

INSECT-FREE TOBACCO EXPORTS FROM THE TROPICS

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Abstract For many years exports from India, in common with most other countries supplying tobaccos, were commonly found to be infested with the tobacco or cigarette beetle, *Lasioderma serricorne*, on arrival in the United Kingdom. In most cases this resulted in re-fumigation before the shipments were allowed inside the cigarette factories. This paper deals with the methods used to achieve a zero-infestation status in very large annual tobacco exports, thus saving significant annual re-fumigation costs to the exporter, explains a fully tested and auditable storage and transport system guaranteeing freedom from tobacco beetles, and shows that insect free infestable commodities can be sourced from a tropical region. The main subjects covered include warehouse structural improvements and quality, hygiene schedules, flying insect proofing, tobacco beetle detection and trapping, timing of activities and the development of operational standards as Practical Protocols, which formed the basis of a complete manual for the export division of the company. The result after three years of development was an auditable system actually delivering very large tonnages of containerised beetle-free semi-processed tobacco exports.

Key Words *Lasioderma serricorne*, warehousing, fumigation, pheromone trapping

INTRODUCTION

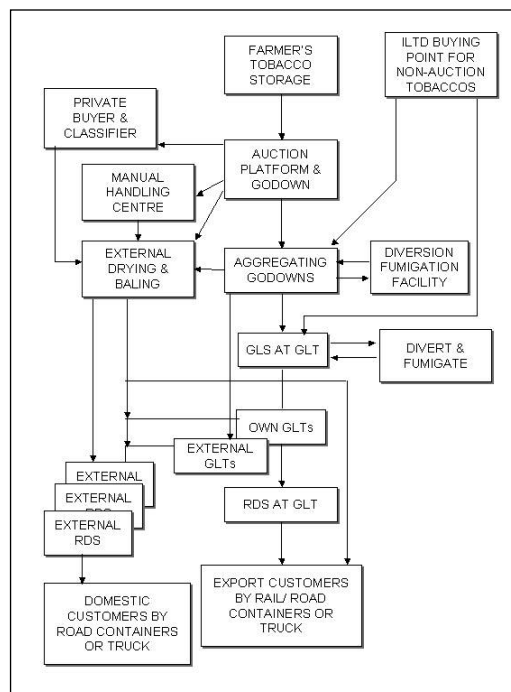
Dried tobacco leaves, despite containing varying concentrations of nicotine (an insecticide used primarily for the control of agricultural pests such as sap-sucking aphids, whiteflies etc), are very susceptible to attack during storage from the producer's drying barn at farm level, subsequently throughout the various processing stages, and including cigarette making and storage, and despite the latter's product wrappings. Two species of store product insects: tobacco or cigarette beetle, *Lasioderma serricorne*, and tobacco moth *Ephestia elutella* are able to attack tobaccos during these stages, each causing many millions of dollars of damage across the world. Prevention of this damage is of interest to many countries in the warmer supplying countries.

A major British cigarette manufacturer had for many years sourced much of its raw and semi-processed tobaccos from the Indian sub-continent, shipments arriving in cardboard cases in 40-foot sea-freight containers. The frequent occurrence of tobacco beetles in these shipments disrupted its United Kingdom factory processes due to the need to re-fumigate incoming stocks. The costs of re-fumigation were passed back to the supplier, with an ultimate sanction of finding an alternative supplier better able to provide beetle-free tobacco products. Discussions between both main parties resulted in the proposal to use an independent infestation consultant to assess the situation in India, to draw up a plan identifying the problem areas and processes, and to develop a system to manage the beetle infestation at the supplier, and to deliver infestation-free export tobaccos to overseas factories.

This project was established in 1997 in India to investigate the problems of tobacco beetles in pre-cigarette tobaccos, and to develop effective control techniques, which could be implemented in quite simple storage and distribution systems. The intention was to measure the extent of the beetle problem in any storage facility and to have a codified system of improvements preventing further beetle incursions following high-quality phosphine fumigation, and resulting in completely beetle-free exports arriving at the European destinations, with no further pest control actions being necessary. The project terminated in 2004, with successful beetle-free exports received by most of the European users of Indian tobaccos.

This paper looks at the development of a wholly enveloping, tried and tested, and for the first time, auditable, system of guaranteed beetle-free tobacco supplies from the tropical farms of original leaf, through to the factory of final cigarette manufacture and thence to the domestic cigarette markets of Europe.

Figure 2. Tobacco Flow: farmer auction to export consignment



Product Flow

The tobacco handling system in Andhra Pradesh in eastern India is quite complex (Figure 2), though neither it, nor tobacco beetle control itself, involves especially difficult technical issues. In theory managing beetle control would be very logical, though at the start of the project, experience in the trade showed that tobacco handling in tropical regions always involved a serious degree of beetle infestation escaping with the finished part-processed dried tobacco product, which inevitably then found its way into final cigarette factories.

The project started with a widespread survey of beetle activity within the dried tobaccos offered for sale by farmers through Auction Platforms (usually situated in very rural communities), through the Aggregating Godowns (bulking-up warehouses) which in turn supply specific grades of tobacco to the processing factories, known as Green Leaf Threshing Plants (GLTs), which manufacture the exportable commodity of re-dried tobaccos. These re-dried stocks (RDS) are transported to the docks via the warehouses of stored RDS tobacco consignments. The Indian centre of this whole commercial activity is mainly in the eastern agricultural state of Andhra Pradesh. The export port for this processed crop is primarily Chennai, (Madras) in Tamil Nadu.

Beetle Trapping

The survey technique involved the already well-known pheromone-based adhesive trap known by its trade name as the Serrico Trap. This is a Japanese design, with a *serricornin* synthetic female sex scent lure tablet on an adhesive strip of thin card, for attracting male beetles. This trap design, which also incorporates a female beetle lure of “tobacco essence” was standardised throughout the Indian company’s operations, and was also recommended by the UK tobacco importer, who also insisted on such traps being inserted one-each into the exported container of tobacco bales. Because the tobacco beetle traps were vital to the detection and assessment of beetle populations, and therefore to prevention and control strategies, the methods of use and interpretation of results of the trap were investigated and extensively codified in Practical Protocol 1. The storage of new traps and lures, the positioning of traps in factories and warehouses, and the replacement schedules were all standardised through comprehensive protocols.

For this project it was assumed that the Serrico-brand traps were effective in detecting beetles, so standardisation of activities allowed comparisons to be made between different sites, where variation in beetle populations resulted from the temperature and humidity changes with the seasons. Much later (after the project was completed) extra data came from comparison trials conducted by the tobacco suppliers in South Africa, and these suggested that an alternative German-made pheromone trap design could give even more sensitive results. But for this present project, we tried to minimise changes and variability, to allow simple comparisons site-to-site, and store-to-store and season-to-season.

The results from trapping had to be incorporated into an escalation procedure. A total beetle count of 15 per store was chosen as a starting point — more than 15 combined total beetles per storage “cell” per month (the replacement lure period) triggered a whole-store fumigation. So to make sense of this plan with its potentially costly treatment action, careful structural assessments were made, with re-hanging of doors, and the introduction of meshed inner doors to all warehouses. Self-closing systems were investigated, and simple weight on a pulley gravity systems were adopted for stores with sliding doors. For other warehouses, keeping doors closed was upgraded to an action of primary importance for all accessing the stores.

Proofing Measures for Re-Dried Stock Warehouses

Even though few staff expected such straightforward actions to have an affect, nevertheless beetle trapping was showing the results of leaving doors open, and it was not long before store structural repairs, mesh proofing to ventilators, windows and doors, and the changes in beetle trap numbers were seen as an integrated system. Failure to close screen doors (eventually viewed as a serious failing) always resulted in a rapid rise in beetles on traps. And the result of exceeding 15 beetles per store was a full-warehouse phosphine fumigation at considerable expense.

On the other hand, preventing beetles access into these critical stock warehouses brought the promise of a dramatic decrease in the number of stack fumigations. Within two years of commencing the project, we achieved a reduction from the initial annual 10,000 individual stack-fumigations, to around 3,000 per year. Proofing beetle ingress was fairly straightforward, with imaginative use of wooden and steel frames with stainless steel 1.5mm wire mesh, as commonly used domestically for mosquito proofing, and self-closing sliding and hinged screened doors, permanently screened ventilators and aeration grills. Much improved local site hygiene eliminated all tobacco waste and excessive weeds where adult beetles may congregate in the darker and more humid areas.

FINISHED PRODUCT PACKAGING

Export consignments were packed in several possible formats, depending on the quality and type of the tobacco, and the destination markets. Most commonly, 200 kg dried partly-shredded tobacco leaves were compressed by an end-of-line 7-tonne press, into either new or good-condition second-use heavy-duty fibreboard cases, which were stored in on-site protected warehousing (RDS stores) whilst they cooled to ambient temperatures. Some consignments were held in elongate bales of hessian wraps. An important difference between these packaging types was the presence of a polythene liner inside most of the cartons, almost precluding achieving a required phosphine gas concentration for the recommended exposure period.

Customer Stock Inspections

It was a well-established practice for customers to arrive on site to open and visually grade cases of their consignments before despatch. This had traditionally been done within the warehouses, which was always a worry in case beetles were present and transferred from stack to stack and thence inside the newly-opened fibreboard cases. It was agreed that this activity would continue but only in newly-developed and totally screened “inspection sheds”, complete with north-light roofs for good illumination, and permanent pheromone-trap beetle monitoring. Inspections would only take place if no beetles were detected within these sheds.

Stack Fumigations in Export Stock Warehousing (RDS Stores)

Under the terms of the international Montreal Protocol, the common fumigant gas methyl bromide was being withdrawn by the start of this project, and for this reason and company technical guidelines, only phosphine gas was available for tobacco fumigations.

Investigation showed that many of the fumigation contractors used by the Indian tobacco supplier often made their own decisions on the need to re-fumigate approximately 30% of the long-term stored tobaccos, in response to the discovery of further outbreaks of beetle infestations. As noted above, the improvements in warehouse structures and hygiene, and the addition of good proofing helped reduce the stack fumigations from 10,000 to 3000 per year. Practical training and guidelines/Codes of Practice for the fumigators made an important difference to the quality and long-term effectiveness of the stack fumigations. The gas dosages remained similar, but the improved quality of warehouse floors, fumigation sheeting and sand-snake sealing, together permitted much longer fumigation exposure periods to be achieved with consequently minimised re-fumigation requirements. Fumigation quality was assessed by gas measurements during the treatments using monitoring sample lines of thin-bore nylon capillary tubing and either electronic meters (usually the Bedfont EC80) or glass reagent tubes, and by testing for live beetles with the by-now ubiquitous pheromone beetle traps. The trap results gave monthly totals, and only when the pre-determined 15 beetles per store was exceeded was re-fumigation of the entire warehouse stock sanctioned.

The polypropylene tobacco case liner (introduced originally to prevent excessive drying, and/or moisture migration) was changed to a micro-perforated liner, allowing sufficient gas penetration, whilst helping to limit moisture migration (particularly drying out), over the potential several years of the storage period.

Initially, the international tobacco industry stated a minimum concentration of phosphine of 200 parts per million in the centre of one of the more difficult lower cases in a five- or seven-high stack, for at least 48 hours within the 4 day exposure period. However, further research showed that at least 5 days was required for 100% mortality. The presence of phosphine resistance amongst the AP beetles was a warning that it would only get worse if it were allowed to develop through ineffective fumigations, so a standardised 8-day exposure period with a minimum of 400 ppm over at least 4 days, was specified for this tobacco project, once the warehousing floors were upgraded, and sheeting and sand snake specifications were agreed upon.

Since the great majority of exports were undertaken in 40-ft freight containers, either loaded onto transport lorries at the warehouses, or into containers on flatbed rail trucks, it made sense to re-stack tobacco consignments in stores into 30-tonne loads — i.e.: each twin row of 200 kg cases formed a complete 40ft container-load. If the twin-rows could be stored close together in a warehouse, sheeting and subsequent fumigation could be undertaken with specified, pre-sized fumigation sheets, for which the required sand-snakes could be stockpiled. All of these preventative and control activities were standardised and codified into best practice guides — the Practical Protocols listed at Table 1.

Fumigation of the cooled re-dried part processed tobaccos, took place in specially cleaned and insect-proofed warehousing — the RDS stores. But because fumigation has no long-term effect, the condition of the warehouse floors was standardised — smooth concrete, with all cracks effectively repaired before stocks were permitted in. Store hygiene was also standardised. In many of the warehouse complexes, competitions with occasional inspections and small prizes were introduced to encourage storekeepers and their workers to maintain the best possible standards. The cash value of prizes was less important than the signed certificates, which were framed and kept in the associated offices. This had a dramatic effect on the cleaning schedules, the very clean floors and beetle meshes, and the upper walls and tie-rods no longer showing build-ups of tobacco dust, rapidly became the norm rather than the exception. Even widely separated sites within AP competed for this recognition.

The bigger problem was incorporating the number of privately operated warehouses into this scheme, but as the whole organisation became accustomed to higher standards, regularly inspected by middle managers, so it became easier to persuade other storekeepers and staff to aim high. The ultimate sanction was to revoke the contract as alternative warehousing became available.

Another issue, which still struck at irregular intervals, was maintaining this structural standard against the commercial offers of lower unit cost warehousing. At the highest level, managers agreed that this standard should be maintained since the risk of slippage could allow beetles to develop un-noticed, and eventually to

affect the export quality. But in an effort to maintain lower overheads, managers were sometimes attracted to cheaper warehousing. It was occasionally necessary to remind managers that, before this project started, there was an annual cost running at £330,000 in re-fumigation fees imposed by the UK buyer, who was actively searching for an alternative source of guaranteed tobacco stocks.

Export Consignment Outloading

As a part of the whole-site approach, tobacco freight container loading was not permitted after 15.00 hours each day - random beetle trapping on outside walls near the warehouse doors and loading spaces, had shown wild *Lasioderma* activity to increase noticeably after early afternoon. Thus another advantage of pheromone trapping: the clear visual proof that the recommended changes in working practices were based on facts and not just hunches.

Containers supplied for loading exports were carefully selected at the docks, cleaned, sprayed with approved hard-surface insecticide sprays and delivered to the export points ready for loading. Loaded containers were then moved to the export port, where the final quality control was undertaken. The practical method was to fumigate with phosphine gas the dried tobacco products, in their final freight containers, on the quayside, prior to loading them on board the vessel bound for Europe.

However, there were some logistical constraints in the system: 1) the individual shipping containers varied and were not always probably gas-tight, 2) the time allowed either for transport from the factories, or on arrival at the port, sometimes clashed with the vessel's arrival and loading dates, 3) the agreement and cooperation of the Customs service, and the port's stevedores to permit in-container fumigation at a pre-allocated safe area within the dock estate, varied from time to time, 4) post-fumigation ventilation *and* the introduction of a new beetle trap inside each container needed to happen shortly before loading the container on the vessel.

Table 1. Practical Protocols

NO.	PRACTICAL PROTOCOL	PAGES
1	The Serrico Trap	7
2	Tobacco Beetle Management at Farmers' Premises	2
3	Tobacco Beetle Management at Auction Platforms	2
4	Warehouse Hygiene	1
5	Insect Screening of Warehouses	1
6	Insecticide Spraying in Warehouses and Factories	3
7	Insecticide Fogging and Misting in Integrated Pest Control	2
8	Stacking Practices	2
9	Cotton Sheeting Infestation Barrier	1
10	Phosphine Fumigation of Tobacco	3
11	Fumigation Sheet Integrity	2
12	Bedfont EC80 Phosphine Gas Monitor	2
13	Quarantine Fumigation of Green Leaf Bales	2
14	"Tunnel" and "Platform" Fumigations	2
15	Handling Fumigated Freight Containers	2
16	Freight Containers for Tobacco Exports	2
17	Warehouse Structure and Standards	2

RESULTS AND CONCLUSION

This paper has described a straightforward, though comprehensive, system of ensuring beetle-free exports of dried tobacco products from a tropical region to the cigarette factories in temperate Europe. The principles and details involved, achieved a zero-beetle export commodity on arrival in Europe, despite the very widespread and high pressure beetle population on the export tobaccos throughout the Indian tobacco supply chain. The successes occurred by creating and following a strict set of guidelines (the Practical Protocols), where two particular aspects were of the greatest importance: 1) the use of a very effective detection system in the form of the pheromone-based tobacco beetle trap; 2) the support and encouragement of the Exporting Company's Head of Technology, who set very high standards himself, and who insisted on the codified guidelines becoming a compulsory manual within his company

The end result was a fully tested system, which also allowed non-technical Auditors to assess the success of each stage in the process against written procedures and outcomes, and for any occasional failures to be traced back to source and therefore to be explained and future problems to be anticipated and prevented. Much of this paper also will be relevant to companies supplying dried foods of tropical origin to European manufacturers, where insect damage and contamination detected in human foods can have serious legal consequences.

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