help to solve this problem, market conditions do not at this stage justify the substantial capital investment that would be needed to refrigerate and/or freeze larger commercial volumes (hundreds or even thousands of tons). If and when the fruit supply bottleneck has been sorted out, and if a premium market clearly demands a frozen product, this cost-benefit equation should be revisited to see whether it would make economic sense.

h) While heat-sealed plastic bags provided a cheap packaging option to use for trials they are not the best solution in the longer term. It is difficult to achieve a perfect seal if the insides of the bag are not dry and clean. Once frozen, the icy juice tends to damage the plastic bags during handling, causing leakages when the juice thaws (most of the juice produced in 2003 was lost in this way after transfer from Ondangwa to the cold room at KAP; a large household freezer was purchased to keep the remaining samples). In the longer run it will probably be necessary to pack the juice or pulp in double plastic bags inside metal or plastic drums, or cardboard boxes. For sample shipment plastic bottles provide a convenient interim solution.

i) Potassium metabisulfite and potassium sorbate preservatives were tried and could preserve the juice for up to 17 days at room temperature before fermentation started. While preservatives lower the market value of the juice/pulp they are acceptable in certain market segments and should be tried at a wider scale. They are especially likely to be acceptable in the preservation of skin products intended for the extraction of flavour compounds and other chemical constituents.

j) Technically the KAPMOND10 presses worked well and the only problems experienced were (still) related to the hydraulic jacks, but the modified design allowed jacks to be replaced quickly, with little overall effect on productivity. The new hand-powered design is also much less likely than the previous pedal-powered model to suffer the deleterious effects of excessive force being applied by the operator.

k) A production capacity of 180 kg juice per press per 7-hour shift (allowing an hour for start-up and cleaning) was confirmed as realistically attainable, provided fruit sorting and delivery to the press station proceeded without interruptions or delays. Due to the low quantities of fruit available, only day shifts were worked.

l) After pressing out the juice the remaining fruits consist of around 45% stone and 55% skin and pulp. Manually separating stones from skins takes about one person-hour per 10 kg. With a better work flow this rate could probably be increased, but if a significant demand for skin pulp develops a faster and cleaner (mechanical) solution would need to be found.

For a more detailed account of lessons learned from MJP[3] Phase One, see the technical report by Roger Gamond attached as Appendix B.

3) Discussion of questions posed and answers obtained during MJP[3] Phase One

The outputs of MJP[3] Phase One are reported here in the form of answers to the questions posed in early 2003 (for which see Appendix A). Crucial unresolved questions around commercial-scale marula fruit processing are identified, and suggestions are made about how they can be answered during Phase Two pilot processing.

3a) Raw material procurement

Q: How do we reliably get large quantities of marula fruit to a central processing facility (and preferably return the seeds to rural areas where they can be decorticated)?
A: The suggested solution is a system of agents who own suitable vehicles and earn a mark-up of 25c/kg for buying fruit in areas known to them, and then delivering to the factory according to a pre-agreed schedule. This system can easily be combined with direct factory-gate purchases (by appointment only to avoid over-supply) from producers who can organise their own transport. It is however suggested that the creation of such a primary supply chain be left to the commercial entity or entities that will take marula fruit processing forward at the end of the pilot processing phase (most likely the Eudafano Women's Cooperative in the NCRs, and maybe others, too) and that smaller quantities of fruit be purchased directly for the more limited technology trials proposed below for Phase Two. The return of seeds would have to be negotiated between individual agents and the resource owners from whom they buy fruit, but EWC might be able to institute a simpler centralised system.

Q: Would mobile processing be a viable alternative to a central facility?
A: No, but it could later be developed into a viable complementary system.

3*b) Quality control*

Q: How do we deal with the problem of people keeping their best marula fruit for own use, and selling only poorer or sub-standard fruits to the processing facility?
A: In reality this did not turn out to be a problem. The agent system suggested above, combined with clear messages about desired/acceptable fruit quality, would further discourage supply of sub-standard fruits.

Q: Would the aggregated quality of these fruits still deliver a product acceptable to the target markets? What mutually acceptable quality standards can we negotiate with these markets?
A: While the quantity of fruit purchased in 2003 was not really large enough to provide a definitive answer, the overall quality of the fruit processed and the juice produced appeared to be fairly standard and representative of the overall harvest. The frozen juice (and the omaongo produced from it) was acceptable to traditional consumers in local and

Windhoek informal markets. Fruit fly infestation (especially in the later part of the season) remains a concern for export markets.

Q: How do we conserve large quantities of pulp for transport to distant markets (in ways that are acceptable to those markets)?
A: Barring a major additional investment in refrigeration/freezing technology, the best solution for juice might be to pasteurise it, provided loss of volatile flavour compounds can be limited. At this stage it appears that the use of preservatives would also be acceptable to some potential markets for juice, and to markets for skin pulp (which can however also be pasteurised if the client so desires).

3c) Prices and markets

Q: Can we pay the prices expected by Namibian producers (most of whom thought 50c/kg was too low) and compete with South African processors (who pay 25c/kg)? Can we secure enough quality fruit if we only pay 25c/kg?
A: A farm-gate producer price of 50c/kg and a delivered-factory-gate price of 75c/kg appear to be the lowest that would be widely acceptable under current conditions. With increased economies of scale such prices should result in a cost structure acceptable to most markets, especially if all of the skin fraction can be sold to specialised extractors of flavours and other compounds.

Q: Are there niche or export markets that will allow us to obtain and pay premium prices?
A: It is highly likely that marula juice – correctly processed – will have significant biologically activity that might interest the fast-growing international niche markets for functional and nutraceutical drinks. Accessing these markets requires further high-tech research (aimed at securing active product development partnerships with appropriately resourced commercial partners in major markets like the EU, Japan and US). It is proposed that Phase Two includes targeted anti-oxidant activity assays by a highly reputable international laboratory.

3d) Technology and economies of scale

Q: Which market segments will find the quality we can currently produce acceptable?
A: The juice produced during Phase One was acceptable to local and national informal markets for omaongo, and is also expected to be acceptable to more formal markets once it can be pasteurised (as it will be during Phase Two).

Q: What technology would we need to access other markets? How do we "right-size" these technologies if we don't know the real size of the markets?
Cage-and-plate technology can be scaled relatively easily. A pasteuriser appears to be an essential requirement for some markets (those that will not accept chemical preservatives). The technology needed to access markets for fruit or skin pulp (i.e. an appropriate pulping system) is suggested below and will be tried during Phase Two. Due

to the low fruit supply in 2003 the question of right-sizing technology cannot be answered yet (but the new technology to be used in Phase Two can also be scaled up without too much effort).

3e) Further value-adding

Q: The IFTT was asked to consider in principle whether it wanted to support further downstream value-adding trials at this stage, including:

- *Trials to develop standardised recipes for jams, cordials, chutneys etc. and make available technology packages at a scale that will be financially viable; included in this is the need to address difficulties in obtaining packaging*
- *The use a solar oven to pasteurise juice in 750 ml beer bottles closed with star caps*
- *Distillation trials with marula (or sourcing appropriate distillation technology assistance from the University of Stellenbosch)*
- *Trials to make a standardised, bottled version of omaongo that can be marketed throughout the year*
- *Liqueur trials with marula*

A: The IPTT never expressed itself clearly on this matter. Some trials with jams and cordials were conducted by Unam's Department of Food Science and Technology under the DoF/FAO indigenous fruit trees project, using frozen juice and skins supplied by MJP[3]. It is suggested that such trials be left for a later stage, and then preferentially be taken up directly by, or in close collaboration with, the private sector (e.g. EWC).

4) Objectives and results

The specific objectives of MJP3 Phase One and the results obtained are discussed below.

a) *To establish whether it is possible to buy at least 334 tons of marula fruit of an acceptable quality for 25c/kg in the NCRs*
It was not possible to do so in 2003, even at 50c/kg. The 2003 fruiting season was so bad that this question still remains unanswered, but it would certainly be much easier for an organisation of marula producers (like EWC) to buy such quantities. No large scale purchases are proposed for Phase Two.

b) *To quantify the cost and logistics of conducting purchases at this scale by collecting fruit from central points*
Although the poor fruiting season clearly distorted the situation it would appear that such a system is not viable (or at least not without substantial additional organisational work) – a system of agents (which could also be organised community groups) combined with factory gate deliveries as detailed above (and in Appendix B) is considered a better long-term solution, both for masnaging the fruit supply and for lowering the logistical costs.

c) *To establish the cost and practicality of conducting purchases at this scale at the factory gate (and to assess the fair price differential – if any – to pay people who deliver fruit to the factory)*
A factory-gate system appeared much more workable, allowing a more reliable fruit supply and a ready mechanism to control over-supply. Most transporters found 25c/kg an acceptable mark-up for delivering fruit.

d) *To investigate the practicalities of returning nuts to purchase areas for decortication*
It remains highly desirable to develop an appropriate solution to this problem (which is clearly of concern to most fruit producers) but no workable system is apparent yet. Again, an organisation like EWC could probably resolve this better.

e) *To evaluate the relative technical performances of the KAP and RDC press designs and to make recommendations for improvements to the designs*
No RDC press was available for comparative trials. The KAPMOND10 press has been improved by making it easier and quicker to change the jack.

f) *To establish the practicalities of processing at least 2 tons of marula fruit per 7-hour shift using 10 small hydraulic presses*
With a good work flow and an interrupted fruit supply it would be possible to process up to 6.5 tons of fruit per 7 hours with 10 presses, producing 1.8 tons of juice.

g) *To assess the maximum and average quantities of marula fruit that can be processed per shift with 10 such presses*
With a good work flow and an interrupted fruit supply it would be possible to process up to 6.5 tons of fruit per 7 hours with 10 presses. There was not enough fruit available to derive a reliable average figure, but it should not be lower than 5 tons.

h) *To investigate an optimal work-flow system for such processing*
The system used was quite efficient, given the inherent limitations of the COSDEC processing venue, but again there was not enough fruit (and hence not enough data) to provide a definitive answer. It is suggested that Phase Two (which will use a very different production line) gathers data that would be required to process-engineer an effective work flow in a more sophisticated technological set-up.

i) *To investigate the effects of degree of fruit ripeness on juice and pulp quality*
The best stage for juice processing appears to be while the fruits are still light green. Over-ripe fruits are not acceptable (but are relatively easily rejected at the sorting and cleaning stage). Phase Two should start developing further guidelines for especially skin processing (but is unlikely to provide a conclusive answer in one season).

j) *To investigate the labour requirements of manually expelling the pips from pressed fruit in preparation for skin pulping*
It takes about one person-hour to separate 10kg of pressed fruit, but this figure could

still be improved.

k) *To produce small samples of skin pulp for research purposes, and investigate suitable technology for larger-scale skin pulping*
Small quantities of skins were pulped during Phase One using a household food processor. However, in view of the fruit supply problems no samples sent to commercial partners for evaluation, to avoid disappointing potential markets. Independent analyses of such skin pulp samples should be a priority during Phase Two, so as to allow better identification and engagement of suitable commercial product development partners.

l) *To investigate the practicalities of freezing and/or chemically preserving juice and pulp at small industrial scale for transport to distant markets*
Freezing would only be a feasible option if substantial additional investments in refrigeration technology and back-up power supply were made, but at this stage it is unclear that the scale of the opportunity and the confirmed market interest would justify such investment. Chemical preservation, which presented some problems at village level, worked well at this larger scale and allowed juice to be stored at ambient temperature for up to 17 days. The acceptability to different markets of various potential preservatives needs to be clarified.

m) *To conduct two mobile processing sessions in rural areas to assess the practicalities and demonstrate the technology*
None of the producer groups contacted could guarantee that enough fruit would be made available to justify a mobile processing trial and no such trials were therefore conducted. The technology was however further demonstrated at a training session for current and prospective press owners.

n) *To make available large samples of frozen or preserved juice and pulp processed at different stages of ripeness for assessment by potential partners in the Namibian and South African beverage and dairy sectors, the European cosmetics sector, and such other markets as might show an interest (e.g. to small entrepreneurs who might want to produce omaongo for Namibian urban markets)*
Again, it was judged prudent to delay the supply of commercial samples to prospective clients until the fruit supply situation could be assessed more accurately. SMEs producing omaongo for sale in Windhoek generally found the frozen juice acceptable, but some reported problems of slow fermentation and/or excessive scum forming during fermentation (which could possibly be corrected by adding a vigorous starter of selected yeast after the frozen juice has melted).

o) *To negotiate mutually acceptable quantities, quality standards, packaging specifications, delivery schedules and prices with interested commercial partners*
Despite some technical problems, pressed juice frozen in 10 litre plastic bags is acceptable to national informal markets for omaongo. The rest of this work has been

deferred to Phase Two.

p) *To build up a stock of frozen and/or preserved juice and pulp for use in downstream value-adding trials*
In addition to the omaongo trials mentioned above, some of the juice extracted during Phase One was used to make marula jelly at small scale. The jelly had an excellent flavour but most consumers thought it was too runny. Some frozen juice and frozen skins were supplied to Mr Bille and Ms Steppich of Unam's Department of Food Science and Technology, who used these raw materials during out-of-season processing trials under the DoF/ FAO indigenous fruits project and reported that they had successfully made several products, including jams and cordials.

q) *To give potential entrepreneurs and other interested people an opportunity to see the presses in action (and the opportunity to use such a press to process excess fruit against a nominal charge) – if the timing coincides with the marula festival (held on Independence Day in 2003) this popular event would represent another great technology demonstration opportunity*
Unfortunately the trials did not coincide with the marula festival, but several interested people visited COSDEC to see the presses in operation. It is not clear to what extent subsequent orders were the result of this technology demonstration. The ten presses purchased for the trials were subsequently distributed by MAWRD to various ADCs and other stakeholders for hands-on trials.

r) *To make available better technical information and financial data for planning the second year of pilot processing*
Technical information generated during Phase One was one of the inputs used to design the Phase Two technology package and trials detailed below, but due to the low levels of fruit supply insufficient financial data was generated to enable meaningful additional business planning.

s) *Subject to the decision on ownership agreed at the 2nd Stakeholders Workshop, and assuming the pilot project shows commercial processing to be viable, to seek the financial participation of private sector partners (primary producers and others) in the establishment of a fully commercialised marula juice and pulp production facility in the NCRs*
The outcomes of the workshop (and the realities of fruit supply) would appear to favour eventual transfer of the opportunity to EWC's new factory at Ondangwa, but Phase One did not generate enough information with which to approach either EWC or other investors.

5) Developing equipment for Phase Two

For details (and pictures) of the technology package developed for use during MJP[3] Phase Two, see the final report *Marula Fruit Processing Equipment* submitted separately to the IPTT in February 2005. Pertinent details are summarised below.

5a) Background to technology developed for Phase Two

Although the KAPMOND10 cage-and-plate hydraulic press used during Phase One does what it was designed to do (i.e. produce more marula juice with less effort than traditional manual extraction methods) it has one major limitation, which is that it cannot extract the more solid fraction of the fruit pulp (which adheres strongly to the pip) or any of the skin (which contains much of the actual marula flavour).

With financial support from French Cooperation an attempt was made in 2002 to develop an alternative small-scale marula pulping technology at CIRAD-AMIS in Montpellier, France. A young Namibian lecturer from Unam, Ms Penny Hiwilepo, was supported by the IPTT to go to Montpellier and work with French researchers. The IPTT also paid for shipping two loads of fresh marula fruit to CIRAD.

The outcome of this initial work was disappointing. It was very expensive to ship largish quantities of fresh marula to France and despite refrigerated transport the fruit took five days to get there and deteriorated quite badly in transit. Nevertheless CIRAD did do some processing trials and followed up with a visit to Ondangwa during Phase One of MJP[3]. CIRAD then recommended the development (in France) of a technology based on a potato peeler modified into a slicer (the details can be gleaned from two confidential CIRAD reports previously circulated to the IPTT).

Several obstacles to implementing this proposal by CIRAD later cropped up:
a) CIRAD insisted that it was subsidising the technology development process and therefore entitled to co-ownership of any intellectual property created;
b) CIRAD was initially not prepared to do the work confidentially and only later agreed, grudgingly, to a period of confidentiality which would have given Namibia at most an 18-month lead in the market;
c) The technology package proposed by CIRAD was not complete and the cost of buying the rest of the equipment was not clear;
d) The slicing technology proposed by CIRAD would have been able to produce only one type of product (a mixture containing skin, pulp and juice more or less in their natural ratio);
e) The timeframe proposed would not have resulted in a workable processing package being transferred to Namibia in time for the 2005 marula season; and
f) The work plan relied on several additional shipments of fresh marula fruit being sent to Montpellier at great expense without any guarantee they would arrive there in a state representative of the overall quality of the Namibian marula harvest.

In view of these difficulties – which dragged on until it was too late in the 2004 season to do significant work – the negotiations with CIRAD were abandoned and an alternative proposal submitted to French Cooperation/NOREESP (which donated Euro 30 000 to support the development of the technology package detailed below) and the IPTT (which paid the balance).

5b) Approach used to develop Phase Two equipment

At present there is not yet a standard marula fruit processing technology package, or any fixed product specifications for marula fruit products (for a review of what is known about other previous or existing instances of marula fruit processing, see Appendix A). Furthermore, there are clearly differentiated market segments that can be targeted with various marula products, provided the technology available is flexible enough to produce such variety.

The most striking result obtained during Phase One of MJP[3] was that only 11 tons of marula fruit could be purchased (out of a target of 334 t). It is proposed that this problem of quantities (which in 2003 had a strong seasonal element) would in the longer run be best resolved by an organised group of marula owners and producers, such as EWC.

In choosing the technology package for Phase Two versatility was therefore accorded priority over total production capacity, or smooth process flow. The result is a set of equipment that can produce many different mixes of marula juice, fruit pulp and/or skin pulp samples, so that realistic standards can be agreed with product development partners.

An important secondary aim is to test the peak capacity of different components to inform further planning. Depending on how market developments play out, and assuming supply-side problems can be sorted out with a better purchasing system run directly by the producers cooperative, such a modular approach should provide sufficient data to process engineer a permanent marula fruit processing facility in 2006 or 2007.

5c) Overview of Phase Two equipment

For more details and photographs see final report on *Marula Fruit Processing Equipment* submitted separately to the IPTT.

i) Reception, grading and storage
A pallet lifter/stacker trolley and 40 wooden crates (with a capacity of about 250 kg of fruit each) mounted on pallets are used for fruit transport and handling.

ii) Sorting
Two stainless steel sorting tables aimed at facilitating the initial sorting of fruit (and the manual separation of pips and skins) have been altered as follow:

- a 100mm stainless steel rim has been added lengthwise on both sides of the table top to stop fruit rolling off
- stainless steel tapered spouts have been added to each end of the tables to channel fruit, pips and skins to tubs or buckets

iii) Washing and draining

Two 1000 litre stainless steel tanks fitted with tilting draining baskets are used for washing. The first tank rinses off dirt, the second disinfects (chlorinated water). Two pool filters and pumps circulate and recycle cleaning water to reduce water consumption. The pumps have been modified by fitting a simpler DOL starter with an overload breaker. Three 1000 litre plastic tanks mounted on pallets provide a back-up supply of water.

iv) Juice pressing

The ten KAPMOND10 presses used for Phase One of MJP[3] are used to press a relatively clear juice suitable for *omaongo* and other beverages. Pressing squeezes open the fruits, but leaves the pips inside the skins.

v) Juice filtration and storage

Juice is filtered through stainless steel mesh into one of three food-grade plastic tanks mounted on pallets that fit into a 12 m^3 portable cold room. One stainless steel agitator per tank has been manufactured to keep contents mixed; these agitators are driven by electric bench drills for which appropriate stands have been made. At this stage the juice can optionally be pasteurised, chemically preserved, fermented or frozen.

vi) Separating skins from pips

For current sample production purposes skins and pips are separated manually on the same stainless steel tables used for fruit sorting. Once it is clear whether or not there are niche markets for pure fruit pulp and/or pure skin pulp this part of the production line would need to be revisited (or at least extended to more table space).

vii) Crushing skins

A fruit mill is used to crush skins into a coarse puree. It should theoretically also be able to do so even when the pips have not been separated from the skin. This machine was delivered with a poor electric connection (just loose wires) and has been properly re-connected with cable, plug and a DOL starter with an overload breaker. A small Drotsky hammermill is available to try as a back-up alternative at this processing stage.

viii) Pulping crushed skin and/or removing adhering pulp from pips

A brush pulper transforms the coarse puree into finer pulp. It also had to be rewired completely.

ix) Mixing juice/flesh pulp/skin pulp

This is done in the same tanks (with mixers) used for temporary storage.

x) Pasteurise

The pasteuriser has a peristaltic pump circulating product through heating (and optionally also cooling) coils. It can be fitted with stainless steel rods to reduce flow rates for less viscous materials. The pasteuriser was also delivered without proper electrical connection; required wire and plugs were bought for the pasteuriser and the pump has been properly connected with a DOL starter and overload breaker. This is the only piece of equipment that could not be tested at the KAP workshop because it needs a 45-50 Ampere current.

xi) Packaging

To be negotiated with partners. Initially three types will be used to store samples: PET bottles (5 litre, 500 ml, 100ml), 25 litre plastic jerry cans, and heat-sealed plastic bags.

6) MJP^3 Phase Two proposal

This section of the document proposes a strategic approach to and budget for marula fruit processing trials to be conducted in northern Namibia during the 2005 marula season.

6.1) Strategic approach of MJP^3 Phase Two

Before marula fruit processing in Namibia can be placed on a fully commercial footing the following issues still need to be addressed:

a) The equipment that has already been purchased must be tested on marula fruit to determine its production capacity and throughput, and further modified if necessary
b) The unique and potentially valuable characteristics of marula fruit must be analysed in more detail so that future negotiations with commercial partners can be conducted from an informed footing
c) Commercial R&D partners must be supplied with a range of potential product samples for evaluation and their views on likely market volumes must be obtained
d) The question of fruit supply logistics must be resolved
e) An appropriate scale of operations must be chosen for commercial processing
f) A financial and business plan must be drawn up and adequate operating capital must be sourced
g) A processing facility (or facilities) must be planned in detail and equipped

Issues a, b and c (equipment, analyses and samples) are relatively easily addressed from within a project framework and are therefore proposed as the core work to be done under MJP^3 Phase Two.

Issue d (fruit supply) is best tackled in close cooperation with a large and well-organised body of marula producers such as EWC and its eventual resolution depends to a significant extent on the projected volumes required by markets. It is nevertheless possible to advance the issue of fruit supply logistics during Phase Two through discussions with EWC (and other organised suppliers such as the national CBNRM movement).

Issues e, f and g (scale, business planning, commercial facility) are inter-connected and can only be progressed to a significant extent after the preceding issues have been resolved. It is therefore suggested that the information gathered during Phase Two be fed into this process and further advanced under the business planning processes envisaged for the proposed new natural products company and the EWC marula factory in Ondangwa.

6.2) Testing and modifying equipment

It is not yet 100% certain that the equipment procured in 2004 with support from French Cooperation/NOREESP and described in section 5 above is fully appropriate for marula processing, because it was bought/made outside the marula season and could not be tried under realistic operational conditions (and the pasteuriser could not be tested at KAP at all due to an inadequate electrical power supply).

To test (and adapt, if necessary) this equipment it is proposed that:

- The equipment be moved to Ondangwa and temporarily installed at COSDEC
- Each piece of equipment be tested in turn to see whether and how well it works, and to determine its actual productivity and yield
- Suggested improvements and/or modifications (if any) be budgeted separately and presented to the 36th IPTT meeting scheduled for 18 April 2005 for approval.

6.3) Analysing marula for potentially valuable characteristics

During MJP^3 Phase One research into potential markets for marula products led to the conclusion that one of the most marketable qualities of a new fruit juice product in world markets would be strong scientific evidence of significant anti-oxidant activity. This is exactly what has driven the recent rapid growth of markets for novel juices such as noni and cranberry, and it is moreover a characteristic that would neatly match the product development interests of some major potential partners identified with assistance from PhytoTrade Africa.

It is therefore suggested that MJP^3 Phase Two takes a similar research approach to the one that led to the marula oil partnership with Aldivia, i.e. commissioning key work from a highly reputable international research laboratory and using the results (provided of course they are positive) to initiate a serious collaboration with a well-resourced commercial partner that has the technical and marketing wherewithal to take the product all the way through to larger international markets.

In this regard it is proposed to commission combined assays of hydrophilic ORAC (Oxygen Radical Absorption Capacity), total phenolics and total anthocyanins from Brunswick Laboratories in the USA (which is widely respected as the leading international service provider in this specialised field). Three separate samples (juice, fruit pulp and skin pulp) will be submitted for analysis. A positive report from Brunswick is sure to pique the interest of even the most demanding and sceptical commercial partner.

6.4) Supplying samples to potential commercial R&D partners

While pure research such as that proposed above can be very valuable in negotiations with commercial product developers it is not an absolute prerequisite for all markets. Furthermore, several such partners have already been engaged in discussions and are keen to receive marula fruit product samples for evaluation. Without revealing confidential commercial information, these include:

- A small, focussed and highly innovative botanical extracts company in South Africa that also owns a subsidiary specialising in the supply of ready-to-mix fruit juice blends to high-end clients such as Ceres – this partner is interested in sourcing

stabilised marula juice and in extracting marula fruit flavour from a stabilised skin pulp
- A small distillery in Germany that produces premium schnapps from exotic fruits
- A Swedish subsidiary of one of the world's largest food and beverage companies, in cooperation with a well-known Swedish university
- A top-ten flavour and fragrance company based in France that has been trying to source a reliable supply of stabilised marula products for a few years without success
- One of the largest blenders and distributors of tropical fruit juices in eastern Europe, based in Poland
- Australian and American ice-cream manufacturers

In addition to these partners all the major international players in the flavour and fragrance industry were identified during Phase One and it is possible that some of them might also take up product development opportunities once the offer of collaboration can be backed up with results from Brunswick Laboratories.

As far as possible the cost of shipping samples will be recovered from the recipients, but a substantial budget has been provisioned for those cases where it would be justified to pay such costs simply to secure a chance of longer-term collaboration. A major additional expense will be the transaction costs of concluding appropriate Material Transfer Agreements with the recipients of samples.

6.5) Fruit supply, scale, business planning and commercial facility

While these four issues are crucially important to the eventual success of sustainable marula fruit processing in Namibia they are not easily answered within a time-bound project framework. They are moreover bound up with a number of current developments that are as yet too unclear and/or dynamic to allow detailed project planning. Specifically:
- The EWC factory has been officially opened but its business planning has not been finalised yet as far as expanding beyond its existing marula oil business is concerned
- Under the LIFE Plus and ICEMA projects substantial financial and organisational support will be provided to community-level natural-resource-based business enterprises within the organised CBNRM movement, which could (and probably will) radically alter the lay of the land as far as fruit supply and/or local processing are concerned, but at the time of writing neither the scope nor the operational modalities of this support have been clarified with any degree of precision
- While there are many interested parties in many different market segments some of these markets are too small to be commercially interesting on their own, and some are probably too large to be supplied in the near future by Namibia alone – it is crucially important to negotiate the right initial mix of right-sized clients without putting off the bigger fish altogether
- In addition to the EWC business planning it is envisaged that planning for the new natural products company will proceed apace as from early April, which might well have significant impacts on the technical, financial and management resources that can be brought to bear on further commercialising Namibia's marula resource

- Marula is widespread and common in the SADC region and in Africa more generally, with South Africa the current market maker due to the success of Amarula liqueur. Many research and rural development interventions in other neighbouring countries are targeting marula fruit and oil processing, usually at a small scale – to stay ahead in the game Namibia needs to be smarter than its competitors in establishing commercial processing facilities for marula products.

Against this background it is proposed that additional time be included in the project coordination component of the budget for further consultation and strategising around these key considerations, accompanied by a large dose of realism about what can and can't be achieved within the scope and timeframe of MJP^3.

6.6) Bridging phase

The 35th IPTT meeting held on 21 February 2005 authorised internal re-allocation of the remainder of the MJP^3 Phase One budget for a bridging phase that would allow Phase Two to start up without further delay. This bridging phase was to run until 14 March 2005, with any justified overspend to be included in the first instalment of the Phase Two budget. A proposal that fees be increased during the bridging phase from their 2003 levels was however turned down by the IPTT.

Additional expenses incurred during the bridging phase (up to and including 14 March 2005) included:

- 12 days of work by Roger Gamond to prepare the equipment, pack it into a container, unpack it in Ondangwa, set it up at the COSDEC processing venue and start trials
- 11 per diems for Roger Gamond, 5 for Julien Gallardo (French volunteer) and 12 for Thomas Ambinga (KAP technical assistant)
- 3076 km of project transport
- Sending equipment to Ondangwa (by TransNamib container)
- Miscellaneous small equipment and consumables
- Limited fruit purchases
- Limited casual labour to unload equipment and start processing

In addition to these expenses the remainder of the consultant days due, and CRIAA SA-DC's admin fee, were finally charged to the budget. This brought the total expenditure on MJP^3 Phase One to N$392 567.90, compared with an original total budget of N$701 334, of which N$437 891 was actually received from NAB as a first instalment. The final surplus on the MJP^3 budget (after the bridging phase) was therefore N$45 323.35.

6.7) Proposed budget for MJP^3 Phase Two

The IPTT has already in principle approved a budget for MJP^3 Phase Two of N$560 000 plus the surplus from Phase One (part of which was used during the bridging phase). The actual budget proposed below amounts to N$604 164.

a) Human resources

CRIAA SA-DC proposes to deploy the following team for MJP[3] Phase Two, to cover the various areas of responsibility:

- *Project coordination, market liaison and business development:* Pierre du Plessis (PdP)
- *Technology, production and preservation trials:* Roger Gamond (RG)
- *Technical assistant:* Thomas Ambinga (TA)
- *Data capture/analysis and research sampling:* Julien Gallardo (JG)
- *Financial analysis and business planning:* Michel Mallet (MM)

	Days required	Over period	Rate (incl. VAT)	N$
PdP	40 (incl. reporting)	Mar-Sep	2 300	92 000
RG	45	Mar-Jul	2 300	103 500
TA	45	Mar-Jul	100	4 500
JG*	30	Mar-Jul	250	7 500
MM	12	Mar– Jul	2 300	27 600
Sub-total	*127*			*235 100*

* French volunteer, charged at actual cost to CRIAA SA-DC

b) Per diems in the NCRs

PdP	20 x N$500	10 000
RG	40 x N$500	20 000
TA	40 x N$50	2 000
JG	25 x N$220	5 500
Others	40 x N$150	6 000
Sub-total		*43 500*

c) Project transport

Whk – NCRs – Whk 5 x 1 600 km x N$3,50/km	28 000
Project travel in NCRs 6 000 km x N$3.5/km	21 000
Sub-total	*49 000*

d) Research costs

Sample preparation (packaging, labels etc.)	8 000
Laboratory analyses (microbial loads etc.)	30 000
Shipping samples to partners	25 000
Sub-total	*66 000*

e) Capital equipment (remains MAWRD property)

Miscellaneous small equipment	4 000
6m container for equipment storage[2], delivered Ondangwa	20 000
Sub-total	*24 000*

f) Facilities

Rent, water and electricity - 3 months at N$1 500	4 500
Sub-total	*4 500*

g) Consumables

Preservatives	7 000
Cleaning materials	2 000
Equipment maintenance and spares	3 000
Sub-total	*12 000*

h) Casual labour

3 x N$50/day x 40 days	6 000
Sub-total	*6 000*

i) Fruit purchases

50 tons at N$750/t	37 500
Sub-total	*37 500*

Sub-total	***477 600***
Contingencies (10%)	47 760
Sub-total	*525 360*
Admin (15%, charged only on actual expenses)	78 804
TOTAL	**604 164**

6.8) Proposed schedule of payments

At project signing: 40% (N$241 666)
End-May: Reimbursement of all invoiced expenses (excluding consultant costs)
End-July: Reimbursement of all invoiced expenses (excluding consultant costs)
Balance at presentation of final report (by 17 October)

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[2] Storing equipment at MAWRD in Ongwediva proved inconvenient during Phase One (moving equipment there and back again) and will be much more difficult with the larger set of equipment used during Phase Two. Buying a container and storing it at the EWC factory in Ondangwa, where there is good security, is considered a more practical (and ultimately cheaper) alternative.

APPENDIX A

(Extracted from *MJP3 Phase One Proposal*)

2) Current [February 2003] knowledge about marula juice and pulp processing

Because marula is such an obvious surplus resource in season in some rural areas there have been a number of attempts over the years in various Southern African countries to produce marula juice/pulp commercially, all of which (except for the *Amarula* pulping facility) have either ended in failure, or are still struggling to overcome major constraints.

An unfortunate side effect has been a large degree of scepticism among commercial players about the ability of any marula juice/pulp producer to supply sufficient quantities (aggravated by concerns over the seasonality of the supply). Not that these potential industrial partners are unaware of marula's marketing potential – many have resorted to using "nature-identical" marula flavour, or even marketing products without any marula content under the name "Marula", while many others are fully aware of the retail market potential of a good marula product (e.g. SAB has been reported as being interested should a production of around 6000 tons a year of concentrate be guaranteed). It ultimately boils down to the old business challenge: "Show me the goods".

From the above it is clear that the odds are heavily stacked against commercially viable marula fruit processing in Namibia, and that every possible measure should be taken to maximise the chances of success. One way of doing this is to tease out relevant lessons from previous efforts.

Detailed below are some of the current and previous attempts to produce marula juice and/or pulp commercially, and a short selection of relevant technical knowledge gleaned from the literature and from previous research:

2a) Distel/Mirmar marula pulp factory, Phalaborwa, South Africa

This factory started out in a double garage but now comprises a ZAR20 million or more facility jointly owned by Mirmar (a local company started by Mr Thys Slabbert to process marula) and Distell (the third largest liquor company in the world, manufacturers of *Amarula* liqueur). Between 2000 and 3000 tons of marula fruit a year is processed into a pulp that includes most of the flesh and skin (thus around 1500 to 2400 tons of pulp a year). This pulp is chilled on site and transported in refrigerated tanker trucks to the Western Cape, where it is fermented, distilled and aged before being formulated into the world's second-biggest selling cream liqueur. The basic production model used is as follows (all equipment is stainless steel unless otherwise specified):

a) The factory only works for two to three months of the year, at the peak season (most likely because fruit supply is too erratic on the "shoulders" of the season to justify running the very large production system)

b) Fruit is purchased on a regular schedule directly from primary harvesters at pre-designated points by Mirmar trucks fitted with wooden fruit harvesting crates (harvesters have complained that the trucks do not always run on schedule, wasting their time and sometimes causing collected fruit to spoil)
c) Additional fruit is purchased at the factory gate, for the same price paid at collection points – such sellers can plan the timing of their sales to suit their other commitments, are guaranteed of a sale, and receive immediate cash payment, and many people therefore prefer to organise transport to the factory, rather than waiting for a truck, despite having to bear transport costs
d) The price is 25c/kg for fruit, but for ease of transaction payment is usually agreed on a volumetric basis
e) Fruit enters the production line through a chlorinated bath (situated outside the main processing area and with easy access from the driveway) which rinses off dust and helps to lower natural yeast loads
f) It then moves along a mechanised sorting lane where bad fruits are sorted out by hand and excess water drains off
g) Selected, washed fruits then move into the main factory along an augur, and into high holding bins
h) From these holding bins fruit moves into two large custom-built machines resembling kitchen blenders, where it is chopped up and the pulp stripped from the pips by fast-moving blades (the pips are left almost completely stripped)
i) Pips are removed from the blenders in batches
j) From the blenders the pulp is pumped through a rapid chilling radiator to chilled storage tanks (it is not clear whether preservative is added at this stage)
k) The pulp is transported 30 tons at a time in chilled tankers to the Western Cape for further processing

Some further observations about this business:

a) It produces a specialised product for one committed (share-holding) client, which controls and profits from several additional value-adding opportunities before *Amarula* is finally sold in more than a hundred countries around the world. In such a vertically integrated production system culminating in one extremely successful final product, the price of the pulp is easily negotiated, and the capital investment in equipment easily justified and redeemed
b) Since capital costs were no object, the factory is over-designed so that it can process large quantities of pulp in a short time, and continue to meet the demand for *Amarula* for some time to come
c) The market success of *Amarula* is based on a good product backed up by many years of high-budget promotion and advertising which made full use of the uniquely African marketing features of marula fruit – without such ad-spend (and the distribution capacity to access widespread markets) the economic viability of the current processing facility would have been completely different
d) It produces substantial quantities of pips as a by-product and has branched out into marula oil and cosmetic production

e) Mr Slabbert has mentioned a desire to build an ISO-certified marula preservation facility to produce juices, jams etc. for local and export markets

f) There have been discussions with Distell about moving the fermenting and distilling parts of the production process to Phalaborwa

g) The factory has started a community trust and has used this show of social responsibility as an additional marketing tool

h) If and when additional production capacity is required to keep the world in *Amarula*, another processing facility might eventually be required; Mr Slabbert (who did his apprenticeship at Tsumeb and says he is very fond of Namibia) has indicated that he might even consider erecting a similar facility in Namibia

i) In the absence of a similar "captive" market, this business – for all that it is a shiny example of a well-run processing facility – is of limited use as a model for how Namibia should proceed with valorisation of its marula resource in the immediate future, except to highlight the many benefits that can result from a sound relationship with a well-resourced industrial and commercial partner

2b) Mineworkers' Development Agency/Mhala Development Centre/Marula Natural Products (Pty) Ltd, Bushbuckridge, South Africa

Marula pulp production was started several years ago by MDA as a donor-funded income-generating project for rural people and later "privatised" as Marula Natural Products (Pty) Ltd. Manual juice processing was chosen as a way to maximise employment opportunities. Production was started before a clear market had been identified, so as to assess the scale and practicalities of juice extraction and make available large samples of marula juice for product development.

A formal-market, bottled marula beer (called Vukanyi, diluted, with extra sugar and gas to meet the taste expectations of the targeted – tourist - market) was developed in cooperation with the CSIR, and a micro-brewery was established at the CSIR in Pretoria (to overcome the technology management constraints associated with running such a process in Bushbuckridge). Partly due to its limited scale, and partly due to the cost of transporting juice to Pretoria and bottled beer back to the target market (Lowveld tourist lodges) the brewery was not financially viable enough to justify the management costs and created so few additional jobs that it was later abandoned. The project also branched out into marula oil production, based on the Namibian model, with which it has had some success.

In an attempt to increase the scale of fruit purchases so as to benefit large numbers of harvesters, it was decided to target potential markets for marula pulp/juice as a raw material. A brush pulper was imported from India, but its production was low (around 30 kg/hr) and manual processing was continued in parallel. In the 2002 season production had not yet met the levels required by commercial partners (the establishment of a Namibian project could result in sufficient combined supply to tip the opinion of a major fruit juice blender and marketer).

The production system works as follows:

a) Because the daily processing capacity is low and the need for employment is urgent, juice production is carried out over most of the marula season
b) Fruit is collected from pre-designated purchase points (organised by village committees, at 25c/kg) by a project vehicle and transported in bulk to Mhala
c) At the factory the fruit is dumped in heaps under a shadecloth structure that is closed on top and to the west, but open on the other sides
d) Processors sort out good fruit from this heap
e) Because of rough handling and slow processing a large percentage of fruit is wasted
f) Fruit is rinsed in a large bath immediately prior to processing – it drains and dries in smaller heaps next to the processors
g) Juice extraction is done manually (sometimes supplemented by a brush pulper) by around 20 women who sit on reed mats on a washable concrete floor under a tin roof that adjoins the factory but is open to the east and south
h) The juice extractors are paid a daily wage and are expected to meet production targets of around 20 litres a day
i) Table forks are used to open the fruits over plastic bowls – the juice and pip with its adhering pulp are squeezed into the bowl and the skin is discarded to one side
j) When sufficient quantities of pips have accumulated in the bowl they are again squeezed and rubbed by hand to release more pulp – "dry" pips are then discarded to one side
k) When a woman has accumulated a few litres of juice and pulp in her bowl she gets up, walks over to a record-keeper with an electronic scale and decants her production into a plastic bucket, where it is weighed and recorded; she then fetches more fruit if necessary before returning to her work-station
l) As soon as the weighing bucket has accumulated sufficient juice it is poured into a food-grade plastic bag, heat-sealed, numbered and then placed in the pre-chilling section of the freezer room (from where it is later moved back through another door into the main frozen storage part)
m) The frozen blocks of pulp are packed into refrigerated trucks for transport to buyers

This production unit:

a) Is constrained in its ability to reduce per unit production costs (on the manual part of its production) because of paying a daily wage
b) Does not (or did not in the 2002 season) have a viable technological alternative to manual processing (within its project-driven parameters of employment creation)
c) Will always face questions about the hygiene of its manual processing methods
d) Cannot scale up production easily (without investing in building a larger processing area, or procuring alternative processing technology, which would however contradict its employment-creation goals)
e) Would probably not be able to survive on a purely commercial footing (without project-funded subsidy), unless it somehow managed to secure a premium price unrelated to real market conditions (which would still leave its long-term sustainability suspect)

f) Cannot in its present form have a significant impact on rural poverty because it only processes at most two tons of fruit a day (at a high cost)

The main lessons Namibia can learn from this exercise are that adapted traditional processing is unlikely to meet the quantity, quality and price expectations of formal markets, and that penetrating formal markets with a marula retail product is a difficult exercise fraught with pitfalls, not to be attempted lightly or with insufficient budgets. Good ideas include the heat-sealed plastic bags and the pre-chilling compartment in the freezer room.

2c) Gwezotshaa Natural Resources Trust, Gweta, Botswana

Marula pulp production was attempted by this community-based trust with assistance from a USAID-funded project. Market research indicated that the project would have to aim at processing around 12000 tons of fruit to guarantee the annual concentrated juice supply of 1000 tons required by commercial partners. This quantity was beyond the scope of the project at that stage and in the 1996 season 85 tons of firm green marula fruit was transported to Granor Passi's factory in Pietersburg, where it was processed and samples distributed to the beverage industry. These samples were rejected as too "green" tasting. It was decided to move processing to Gweta so that ripe fruits could be processed (and nuts could be retained on site for later community-level processing).

For the 1997 season two impact/brush pulpers (Brown Model 202, designed for soft fruit) were imported from the USA, mounted in series (pulper and finisher, fitted with coarse and fine screens, respectively) on a trailer in South Africa, and supplied with diesel engine, with the idea of moving the equipment between areas with high concentrations of marula. However, a bureaucratic failure to register the trailer for road use necessitated employing it as a stationary unit. This resulted in much higher transport costs and delayed deliveries due to periodic fuel shortages in the area.

The start of production was further delayed by problems in sourcing operating capital, by inefficiencies of management (decisions had to be endorsed by a community-elected Management Board) and by a commitment to work through Traditional Authority structures. In the end the project produced just under 20 tons of marketable pulp at an extraction rate of 6:1 (against an expected extraction of 3:1 and a production target of 330 tons of juice/puree/pulp) and lost at least Pula 800/ton (or Pula 1800/ton if the cost of barrels is added).

Some relevant facts are:

a) Fruit purchases and primary quality control were left to "recorders" in the participating villages, with weekly payments against record sheets – this worked fine as far as payment was concerned, but increased transaction and transport costs and resulted in inefficient quality control (due to the fact that recorders found it hard to reject sub-standards fruits offered by relatives and neighbours), which was made

worse by transport problems – in the end up to 50% of the fruits purchased were rejected before processing
b) Villagers were paid a rather measly P3.25/50kg bag, or P65/ton – around N$0.08/kg – and probably did not prioritise marula harvesting, or pay particular attention to selecting quality fruit (they were also supposed to later share collectively in the profits through community-level benefits, which did not materialise)
c) Local transporters were involved when it became clear that alternative arrangements were needed – they were paid P37.50/ton for delivering fruit to the processing site (the report on this project makes the interesting point that using local collators and transporters involves local elites and serves as an important nucleus for social mobilisation and organisation at harvester level)
d) Despite previous trials the pulpers were not well suited to marula fruits and experienced several technical problems, made worse by delays in starting the processing, which in turn resulted in much drier late-season fruit being delivered for processing – as a result the actual throughput was only 1.3 tons per hour (=220 kg of puree), as opposed to a projected throughput of 3t/hr (1t puree/hr)
e) The technical problems also resulted in the formation of lumps in the pulp, which made it impossible to mix preservatives properly, resulting in more than 30% of the production starting to ferment before it could be moved to cold storage in Maun (some 200 km away) – this cold storage (and transport) was not planned into the initial production costs and contributed to the overall loss incurred
f) The food-grade plastic barrels used for packaging (and transporting them from South Africa to Gweta) represented a significant additional cost; the barrels were of poor quality and did not close properly, necessitating the use of a double plastic liner closed with wire ties, which allowed additional time for air to enter the pulp and set off fermentation, and further increased costs

The main lessons for Namibia are:
a) Do not be too ambitious in the beginning – rather start small and solve problems as they arise, to ameliorate the (inevitable) losses on the first year or two of production
b) Do have cold storage available on site, even if preservative use is planned
c) Do everything possible to rationalise transport costs, with a back-up plan for marketing fermenting juice
d) Do not expect too much of the technology unless it is fairly clear of how it will perform with fruit of varying quality
e) Do not trust in one expensive machine which can break down and cause the whole system to fail – rather use many copies of smaller, simpler equipment and have plans in place to scale up when justified
f) Move as many aspects of collating and delivering fruit to a local level as soon as possible, but give the managers of the production facility a free hand to fire non-performing workers, and to be ruthless about fruit quality control (e.g. reject any and all bags that contain two or more sub-standard fruits)
g) Start off with a fair primary producer price (calculated on local cost factors and extrapolated to commercially realistic volumes) and subsidise initial losses if necessary

h) Pay primary producers directly (and do not rely on promises of later benefits, or traditional leadership, to generate sufficient commitment among harvesters)
i) Use the cheapest effective form of packaging until exact requirements have been negotiated with buyers

2d) Veld Products Research and Development, Botswana

In addition to its substantial work on domesticating wild natural resources, this NGO has been working on marula fruit product development for a number of years, so far without noteworthy success. It has developed a pulping process that consists of:
a) washing the fruit
b) blanching the washed fruit at 95^{o} C for 5 minutes
c) macerating the blanched fruit to separate the seed from the pulp and skin
d) passing the chopped pulp and skin through a brush pulper fitted with a 1mm screen to separate most of the pulp from the skin
e) passing the remaining skins and some pulp through a colloid mill to reduce the skin to a soft thick paste

The throughput and efficiency of this process is not known, but is believed to be too time-inefficient for larger-scale commercial operations.

From the pulp and the skin colloid (combined in various proportions) VPR&D has made (in collaboration with other people and institutions):
a) several potentially interesting jams and chutneys (some of them mixed with other indigenous fruits) – marula jam is now produced and marketed at SME scale by a number of CBOs in Botswana
b) yoghurt and ice-cream flavourings (again, sometimes mixed with other fruit) – there has been no commercial uptake
c) two different versions of “fruit cheese” (a thicker version of fruit leather), consequently taken up as an SME opportunity by at least two CBOs in Botswana, but with unspectacular commercial results
d) a cordial (syrup) of unacceptable flavour
e) skin-and-flesh marula atchar that was a failure (the bottles exploded)

Most recently VPR&D produced a test batch of marula cider in collaboration with a local food research institute; the product was described as very good and 2000 bottles were being used for test marketing in local bottle stores. A lip balm made from marula oil and beeswax has reportedly been enjoying good local sales.

Possible lessons for Namibia include:
a) Do not get too hung up about producing finished products – try to get a substantial production of raw material going and further value-adding will have a much better chance of success
b) Try to keep the processing technology simple and affordable, so that it can be scaled up and/or replicated at reasonable cost

c) There are distinct product-formulation advantages to be had from separating (and then re-mixing in various proportions) the juice/pulp and the skin

2e) Tulimara, Zimbabwe

Tulimara started out as a private business producing herbal teas and jam from masau (*Ziziphus mauritiana*) in collaboration with the Zimbabwean NGO SAFIRE (which handled community-related aspects of the production system). Marula jelly was added to the product line at a later stage. In 2002 SAFIRE registered a company, Speciality Foods of Africa (Pvt) Ltd, which bought the Tulimara trade name from Tulimara (Pvt) Ltd.

In addition to makoni tea, masau jam and marula jelly, Tulimara also produces canned bambara groundnuts and cow peas. All its processing and packaging is done on a contract basis by a large food processor.

Tulimara’s production of marula jelly is low (the exact quantity is not known). Juice for jelly production is extracted manually (in the same way used by the MDA project described above). The jelly itself is commercially acceptable but not as good as some products made at a smaller scale (specifically, it is quite dark and does not have the beautiful clear red-brown colour of the best marula jelly). The main positive features are well-designed packaging, including an innovative handmade wire-basket presentation pack that holds two bottles (one masau and one marula) and an established local market.

At the current scale of production it seems unlikely that Tulimara’s marula processing would be viable by itself (i.e. capable of paying management and overhead costs without the support of other products in the range).

2f) Infruitec, Stellenbosch, South Africa

As part of the government-sponsored Commercial Products from the Wild project, Dr Chris Hansmann of Infruitec has developed a small marula juice production system based on an Indian brush pulper and an in-line steamer/pasteuriser built at Infruitec. This package costs about N$85 000 and can produce around 30 kg of pulp and hour, which can then be formulated (through the addition of water and sugar) into 100 litres of marula nectar, pasteurised and manually hot-filled into bottles.

A simple calculation will show that the KAP hydraulic press is at least three times more cost-efficient (in terms of kg/hr/N$) than this package, in addition to being locally made, readily available, and more easily scaleable.

The pasteurised juice produced by the Infruitec package loses a significant amount of marula flavour in processing, probably at the time when it is hot-filled into glass bottles (which would allow volatile flavour compounds to escape). While in-line pasteurisation remains an option for stabilising marula juice (and in-bottle pasteurisation is the most effective and accessible preservation option tried so far) it requires further research before it can be recommended as a commercial option. As has been suggested by the IFTT, it would be interesting to involve a partner such as Namibia Diaries in such trials.

2g) Various small-scale producers

There are a number of projects and SMEs in Namibia and Southern Africa that produce marula jam or jelly on a small-scale (one business in South Africa was reported to have reached a production of 50 000 bottles a year, but then closed down for unknown reasons). Most of these businesses extract juice by hand, or by boiling sliced fruit. There is not much that Namibia can learn from them at this stage that would be relevant to pilot-scale marula juice/pulp production. However, many of these businesses would benefit greatly from the availability of a cost-effective small press of proven efficiency and durability, and might thus become an export market for Namibian-made technology.

2h) Eudafano Women's Cooperative members, northern Namibia

The producer association members of EWC have been using the small hydraulic presses designed and built at KAP for two years without major problems. For the 2003 season the presses have been modified to make exchanging the hydraulic jack easier, and the jacks have been upgraded to 10 tons (there has been no opportunity as yet to assess the effects of the changes on production). While more details about the performance of these presses (the old version) are available from the PIF Phase One Final Report, the following points are worth summarising here:

a) The bench-mark processing capacity is 25-40% juice (depending on fruit quality) expressed from around 40 kg of fruit per hour
b) Under field conditions some operators have achieved outputs of up to 200 litres a day
c) The presses themselves have been remarkably problem-free (more so if they were not frequently transported) and problems with the hydraulic jacks could be rectified in the field, by the RDC at Ongwediva, or by exchanging a new jack
d) The press yields a liquid juice with varying (depending on fruit quality) quantities of pulp (which settles out as a heavy sediment in time) – this juice is very similar to the first-run juice traditionally produced by hand, and therefore makes fine omaongo
e) The flavour of this juice is acceptable but less than optimal, because significant parts of the marula flavour is contained in the skin
f) Fitted with their oil pressing adaptors the presses can reach a higher pressure than the 30t KAPMOND model used for commercial marula oil production (probably achieving a higher extraction rate, but not the same hourly production due to a much smaller cage) – press owners can now also produce marula oil for own use or marketing

In addition to other, more technical, reasons outline below, these presses are designed to constitute a potentially viable business opportunity that can be paid off with an Agribank loan (i.e. the financing facility that has largely driven the rapid growth in the small milling sector) and as such it will be a valuable technology demonstration opportunity to use them (and make them available for hands-on trials) during the pilot processing. The prototype of the RDC press (of similar size but different design) was only completed late last season and has not been tested extensively, but if copies were readily available it would be good to use some for comparative purposes.

2i) Research done at CIRAD-AMIS

The work done at CIRAD last year was interesting but inconclusive, due to the poor quality of the fruit that could be supplied in the late season of a drought year. For details refer to the confidential report submitted to the IFTT. There is nothing in the CIRAD report that contradicts the pilot processing proposed (although further work could obviously result in major improvements and higher-value products).

2j) Considerations based on literature and previous trials

The following random points are of interest in designing marula juice/pulp pilot processing:

a) Marula skin contains 153 separate flavour compounds and many other potentially useful natural substances – it is likely to be of great interest to commercially orientated researchers, provided a significant supply can be demonstrated
b) As marula ripens its juice yield at first increases, and then decreases; concurrently the flavour profile changes from green to over-ripe; somewhere along these two graphs lies an optimal point for processing, which has not been determined yet (but will hopefully emerge from the CIRAD research)
c) Refrigerated marula fruits produce a much clearer juice than fruits pressed at room temperature (without significant impacts on yield); the effects of cold pressing on flavour are uncertain, but some researchers have reported cold damage to refrigerated fruit (fruit kept in cold storage at KAP for more than a month turned brown but still yielded reasonable quantities of fair quality juice)

3) Project design features based on current knowledge

3a) Raw material supply

Environmental sustainability: The marula population of the NCRs is healthy, valued, protected and most likely on the increase. Marula propagation is simple and well understood. Several elite specimens are known and plans are afoot for their propagation and cultivation. The only conceivable threat to the resource (barring new and unforeseen plagues) is the extremely long-term genetic erosion that might arise from the widespread release and adoption of selected cultivars.

Biophysical availability: We still have no better idea of the number of marula trees in the NCRs than the "best guess" of a million. To be conservative, let's assume there are only half a million. We know 80% of them are female – that's 400 000 fruiting trees. A survey last year found an average yield of more than 600 kg/a. Let's allow for bad years and say 500 kg/tree/a – that's 200 000 tons of fruit. If we can mobilise just 1% of this we will process almost as much as the *Amarula* facility at Phalaborwa.

Socio-economic availability: How much fruit people will harvest and sell depends largely on the price. To remain price-competitive with South African producers it is proposed that 25c/kg be offered to primary producers who deliver at collection points. To minimise the initial impacts on neighbours who do not have marula trees and limit the danger of oversupply it is further proposed that purchases be done only once a week at each collection point, that individual quotas be set at what a person can physically carry, and that the quality standards be set quite high (only firm greenish-yellow unblemished fruits).

Geographic location: The highest density of marula trees is found in the eastern Ohangwena region, but to provide information about supply in other regions it is proposed that purchases be done in all areas where the Eudafano Women's Cooperative has producer association members. This leaves open the option of restricting purchases to EWC members in cases of radical oversupply.

3b) Processing technology

KAP and RDC hydraulic presses: Because they are readily available, easily scaleable and highly cost-effective (compared to more sophisticated imported technology) it is proposed that the pilot processing be done with these local technologies. This will also enable a comparison of the relative performance and merits of the two designs.

Higher-tech options: It is proposed that the use of more complicated technology be investigated at a laboratory-scale in a continuation of the established relationship with CIRAD-AMIS, part-sponsored by French Cooperation. Details of the work proposed can be gleaned from the confidential CIRAD-AMIS Final Report submitted to the IFTT. Dr Yves Lozano can travel to Namibia in early April to familiarise himself with on-the-ground realities, and discuss the details of further research collaboration.

Press residue processing: Small hydraulic presses squeeze open the majority of fruits and expel between 25% and 40% juice (w/w), leaving behind a compacted mass of fruit skins with the pips and their adhering pulp still inside. To quantify the labour involved in expelling the pips, investigate further processing options with the adhering flesh, and make available skins for further processing into pulp, it is proposed that a portion of the processed fruits be further processed by hand.

Downstream processing trials: Maximum synergy will result from coordinating this work with the fruit transformation trials budgeted for in the FAO/DoF indigenous fruit trees project. It would also be beneficial to involve existing SME-scale processors (e.g. Women's Action for Development at Mahenene). For the time being (given the many uncertainties that remain) it is probably best to continue these trials at SME scale, and to avoid capital expenses on larger-scale processing equipment until more details of such an investment have been elucidated.

3c) Preservation trials

Refrigerated storage: Cold storage (freezing) is the most acceptable form of preservation for high-value market niches, but might be prohibitively expensive in other markets. Nevertheless, refrigeration is essential in the processing trials, and it is therefore proposed that the project budgets to rent a refrigerated 12m container for three months.

Packaging: Bulk refrigeration is standard practice in commercial juice processing, but beyond the scale of a pilot project. For the first year it is proposed that the juice and pulp be frozen in heat-sealed, food-grade plastic bags, shaped in moulds during freezing to facilitate efficient stacking. Alternative containers can be tried at smaller scale.

Chemical preservation: Some preservatives are used in such small quantities that it was not practical to test them during PIF Phase One. It is proposed that a part of the juice be chemically preserved after further consultation with potential markets about acceptable types and levels of preservatives.

3d) Markets

Emergency markets: It must be acknowledged that refrigerated storage is vulnerable to prolonged power cuts and mechanical failure of the compressor. Should the refrigerated container be rendered inoperative for long enough to thaw frozen juice and start fermentation, the only option would be to sell the resulting omaongo in local or urban markets at a discount.

Local and national markets: There is a substantial price gradient (of up to 500%) between omaongo in the NCRs and in Windhoek, which implies an opportunity for small-scale entrepreneurs (with access to appropriate traditional knowledge) to buy juice from the pilot project, transport it to an urban area, and sell it. If juice production exceeds targets or freezer capacity this market could be actively stimulated.

Market liaison: A crucial reason for pilot processing is to develop mutually acceptable quality standards in collaboration with prospective buyers. For this reason the proposal makes substantial provision for pro-active market liaison work.

3e) Strategic considerations

Publicity: PIF Phase One did very little active publicity seeking, to observe as "undisturbed" as possible a baseline scenario and avoid creating too much expectation too soon. During the pilot processing however, it would be strategic to briefly whip up public enthusiasm, so as to get a glimpse of the potential fruit supply. In this regard it is proposed that public announcements on NBC radio be used (ideally around the third week of processing) to inform the public that a certain price is offered for good marula fruit delivered to the factory gate, and that interested parties should phone for an appointment to sell. Quality requirements should be very explicit. If the response is not too overwhelming the appointment requirement might be dropped.

Scheduling supply: In the first week of processing smaller quantities of fruit will be needed for training press operators and experimenting with workflow. It would be most convenient to buy these fruit through EWC producer associations. These first purchase visits can also be used to recruit a local purchasing assistant, agree a convenient venue, and set purchasing dates. In the second week purchases should be conducted at a rate of two a day at the 10 producer associations that responded best to the first round. Depending on the quantities that seem to be available the second round of purchases can be opened to non-members if the EWC association agrees. In the third week factory-gate purchasing should be tried in parallel with collection. In the fourth week fruit should mainly be bought at the factory gate, but central point collections should continue to asses quality differences (i.e. whether collators can match the standards of tree owners), changes in supply levels, and possible regional seasonality.

Selection opportunity: Wide-ranging purchases offer an obvious opportunity to identify exceptional marula fruit, and thus trees for inclusion in the DoF/FAO domestication programme. Buyers should record the names of people supplying obviously superior fruit.

4) Project features designed to answer questions

The crucial unresolved questions – in addition to the overriding question of costs, prices and markets – that must still be addressed around commercial-scale marula fruit processing, and suggestions about how they can be answered through a pilot processing project, are detailed below.

4a) Raw material procurement

How do we reliably get large quantities of marula fruit to a central processing facility (and preferably return the seeds to rural areas where they can be decorticated)? Would mobile processing be a viable alternative to a central facility?

Buying and transport: An ideal solution would be to have fruit delivered and one of the strategies that must be tried is to mobilise collators (and/or vehicle owners) through a price incentive at the factory gate. Due to the need to manage oversupply, and because the price differential should be fairly assessed by quantifying the real costs, this cannot be done from the outset. It is proposed to use a project LDV (with a trailer) to move fruits from buying points to the processing facility. To minimise bruising and facilitate quality control fruits will be transported in boxes. A local assistant will be recruited at each buying point. Buying 1600 kg of fruit at 25c/kg the money involved in each load (N$400) is probably not significant enough to warrant unusual security measures. At around 25 kg of fruit per bag, 64 transaction per load will be concluded – with an efficient system this can probably be done in two hours or so (but initially it will take longer).

Returning seeds for decortication: This is highly desirable, and should be tried. A standard volumetric exchange system will be relatively easy. It should be made very clear to sellers that they will not receive seeds in exchange during the first purchase, and that they will receive seeds randomly, with no guarantee (and a low probability) that they will get their own seeds back. To avoid disputes and keep transaction costs reasonable it is probably best to return stones in bulk wherever producer groups can handle the distribution on their own.

Mobile processing: Moving the press to the resource has much to commend it, not least of which is economy of transport, an instant solution to seed distribution and ownership, and an excellent technology demonstration and training opportunity. Doing so for anything else than omaongo production, however, requires suitable mobile refrigeration equipment, and/or further preservation trials. To quantify whether such an additional capital investment (e.g. a refrigerated tanker-trailer) would be viable, or whether mobile processing is best reserved for omaongo production, it is proposed that two mobile processing sessions be organised in areas with extremely high marula concentrations.

4b) Quality control

How do we deal with the problem of people keeping their best marula fruit for own use, and selling only poorer or sub-standard fruits to the processing facility? Would the aggregated quality of these fruits still deliver a product acceptable to the target markets? What mutually acceptable quality standards can we negotiate with these markets? How do we conserve large quantities of pulp for transport to distant markets (in ways that are acceptable to those markets)? These questions are closely related to on-going investigations into the right stage of ripeness at which to process marula.

Fruit quality: It would be impractical to control marula for taste, but the buyer can at least insist on unblemished fruits at the right stage of ripeness. For this reason visual quality criteria should be rigorously applied. We strongly suspect that the average fruit quality would tend towards mediocrity, but we also think it would still be acceptable to the market (there aren't that many truly awful marula trees). There should be no special effort to buy only the very best fruits, as this will cause distortion of the sample quality and lead to problems when production is scaled up. A major known quality problem is fruit fly infestation, and an effort should be made to engage research personnel in trials of various (preferably biological) measures to control this pest.

Product quality: The aim should be to make, within the limitations of raw material quality, (a) premium product(s) that significantly retains the positive flavour characteristics of good fresh marula. All the work done to date suggests that this will require mixing a certain proportion of skin with the juice – ratios should be tried in close cooperation with commercial partners. Unlike the juice, all of which can as a last resort be sold locally as omaongo, it is anticipated that the demand for skin pulp (samples and/or commercial orders) will be relatively small at first. The strategy proposed is therefore to process samples with kitchen-scale equipment, and to quantify the potential supply of this product. Micro-biological loads must be routinely and randomly tested. The effects on various markets of the potential presence of fruit-fly maggot residues should be assessed. Mutually acceptable and practicable preservation methods must be agreed with buyers as part of product standards.

4c) Prices and markets

Can we pay the prices expected by Namibian producers (most of whom thought 50c/kg was too low) and compete with South African processors (who pay 25c/kg)? Can we secure enough quality fruit if we only pay 25c/kg? Are there niche or export markets that will allow us to obtain and pay premium prices?

Fruit price: There is currently no set price for marula fruit in the NCRs. It is therefore proposed that Namibia initially matches the SA price of 25c/kg (since the main SA markets are in the Western Cape, that would leave Namibian producers about as far from the market as producers in Mpumalanga and Limpopo provinces, SA's main marula-producing areas, and therefore in a position to match SA prices). The PIF Phase One Final Report contains more detailed calculations and discussion as to why 25c/kg is a reasonable price to pay in the NCRs.

Availability: Opinions are divided on the quantities of fruit that can be bought at 25c/kg, but SA harvesters mobilise around 3000 tons a year at this price. All cash income opportunities are valued in the NCRs and on the balance it seems likely that significant quantities of fruit can be mobilised even at this low price. It is guestimated that a marula processing facility would need to attain a production of at least 100 tons of pulp a year to achieve the sort of economies of scale that would place the product on the market at a reasonable price and profit (although this might still not be enough for some of the larger potential partners). To see if the required 334 tons of fruit is readily available, and to quantify the "delivered at factory gate" option, it is recommended that the IFTT makes a provision for trial purchases of this quantity (N$83 500), even though most of these fruit will not be processed in the first year (manual processors can be invited to help themselves against a nominal payment if and when quantities exceed the pilot processing capacity, possibly with an opportunity to try one of the presses).

Markets: The two known markets that have shown an interest in marula fruit are the SA beverage market and sections of the European cosmetics market. Potential Namibian partners such as Nambrew and Namibia Dairies have previously expressed an interest in collaborating around marula product development, but on condition that an adequate raw material supply is demonstrated and guaranteed. Several enquiries have been received from overseas buyers who are keen to find an alternative marula liqueur that can compete with *Amarula*. There are definite national markets for a standardised and bottled version of omaongo, but the extent of these is hard to quantify, and prices will be squeezed by informal-sector producers and traders. Researchers in Israel have developed technology for various marula products, and putative markets for these products, but are hampered by low overall production (from a few irrigated orchards) and high production costs; they have expressed an interest in licensing the technology to producers in Southern Africa, with an appropriate marketing arrangement thrown in – this option might be further explored. It is highly likely that marula juice – correctly processed – will have significant biologically activity that might interest the fast-growing international niche markets for functional and nutraceutical drinks. Accessing these markets requires further high-tech research (aimed at securing active product development partnerships with appropriately resourced commercial partners in major markets like the EU, Japan and US), but a useful first step would be to demonstrate the potential availability of sufficient raw material to warrant such work.

4d) Technology and economies of scale

Which market segments will find the quality we can currently produce acceptable? What technology would we need to access other markets? How do we "right-size" these technologies if we don't know the real size of the markets?

Pressed juice: SA juice manufacturer Wilde claims on its box to sell "real pressed juice", while Ceres sells various juices "with real fruit cells". From this it is clear that there is most likely a market niche for the type of juice that can be produced with a hydraulic press (even if it is unfiltered). We know that such juice is also acceptable for omaongo production and – provided it is not allowed to start fermenting – for jelly and cordial (syrup for dilution in a drink). Mixing back various quantities of pulped skin will open up additional possibilities and it is likely that the cosmetics market would prefer a pulp that is mostly skin. These are enough potential markets to justify a serious processing effort based on hydraulic cage-and-plate pressing, supplemented by skin pulping.

Scaling up or down: One of the advantages of cage-and-plate technology is that is can be scaled relatively easily. Much larger models of such presses are readily available in the international market, or can be manufactured in Namibia with little effort. On the other hand, fewer copies of the small presses could be disseminated to decentralised processing centres, should this seem a better option. All other things being equal such scaling up or down will have little effect on the quality of the final product, enabling project planners to maintain the initial sample quality, but at any chosen scale.

Alternative and higher technologies: It is easy to imagine niche markets for products of higher technologies (e.g. a concentrate produced through selective membrane technology, or a freeze dried flavour-extract), but substantial additional research is required before such possibilities are actualised. Again, such technology can best be developed to a suitable scale if more accurate figures about quantities (raw material supply and market demand) are available. Assuming that the cosmetics industry confirms its interest in a skin pulp, a suitable pulper would be the next most pressing technology development need.

4e) Further value-adding

In addition to making larger samples of juice and pulp available to potential commercial partners, pilot-scale marula fruit pressing will enable downstream processing trials at a larger scale than has been possible so far – an essential step in ensuring that Namibia is not restricted to being a supplier of raw materials[3]. It makes sense to plan such trials to coincide with the pilot project, and to coordinate them with the work planned with CIRAD and under the DoF/FAO project. Since further discussions with these partners are required, ***the cost of such downstream processing trials is not included*** in the present proposal.

The IFTT is asked to consider in principle whether it wants to support such trials at this stage, in which case a more detailed proposal will be prepared after further consultation. It is anticipated that such a proposal would continue with all or some the following work started under PIF Phase One:

- Trials to develop standardised recipes for jams, cordials, chutneys etc. and make available technology packages at a scale that will be financially viable; included in this is the need to address difficulties in obtaining packaging
- The use a solar oven to pasteurise juice in 750 ml beer bottles closed with star caps
- Distillation trials with marula (or sourcing appropriate distillation technology assistance from the University of Stellenbosch)
- Trials to make a standardised, bottled version of omaongo that can be marketed throughout the year
- Liqueur trials with marula

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[3] Due to the limited size of the Namibian market for finished products, and the difficulties associated with penetrating export markets for such products, it is advisable to concentrate at first on supplying semi-processed raw materials to industry (local or export), so as to incubate a much larger economic opportunity accessible to many more primary producers, and provide a solid foundation for more local value-addition. In line with national policy on value-adding, industrial development and job-creation, however, such raw material exports should be seen as a transitional step towards greater national benefaction of the marula resource, to be supplanted by exports of finished high-value products as soon as it is financially, commercially and technologically viable.

APPENDIX B

MJP3 Project

LESSONS LEARNT FROM THE PROJECT IMPLEMENTATION
Technical Report by Roger Gamond
24/04/03

- Targeted population awareness**:** at least 1 or rather 2 weeks before the project starts, marula fruit producers must be informed (radio broadcast) of the project start with clear requirements for fruit quality, selling procedures and purchase/transport prices.
It must be emphasized that the project does not target at the fruit segment which is traditionally processed, but at the one which is regularly not exploited (a lot of households own several trees but only use the fruits from one or two trees because they have no opportunity to valorise all the production).

- Purchase price: 25 cents per kg seems definitively too low; 50 cents seems broadly accepted.

- Transport*:* 25 cents per kg (N$ 250.00/ton) looks quite attractive to small local transporters, provided that they have not to drive many km to get only a few kg of fruits.

- Fruit supply quality: despite our concerns, people did not sell bad quality fruits; yes, we got especially at the beginning when fruits were collected under the trees over ripe fruits, but with little experience, you are able to identify them, particularly when you take them in your hand: they feel soft and empty, even if they look good. Anyway, these fruits float as soon as they are poured into the washing tub and they are discarded.
Regarding the size of the fruits purchased, their weight ranges from as little as 13g to 94g (proportion of 1 to 7)
We may share the fruit sizes into 3 categories:

- less than 18g (55 to 56 fruits/kg): almost exceptional
- from 20 to 55 g (18 to 50 fruits/kg): most common
- from 55 to 90g and more (10 to 18 fruits/kg): almost exceptional

- Fruit supply management*:* it is one of the most important and difficult project component allowing to achieve the juice production target. Over supply leads to huge losses (fruits over ripe or damaged, extra time needed to select the right ones), too low supply leads to losses by waste of time as press operators and casual workers are not fully employed.
It seems that the best way to get the right supply at the right time is to deal with local transporters judiciously selected according to the area they commonly cover, because:

- they know very well local people and marula tree locations;
- they can easily assess the fruit quality (and refuse/reject non standard fruits)
- they are able to bring to the processing centre the expected/required quantities at the right time.

For the project, this strategy would save a lot of time and energy:

- dealing with a few local transporters instead of thousands of small producers
- record/book keeping and financial transactions reduced to a minimum
- possibility to plan with local transporters a daily/weekly fruit supply
- easy work organisation
- full employment of press operators and casual workers
- no misunderstanding/dispute with producers

- Fruit weighing: weighing the fruits with a hanging or electronic scale is an accurate but too long process and most of rural people may rightly be suspicious about figures, especially when you have to play with buckets tare. During this project, we have successfully used plastic buckets as measuring units, each hipped bucket being counted as 10 kg of fruits. It is simple, quick and people can follow and understand the calculation leading to the amount they receive (1 bucket = N$ 5.00 if the fruits are collected under the tree or = N$ 7.50 if the fruits are delivered at the processing premises).

- Fruit selection and washing before processing: roughly, one worker is needed per press to sort out and wash the right quantity of fruits to feed regularly the press.
Fruits must be first sorted out in order to discard the damaged fruits and separate green/unripe ones (washing water could be quickly contaminated by rotten fruits if they had not been previously removed).
We only used clean water to quickly soak/stir the fruits to remove vegetal debris and soil stuck to the fruit skin.
It must also be highlighted that the bucket capacity corresponded exactly to the cage capacity, strongly facilitating fruit handling.
When quickly soaking the fruits in water to clean them, it is interesting to note that over ripe fruits float at the top of the washing container and can easily be discarded.
The draining rack, as designed and built, is fully appropriate to its use.

- Fruit processing: presses are now almost fully appropriate; the few problems we got only related to jacks: one jack remained stuck at full ram; another was stopped because the plunger's seal was leaking; the last one got its plunger broken at the top, in the hole axis.
The last needed improvement would be a stainless steel disc replacing the plywood plate on the press' s plunger, as this wooden plate is wearing quickly.
The new tray design (straight edges) prevents juice overflowing; the hand lever (replacing the former pedal) did not give any problem; since the jack's driving joints, rods and lever are directly fastened on the jack (and no more on the press itself), jack replacement is simple and quick.

- Press (and operator) performance: we got reliable data on press productivity: our best operator (Nikanor), provided its press was timely fed with fruits, was able to regularly process between 8 and 9 batches of fruits (± 11 kg) per hour meaning, at 27.5% extraction rate, a yield of 25.7 kg of juice (from 93.5 kg of fruits) per hour and a daily production, on a 7 hour basis, of 180 kg of juice.
Processing productivity strongly depends on an efficient work organisation: starting at 8h00 in the morning, we have been able several times to start pressing at 8h15 because fruits were already selected the previous afternoon and had just to be washed.
Obviously, fruit quality is also a deciding factor as healthy fruits are quickly sorted out while a hip of mixed quality fruits takes a lot of time to be sorted out.

- Traditional processing way: in order to be able to compare manual processing (traditional and social sides of the activity not taken into account) and mechanical processing, we made a few trials leading to these results: average extraction rate from 13 to 14% (just half of the result with the fruit press); time spent to punch, squeeze and separate skin and pip: from 12 to22 kg/h, depending on fruit size and ripeness (12 kg/h relates to small fruits -32/33 fruits/kg – and 22kg/h relates to high quality fruits – 21 fruits/kg -).

- Daily processing time: processing marula fruits for 7 hours a day is the maximum that may be done, as daily cleaning of buckets, tubes, presses and processing room's floor is compulsory and takes a lot of time (sticky juice, difficult to get rid of).

- Juice filtration: we noticed that juice very recently extracted, was really easy to filter through the stainless steel mesh bought for this purpose. Juice extracted a few hours before was much more difficult to filter as the mesh was very quickly blocked by what looked like mucus. Pulp micro fibre or already foam resulting from fermentation inception ?

- Juice packaging: it has been difficult and time consuming the first times to seal the plastic bags filled with 10 kg of fruit juice because the seal was not tight as soon as the inside walls of the bags were not perfectly clean and dry. This sequence improved after we got the new sealer and a bit of experience. Another problem is that it is difficult to minimize the air amount inside the bag when sealing it; the air pockets then allow liquid condensation inside the bag, generating ice when freezing. Bag sealing remains a critical step in the process and packaging may be improved with another method to be found.

- Juice deep freezing: according to technical documents dealing with juice preservation, deep freezing is the best method to keep the whole fruit flavour. However, if juice freezing is easy and quick at household level, it becomes tricky when you have to deep freeze 150 to 250 kg of juice at once.
Even with the thermostat adjusted on minus 10 or 15 degree Celsius, juice freezing requires at least 18 hours, provided that the bags are spread in only one layer in the freezing container. We have been able to deepfreeze our daily production because it was quite low (250 kg maximum of juice per day). A higher juice production would have required the use of shelves.
Juice bag storage in our cold room, even with the thermostat adjusted to minus 10, is critical: if bags are well placed in the cold air flow, they stay frozen; but as soon as bags are piled up in several layers or touch a wall or a pallet, the juice thaws at this contact point. Our cold room being overfilled with oil jerrycans, it is not possible to spread the juice bags in one layer.

- Freezing container: as the cooling unit is electrically driven, any power failure is critical because if the juice is not chilled in, let say 6 to 7 hours (depending on the room temperature), fermentation strongly starts and inflates the plastic bags, putting at risk the seal.
Another consequence of a long power failure we experienced is that there is also water failure (municipal pumps also electrically driven) and no way to carry on processing (no more washing possibilities).

- Chemical preservation: it has (fortunately) be tested before we had this long power failure, allowing to rescue the day production. The best tested preservation method, previously identified on several documents, requires very low quantities of potassium metabisulfite and potassium sorbate. Potassium metabisulfite is an antiseptic that destroys most of bacteria and Potassium sorbate destroys yeasts, preventing the juice from fermenting. At very low percentage, as it was tested on samples, this mix preserves the juice for about 17 days; after that, fermentation starts. Obviously, preservation time increases with the percentage of these two preservatives.

- Pasteurization: no attempts have been made this time because we had already successfully tested this method two years ago. Pasteurization is a simple way to destroy most of yeasts and bacteria; the only risk is an alteration/loss of flavour mainly caused by a too long heating time or a too high temperature. If pasteurization is easy at bench/household scale, a pasteurizer is required for preservation at semi industrial scale.