Recent outbreak of coffee rust in Papua New Guinea caused by *Hemileia vastatrix* and the future of its coffee production

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Summary

The occurrence of *Hemileia vastatrix* in Papua New Guinea threatens future production of coffee in PNG and increases the risks to the growing Australian industry. Short-term and long-term measures to deal with the problem in PNG are outlined. Urgent administrative action is required if there is not to be a major fall in PNG coffee production both in the medium term and more permanently. PNG may need foreign aid to enable it to cope with the problem.

Coffee rust caused by the fungus, *Hemileia vastatrix*, is not new to the Austral-Pacific region. It is present in Fiji, New Caledonia, Vanuatu, Samoa and now in Papua New Guinea (PNG). Australia and Hawaii are fortunate to be free from this debilitating disease (McCulloch 1986). However, it is spreading in the region. It was detected* in PNG in April 1986 in the Western Highlands coffee-growing region of the country. It seems likely that the disease was already present for about one year before detection. It has already spread widely. It poses a substantial threat to the viability of PNG's coffee industry.

Coffee is PNG's main agricultural export earner. Coffee grown in PNG is largely of the Arabica type (*Coffea arabica*) which provides high quality coffee but is most susceptible to coffee rust especially at lower elevations. In some of the lowland areas, Robusta coffee (*Coffea canephora*) which produces lower quality coffee, is cultivated. A few isolated incidences of the disease have been identified in the lowlands as well.

The severe nature of the damage caused by the fungus, the rapid rate of spread of the disease through release of fungal spores in large quantities into the air and their dispersal by air currents, and accidentally by plantation workers and coffee buyers on their clothing as they travel from one village to another means that it is likely to spread widely and quickly in the industry to cause considerable loss. A further factor contributing to the severity of the disease is the inconspicuous initial development of the fungus before it becomes visible by which time serious damage has occurred (Waller and Turner 1986).

*Examined microscopically and confirmed by a plant pathologist on 30 April 1986.

The fact also that the whole of PNG's main coffee area is in a geographically close-knit area in the highland provinces facilitates the spread of the fungus. Unfortunately, both growers and the majority of those interested in the industry have been unprepared for the occurrence of the disease. Coffee gardens on the majority of smallholdings are suffering from inadequate husbandry practices such as lack of weeding, pruning and fertilizing, so there is little scope to curtail the impact of the disease.

Coffee rust attacks the leaves of coffee bushes initially reducing their photosynthetic ability and subsequently defoliating the bushes. If no control measures are adopted or if measures are ineffective, the rate of loss of coffee production due to disease normally follows an exponential path over a 5-year period (Waller and Turner 1986; Shaw *et al* 1986). The *slow* loss of yield during the early stages (first 2 years or so) of the disease makes it possible to adopt simultaneously both chemical and other measures of control to compensate for yield losses. Nevertheless, because an economically sound eradication program is not possible, coffee rust will continue to be a major problem in PNG, adding to cultivation costs as long as PNG continues to cultivate its current susceptible varieties of coffee.

In PNG the disease may very well cause the abandonment of coffee production by a large number of small marginal growers or growers who do not carry out even the basic management practices on their holdings. Smallholder growers use only minimal inputs and engage in little husbandry at present. The whole economy of PNG and particularly of the Highlands, which are densely populated, can be expected to suffer economic difficulties. Moreover, few alternative cash crops can be grown in the Highlands.

In the short-run, fungicides can be used as a prophylactic and to control the disease once it is present. Either way, the cost of production is increased. Along with the chemical control, it seems desirable that the husbandry of coffee stands be improved in order to (*a*) make control measures more effective (e.g., pruning and removal of undergrowth will improve the coverage of fungicides on coffee plants) and (*b*) to compensate for the increase in cost due to spraying. Since most coffee (especially smallholder coffee) in PNG is not well managed, coffee gardens often have overgrown trees which cannot be easily sprayed by means of simple knapsack sprayers. In order for spraying to be effective, most of the foliage should be wetted with the chemical sprays including systemics. This can only be achieved by knapsack sprayers when coffee trees have been adequately pruned. (Pruning is also required to increase production of berries.) Reduction of leaf area to be sprayed as a result of pruning lowers chemical requirements considerably. However, pruning of overgrown trees already affected by rust is not advisable as this liberates vast quantities of fungal spores into the air and enhances spread of the disease to other trees. However, if rust-affected overgrown trees are not treated, they remain as reservoirs of infection. Control of rust in such trees may require motorized sprayers.

Most PNG coffee growers are smallholders who utilize minimum labour and material inputs in cultivation of coffee. Consequently, prior to the incidence of coffee rust, most growers in PNG incurred little cultivation expenditure (De Silva *et al.* 1986; Harvey-Jones *et al.* 1986). But if coffee production is to continue on the existing holdings, greater inputs will be essential in the near future.

The long-run viability of the industry in PNG and profitability of coffee growing to individual growers (given their existing attitudes which can be expected to change slowly, if at all) rest on measures to reduce the quantity of chemicals needed for prevention and control of the rust. The best means of achieving this would be by replacing the existing coffee varieties with varieties resistant to as many known races of the rust as possible. Allowing sufficient time for the build up of stocks of such resistant varieties and the usual time lag for diffusion to growers, a replacement program would take more than 10 years even if commenced almost immediately.

Figure 1 indicates some alternative scenarios for levels of coffee production in PNG in relation to alternative strategies for responding to the occurrence of rust. It is assumed that the normal production level at the time of the outbreak (AF) would continue over the next 20 years in the absence of rust. The model presented in the figure also assumes that the response of growers to price changes during the next 20 years is relatively insignificant or economic conditions are assumed stationary. As in Shaw *et al.* (1986) it is assumed that coffee production may decline by about 70% in the first 5 years *if* no control action is taken. The slope of the segment MG of curve AMGED is much steeper than the slope of GED. Even if rust control is not practised, it is assumed that production will stabilize at the end of the 20-year period at about 15% of the target production level mainly due to Robusta coffee and survival of some of the Arabica coffee at the higher altitudes.

Curve AMD′ assumes that the decline in production is caused by marginal farmers abandoning coffee for economic reasons plus a progressive decline in coffee produc-

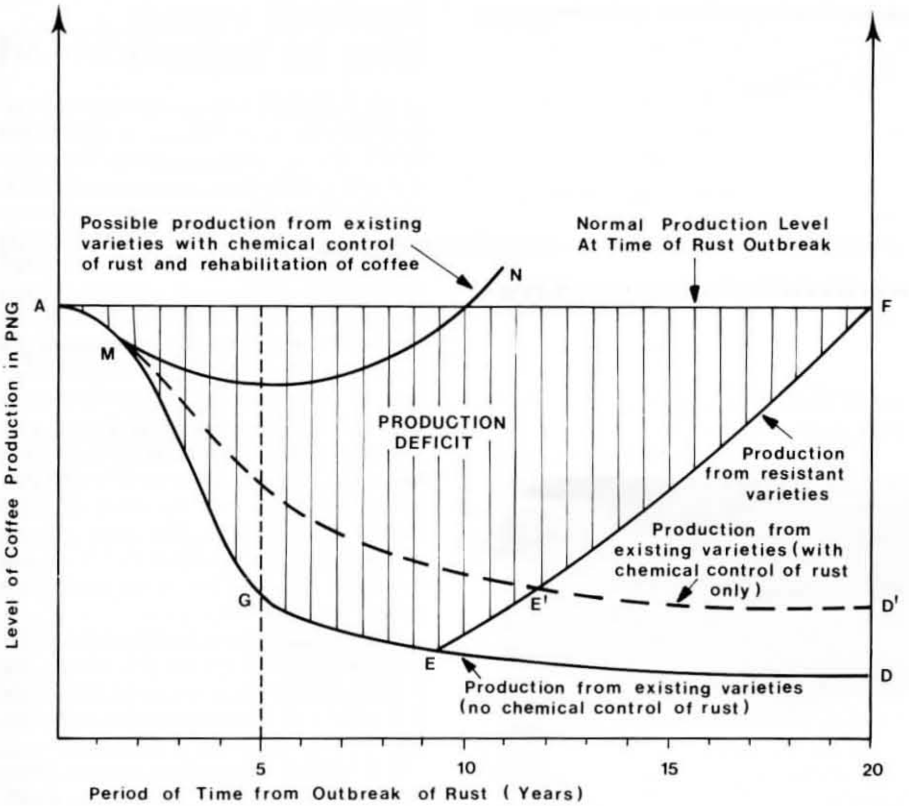

Figure 1 Possible levels of coffee production for alternative response strategies, given the occurrence of rust (hypothetical scenarios, see text).

tion owing to senility of the existing trees and their replacement with resistant varieties and/or other crops either in mixed culture with coffee or through diversification. When the production pattern stabilizes at the end of the 20th year (see point D'), it is assumed that the country's production will constitute 30% of coffee from existing varieties. The yield (EF) due to resistant varieties is assumed to reach the target level within 10–15 years, although by this time complete diffusion of resistant varieties may not have occurred. For simplicity, it is assumed (*a*) that resistant varieties are *immune* to rust and have the same or higher yield potential as the existing coffee and (*b*) that there is no variation in resistance to rust due to the elevation. The immunity assumption implies total lack of need for chemical control and hence rapid diffusion of resistant varieties. While complete immunity to rust is quite unlikely, dropping the assumption may not significantly alter the shape of EF because even if fungicides are needed in growing resistant varieties, much smaller quantities will be required. The lowest yield deficit and the quickest means of achieving the target is assumed to be through an integrated program of rehabilitation and fungicide-based control and prevention (see curve AMN). In any case, much more research is needed to determine the likely position and slope of these hypothetical alternative production paths.

In order to carry out effectively some of these strategies, PNG may need foreign aid, especially technical experts such as could be provided by Australia (for instance in micro-propagation techniques, propagation of planting material (possibly in Queensland) and formulation of chemical control programs.

The release of rust-resistant trees to growers should follow a pattern which protects individuals as far as possible from massive income falls due to the fungal attack and/or tree replacement. For example, all growers of Arabica coffee in the lower altitude Highland area should share replacement stock as it becomes available so that each replaces some trees rather than a few replacing all their trees at once. In this way no grower faces a massive decline in income by having all trees simultaneously replaced, while all growers have some disease-resistant plantings.

The success of the long-term measures proposed here depends on the premise that new varieties of coffee brought into PNG are resistant to as many of the known races of the fungus as possible, especially the ones already in PNG. Currently about 30 races of *Hemileia vastatrix* have been identified in the world (Shaw *et al.* 1986).

Given the difficulty of controlling the spread of coffee rust from one country to another, it seems desirable that Australia's expanding coffee industry (located in Queensland) be based on rust-resistant varieties. Increased efforts with respect to plant quarantine would also not be misplaced given the proximity of PNG to Queensland. Australia would seem to have a special interest in helping deal with coffee rust in PNG on humanitarian grounds since, for small growers, coffee is their only cash crop and no alternative cash crops are available at present. It is possible that the coffee rust will destroy the whole coffee industry as it virtually did in Sri Lanka.

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