

Preface

In 1995, I arrived in Papua New Guinea to take up the position of lecturer in soil science at the University of Technology in Lae in the Morobe Province. The position embraced a teaching and research component and the university encouraged interaction with other scientific disciplines like forestry, entomology and ecology. Being new in a country where there were only a handful of soil scientists and keen to see the country-side, I took the first opportunity to get to the field. That came soon.

Within a week after my arrival, I was taken to the experimental sites of a Dutch forest ecologist at about one hour drive from the university. He showed me soil erosion measurement plots in an area where shifting cultivation was common. Soils were young and rich, and with more than 4,000 mm rain per year you could almost watch plants growing. Despite the heavy rainfall and the fairly steep sloping land, there was relatively little soil erosion in the vegetated plots. At that first day in the field I was not particularly taken by those findings but was absorbed by the surrounding rainforest – that massive cathedral of all colour greens, those giant broccolis.

In several places, the rainforest was cleared and smallholder farmers had planted plots with taro, sugar cane and sweet potato. As in many shifting cultivation areas in the humid tropics, the landscape was a mosaic of untouched forest, cultivated plots and secondary regrowth. The secondary fallow vegetation was dominated by a single species, a few metres high, lush green and in massive dense stands: *Piper aduncum*. It was the first time I saw such stands of this shrub; its peculiar smell was everywhere.

When we drove back to the university, I saw stands of *Piper aduncum* on all fallow land but also on road-cuts and it was also the first plant revegetating fresh landslides. The Dutch forester told me that *Piper aduncum* is indigenous in South America and that little was known about it. Whilst driving through the patchwork of forest, crops and fallow land we wondered how it got there, why it was so successful, and how it affected the cropping phase. Those questions formed the start of an intriguing research journey.

Later on that week, a group of foresters and ecologists told me that the spread of *Piper aduncum* was closely linked to selective logging of the rainforest. Some farmers around the university told me it has always been there, whereas others remembered that their relatives brought it in from other parts of the country. Many farmers claimed that *Piper aduncum* fallows affected their cultivation systems: some liked it, some didn't, some said it dries out the soil, whereas other mentioned that *Piper aduncum* fallows give the soil a lot of “grease” – that is a high soil fertility and high yielding crops

once the fallows are cleared and crops are planted. Some of my colleagues viewed *Piper aduncum* as an insignificant weed that sooner or later would be taken over by natural fallow vegetation, whilst others hadn't noticed its presence. It seemed that little research was being conducted on *Piper aduncum* in the shifting cultivation systems.

It took several months of thinking, discussions and research fund applications before serious field experiments could be started. Coming from Western Kenya, where we had worked on natural and improved fallows in on-farm experiments, I looked for a site in which experiments could be conducted in between farmers' fields, but in which all operations (harvesting, planting, weighing of produce etc.) were researchers-managed. With the help of various people and Drs Mark Johnston and Mike Bourke we found such site: near the primary school and health post in Hobu.

In Hobu, *Piper aduncum* was overwhelmingly present, farmers were keen to cooperate, and it was close to the university. From then on, I spend at least a day per week at Hobu – mostly for the research but also as part of field practicals for the soil science and ecology courses that I was teaching. Farmers in Hobu agreed to clear about half a hectare and plots were laid out to investigate the effects of different fallows on sweet potato, which is the main staple crop in the area. Other plots were laid out to investigate biomass and nutrient accumulation of *Piper aduncum* and other fallow vegetation types. A weather station was installed near the health post. The school was involved in managing the plots and various farmers assumed responsibility for parts of the experiments.

We also started a series of nutrient management experiments at Hobu as well as the university experimental farm with sweet potato, taro and maize. The experiments included various rates and types of inorganic fertilisers and poultry litter with the idea to compare the results with the fallow trials and in order to intensify the predominant shifting cultivation systems. Although about two-third of the area was under primary forest, sooner or later farmers had shift to more permanent farming systems including the use of inorganic fertilisers and other amendments.

Although the running of all these experiments and data analysis took most of my research time, investigations on the invasion of *Piper aduncum* continued. Some were more successful than others. We looked into ecological aspects of the invasion and started a seed bank trial using soils from different areas. Spectacular differences were found. A greenhouse trial was started using soils in trays covered with *Piper aduncum* litter and in which lettuce and other vegetables were sown. The idea was that the litter contained substances that were toxic to seedlings of other plan species – the so-called allelopathic effect. All vegetable seeds germinated and grew perfectly, although chemically analysis and the literature suggest showed that *Piper aduncum* leaves could have such effect.

We continued to look on the questions of its invasion: how could an exotic species be so successful and when was it actually imported or had it be brought in by accident? Our research was started when the internet emerged in Papua New Guinea and I thank many contacts and information sharing through that electronic network. Contact with botanists and ecologist in different parts of the world increased the knowledge on the origin and spreading. At the time of the experiments, awareness on the spread of *Piper aduncum* grew from other disciplines (e.g. pharmacology, entomology, quarantine experts, taxonomy). It was exciting to follow the research from people with different disciplines focussing on the same plant and issue: the invasion of *Piper aduncum*.

Through the years we quantified some basic characteristics on *Piper aduncum* and published a series of papers. This book brings the major research papers together supplemented with an introduction and a set of conclusions. The papers have been loosely grouped in four parts. In the first part, the origin and spreading of *Piper aduncum* is described, including a general introduction on bioinvasion and *Piper aduncum* in different parts of the world. In the second section, biomass and nutrient characteristics are summarised and much of this information was unknown whereas it largely affects the management of nutrient the in shifting cultivation systems. The third part brings together the papers on nutrient management of sweet potato in Papua New Guinea; there are papers on nutrient deficiencies, nutrient use efficiency and the effects of different fallows on sweet potato. The last section focuses on some of the socio-economic effects of the *Piper aduncum* invasion - a research area which has received little attention, both nationally and internationally. The book ends with some conclusions including ideas for future research, followed by colour plates of *Piper aduncum*.

During the past 10 years, I have been in contact with many people discussing the issue of plant invasion and especially that of *Piper aduncum*. The discussions influenced the research, the writing of our papers but also increased my knowledge on bioinvasion and shifting cultivation. I was in contact with botanists, herbarium directors and sociologists and for an ordinary soil scientist such interaction was enlightening. During fieldwork I was in close contact with villagers in the Hobu area where the on-farm trials were conducted between 1996 and 1998. I would like to thank the people in the Hobu area for their great support and interaction. There was no difficulty in explaining the use and meanings of the on-farm experiments as farmers in the area had lived with the *Piper aduncum* dominance in the fallow vegetation for many years and farmers' opinions steered the research.

Several students from the University of Technology were involved in the on-farm experiments at Hobu. I wish to thank Mr Wesley Julius, Mr

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All in all, it has been an exciting 10-years research journey, a bit wobbly at times, but highly enjoyable. Joy may be enough to stimulate research and advance a publication record, but for any academic sensitive to real-world issues that is insufficient. It is therefore my hope that the research described in this book will encourage more detailed and more spatial investigations and that the results will help to alleviate the constraints of the poor smallholder farmers in areas where *Piper aduncum* dominates the fallow vegetation. Moreover, I hope that this book will contribute to the difficult discussion on the use and need of biodiversity in areas of plant invasion and increasing agricultural activity.

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