ENHANCEMENT OF COFFEE QUALITY THROUGH PREVENTION OF MOULD FORMATION

Overview of socio-economic studies in Indonesia

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Context

This work corresponded to a study managed by FAO in connection with the project entitled "Enhancement of coffee quality through prevention of mould formation", intended to assess the degree of OTA contamination in coffee, and possible solutions adapted to each local context in 8 countries. For Indonesia, the project was drawn up and implemented jointly by ICCRI, CIRAD and the national consultant from LRPI, W.R. Susila.

Three socio-economic studies were selected by ICCRI and FAO in February/March 2004. CIRAD was not involved at that stage, but was able to fine-tune the study protocols in May 2004.

The three studies were as follows:

1) Targeted Investigation of Robusta Coffee Processing and Marketing Chain in Lampung,
2) Study of the adoption of the wet process in Pupuan-Bali and feasibility of the introduction of wet processing in East Java,
3) Targeted study of the Arabica coffee production chain in North Sumatra (Mandheling Coffee).

Five documents were produced on those 3 studies:

1) Targeted Investigation of Robusta Coffee Processing and Marketing Chain in Lampung, W.R. Susila, National Consultant,
2) Investigation of the feasibility of wet processed Robusta by Smallholder Farmers in East Java, W. R. Susila, National Consultant,
3) Targeted Study of the Arabica Coffee Production Chain in North Sumatra (The Mandheling Coffee), W. R. Susila, National Consultant,
4) Study on the Robusta coffee production chain in Lampung: Analysis of the "Nestlé project" for the prevention of moulds responsible for ochratoxin A contamination. A. F. Ruscassie, B. Sallée, E. Cheyns, CIRAD, and
5) This overview based on studies 1 and 2 only.

Research issues

In theory, where OTA are concerned, the reasoning of the Indonesian coffee supply chain is based on the following hypotheses:

- When EU[1] norm projects were considering a maximum limit of 5 ppb in green coffee, studies estimated the risk of contaminated batches at under 5%, far behind certain other rivals on the robusta market,
- The 5 ppb norms in roasted coffee still substantially minimize that risk, since less OTA is systematically measured in roasted coffee than in the green coffee sample from which it comes (at least 70 to 80% on average[2]),

[1] European Union

- Yet, "risky" conditions and practices on farms and in the supply chain are clear: shoddy harvesting, a great deal of rainfall during the harvesting period, nonexistent or very rudimentary drying equipment, marketing up to the exporter with a high moisture content (18 to 20% on average), possible long storage at different levels, by farmers for cash-flow reasons, by middlemen and traders to acquire a sufficient volume or to speculate, etc.

This contradictory situation led the relevant authorities and the Indonesian research institute to make the following statements:

- In theory, the Indonesian coffee supply chain will only be slightly affected, if at all, since international roasters need robusta and the probability of having contaminated batches is greater with the other "origins",
- Yet, vigilance is called for, and risks should be minimized as much as possible.
- In order for farmers to adopt the best practices, particularly when drying, it is essential to obtain a quality premium making it possible either to envisage investment, or to compensate for the increase in production costs.

ICCRI therefore proposed these 2 studies, on the robusta supply chain in Lampung and on the switch to wet processing in East Java, which corresponded to this strategy:

- Initially, in Lampung, it was a matter of assessing the efficiency and reproducibility of introducing quality premiums for farmers, based on two objective criteria: moisture content and number of defects. That system is currently in place in a supply chain commonly known as the "Nestlé supply chain".
- In the second case, innovation mostly focuses on technology, with the adoption of robusta wet processing, hence with a potential premium for the end product. In order to propose that change in East Java, ICCRI suggested carrying out an analysis/overview at Pupuan (Bali) where that technology was introduced in 2002 and, on that basis, assessing the feasibility of that innovation in a distinct context (East Java).

Theoretically, in both cases, the risks of OTA contamination were minimized and farmers were better remunerated.

Lastly, this overview ends with some thoughts on the consequences for stakeholders in the Indonesian robusta supply chain of the EU introducing OTA norms.

[2] This involves measurement differences. It seemed to be attributed to OTA degradation during roasting, but recent studies prove that there is indeed OTA degradation but also "masking" in biochemical complexes, which the analysis methods in the norms cannot measure.

1. Study of the "Nestlé" robusta supply chain in Lampung

Only the most notable results from the documents (1 and 4, see page 2) are indicated here. The detailed analysis of the supply chains and production systems can be found in those documents.

1.1. Analysis/Overview of the "Nestlé" system

For farmers

For farmers, it was a matter of producing green coffee with a moisture content under 12% and fewer than 120 defects. Two options were possible:

- Either wash and sort green coffee obtained conventionally,
- Or use practices that minimized the number of defects (in particular, selective harvesting), and improved drying.

Most of the farmers involved in the Nestlé project went for the first option, which was reflected in a work overload for drying and sorting, a loss of weight estimated at between 14 and 27% (loss in water and weight of defects) and slightly deferred payment (5 to 7 days). Farmers therefore needed to be able to cover the extra work and not be forced into rapid or conditioned sales (sale for credit repayment) in cash-flow terms.

Analyses showed that not all the farmers had the same possibilities of adopting the Nestlé system.

Table 1: Criteria governing adoption of the Nestlé system by type of farmer

	Cash-flow level at the start of harvesting	**Labour availability**	**Accessibility to cooperative sales**	**Possibility of adopting Nestlé system**
Type 1	Negative to zero	Low	Low	Very difficult
Type 2A	Very low	Average	Average	Difficult
Type 2B	Low	Average	High	Possible
Type 3	Low	High	High	Possible
Type 4	High	High	High	Possible

These types of farmers are summed up in the following table:

Table 2: Differentiation between types of farmers

	Area	Investment capacity	Type of labour in plantation	Work on another plantation	Level of diversification as a % of agricultural earnings not from coffee	Drying method	Level of schooling
Type 1	0.5 to 1 ha	none	Family	Compulsory	30%	Bare soil	Low
Type 2 A	1 to 2 ha	very low	Family	Optional	50%	Bare soil	Low
Type 2 B	1 to 2 ha	low	Family	Optional	50%	Bare soil	Average
Type 3	2 to 5 ha	low	Family and hired	None	40%	Bare soil-cemented area	Average
Type 4	> 5ha	high	Hired	None	20%	Cemented area	Average

The discriminant criteria for this typology were: the area planted to coffee, the capital level, the employment of hired labour, and the level of schooling. The differentiation between types 2A and 2B came from the level of schooling. In general, the "2B" farmers, with better schooling, had a secondary activity enabling them to take certain risks.

On a sample of 90 farmers, the distribution of types was as follows:

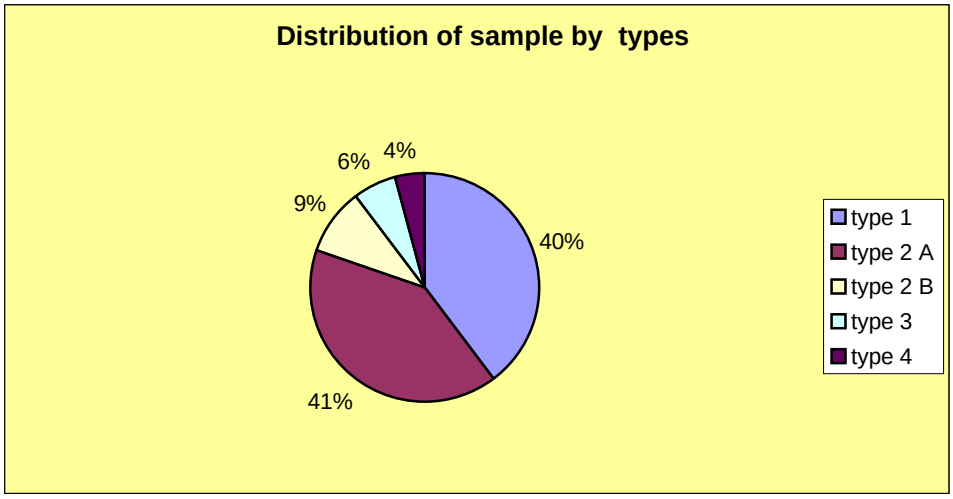

Figure 1: Distribution by types of the 90 farmers interviewed

Thus, only 19% of farmers adopted the Nestlé system.

Cash-flow, and as a corollary, income diversification, was one factor explaining the adoption of the Nestlé system. An analysis of the data (figures 8, 9 and 10 of document 4, see page 2) clearly showed that.

Its merits in economic terms were not obvious to farmers. The premium was real but it had to at least compensate for weight losses and extra costs. The farmers felt that the premium ought to amount to at least 30% of the price of traditional quality (called asalan). For average basic production of 800 kg of wet hulled unsorted coffee[3], overall farmer income increased, but the income per day's work could be lower.

[3] This is average production for type 1 and type 2 producers.

Table 3: Comparison of earnings and work output between the traditional system and the Nestlé system for a price difference of Rp 1200

	Traditional system	Nestlé system (family labour)	Nestlé system (hired labour)
Volume sold in kg	800 kg	688 to 584 kg	688 to 584 kg
Sale price	Rp 4000/kg	Rp 5200/kg	Rp 5200/kg
Result	Rp 3 200 000	Rp 3 270 000 to Rp 3 660 000 (Nestlé sale + defects)	Rp 3 270 000 to Rp 3 660 000
Income	**Rp 2 980 000**	**Rp 3 050 000 to Rp 3 440 000**	**Rp 2 890 000 to Rp 3 280 000**
Labour provided	92 man-days	108 man-days	
Income/day's work	**Rp 32 400/man-day**	**Rp 28 200 to Rp 32 000/man-day**	

Lastly, only farmers near the cooperative created for this supply chain (KUB) produced the quality required by Nestlé. This was a classic result in the organizational environment. Involvement in the cooperative was an explanatory factor.

For the supply chain

The studies revealed three main results:

- The Nestlé system was very worthwhile for middlemen and traders,
- Introduction of this system made it possible to generalize objective quality criteria (moisture content and % of defects) even in the traditional supply chain and,
- The Nestlé project made it possible to strengthen or create farmer organizations.

A comparison of the advantages for the different stakeholders in the supply chain is given in the following table:

Table 4: Comparison of incomes for a farmer, a middleman and a trader in the traditional and Nestlé supply chains

	Farmer (800 kg)	Middleman (50 t)	Trader (500 t)
Income in the traditional supply chain (in 000 Rp)	2 980	6 500	25 000
Income in the Nestlé supply chain (in 000 Rp)	3 050 à 3 440	7 500 à 14 500	40 000 à 80 000
% increase in profits due to the Nestlé system	2 to 15%	15 to 120%	60 to 220%

This partly explains why the Nestlé project, which was originally planned with direct purchasing from farmers, gradually turned to middlemen and traders for its raw material supplies.

Generalization of "Cera Tester" moisture meters and the estimation (sometimes measurement) of defects in the traditional supply chain were an improvement that could be attributed to the creation of the Nestlé supply chain. Visual and tactile estimation was still generalized in contracts between farmers and middlemen, but objective criteria were beginning to be introduced.

Lastly, it was undeniable that the Nestlé project had helped to strengthen farmer organizations in Ngarip, in the founding village, but also in the region.

For the prevention of mould formation

The Nestlé system enabled better control of mould formation than in the traditional supply chain. We took as the main criteria the time between harvesting and green coffee beans at a 12% moisture level, when water activity no longer enabled growth of *Aspergillus* spp., which is responsible for ochratoxin A production.

When Nestlé bought coffee directly at 12% moisture from farmers, that duration was minimized. But such cases were increasingly infrequent.
When Nestlé bought from its trader, who himself obtained supplies from farmers and middlemen, the duration was undetermined as the background of the coffee was unknown. In order to avoid that problem, Nestlé only bought coffee via that supply chain during the harvest period. That measure also partly explained why the instant coffee production factory, which had to work all year round, only purchased a small share of its requirements via that supply chain.

That duration was studied in the particular case of coffee from Ngarip, in the traditional supply chain and in the case of direct purchasing from farmers.

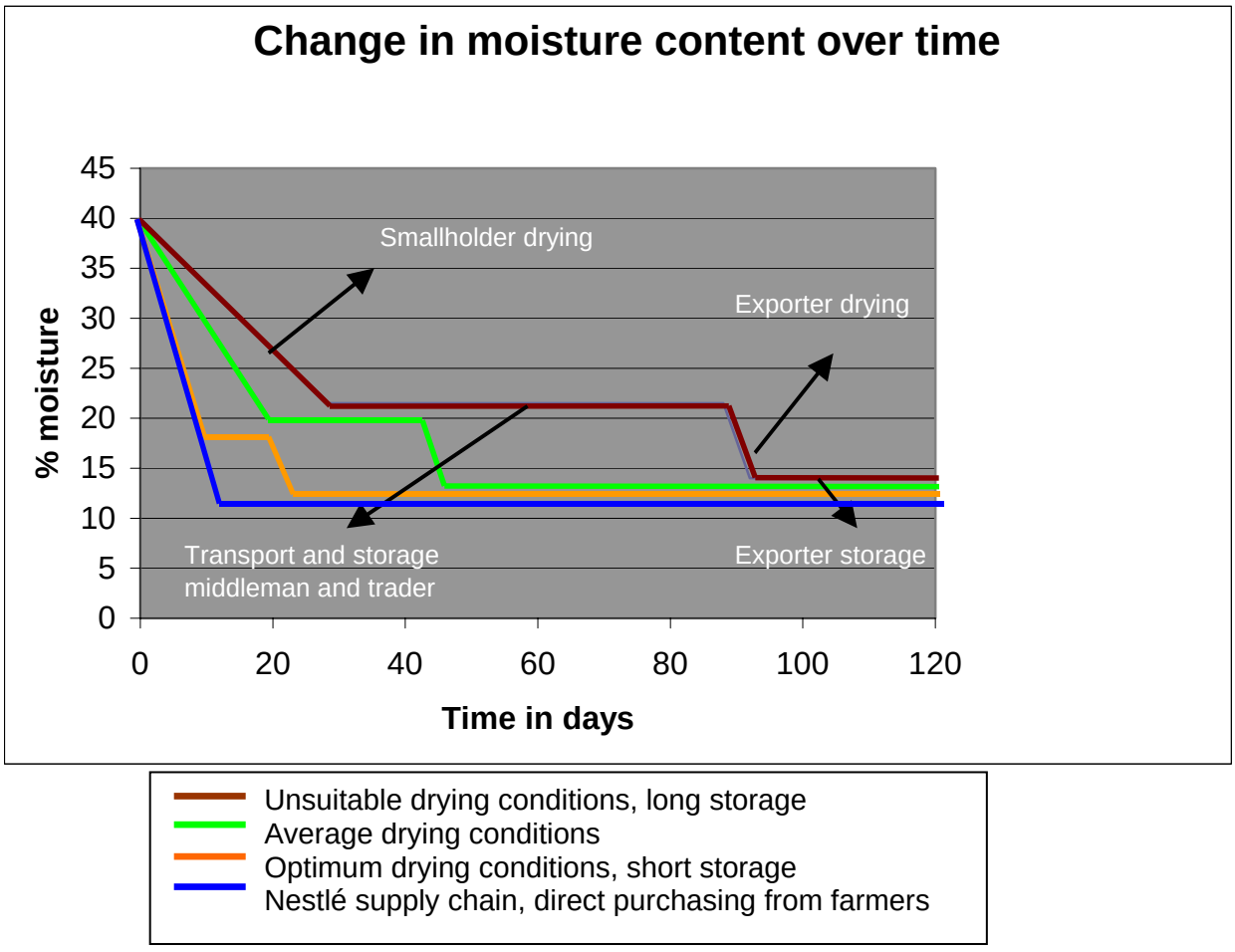

Figure 2: Change in moisture content over time depending on coffee circuit in the supply chain

The moisture rates and number of defects in samples taken from stakeholders in the supply chain were as follows:

Table 5: Moisture Content and Defects at various stakeholder levels

Stakeholder	MC		Defects	
	Average (%)	CV (%)	Average	CV (%)
Farmer	19.43	13.94	210.61	91.66
Middleman	19.08	10.56	189.00	47.35
Trader	17.77	8.85	140.24	26.58
Exporter	12.73	5.89	57.88	20.09

MC : Moisture Content
CV : Coefficient of Variation

These data clearly show that final coffee drying to 12% was mostly carried out by exporters. All in all, the middlemen played a very limited drying role, since the moisture content varied very little up to the exporter. However, those stakeholders "homogenized" the coffee by mixing yields of different origins; the coefficient of variation clearly showed that.

In the traditional supply chain, farmers could store their coffee with a high moisture rate, for cash-flow purposes. Middlemen thus received coffee up to the end of October (for a harvest mostly in June and July). Each actor in the middleman, trader, exporter sector could thus store coffee to build up batches, to speculate, etc. The following figures illustrate this storage function.

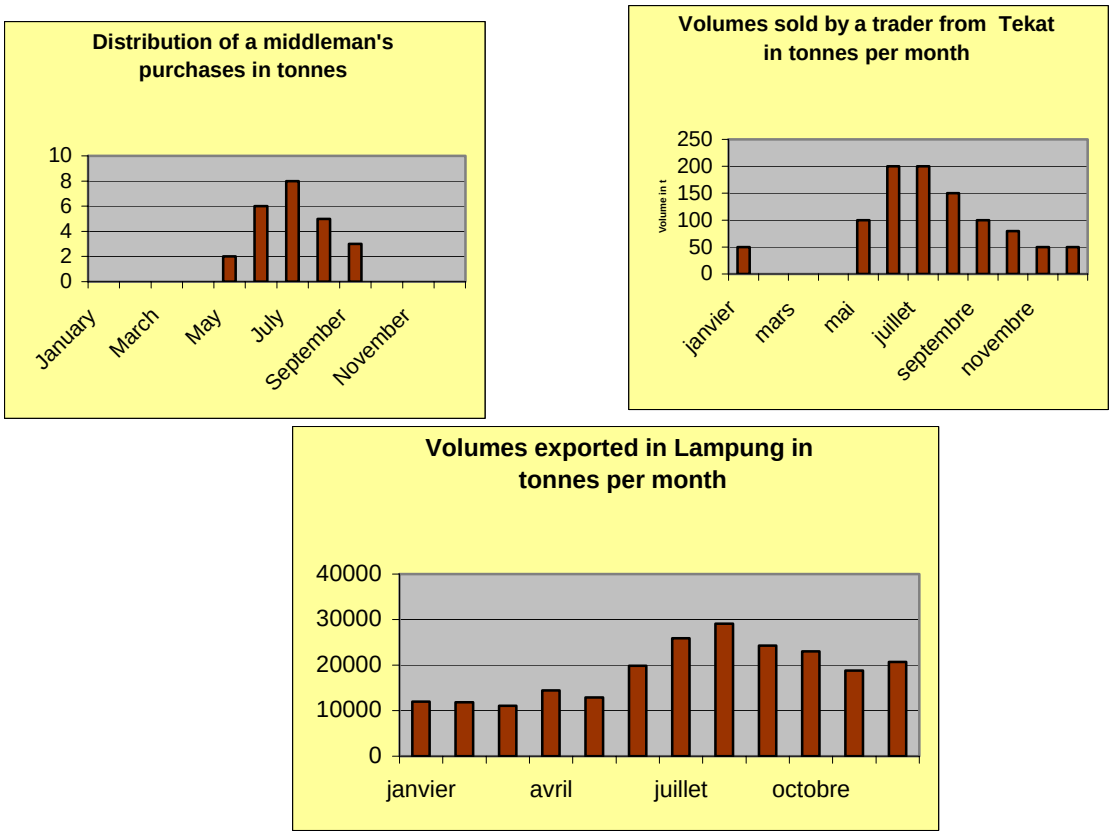

Figure 3: Annual distributions for the sales of a middleman and of a trader and volumes exported in Lampung

In addition, in order to achieve a minimum of defects, the stakeholders in the Nestlé supply chain had to carry out sorting. For example, farmers who sold directly to Nestlé, passed their coffee twice through a huller, before re-drying and sorting by hand again. Manual sorting and winnowing was seen among middlemen (see photo 20, document 4). Nestlé traders even used densimetric sorting. All these operations made it possible to remove potential sources of ochratoxins, particularly bits of shell debris which were the most contaminated.

OTA analyses carried out on farms and throughout the Nestlé and traditional supply chains did not enable any significant difference to be measured between the supply chains, as the ochratoxin contents measured were extremely low in all cases.

1.2. Reproducibility of the system

The Nestlé system was difficult to reproduce, for many reasons. The main three are indicated below.

Firstly, Nestlé is a roaster, an instant coffee producer. To obtain its raw material, the factory traditionally called upon local exporters, who prepared coffee for it in accordance with its conditions. Commercial benefit was derived from instant coffee sales and exports. In order for another stakeholder in the supply chain to play that role, it would be necessary to be at the same level in the supply chain, i.e. that its activity be centred on roasting. Exporters could not afford to adopt the same strategy, since it would mean transferring the drying and sorting activity upstream and thereby losing its benefits. However, the other national roasters did not have the same strategy as Nestlé regarding their image of being associated with coffee safety and did not therefore wish to risk making purchases further upstream, which would only lead to problems. Neither did they have the infrastructure available to Nestlé (programme manager, technicians, trial plots, etc.).

Secondly, the demand from buying centres and international roasters was centred on low price markets/volumes. Even the lower grades, notably 20/25[4], were sold without any problems unblended, at a low price. For exporters, there was no demand for quality coffee. Consequently, they could not consider passing on quality premiums to farmers. Only exporters linked to international groups had access to very narrow special markets: quality wet processed robusta, peaberries, extra large beans (or ELB), etc. For most of those markets (especially ELB and peaberries), only exporters could prepare a batch by sorting a very large volume, bought from farmers via the traditional supply chain. For wet processed robusta, or good quality high altitude dry processed robusta, exporters might have markets and organize supplies under contract with farmers or traders. That was the case for the wet processed robusta market at Pupuan in Bali which will be discussed in part 2. But all those markets remained very limited and only involved very few farmers.

Thirdly, most of the stakeholders met in the supply chain, notably exporters, considered that the Nestlé system was not really worthwhile for farmers, which tallied with our analyses. They felt that the Nestlé company could invest in that type of innovation because experience of localized rural development, with direct buying from farmers, served its image perfectly.

[4] This was green coffee with between 20 and 25% of its weight in defects.

1.3. Opportunities for change

The studies tallied: the Nestlé system was a step forward in the organization of subsectors based on the production of symbolic and/or material attributes. The authors proposed relying on those fledgling organizations to propose strategies working towards that: switch to wet processing, production and sale of roasted coffee, fair trade, etc. It was a logical result. In fact research showed that most of the value of the coffee sold to consumers was procured by stakeholders who sold symbolic and service attributes: roaster brands, fair trade and organic coffees, coffee chains such as Starbucks, café owners, etc. However, stakeholders whose contracts were based on the "material" attributes of coffee, such as physical or sensory characteristics, only shared a small percentage of the end-value. The traditional supply chain and the Nestlé supply chain in Lampung were based on material attributes. If farmers wished to obtain better remuneration for their coffee, and therefore take more care in its preparation, they had to produce and sell symbolic attributes. The options proposed by the authors, roasted coffee on the domestic market and fair trade coffee (of the FLO International type)[5], work towards that.

[5] Fair Trade Labelling Organization

2. Adopting wet processing in Bali and East Java

In this study, it was necessary to:

- Carry out an overview of the switch to wet processing launched in Bali in 2002 and,
- Study conditions for reproducing that project in East Java.

2.1. Wet processing in Bali

For farmers at Pupuan in Bali, the switch from dry coffee processing to wet processing was a success. Farmers were better remunerated and easily adopted wet processing.

The key factors for that success were:

a) Access to the wet processed robusta market via ICCRI and the exporter PT Indo CafCo. That exporter guaranteed a minimum purchasing price to farmers.

Table 6: Comparison of selling prices for dry and wet processed coffees

	2003	**2004**
Minimum price guaranteed to farmers by the exporter	Rp 5600/kg	Rp 6750/kg
Price of dry processed coffee	Rp 4800/kg	Rp 5200/kg

b) Substantial and well-organized technical supervision by ICCRI and the Dinas Perkebunan extension service,

c) An effective farmer organization system. Farmers belonged to Subak Abian, a highly structuring social and religious organization in Bali. Projects were discussed and adopted within that context. It was a very efficient form of appropriation.

d) The existence of acknowledged leaders, in the Subak Abian, in charge of the project and of innovation, and

e) Local government support.

This last point was fundamental in the economic studies. The investments required to fund processing equipment and buildings came from the Bali province, amounting to Rp 175 million. If the farmers had had to cover the costs of installation, it could be considered that the processing price would have trebled. In fact, if the factory were amortized over 10 years, it would have been necessary to add Rp 17.5 million each harvesting season. In that simulation, the possible repayment of interest on loans was not taken into account, it was considered that farmers could fund themselves and had access to interest-free loans.

Table 7: Processing costs for 100 kg of cherries depending on the funding method

	Public funding of installations	Amortization by farmers over 10 years
Annual operating costs	Rp 10 million	Rp 10 million
Initial investment spread over 10 years	Rp 0	Rp 17.5 million
Total	Rp 10 million	Rp 27.5 million
Cost of processing 100 kg of cherries	Rp 11 000	Rp 30 250

Thus, profits calculated on an average basis of 4 tonnes of cherries would be as follows:

Table 8: Comparison of profits from wet and dry processing

	Dry processing (4 t in DP)	Wet processing (4t in WP)	Wet processing with amortization
Profits in Rp	4 880 000	5 610 000	4 840 000
% increase/dry method		14 %	-1%

In health terms, wet processing is usually less risky than dry processing. Ochratoxin measurements were carried out on 4 wet processed samples and 6 dry processed samples. The results showed that dry processed coffee had very low OTA levels (average of 0.14 ppb). The wet processed samples were OTA-free.

The ongoing technical problem with wet processing was the adherence of silverskin to the bean. This was not a defect under local classification (or of the Green Coffee Association), but the appearance of the coffee was not optimum, even after going through a polisher. As the high premium market targeted was based on quality, the problem needed to be solved by ICCRI with the farmers.

2.2. Reproducibility of the innovation in East Java

The feasibility study for introducing wet processing among smallholders focused on 4 aspects: technical, organizational, commercial and economic.

Technically, the farmers at Garahan in East Java had a problem in adapting processing equipment; they considered that the equipment proposed in Bali was not appropriate since it consumed too much water, and that the pulpers traditionally used in North Sumatra (hand pulpers) had too small a capacity that did not match the high cost of labour in East Java. Farmers wanted medium-scale equipment (around 250 kg of cherries/hour) which was mobile and motorized, and which combined pulping and washing operations. ICCRI was called upon for this point.

Organizationally, farmers in East Java did not benefit from the traditional structure existing in Bali. However, they worked in groups for certain activities and tended, as in Bali, to accord a religious dimension to their organization. However, the farmers were aware of their lack of organization and pinpointed their weaknesses, on which training could be based: strategy and programming, leadership, relations between quality and premiums.

For the market, studies showed that East Java was traditionally a producer of washed robusta coffee (wet processing) of a quality known under the name of WIB (*West Indische Bereiding*). That coffee was produced on the large State farms or private estates. For economic reasons (high labour costs and low coffee prices) that production has been partly abandoned.

Table 9: Export of Robusta coffee from East Java (in tonnes)

Coffee Type	2000	2001	2002	2003	2004
Robusta	(37,159)	(30,794)	(32,686)	(33,098)	(32,967)
Wet Process	**11,166**	**10,306**	**9,035**	**8,590**	**6,848**
Dry Process	25,993	20,488	23,651	24,508	26,119

There was therefore an opportunity for organized farmers to take over from the estates, though it would be necessary to produce impeccable quality similar to that supplied by those estates.

Economically, the studies showed that, under current conditions (dry processing price at Rp 5250/kg), the premium obtained with wet processing needed to be at least 33% of that price, the ideal being premiums ranging from 37 to 52% of the price of a kg of dry processed coffee.

2.3. Conclusion

Switching from dry robusta processing to wet robusta processing has been a success in Bali and is "feasible" under other conditions. However, it is necessary to be able to count on:

- A known, targeted market, and an exporter interested in marketing that type of coffee,
- An efficient and structured farmer organization,
- Technical support and,
- Financial support.

In terms of coffee health quality, wet processing is an effective way of processing coffee to avoid mould formation. Access to a limited but demanding market is also guaranteed.

3. Conclusions of the studies and effect of introducing OTA norms on the Indonesian robusta coffee supply chain

The socio-economic studies conducted in Indonesia showed that "supply chain" or technological solutions that would enable farmers to obtain better remuneration for their production in return for an improvement in the quality of the coffee produced, are "feasible" under certain conditions.

A quality premium is possible for dry processed robusta if a dominant stakeholder in the supply chain (exporter, Nestlé, AEKI[6], etc.) opens up a market and creates a subsector with remuneration based on objective attributes: moisture content and defects are good criteria. However, such an initiative is not easy to establish. Only exporters linked to large international trading groups can allow themselves such a risk. It will also be necessary to be able to count on serious farmer organizations from which exporters can procure supplies under contract in accordance with specifications. In addition, it will be necessary for the quality premium to compensate largely for weight losses and the extra costs associated with producing the required attributes. Lastly, those organizations should be able to count on financial backing to create working capital and overcome farmer dependency on loans often provided by middlemen.

A quality premium exists for wet processed robusta. In theory, Indonesia had a lucrative market for that type of product. But, here again, the success of that innovation involves the existence of an efficient organizational structure and financial support for investments and working capital. The technical problems ought to be overcome without any major difficulty.

In all the analyses carried out in Lampung, Bali and East Java, OTA rates were very low, corroborating the first results obtained. Despite risky practices, Indonesian coffee is little affected by this problem. According to the main people involved, exporters, it would be enough to strictly forbid the export of coffee from the previous harvest to further minimize that risk.

The norms introduced by the EU concern roasted and instant coffee, i.e. those norms transfer the responsibility of checking for OTA contamination to roasters and European manufacturers.

Those stakeholders are prepared and have been working on health quality for several years. They know that readings on roasted coffee are 50 to 80% lower than on the green coffees from which they are made. They can therefore bank on a maximum of 10-12 ppb in green coffee, given that they can further blend healthy and contaminated coffee prior to roasting and thereby "dilute" OTA. Under such conditions, coffee buyers will be more suspicious of only a few, well-known sources. Indonesia is not one of them. The global tendency is therefore likely to favour Indonesian robusta coffee. However, it is difficult to envisage a health premium; it seems more likely that the market will apply a discount to risky origins, at least to compensate for analysis costs.

Indonesian exporters will remain worried, because their clients will bring in more and more checks, under pressure from the "precaution principle" of European consumers.

[6] Association of Indonesian coffee exporters.

Exporters linked to large international trading companies are usually the first to react because information circulates better among them, and pressure from buyers is more present. They would need to secure their supplies by checking traders' batches and set in place a norm for rejecting the oldest coffees with most defects.

National exporters will also be under pressure, but they are less well informed and relatively at a loss with regard to the problem. Eventually, they would need to adopt similar measures to international exporters and sell doubtful batches on less discerning markets.

In all cases, it is not very likely that a health quality premium will be paid upstream in the supply chain unless one is received from their customers. Here again, one can merely imagine a large discount for the most dubious coffees.

Middlemen have no reason to move if exporters do not modify their remuneration system. In the case of rejected coffees, they will apply discounts. Hence, no impact on farmers.

However, the system could evolve towards the emergence of a few initiatives on differentiated markets, wet processed coffee, roasted coffee, fair trade and/or organic coffee, with quality premiums encompassing a health aspect. Such initiatives, which require heavy human investment, will only slightly affect farmers.

In order to potentially affect the majority of farmers, it would be necessary for one main stakeholder to push for a more evident remuneration of quality upstream for more differentiated supplies downstream. Very logically, exporters would have to play a major role in such a reform, notably their association AEKI. The State also has a preponderant role to play in providing impetus, as W. Susila highlighted on several occasions.