Record of Significant Soil and Land Resources Research in the South West Pacific

D.M. Leslie

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Contents

Letter to the Reader

The New Zealand government has had a long history of supporting soil and land resources research in the Pacific dating back to 1938 when Hamilton and Grange conducted an investigation of soils in Western Samoa. This support has included funding and technical assistance to Pacific Island countries through soil surveys, soil analysis (chemistry, physics, mineralogy), soil characterisation, soil classification, soil fertility analysis, agronomic studies, soil interpretation for land use, information technology applications of soils data, and training for national and regional staff working in soils and agricultural research.

The work has been mainly conducted in the southwest Pacific – the Cook Islands, Fiji, Niue, Tonga, and Western Samoa – but has also involved regional soils projects including the South Pacific Agricultural Chemistry Laboratory Network (SPACNET).

The New Zealand Agency for International Development (NZAID) and its predecessors have been major funders for this work. Similarly, the New Zealand Soil Bureau (now Landcare Research) was the major technical contributor to the New Zealand funded soils research in the Pacific.

This report establishes an inventory of the soil and related research in the Pacific supported by New Zealand over the last 70 years. This inventory is invaluable because soil and related agronomic research underpins the development of sustainable livelihoods in most Pacific countries.

Without this inventory, there is high risk that details of the research would be lost through loss of institutional memory due to institutional change, staff turnover, retirements and loss of data within both Pacific and New Zealand organisations. This document will help to minimise the impact of those factors.

We expect the inventory of soil research provided in this report will be used widely by government departments in Pacific countries, donors, and other organisations to access information about soil attributes and their spatial distribution in order to help plan crop production and agricultural development. It will support technology transfer initiatives in these domains and provides insights to Pacific soils for scientists new to soils research in the southwest Pacific.

Most importantly, this inventory of soil research provides the people of the Pacific with a summary of the work done by New Zealand which they can readily access either in hardcopy or digital form.

Signed:

Warren Parker
Chief executive
Landcare Research
Lincoln
New Zealand

Craig Hawke
Director – Pacific Group
International Development Group
NZ Ministry of Foreign Affairs and Trade
Wellington, New Zealand

‘Aleki Sisifa
Director
Land Resources Division
Secretariat of the Pacific Community
Suva, Fiji

Foreword

The importance of the soil factor in plant production has long been recognised in Pacific Island countries. Within traditional agricultural systems, variations in soils are frequently reflected by differences in crop production patterns and soil management practices.

Land use is dynamic and responds to economic, social and population pressures. Most Pacific Island countries depend heavily on agriculture for income. Agricultural development within a context of profitability, social desirability, and environmental conservation is a national objective. Such changing needs and pressures focus attention on the necessity for soil resource information. Soil science can provide the soil-related information necessary to help minimise the risks associated with evolving agriculturical systems during the initial, and most vulnerable, stages of development. It was within this framework that soil resource studies and soil research were instigated by NZ Soil Bureau, DSIR, in various countries of the South West Pacific.

Research by NZ Soil Bureau in the South West Pacific was initiated in relation to two main criteria; first, the perceived value of work in helping solve soil-related problems, and second, the contribution to scientific understanding.

Soil research aims to enhance the living standards and quality of life within the values held by the Pacific Island countries. Soil survey projects describe the nature of soils and their occurrence across the landscape. The soil map therefore acts as a resource document for improving subsistence and cash crop production on a sustainable-yield basis. Other projects contribute to agricultural development by research into specific aspects of soil fertility and crop production.

Research also aims to further our understanding of the soil system. Our ability to solve soil-related problems depends on our understanding of the processes occurring within the soil system.

The majority of projects undertaken by NZ Soil Bureau were regarded as extensions of New Zealand's Overseas Development Assistance programme (NZODA), instigated at the request of some Pacific Island countries and funded by the Ministry of Foreign Affairs under either bilateral or regional aid programmes.

One cannot overstate the value of soil and land information in supporting economic development, alleviating poverty, and improving knowledge about ecosystem processes and managing the overall health of environments. Significantly the information does not age but new approaches can reinterpret the data and IT technologies can better integrate and 'massage' these for the benefit of scientists and other end-users.

Sadly in this electronic era the perceived value of the hard copy has diminished. However, it is vital that technical reports, scientific papers, and maps are all retained. Ideally they should be housed somewhere accessible (such as a relevant science library) but at the very least, in personal collections. When working staff retire, they have a responsibility to pass these valuable resources on to other appropriate staff at retirement.

A similar compilation could be prepared for the floras undertaken in the South West Pacific (Cook Islands, Niue, Tonga) and the plant protection work that grew out of the 1974 FAO/UNDP Regional Pest and Disease Survey.

David Leslie
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Landcare Research – Manaaki Whenua
Nelson
May 2009

1. Background

1.1 History of soil and land research programmes

The NZ Soil Bureau had a long involvement with the South West Pacific starting with an investigation of soils on Western Samoa (Hamilton & Grange 1938). Reconnaissance and soil surveys were made on Western Samoa (Wright 1963), the Lower Cook Group (Grange & Fox 1953), Niue (Wright & Van Westendorp 1965), Fiji (Twyford & Wright 1965) and Tongatapu (Gibbs 1976) during the 1950s and 1960s.

These early soil surveys provided much useful information on the nature of soils, their distribution and properties, and provided resource documents for agricultural and forestry development. The soil surveys of Fiji, Niue and Western Samoa by A.C.S. Wright are particularly noteworthy in this respect. Assessed by today's standards these surveys are of particularly high quality but because of the mapping scale they must be considered as reconnaissance only. The central concept of the soils characterised in these early surveys has proved to be very accurate, a factor that has helped considerably in the subsequent more detailed surveys in the Cook Islands, Fiji, Niue and Tonga.

Much of this early work formed the basis for the Oceania sheet of the FAO/Unesco *Soil Map of the World*.

1.2 Institutional change

In 1988, following the disestablishment of the Soil and Water Division of the Ministry of Works, the land-oriented research parts of the latter were merged with Soil Bureau, DSIR, to become the DSIR Division of Land and Soil Sciences.

In 1990 DSIR restructured into 10 mega divisions to provide a flatter structure that made it easier to pool together multi-skilled teams. This saw the creation of DSIR Land Resources through the merger of the following Divisions: Land and Soil Sciences, Botany, Ecology, and the Science Mapping Unit.

Based on the recommendations of the 1991 Ministerial Science Task Group, nine Crown Research Institutes were established in 1992. Landcare Research resulted from the merger of the following: DSIR Land Resources; Remote Sensing Group of DSIR Physical Sciences; Plant Materials Group of DSIR Fruit and Trees; DSIR Plant Protection; the Forest and Wildlands Ecosystems Division of FRI; and the Rabbit and Land Management Unit from MAF Technology.

1.3 Institutional memory loss

As organisations evolve and refocus research into new areas, and staff with the past project work experience age and retire, institutional memory can be lost very quickly. This setting has been the motivation to document some of the significant past soil and land resources research

and some key commercial projects conducted in the South West Pacific by Landcare Research and its predecessor organisations. To illustrate the seriousness of the institutional memory loss, project staff who are retired or deceased have been identified by an asterisk.

1.4 Where are the data held?

The majority of the soil research conducted in the DSIR era were formally published in hard copy as Scientific Reports, Soil Survey Reports, Bulletins, or papers in various well-known scientific journals. Spatial soil information from the Cook Islands, Fiji, Niue, Samoa and Tonga has been digitised and is on e-archive with a print-on-demand service available.

Less formal technical reports are held by the Landcare Research library, and commercial reports, e.g. Tonga Forestry Project, are held by the International Business Group of Landcare Research.

1.5 The programmes

For each programme described there is a brief description of the actual services provided, the terms of reference as set by the donor/client, the New Zealand technical staff and in-country counterparts involved, timing and duration of the project, and finally, a complete chronological listing of publications that emanated from the research.

As is the case for soil survey and associated characterisation of soils, the pedologist is very dependent on laboratory services; the majority of laboratory analysts did not visit or become involved in the field phase. However, the analyses have been appropriately acknowledged as ‘co-authors’ in the many publications.

2. Cook Islands Soil and Land Use Programme

2.1 Phase one: Soil survey and soil resource characterisation/evaluation with land use interpretations (1974–76)

SERVICES PROVIDED:
Soil Bureau, DSIR, supplied seven soil surveyors to conduct soil surveys of Rarotonga, Aitutaki, Mauke, Atiu, Mitiaro, and Mangaia islands. The soil survey teams were assisted during the sampling phase by a soil chemist, a soil physicist, and an agronomist. Cartography was undertaken by the Science Mapping Unit of DSIR.

TERMS OF REFERENCE:
- Prepare detailed (scale 1:15,000) soil maps
- Fully characterise soils through physical, chemical and mineralogical analysis at NZ Soil Bureau laboratories, Taita, New Zealand
- Prepare Soil Survey Reports for each island, in which: soil series are defined and classified; soils are placed into defined suitability classes for a range of crops and potential land uses; and information provided about soil limitations and ameliorations
- Prepare a 'popular' booklet targeted for the lay reader and explaining the nature and distribution of Cook Island soils
- Prepare the Soil Taxonomic Unit Descriptions (STUDs)
- Report interim project outcomes at a seminar and field workshop, attended by government officials and landowners, one year after project implementation

LOCATION: Southern Cook Islands Group

CLIENT: NZ Bilateral Aid Programme (Ministry of Foreign Affairs), with the Ministry of Agriculture and Fisheries, Government of the Cook Islands

NO. OF NZ PERSON MONTHS: 105 (field, laboratory, editing)

DATE: June 1974 – December 1976

2.2 Phase two: Fertility and hydraulic properties of selected Cook Island soils (1976-80)

SERVICES PROVIDED:
Soil Bureau, DSIR, provided two agronomists, three chemists, a mineralogist, and a soil physicist, with pedological support as required; glasshouse and laboratory facilities; and training programmes in the use and maintenance of the neutron probe and conduct of field fertility experimentation.

TERMS OF REFERENCE:
- Conduct initial glasshouse experiments using subtractive techniques (with green panic) to assess the fertility of major selected soils

- Design and implement field fertiliser experiments (using maize) to validate results of glasshouse experiments
- Prepare various reports describing fertility status of soils, and detail about nutrient deficiencies limiting plant growth
- Establish trials on citrus to assess the efficiency of current fertiliser recommendations in terms of fruit yield and quality and tree growth rate
- For the banana and citrus industries, recommend the form, formulation, and quantities of fertiliser required by the Cook Island government
- Measure/monitor selected soils on Aitutaki and Rarotonga to better understand soil moisture relationships under citrus, banana and coconut
- Test results from neutron-probe measurements with water-balance models; and from undisturbed cores derive data on the water storage and transmission characteristics
- Monitor irrigated and non-irrigated citrus blocks at Totokoitu Research Station, Rarotonga, to provide irrigation schedules for citrus

LOCATION: Southern Cook Islands Group

CLIENT: NZ Bilateral Aid Programme (Ministry of Foreign Affairs), with the Ministry of Agriculture and Fisheries, Government of the Cook Islands

NO. OF NZ PERSON MONTHS: 20

DATE: July 1976 – 1980

PERSONNEL INVOLVED IN THE COOK ISLANDS SOIL AND LAND USE PROGRAMME:
Soil Bureau staff: Soil Surveyors – John Bruce*, Iain Campbell*, Mike Leamy*, Dave Leslie* (Team Leader), Trevor Webb, Hugh Wilde*, and Alistair Wilson*; Agronomists – Lionel Hume* and John Widdowson*, Chemists – Les Blakemore*, Bernard Healy* and Bob Lee*; Mineralogist – Graeme Claridge*; Soil Physicist – Rick Jackson*.
Cook Islands Agricultural staff: Barry Balbernie*, Fred Charlie, Julian Dashwood*, David Greig*, Parei Joseph, John Jessie, Bill Hosking*, Marii Mahutariki, Anau Manarangi*, Matt Purea*, Taukea Raui, Ngaro Solomona, Kato Tama*, Michael Tavioni, David Tuaeu, Kiriau Turepu*, and Manea Turepu*.

2.3 Publications from Phases 1 and 2

BLAKEMORE, L.C.; WIDDOWSON, J.P. 1975a
Fertility of Cook Islands soils, Interim Report: 1. Glasshouse studies. 2. Soil analyses.

BLAKEMORE, L.C.; WIDDOWSON, J.P. 1975b
Analysis of foliage from orange orchards in Rarotonga, Cook Islands.
NZ Soil Bureau Scientific Report 23. 13 p.

* Retired or deceased

MILLER, R.B. 1975
Cook Islands Soil and Land Use Programme.
Report on Seminar July 21–25, 1975. 40 p.

WIDDOWSON, J.P.; BLAKEMORE, L.C. 1977
Fertility of Cook Islands soils.
Soil Science 123: 409–414.

CAMPBELL, I.B.; CLARIDGE, G.G.C.; BLAKEMORE, L.C. 1978
Pedological study of soils from basaltic parent material on the island of Atiu, Cook Islands.
New Zealand Journal of Science 21: 229–248.

HUME, L.J.; WIDDOWSON, J.P.; HOSKING, W.J.; TAMA, K. 1979
Responses to fertiliser N, P, K and S by maize on three soils of Rarotonga, Cook Islands.
New Zealand Journal of Experimental Agriculture 7: 235–243.

LEE, R.; BLAKEMORE, L.C.; WIDDOWSON, J.P. 1979
The potassium status of some representative soils from the Cook Islands.
Tropical Agriculture 56: 193–203.

NZ SOIL BUREAU and COOK ISLANDS MAF. 1979
Soils of the Cook Islands – An introduction.
NZ Ministry of Foreign Affairs. 44 p.

CAMPBELL, I.B. 1980
Soil Map of Atiu, Cook Islands. Scale 1:15,000.
NZ Soil Bureau Map 168.[1]

LESLIE, D.M. 1980a
Soil map of Rarotonga, Cook Islands. Scale 1:10,000.
NZ Soil Bureau Map 163.

LESLIE, D.M. 1980b
Soils of Rarotonga, Cook Islands.
NZ Soil Survey Report 49. 68 p.

MILNE, J.D.G. 1980
Soil Map of Aitutaki, Cook Islands. Scale 1:15,000.
NZ Soil Bureau Map 165.

WEBB, T.H. 1980
Soil Map of Mangaia, Cook Islands. Scale 1:15,000.
NZ Soil Bureau Map 164.[1]

WILDE, R.H. 1980
Soil map of Mitiaro, Cook Islands. Scale 1:15,000.
NZ Soil Bureau Map 167.[1]

WILSON, A.D. 1980
Soil map of Mauke, Cook Islands. Scale 1:15,000.
NZ Soil Bureau Map 166.[1]

[1] Map is on e-archive; print-on-demand service available

JACKSON, R.J. 1981
Measurements of moisture in some Cook Island soils.
In: Dale W.R. ed. Pacific Island water resources. *South Pacific Technical Inventory 2*. DSIR. Pp. 51–55.

WEBB, T.H. 1981
Soils of Mangaia, Cook Islands.
NZ Soil Survey Report 50. 52 p.

WILDE, R.H. 1981
Soils of Mitiaro, Cook Islands.
NZ Soil Survey Report 53. 20 p.

CAMPBELL, I.B. 1982
Soils of Atiu, Cook Islands.
NZ Soil Survey Report 54. 38 p.

WILSON, A.D. 1982
Soils of Mauke, Cook Islands.
NZ Soil Survey Report 52. 59 p.

BRUCE, J.G. 1983a
Patterns and classification by Soil Taxonomy of the soils of the Southern Cook Islands.
Geoderma 31: 301–323.

BRUCE, J.G. 1983b
Soil taxonomic unit descriptions for the Cook Islands.
NZ Soil Bureau Soil Taxonomic Unit Descriptions 3. 272 p.

BRUCE, J.G. 1985
Occurrence of the orders of Soil Taxonomy of the islands of the Southern Cook Group.
South Pacific Journal of Natural Science 7: 35–44.

HUME, L.J.; HEALY, W.B.; HOSKING, W.J.; MANARANGI, A.; TAMA, K. 1985
NPK fertiliser rates for citrus on Rarotonga, Cook Islands.
NZ Soil Bureau Scientific Report 75. 17 p.

HUME, L.J.; HEALY, W.B.; TAMA, K.; HOSKING, W.J.; MANARANGI, A.; REYNOLDS, J. 1985
Responses of citrus (*Citrus sinensis*) to nitrogen-phosphorus-potassium (NPK) fertiliser on 2 soils of Rarotonga, Cook Islands. 1. Effects of NPK fertiliser rate on soil properties and leaf nutrient levels.
New Zealand Journal of Agricultural Research 28: 475–486.

HUME, L.J.; HEALY, W.B.; TAMA, K.; HOSKING, W.J.; MANARANGI, A.; REYNOLDS, J. 1985
Responses of citrus (*Citrus sinensis*) to nitrogen-phosphorus-potassium (NPK) fertiliser on 2 soils of Rarotonga, Cook Islands. 2. Effects of NPK fertiliser rate, soil properties, and leaf nutrient levels on yield and tree size.
New Zealand Journal of Agricultural Research 28: 487–495.

HUME, L.J.; WIDDOWSON, J.P. 1986
Response of sweet corn to lime on an Ultisol from Atiu, Cook Islands.
New Zealand Journal of Agricultural Research 29: 269–273.

MILNE, J.D.G. 1991
Soils of Aitutaki, Cook Islands.
NZ Soil Survey Report 51. 29 p.[1]

2.4 Other relevant DSIR soil publications

FIELDES, M.; SWINDALE, L.D., RICHARDSON, J.P. 1952
Relation of Colloidal hydrous oxides to the high cation exchange capacity of some tropical soils of the Cook Islands.
Soil Science 74: 197–205.

HEALY, W.B. 1952
Note on zinc deficiency of citrus at Aitutaki, Cook Islands.
NZ Journal of Science and Technology, Sec. A. 34(2): 228–229.

GRANGE, L.I.; FOX, J.P. 1953
Soils of the Lower Cook Group.
NZ Soil Bureau Bulletin 8: 56 p.

BRUCE, J.G. 1972
Soils of Manuae and Palmerston islands, two coral atolls in the Cook Islands.
NZ Journal of Agricultural Research 15: 605–619.

LEAMY, M.L.; LESLIE, D.M.; BLAKEMORE, L.C.; BALBERNIE, B.C. 1975
Soils of Totokoitu Research Station, Rarotonga, Cook Islands.
NZ Soil Survey Report 27. 67 p.

WILDE, R.H. 1988
Peat deposits of Mitiaro, Southern Cook Islands.
NZ Soil Bureau Contract Report 88/17. 33 p.

JESSEN, M.R.; PAGE, M.J.; WILDE, R.H.; MILLER, D.E.K. 1990
Land Use Capability of Atiu, Cook Islands – Survey report and mapper's handbook.
DSIR Land Resources Contract Report 90/15. 81 p.

MILLER, D.E.K. 1990
Erosion control handbook, Atiu, Cook Islands.
DSIR Land Resources Contract Report 90/16. 55 p.

TRANGMAR, B.B.; JESSEN, M.R. 1990
Crop suitability ratings, Atiu, Cook Islands.
DSIR Land Resources Contract Report 90/23. 23 p.

[1] Map is on e-archive; print-on-demand service available

3. Cook Islands GIS Development Project (1993–98)

SERVICES PROVIDED:
This 6-year project was a NZ Ministry of Foreign Affairs and Trade Management Services contract awarded to ANZDEC with technical input provided by Landcare Research. The aim of the project was to assist the Cook Island Government in establishing an integrated GIS facility in four government departments. This was to enable improved access to and management of spatial natural resource information required for departmental decision-making in operations and planning.

The actual services provided included GIS needs assessment, design of the system specifications, and hardware/software procurements:

- A training needs assessment was made and forward training programme developed. The following training courses were conducted, in addition to one-on-one 'hands-on' GIS and database training when consultants visited:
    - An initial 3-month GIS course for 5 trainees in New Zealand
    - A 4-week secondment for a GIS-trained operator
    - A 2-week GIS course in Rarotonga for 22 from five departments
    - A 2-week Paradox course for 10 trainees from four departments
    - A 3-week GIS training course for 8 trainees from four departments
- Digital capture (digitising, scanning) of data included cadastre, land valuation, soils, land use, topography, hydrology, infrastructure, land resources, service utilities and cultural data for the Cook Islands
- Assistance was provided with GIS applications in the agriculture, forestry, environment and land use planning sectors.
- Practical advice was provided on hardware/software maintenance/upgrades and servicing.
- Establishment of three advisory groups: GIS Steering Committee, GIS Technical Operators Group, and a less formal GIS Users Group.

TERMS OF REFERENCE:

- Assist with specification, purchase, installation and commissioning of GIS computer hardware and software in four government departments
- Conduct training needs assessment, develop a 5-year programme, and undertake training as per plan in New Zealand and Rarotonga
- Draft data protocols for data ownership and sharing
- Provide technical support during project implementation with hardware and software matters related to data handling and system development, including maintenance and upgrades
- Assist in establishing an interdepartmental (those with GIS facilities) steering committee; a Technical Operating Group (TOG) comprising the 'hands-on' GIS operators; and Users Forum (all the heads of departments and appropriate SOEs)
- Regularly monitor and report on the achievement of project objectives and identify solutions to any problems that may arise

LOCATION: Departments of Agriculture, Conservation, Survey and Works, Rarotonga.

CLIENT: NZ Ministry of Foreign Affairs and Trade (now NZAID)

NO. OF NZ PERSON MONTHS: 9

DATE: 1993–1998

PERSONNEL:

NZ staff: Roland van Asch, ANZDEC (Project Director); Dave Leslie*, Technical Coordinator/Training Adviser; David Giltrap*, GIS/Database Specialist; James Barringer, GIS/Remote Sensing Specialist.

NZ staff who conducted GIS training in NZ: Robert Gibb; Peter Stephens*; John Dymond; Bruce Trangmar*.

Cook Island key GIS staff: Timoti Tangiruaine, Lynley Andrew, Survey Dept; Patrick Arioka, Cecilia Haupini, Dept of Agriculture; Benjamin Classie, Dept of Conservation; and George Taikakara, Ministry of Works.

Cook Island project management counterparts: Oliver Peyroux*, Surveyor General; Nga Mataio, Director of Agriculture.

Cook Island staff trained in GIS:

- Survey Dept – Vaipo Mataroa, Bob Aratangi, Ken Tiro, Bruce Manuel.
- Ministry of Works – Tua Matepi, Makea Pauka, Gasper Matearíki, Tuaine Tinitau, Adrian Teotahi, Terence Bishop, and Joseph Akaruru.
- Dept of Agriculture – Elizabeth Munro, Tua Kairae, Pavai Taramai, William Wigmore, James MacKilop, Wilson Porima.
- Dept of Conservation – Teariki Rongo*, Wayne King*, Anna Tirea*, Tereapi Pakitoa.

* Retired or deceased.

4. National Soil Survey Project, Fiji (1981–84)

4.1 Soil survey, with soil series characterisation and classification, and crop-specific interpretations

SERVICES PROVIDED:
Soil Bureau, DSIR, provided a senior soil surveyor (through a 3-year secondment to New Zealand Foreign Affairs) to coordinate and correlate the national soil survey of Fiji (with Fijian counterpart, support soil surveyors, cartographers, and laboratory staff).

TERMS OF REFERENCE:

- Prepare semi-detailed national soil maps, at 1:50,000 scale (48 sheets)
- Prepare soil taxonomic unit descriptions (STUDs) for defined soil series
- Prepare reports, in tabular format, outlining 'soil limitations for plant growth' for each soil mapping unit
- Prepare a report correlating soil series according to Soil Taxonomy, FAO and Twyford & Wright systems of soil classification
- Prepare crop-specific interpretative tables for soil mapping units, as governed by availability of requirement data for crops
- Provide training opportunities, as the project requires
- Establish the 'mechanics' for extrapolating results from Fiji SCEP to the national soil survey

LOCATION: Fiji (including Lau Group and Rotuma).

CLIENT: NZ Bilateral Aid Programme (Ministry of Foreign Affairs), with Land Use Section/Research Division of Fiji Ministry of Primary Industries

NO. OF NZ PERSON MONTHS: 60

DATE: June 1981 – 1984

PERSONNEL INVOLVED IN FIJI NATIONAL SOIL SURVEY PROJECT:
Soil Bureau staff: Soil Surveyors – Dave Leslie* (Team Leader), Mike Laffan* and Steve Smith*; Chemists – Les Blakemore* and Brian Daly; Agronomists – Harvey Watts* and John Widdowson*.

Fiji MPI staff: Soil Surveyors – Vilitati Seru*, F.F. Kafoa*, Paramanand Naga*, Viluma Tora*; Chemists – Jone Korovou*, William Magnus, Satendra Singh*.

* Retired or deceased.

4.2 Publications from Fiji National Soil Survey Project

LAFFAN, M.D.; SMITH, S.M.; WATTS, H.M.; WIDDOWSON, J.P.; BLAKEMORE, L.C.; KAFOA, F.F. 1982
Soil resources of Rotuma and implications for land use.
Fiji Agricultural Journal 44(2): 43–52.

LESLIE, D.M.; SERU, V.B. 1982
Fiji Soil Correlation, Classification and Crop Evaluation and Management Prog.
Fiji Agricultural Journal 43(1): 43–46.

MORRISON, R.J.; LESLIE, D.M. (Editors). 1982
Proceedings of the South Pacific regional forum on Soil Taxonomy. Suva, Nov 1981.
Institute of Natural Resources, The University of the South Pacific, Suva, Fiji. 445 p.

LAFFAN, M.D.; SMITH, S.M. 1983
Soil map of Rotuma, Fiji. Scale 1:25,000
NZ Soil Bureau Map 208. [1]

LAFFAN, M.D.; SMITH, S.M. 1984
Soil taxonomic unit descriptions for Rotuma, Fiji.
NZ Soil Bureau Soil Taxonomic Unit Descriptions 14. 90 p.

LESLIE, D.M.; NAKATANI, K.; TORA, T.; MAGNUS, W.; PRASAD, R.A.; MORRISON, R.J. 1985a
Soils of the Fiji pine forests. 2. Soils of the Nabou Forest.
Environmental Studies Report 25. University of the South Pacific (USP), Institute of Natural Resources. 63 p.

LESLIE, D.M.; NAKATANI, K.; TORA, T.; MAGNUS, W.; PRASAD, R.A.; MORRISON, R.J. 1985b
Soils of the Fiji pine forests. 3. Soils of the Lololo Forest.
Environmental Studies Report 26. USP, Institute of Natural Resources. 55 p.

MANNER, H.I.; NAKATANI, K.; TORA, T.; LESLIE, D.M.; PRASAD, R.A.; MORRISON, R.J. 1985
Soils of the Fiji pine forests. 1. Soils of the Vatuma and Masi catchments, Nadi Forest.
Environmental Studies Report 24. USP, Institute of Natural Resources. 71 p.

LAFFAN, M.D.; SMITH, S.M. 1986
Soils of Rotuma, Fiji.
NZ Soil Bureau Soil Survey Report 72. 38 p.

SERU, V.B.; LESLIE, D.M. 1986
Soil map of Fiji. Scale 1:50,000
Land Use Section, Land Resource Planning and Development Division, Ministry of Agriculture, Fiji.[1]

LESLIE, D.M.; SERU, V.B. 1998
Fiji soil taxonomic unit description handbook.
Manaaki Whenua Press. 2 volumes (928 p.)

[1] Map is on e-archive; print-on-demand service available.

5. Soil Surveys of Fiji Agricultural Research Stations (1980–88)

5.1 Soil surveys

SERVICES PROVIDED:
Soil Bureau, DSIR, provided a Team Leader/Soil Scientist and seven pedologists who conducted detailed soil surveys of nine Ministry of Primary Industries (MPI) Agricultural Research Stations – Dobuilevu, Koronivia, Legalega, Naduruloulou, Nawaicoba, Seaqaqa, Sigatoka, Waidradra, Wainigata – plus soil surveys of Tutu Estate and Vunilagi Estate. Soil chemical analyses were carried out in both Fiji and New Zealand, with mineralogy and soil physics analyses required for soil classification undertaken at Soil Bureau Taita laboratories. Cartographic services were provided by DSIR Science Mapping Unit. The project involved production of soil maps at various scales including a wide range of map compilation data and conversion from imperial to metric data.

TERMS OF REFERENCE:
- Prepare detailed soil surveys (scales 1:1500 and 1:3000) of Fiji MPI Agricultural Research Stations (ARS) and two estates
- Prepare survey reports for nine ARSs and two estates that define, classify (Soil Taxonomy) and correlate soils with Twyford & Wright (1965)
- Fully characterise all soil series
- Prepare for publication soil survey reports with accompanying soil maps

LOCATION: Fiji – agricultural research stations at Dobuilevu, Koronivia, Legalega, Naduruloulou, Nawaicoba, Seaqaqa, Waidradra, Wainigata, Sigatoka, and Tutu Estate and Vunilagi Estate.

CLIENT: NZ Bilateral Aid Programme (Ministry of Foreign Affairs), with Land Use Section/Research Division of the Fiji Ministry of Primary Industries

NO. OF NZ PERSON MONTHS: 40

DATE: 1980–1988

PERSONNEL INVOLVED IN SOIL SURVEYS OF FIJI AGRICULTURAL RESEARCH STATIONS:

Soil Bureau, DSIR staff: Soil Surveyors – Mike Laffan*, Dave Leslie* (Team Leader), Malcolm McLeod, Vince Neall (Massey University), Robin Palmer*, Brian Purdie*, Wim Rijkse*, Graham Shepherd*, Steve Smith*; Chemists – Les Blakemore*, Brian Daly, Keitha Giddens*; Mineralogist – Joe Whitton*.

Fiji MPI staff: Chemists – Jone Korovou*, William Magnus, Surendra Singh*.

* Retired or deceased.

5.2 Publications from soil surveys of Fiji agricultural research stations

LESLIE, D.M. 1984a
Soil map of Koronivia Agricultural Research Station, Viti Levu, Fiji. Scale 1:3000. NZ Soil Bureau Map 210.[1]

LESLIE, D.M.; LAFFAN, M.D. 1984
Soil map of Nawaicoba Agricultural Research Station. Scale 1:3000. NZ Soil Bureau Map 212.[1]

LAFFAN, M.D.; PURDUE, B.R.; SHEPHERD, T.G. 1984
Soil map of Seaqaqa Agricultural Research Station, Vanua Levu, Fiji. Scale 1:3000. NZ Soil Bureau Map 213.[1]

LESLIE, D.M. 1984b
Soils of Koronivia Agricultural Research Station, Viti Levu, Fiji. NZ Soil Survey Report 75. 46 p.

LESLIE, D.M. 1985a
Soil taxonomic unit descriptions for Koronivia Agricultural Research Station, Viti Levu, Fiji. NZ Soil Bureau Soil Taxonomic Unit Descriptions 4. 84 p.

LAFFAN, M.D. 1985a
Soil taxonomic unit descriptions for Legalega Agricultural Research Station, Viti Levu, Fiji. NZ Soil Bureau Soil Taxonomic Unit Descriptions 5. 46 p.

LESLIE, D.M. 1985b
Soil taxonomic unit descriptions for Nawaicoba Agricultural Research Station, Viti Levu, Fiji. NZ Soil Bureau Soil Taxonomic Unit Descriptions 6. 58p.

LAFFAN, M.D. 1985b
Soil taxonomic unit descriptions for Seaqaqa Agricultural Research Station, Vanua Levu, Fiji. NZ Soil Bureau Soil Taxonomic Unit Descriptions 7. 48 p.

RIJKSE, W.C. 1985
Soil taxonomic unit descriptions for Sigatoka Agricultural Research Station, Viti Levu, Fiji. NZ Soil Bureau Soil Taxonomic Unit Descriptions 9. 65 p.

McLEOD, M. 1985
Soil taxonomic unit descriptions for Dobuilevu Agricultural Research Station, Viti Levu, Fiji. NZ Soil Bureau Soil Taxonomic Unit Descriptions 12.

RIJKSE, W.C., McLEOD, M. 1985
Soil map of Sigatoka Agricultural Research Station, Viti Levu. Scale 1:3000. NZ Soil Bureau Map 215.[1]

[1] Map is on e-archive; print-on-demand service available.

SMITH, S.M. 1985
Soil taxonomic unit descriptions for Waidradra Agricultural Research Station, Viti Levu, Fiji.
NZ Soil Bureau Soil Taxonomic Unit Descriptions 11. 34 p.

SMITH, S.M.; PALMER, R.W.P. 1985
Soil map of Waidradra Agricultural Research Station, Viti Levu, Fiji.
NZ Soil Bureau Map 217.[1]

PALMER, R.W.P. 1986
Soil taxonomic unit descriptions for Naduruloulou Agricultural Research Station, Viti Levu, Fiji. *NZ Soil Bureau Soil Taxonomic Unit Descriptions 10*. 76 p.

PALMER, R.W.P., SMITH, S.M. 1986
Soil map of Naduruloulou Agricultural Research Station, Viti Levu, Fiji. Scale 1:3000.
NZ Soil Bureau Map 216.

PURDIE, B.R. 1986
Soil taxonomic unit descriptions for Wainigata Agricultural Research Station, Vanua Levu, Fiji.
NZ Soil Bureau Soil Taxonomic Unit Descriptions 8. 48 p.

SHEPHERD, T.G.; NEALL, V.E. 1986a
Soil map of Tutu Estate, Taveuni Island, Fiji. Scale 1:10,000.
NZ Soil Bureau Map 219.[2]

SHEPHERD, T.G.; NEALL, V.E. 1986b
Soil taxonomic unit descriptions for Tutu Estate, Taveuni Island, Fiji.
NZ Soil Bureau Taxonomic Unit Descriptions 13. 102 p.

SHEPHERD, T.G.; NEALL, V.E. 1986c
Soil taxonomic unit descriptions for Vunilagi Estate, Vanua Levu, Fiji.
NZ Soil Bureau Soil Taxonomic Unit Descriptions 18. 49 p.

PURDIE, B.R; LAFFAN, M.D.; SHEPHERD, T.G. 1987
Soil map of Wainigata Agricultural Research Station, Vanua Levu, Fiji. Scale 1:3000.
NZ Soil Bureau Map 214.[1]

LAFFAN, M.D. 1988a
Soils of Legalega Agricultural Research Station, Viti Levu, Fiji.
NZ Soil Survey Report 77. 28 p.

LAFFAN, M.D. 1988b
Soils of Seaqaqa Agricultural research Station, Vanua Levu, Fiji.
NZ Soil Survey Report 79. 29 p.

McLEOD, M.; RIJKSE, W.C. 1989
Soil map of Dobuilevu Agricultural Research Station, Viti Levu, Fiji. Scale 1:3000.
NZ Soil Bureau Map 218. [2]

RIJKSE, W.C. 1990
Soils of Sigatoka Research Station, Viti Levu, Fiji.
NZ Soil Survey Report 81. 58 p.

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[1] Map is on e-archive; print-on-demand service available.

SHEPHERD, T.G.; NEALL, V.E. 1991
Soils of Tutu Estate, Taveuni, Fiji.
NZ Soil Survey Report 85. 111 p.

PALMER, R.W.P. 1992
Soils of Naduruloulou Agricultural Research Station, Viti Levu, Fiji.
NZ Soil Survey Report 82. 45 p.

SMITH, S.M. 1992
Soils of Waidradra Agricultural Research Station, Vitu Levu, Fiji.
NZ Soil Bureau Report 83. 35 p.

McLEOD, M. 1992
Soils of Dobuilevu Agricultural Research Station, Viti Levu, Fiji.
NZ Soil Survey Report 84. 43 p.

5.3 Other relevant DSIR soil publications

FOX, J.P. 1954
Note on the occurrence of a red yellow podzolic soil and associated ground water podzol in Viti Levu, Fiji.
Transactions of the 5th International Congress of Soil Science 4: 28–31.

FOX, J.P.; TWYFORD, I.T. 1954
The soils of the Navua Plains and their chemical status.
Fiji Agricultural Journal 25: 30–37.

TWYFORD, I.T.; WRIGHT, A.C.S. 1965
The soil resources of the Fiji Islands.
Government Printer, Suva. 2 volumes (570 p. 23 maps)

LESLIE, D.M.; BLAKEMORE, L.C. 1978
Properties and classification of the soils from Lakeba, Lau Group, Fiji in Lau-Tonga, 1977.
Bulletin, Royal Society of New Zealand 17: 165–190.

LESLIE, D.M. 1984
Site and soil profile descriptions from Vanua Balavu, Lau Group, Fiji.
Wellington District Office Report WN13. 17 p.

LESLIE, D.M.; BLAKEMORE, L.C. 1985
Properties and classification of selected soils from Vanua Balavu, Lau Group, Fiji.
Journal of the Royal Society of New Zealand 15(3): 313–327.

MORRISON, R.J.; NAIDU, R.; SINGH, U.; LESLIE, D.M. 1989
Andisols and related soils in the South Pacific Islands. In: Shoji, S., Kinloch, D. eds *Properties, classification and utilisation of andisols and paddy soils, Sendai, Japan.* Soil Science Society of Japan. Pp. 459–468.

6. Fiji Soil and Crop Evaluation Project (SCEP) – Phase One (1983–87)

6.1 Crop and soil-specific field trials

SERVICES PROVIDED:
Soil Bureau, DSIR, facilitator for Fiji SCEP, provided a soil scientist and agronomist for the project design team (including representatives from the USA, Australia and New Zealand). Project for the initial 5 years had Australian and New Zealand funding of US$2.5m.

Fiji SCEP involved crop and soil-specific field trials to evaluate soil fertility, nutrient and agronomic requirements for nationally important cash and subsistence crops. A key objective was to develop predictive soil and crop management models for application on farmers' fields.

The overall goal of the project was to contribute to self-sufficiency in food crops and an increase in export earnings for Fiji by documentation and demonstration of crop nutrient requirements on the soils suitable for sustainable cropping systems.

Minimum data sets were identified as part of the project design. Trial sites with fully characterised soils were established at Koronivia, Sigatoka, Seaqaqa and Legalega research stations. Training for trial agronomic and laboratory staff was conducted both in Fiji and New Zealand. Project progress was reviewed annually through the Technical Advisory Committee.

TERMS OF REFERENCE:
- Assemble international project design panel to develop a 5-year programme for SCEP.
- Initiate project planning including preparation of experimental design and minimum data sets.
- Select experimental sites and fully characterise soils at each.
- Provide advice on experimental design and agronomy.
- Undertake training at both Koronivia Research Station and DSIR, Taita, in soil and foliar analysis and methodologies, quality control in the laboratory, and interpretation of results.
- Undertake training in experimental design including soil characterisation, climo-edaphic crop matching, and principles of agrotechnology transfer.
- Make provision for biometric analysis.
- Procure equipment, train Koronivia laboratory staff in use of neutron probe for soil moisture monitoring and experimental sites.
- Establish a Technical Advisory Committee to meet annually and undertake project reviews.
- Publish results from experiments when appropriate and ensure local counterparts are skilled in technical writing.

LOCATION: Project coordinated from MPI Koronivia Research Station with field experiments at agricultural research stations on Viti Levu (Sigatoka, Legalega and Koronivia) and Seaqaqa on Vanua Levu.

CLIENT: NZ Bilateral Aid Programme, Ministry of Foreign Affairs and Trade (DSIR Land Resources manage MFAT inputs) and AusAID (ACIL Australia Pty Ltd manage AusAID inputs) with the Research Division of Fiji MPI

NO. OF NZ PERSON MONTHS: 40

DATE: 1983–1987 (ceased following Fiji coup and withdrawal of aid funding)

PERSONNEL INVOLVED IN FIJI SCEP PHASE ONE:
Soil Bureau, DSIR staff: Dave Leslie*, Project Facilitator/Pedologist; Brian Daly, Laboratory Analyst; Rick Jackson*, Soil Physicist; Bruce Trangmar*, Soil Scientist/Trainer; John Widdowson*, Agronomist.

International staff: Jim Silva*, Agronomist (University of Hawaii); Paul Gregg*, Soil Scientist (Massey University); Paul Haydock*, Biometrician (CSIRO); Ian Wood*, Agronomist (CSIRO); Gary Osborne*, Soil Chemist/Project Manager (Australia).

Fiji MPI staff: Chemists – Surendra Singh*, Jone Korovou*, William Magnus and Bardu Singh*; Agronomists – Kamlesh Chand Puran, Kaniappa Reddy*, Narayan Reddy*, Param Sivan*.

6.2 Publications from Fiji SCEP Phase One

SILVA, J.A.; GREGG, P.; HAYDOCK, K.P.; LESLIE, D.M.; WIDDOWSON, J.P.; WOOD, I.M. 1984
A proposal for Fiji Soil and Crop Evaluation Project (Fiji SCEP).
NZ Soil Bureau Scientific Report 65. 124 p.

TRANGMAR, B.B.; OSBORNE, G.J. 1987
Fiji SCEP experimental methods training course (22 Sept – 3 Oct 1986), Suva Fiji.
Fiji SCEP Technical Report 1. 33 p.

THISTLETHWAITE, R.J.; LESLIE, D.M.; OSBORNE, G.; PATEL, N.; SIVAN, N.; WOOD, I.M. 1989
Review of Fiji Soil and Crop Evaluation Project (Fiji SCEP).
Fiji SCEP Technical Report 2. 170 p.

* Retired or deceased.

7. Fiji Soil and Crop Evaluation Project (SCEP) – Phase Two (1993–99)

7.1 Database, GIS and soil chemistry

SERVICES PROVIDED:
Landcare Research provided an Agronomist/Team Leader; Soil Scientist/Project Director; a laboratory analyst; two soil physicists; and two GIS/database specialists.

Phase Two builds on and continues the services provided in Fiji SCEP Phase 1 with the following additional services:

- Assistance to the Research Division of MAFF (formerly MPI) with institutional strengthening and technology transfer mechanisms.
- Design and establishment of databases for field trial results, farmer practices and integration of these with other relevant databases.
- Design of appropriate GIS system.
- Procurement and installation of GIS hardware and software.
- Digitisation of resource data for GIS and establishment of user access procedures.
- Provision of seven training courses in soil chemistry, each of 2 months' duration, to Fiji MAFF technicians at Soil Bureau, DSIR, Taita.
- Secondment of Soil and Foliar Analyst to Koronivia Research Station laboratory for 3 years.

TERMS OF REFERENCE:

- Assess the institutional strengthening and capacity building needs of the Research Division, MAFF, and prepare programme to address these.
- Assess database requirement and design and establish appropriate operational databases.
- Assess GIS hardware and software requirements, design appropriate system including procedures for maintenance and data security, and make procurements.
- Train staff in database and GIS operations and applications.
- Digitise soil spatial data and integrate these with relevant non-spatial databases.
- Generate single-factor crop suitability maps.
- Undertake a training needs assessment in soil and foliar analysis and develop a training programme, including consideration of a long-term attachment of an Analyst to Koronivia Research Station.

- LOCATION: Project coordinated from MAFF Koronivia Research Station – Research Division (laboratory and agronomy) and Land Use Section (GIS) – with ongoing field experiments at Sigatoka, Legalega, Koronivia and Seaqaqa agricultural research stations.

CLIENT: NZ Bilateral Aid Programme (Ministry of Foreign Affairs and Trade) (Landcare Research manage MFAT inputs) and AusAID (ACIL Australia Pty Ltd manage AusAID inputs), with the Research Division of Fiji MAFF

NO. OF NZ PERSON MONTHS: 106

DATE: 1993–1999

PERSONNEL INVOLVED IN FIJI SCEP PHASE TWO:
DSIR Land Resources staff: John Widdowson*, Agronomist/Team Leader (Fiji, 3 years); Dave Leslie*, Soil Scientist/Project Director; Brian Daly, Laboratory Analyst (Fiji, 3 years); Rick Jackson*, Soil Physicist; John Claydon, Soil Physics Technician; David Giltrap*, Database/GIS Specialist; Julian Cone*, GIS Specialist; and Keitha Giddens*, Laboratory Analyst.

Fiji MAFF staff: Phillip Hine*, Soil Chemist; Josua Wainiqolo*, Soil Chemist; M. Nagatalevu, Weed Specialist; N. Kumar, Agronomist; Kamlesh Chand Puran, Agronomist; Vilitati Seru*, Pedologist.

International staff: Simon Field, Agronomist/Team Leader (ACIL Pty Ltd), succeeded by John Riches* in 1996; Tony Dowling, Agronomist (AusAID PACIFICLAND Team Leader); Gerald Faber, Extensionalist; Ian Wood*, Agronomist (CSIRO); Peter Falvey, Training Adviser (ACIL Pty Ltd); Helen Moriarty, Training Adviser (ACIL Pty Ltd).

7.2 Publications from Fiji SCEP Phase Two

DALY, B.K.; WAINIQOLO, J.L.; CHAND, K.; HART, P.B.S. 1992
The use of microbial biomass carbon for monitoring organic matter dynamics under cropping and agroforestry in two Fiji soils.
Paper presented at the ORSTOM workshop 'Soils and fertility of the small islands in the South Pacific', Noumea, New Caledonia, 16–21 November 1992.

KUMAR, J.; FIELD, S.P.; DOWLING, A.J.; WOOD, I.M.; WIDDOWSON, J.P.; HINE, P.T. 1995
Setting priorities for an agricultural research program in Fiji.
Fiji Agricultural Journal 51(2): 43–52.

DALY, B.K.; WAINIQOLO, J.L.; CHAND, K.; HART, P.B.S. 1996
The microbial biomass carbon for monitoring organic matter dynamics under cropping and agroforestry in two Fiji soils.
Fiji Agricultural Journal 52(1): 35–41.

7.3 SCEP/Fiji Agricultural Chemistry Laboratory (FACL) Joint Technical Reports

CLAYDON, J.J. 1993a.
Report on consultancy with the Fiji Agricultural Chemistry Laboratory, MAFF, Koronivia, 9–27 August 1993.

Prepared for NZ MFAT by J.J. Claydon, Landcare Research.

CLAYDON, J.J. 1993b.
Laboratory methods for water release and solid/void characterisation of soils.
FACL Technical Report 05/95.

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* Retired or deceased.

CLAYDON, J.J.; DALY, B.K.; WAINIQOLO, J.L. 1993
Methods for particle size analysis of soils.
FACL Technical Report 10/93. 17 p.

DALY, B.K.; WAINIQOLO, J.L. 1993a
Methods of analysis for agricultural samples: Soil, plant, animal feed and water.
FACL Technical Report 03/93. 115 p.

DALY, B.K.; WAINIQOLO, J.L. 1993b
Guide to interpretation of agricultural sample analysis results: Soil, plant, animal feed, irrigation water and others.
FACL Technical Report 04/93. 32 p.

DALY, B.K.; HINE, P.T. 1994
Fiji Agricultural Chemistry Laboratory quality assurance manual.
FACL Technical Report 01/94. 70 p.

DALY, B.K.; WAINIQOLO, J.L.; FIELD, S.P.; WIDDOWSON, J.P. 1994
Guide to fertilisers: Composition and calculations.
FACL Technical Report 02/94.

7.4 SCEP Landcare Research publications

DALY, B.K. 1994
MAFF Agricultural Chemistry Laboratory, Koronivia Research Station, Fiji; Final report.
Landcare Research International Business Group Report 052. 15 p.

LESLIE, D.M. 1995
Fiji SCEP proposed training programme (related to N-funded components).
Landcare Research International Business Group Report 061. 25 p.

CONE, J.; GILTRAP, D. 1995
Report on SCEP GIS/Database training, November 1995.
Landcare Research International Business Group Report 078. 21 p.

CONE, J.; GILTRAP, D. 1996
Report on SCEP GIS/Database training, April, 1996.
Landcare Research International Business Group Report 089. 35 p.

LESLIE, D.M. 1997
An introduction to the soils of Fiji.
Fiji SCEP, Ministry of Agriculture, Fisheries and ALTA, Suva, Fiji. AusAID. 182 p.

LESLIE, D.M.; CONE, J.; GILTRAP, D. 1998
Report on the Fiji GIS Training and Final Workshop, including a review of future requirements.
Landcare Research International Business Group Report 152. 21 p.

8. Niue Soil and Land Use Programme (1978–80)

8.1 Soil classification and fertility/radioactivity research

SERVICES PROVIDED:
Soil Bureau, DSIR, provided a senior soil surveyor/team leader, a chemist and an agronomist, with additional specialist technical support, at NZ Soil Bureau, Taita, as required. Glasshouse and laboratory facilities provided by NZ Soil Bureau. Special analyses (nuclear radiation) conducted in collaboration with the Institute of Nuclear Sciences, DSIR.

Note: Cartography undertaken by the Science Mapping Unit of DSIR.

TERMS OF REFERENCE:

- Field-check soil map of Wright and Van Westerndorp (1965) by traverse. Detailed mapping of selected 'windows' within map units. Preparation of 1:50,000 scale soil map.
- Collect samples to facilitate full characterisation and soil classification (according to Soil Taxonomy).
- Assess the fertility status of major soils through subtractive glasshouse experiments; with emphasis on zinc and the nutrient needs in limes and passion fruit.
- Conduct a geochemical investigation to better understand the origin of the soil parent materials and the source of the high levels of natural radioactivity.
- Report interim project outcomes at a seminar and field workshop attended by government officials and landowners, one year after project implementation.
- NOTE: This project primarily designed to 'build on' and 'update' extensive work conducted by NZ Soil Bureau staff during the 1950s and 1960s.

LOCATION: Niue Island

CLIENT: NZ Bilateral Aid Programme (Ministry of Foreign Affairs), with the Department of Agriculture, Government of Niue

NO. OF NZ PERSON MONTHS: 40

DATE: July 1978 – July 1980

PERSONNEL INVOLVED IN THE NIUE SOIL AND LAND USE PROGRAMME:
Soil Bureau staff: Soil Surveyor – Dave Leslie* (Team Leader); Chemists – Les Blakemore*, Bruce Miller*; Agronomist – John Widdowson*.
Niue Department of Agriculture staff: Morris Tafatu* (Director); Alapiti Heka* (Research Officer); Extension Officers – Moleti Tamate*, Liutose Fereti*, Bob Jordan*, Maka Kamupala*, Claasen Makaola*, Niula Molai*, Masiniua Siakia*.
Niue Development Board staff: Harold Stretton* (Manager); Toke Talagi* (Livestock Officer); Kenrick Viviani* (Crops Officer); and Taliu Alapaki* (Field Officer).

* Retired or deceased.

8.2 Publications from the Niue Soil and Land Use Programme

BLAKEMORE, L.C.; WIDDOWSON, J.P.; LESLIE, D.M. 1979
Soils of Niue Island. Interim report.
NZ Soil Bureau, Lower Hutt. 59 p.

MILLER, R.B. (compiler) 1980
Niue Soil and Land Use Seminar, Alofi, Niue, 9–11 October 1979.
NZ Soil Bureau Report. 133 p.

WIDDOWSON, J.P.; WATTS, H.M. 1981
Placement of fertiliser zinc in Niuean soils. (Abstract).
In: 'Soils with Variable Charge' Conference, Massey University, Palmerston North, New Zealand, 11–18 February 1981, Programme and Abstracts. P. 137.

LESLIE, D.M. 1985
Classification by Soil Taxonomy of the soils of Niue.
The South Pacific Journal of Natural Science 7: 100–131.

LESLIE, D.M. 1986a
Soil taxonomic unit descriptions for Niue Island.
NZ Soil Bureau Soil Taxonomic Unit Descriptions 19. 81 p.

LESLIE, D.M. 1986b
Soil Map of Niue Island. Scale 1:50,000.
NZ Soil Bureau Map 228.[1]

WHITEHEAD, N.E.; HUNT, J.L.; LESLIE, D.M.; RANKIN, P.C. 1991
Determination of radioactivity and element concentration in soils from Niue Island.
DSIR Land Resources Technical Record 57. 58 p.

WIDDOWSON, J.P; B.B. TRANGMAR, 1992.
Trace element fertility of coralline soils. Journal of South Pacific Agriculture 1(2); 61–72.

WHITEHEAD, N.E.; HUNT, J.L.; LESLIE, D.M.; RANKIN, P.C. 1993
The elemental content of Niue Island soils as an indicator of their origin.
New Zealand Journal of Geology and Geophysics 36(2): 243–254.

8.3 Other relevant DSIR soil publications

BIRRELL, K.S.; SEELYE, F.T.; GRANGE, L.I. 1939
Chromium in soils of Western Samoa and Niue Island.
New Zealand Journal of Science and Technology A21: 91–95.

GRANGE, L.I. 1949
Soils of some South Pacific Islands.
In: Proceedings of the First Commonwealth Conference on Tropical and Sub-Tropical Soils, 1948. *Commonwealth Bureau of Soil Science, Technical Communication 46:* 45–48.

[1] Map is on e-archive; print-on-demand service available.

WRIGHT, A.C.S. 1949
Soil reconnaissance of Niue Island.
Unpublished DSIR report.

MARSDEN, E.; FERGUSON, G.J.; FIELDES, M. 1958
Notes on the radio-activity of soils with application to Niue Island.
Proceedings of the 2nd United Nations International Conference on Peaceful Uses of Atomic Energy 18: 514–515.

FIELDES, J.; BEALING, G.; CLARIDGE, G.G.; WELLS, N.; TAYLOR, N.H. 1960
Mineralogy and radioactivity of Niue Island soil.
New Zealand Journal of Science 3: 658–675.

VAN WESTENDORP, F.J. 1964
Agricultural production on the Island of Niue.
New Zealand Journal of Agriculture 109: 289, 291, 297, 299.

WIDDOWSON, J.P. 1965
Crop growth in relation to shallow calcareous soils, Niue.
NZ Soil Bureau Report 3/1965. 43 p.

WRIGHT, A.C.S.; VAN WESTERNDORP, F.J. 1965
Soils and agriculture of Niue Island.
NZ Soil Bureau Bulletin 17. 80 p.

WIDDOWSON, J.P. 1966a
Zinc deficiency on the shallow soils of Niue. 1. Field investigations.
New Zealand Journal of Agricultural Research 9: 44–58.

WIDDOWSON, J.P. 1966b
Chlorosis in seedling *Crotalaria anagryoides* on a calcareous soil.
New Zealand Journal of Agricultural Research 9: 261–267.

WIDDOWSON, J.P. 1966c
Zinc deficiency on the shallow soils of Niue. 2. Effects of zinc sulphate on the yield and nutrient composition of crotolaria and sweet corn.
New Zealand Journal of Agricultural Research 9: 748–770.

ROSS, D.J. 1966
Mineralisation of nitrogen and metabolism of ammonium sulphate in some soils of Niue Island.
New Zealand Journal of Agricultural Research 9: 862–873.

FIELDES, M. 1971
Significance of soils of Niue Island to soils formed on coral limestone in the Pacific.
Record of Proceedings, 12th Pacific Science Congress, Canberra (1971) 1: 2.

STOUT, J.D. 1971
The distribution of soil bacteria in relation to biological activity and pedogenesis. Part 2. Soils of some Pacific Islands.
New Zealand Journal of Science 14: 834–850.

WIDDOWSON, J.P.; WATTS, H.M. 1977
Zinc deficiency on the shallow soils of Niue. 3. Response of sweet corn to sources of zinc.
New Zealand Journal of Experimental Agriculture 5: 241–248.

9. Tonga Soil and Land Use Programme (1975–78)

9.1 Soil survey, mapping and characterisation

SERVICES PROVIDED:
Soil Bureau, DSIR supplied four experienced two-person soil survey teams and a soil correlator/team leader to undertake detailed soil surveys of larger and occupied islands of the Tonga Group. Four soil chemists, a soil physicist, and an agronomist joined the teams during the soil sampling phase.
Note: Cartography was undertaken by the Science Mapping Unit of DSIR. Glasshouse and laboratory facilities were provided by NZ Soil Bureau.

TERMS OF REFERENCE:

- Prepare detailed (scale 1:25,000) soil maps.
- Fully characterise soils through physical, chemical and mineralogical analyses.
- Prepare soil survey reports in which: soil series are defined and classified; soils are placed into defined suitability classes for a range of crops and potential land uses; and data provided about soil limitations and ameliorations.
- Prepare a 'popular' booklet targeted for the lay reader and explaining the nature and distribution of Tongan soils.
- Conduct initial glasshouse experiments to assess the fertility of major selected soils.
- Design and implement field fertiliser trials to validate results of glasshouse experiments.
- Prepare reports describing fertility status of soils and detail about nutrient deficiencies limiting plant growth.
- Conduct experiments to explain poor growth of *P. caribaea* in forest nurseries.
- Report interim project outcomes at a seminar and field workshop, attended by government officials, landowners and planners one year after project implementation.

LOCATION: 'Eua Island, Ha'apai Group, Tongatapu Island and Vava'u Group, Kingdom of Tonga.

CLIENT: NZ Bilateral Aid Programme (Ministry of Foreign Affairs and Trade), with the Ministry of Agriculture, Fisheries and Forestry, Government of Tonga

NO. OF NZ PERSON MONTHS: 120

DATE: July 1975 – December 1978

PERSONNEL INVOLVED IN THE TONGA SOIL AND LAND USE PROGRAMME:
Soil Bureau staff: Soil Surveyors – Gary Beecroft*, Allan Hewitt, Mike Laffan*, Dave Ives*, Gary Orbell* (Team Leader), Wim Rijkse*, Hugh Wilde*, Alastair Wilson*; Chemists – Les Blakemore*, Brian Daly, Keitha Giddens*, Dean McGaveston*, Janice Willoughby;

* Retired or deceased.

Agronomists – Phil Hart, Harvey Watts*, John Widdowson*; Mineralogists – Graeme Claridge*, Joe Whitton*.
Tonga MAF staff: Haneteli Fa'anunu*, Siua Halavatau*, Tevita Holo*, Viliami Manu.

9.2 Publications from the Tonga Soil and Land Use Programme

WIDDOWSON, J.P.; BLAKEMORE, L.C. 1976
Fertility of Soils of Tonga, Interim Report 2. 1. Glasshouse Studies. 2. Soil Analyses. 61 p.

LEE, R.; WIDDOWSON, J.P. 1977
The potassium status of some representative soils from the Kingdom of Tonga. Tropical Agriculture 54: 251–263.

WIDDOWSON, J.P. 1977
Proceedings of the Kingdom of Tonga Soil and Land Use Seminar, Nuku'alofa, Tonga, June 14–18, 1976. 109 p.

McGAVESTON, D.A.; WIDDOWSON, J.P. 1978
Comparison of six extractants for determining available phosphorus in soils from the Kingdom of Tonga.
Tropical Agriculture 55: 141–148.

HART, P.B.S.; WIDDOWSON, J.P. 1979
Effect of mycorrhizal fungi on the growth of *Pinus caribaea* in Tonga. (Abstract)
In: *49th ANZAAS Congress, Abstracts*. Auckland, Australian and New Zealand Association for the Advancement of Science. P. 384.

CLARIDGE, G.C.C.; PERCIVAL, H.J. 1980
Clay for brickmaking: A study of the suitability of the soils of the Pacific Islands. New Zealand Journal of Science 23: 335–342.

COWIE, J.D. 1980
Soils from andesitic tephra and their variability, Tongatapu, Kingdom of Tonga. Australian Journal of Soil Research 48: 273–284.

CLARIDGE, G.G.C. 1981
Mineralogy of the soils of the Kingdom of Tonga. (Abstract).
In: 'Soils with Variable Charge' Conference, Massey University, Palmerston North, New Zealand, 11–18 February 1981, Programme and Abstracts. Pp. 176–177.

HART, P.B.S.; MEYRICK, K.F. 1981
Ectomycorrhizae increase zinc intake in pines. (Abstract).
In: 'Soils with Variable Charge' Conference, Massey University, Palmerston North, New Zealand, 11-18 February 1981, Programme and Abstracts. P. 81.

HART, P.B.S.; WIDDOWSON, J.P. 1981
The response of caribbean pine, green panic, and siratro to fertiliser on soils of the 'Eua uplands, Tonga.
New Zealand Journal of Experimental Agriculture 9: 255–262.

* Retired or deceased.

HART, P.B.S.; WIDDOWSON, J.P.; FA'ANUNU, H.O. 1981
Fertility evaluation of some soils in Vava'u, Tonga.
NZ Soil Bureau Scientific Report 47. 30 p.

ORBELL, G.E.; RIJKSE, W.C.; LAFFAN, M.D. 1981
Soil map of part Vava'u Group, Kingdom of Tonga. Scale 1:25,000
NZ Soil Bureau Map 197.[1]

WIDDOWSON, J.P.; HART, P.B.S. 1981
The effects of mycorrhiza on the growth of *Pinus caribaea* seedlings in Tongan soils: preliminary investigations.
NZ Soil Bureau Scientific Report 48. 21 p.

WILSON, A.D.; BEECROFT, F.G. 1981
Soil map of part Ha'apai Group, Kingdom of Tonga. Scale 1:25,000.
NZ Soil Bureau Map 198.[1]

WILDE, R.H. 1981
Soil Map of 'Eua Island, Kingdom of Tonga. Scale 1:25,000.
NZ Soil Bureau Map 199.[1]

CHILDS, C.W.; WILSON, A.D. 1983
Iron oxide minerals in soils of the Ha'apai Group, Kingdom of Tonga.
Australian Journal of Soil Research 21: 489–503.

ORBELL, G.E. 1983
Soils of the Kingdom of Tonga. An introduction.
NZ Soil Bureau, Department of Scientific and Industrial Research, Wellington. 47 p.

WILSON, A.D.; BEECROFT, F.G. 1983
Soils of the Ha'apai Group, Kingdom of Tonga.
NZ Soil Survey Report 67. 32 p.

WILDE, R.H.; HEWITT, A.E. 1983
Soils of 'Eua Island, Kingdom of Tonga.
NZ Soil Survey Report 68. 42 p.

SPEIR, T.W. 1984
Urease, phosphatase and sulphatase activities of Cook Island and Tongan soils.
New Zealand Journal of Science 27: 73–79.

WILSON, A.D.; GILTRAP, D.J. 1985
Effectiveness of "Soil Taxonomy" for prediction of soil chemical properties on Mollisols under a shifting cultivation system in the Ha'apai Group, Kingdom of Tonga.
South Pacific Journal of Natural Science 7: 45–57.

ORBELL, G.E.; RIJKSE, W.C.; LAFFAN, M.D.; BLAKEMORE, L.C. 1985
Soils of part Vava'u Group, Kingdom of Tonga.
NZ Soil Survey Report 66. 47 p.

[1] Map is on e-archive; print-on-demand service available.

WALES, J.F.; THOMAS, R.F.; NORTHEY, R.D. 1986
Engineering characteristics of and effect of lime on some soils from the Kingdom of Tonga.
NZ Soil Bureau Laboratory Report EP 13.

WIDDOWSON, J.P.; WATTS, H.M. 1989
Crop responses to fertiliser on some major soils in Tonga.
In: Haynes, R.J.; Naidu, R. eds *Agricultural development in the Pacific Islands in the 90s* : proceedings of an international conference and workshop held in Suva, Fiji, 31 March to 1 April 1989. Pp. 64–80.

LEE, R.; SEARLE, P.L.; LESLIE, D.M.; WIDDOWSON, J.P. 1989
The distribution of the major soil groups of the southern Cook Islands, Tonga, Niue and Fiji according to soil taxonomy, their chemical properties and fertility status.
In: Haynes, F.J.; Naidu, R. eds *Agricultural development in the Pacific Islands in the 90s* : proceedings of an international conference and workshop held in Suva, Fiji, 31 March to 1 April 1989. Pp. 219–242.

MANU, V.T.; POWELL, H.K.P.; BANKS, L.; SHEAT, A.; WIDDOWSON, J.P. 1990
Accession of SO_4^{2-} – sulphur from Tongan rainfall.
Australian Journal of Soil Research 28: 727–736.

COWIE, J.D.; SEARLE, P.L.; WIDDOWSON, J.P.; ORBELL, G.E. 1991
Soils of Tongatapu, Kingdom of Tonga.
DSIR Land Resources Scientific Report 21. 55 p.

TRANGMAR, B.B. (compiler) 1992
Proceedings of the Soil Fertility and Land Evaluation Workshop, Nuku'alofa, Kingdom of Tonga, 3–7 February 1992.
DSIR Land Resources, Lower Hutt. 239 p.

9.3 Other relevant DSIR soil publications

ORBELL, G.E. 1971a
Parent material and age sequences in soils derived from recent and late Pleistocene volcanic ash, scoria and lava in New Zealand and Tonga Islands. (Abstract).
Record of Proceedings of the 12th Pacific Science Congress, Canberra 1: 7.

GIBBS, H.S. 1971b
Soils of Tonga. (Abstract).
Record of Proceedings of the 12th Pacific Science Congress, Canberra 1: 8.

ORBELL, G.E. 1971c
Soil Surveys – Vava'u and adjacent islands, Tonga Islands.
Royal Society of New Zealand Bulletin 8: 125–130.

STOUT, J.D. 1971
The distribution of soil bacteria in relation to biological activity and pedogenesis. Part 2. Soils of some Pacific Islands.
New Zealand Journal of Science 14: 834–850.

GIBBS, H.S. 1976a
Soils of Tongatapu, Tonga.
NZ Soil Survey Report 35. 15 p.

GIBBS, H.S. 1976b
Soil map of Tongatapu Island, Tonga. Scale 1:100,000.
NZ Soil Bureau Map 81.[1]

CHILDS, C.W.; WILSON, A.D. 1983
Iron oxide minerals in soils of the Ha'apai Group, Kingdom of Tonga.
Australian Journal of Soil Research 21: 489–503.

DALY, B.K.; MANU, V.T.; HALAVATAU, S.M. 1984
Soil and plant analysis methods for use at the Vaini Agricultural Research Station, Tonga. 20 p.
NZ Soil Bureau Laboratory Report AN 2.

10. Tonga Forestry Project (1995–2000)

10.1 'Eua plantation, agroforestry, 'Eua National Park management

SERVICES PROVIDED:
A 6-year Management Services Contract with NZ Ministry of Foreign Affairs and Trade (now NZAID). Actual services provided included:

- Development of the 600-ha 'Eua forest plantation that included preparation of operational, management and business plans.
- Introduction of the tendering process for roading and harvesting rights to maximum revenue from 'Eua plantation.
- Economic assessment of 'Eua plantation and determination of market opportunities for timber products and the optimal forest size to sustainably support markets.
- Advice on forestry sector planning and plantation forest management.
- Installation of a GIS and Forest Management System (FMS) software at 'Eua plantation.
- Extensive training courses in GIS, forest management, forest resource database management.
- Establishment of the 'Eua Forest Plantation Management Committee (EFPMC).
- Preparation of tender documents for roading upgrade and logging for the EFPMC process and allocation.
- Inventory of the standing coconut resource, structural analysis and compared data with 1980 results.
- Report of findings from coconut survey with recommendations.
- Assistance with the viable coconut sawmills on the main islands.
- Preparation of a 5-year National Masterplan for Agroforestry (NMA).
- Skill strengthening at Forestry Division nurseries in support of agroforestry objectives.
- Establishment of agroforestry demonstrations on selected farms.
- Vegetation inventory for Tongatapu with 50 permanent sampling sites selected and described.
- Management Plan for 'Eua National Park published.

TERMS OF REFERENCE:

- Develop commercial forestry, particularly on 'Eua Island. This objective to include:
    - Identify and support management requirements to maintain and develop the 600-ha 'Eua plantation
    - Develop a strategic direction for plantation forestry noting conservation values planned for new plantings
    - Determine the economic viability of the 'Eua plantation and its potential expansion
    - Determine the feasibility of privatising the plantation and steps to achieve commercialisation

    - Conduct a training needs assessment and develop a training programme for Forestry Division
    - Provide infrastructural and administrative support for Forestry Division
- Undertake an inventory of the standing coconut resource. This objective to include:
    - Design inventory and the methodology to provide volume information
    - Determine the sustainability of current and potential levels of coconut timber cut
    - In consideration of coconut deforestation, assess restocking rates and a range of other uses of the coconut resource
- Develop and promote sustainable agroforestry systems. This objective to include:
    - Develop economic and sustainable agroforestry systems that broaden the economic base of farm production and identify market opportunities
    - Establish support for tree planting initiatives by the whole community including schools, NGOs, etc.
    - Train MAF staff and support them in the implementation of agroforestry and reforestation initiatives
- Promote biodiversity conservation. This objective to include:
    - Undertake a national biological survey
    - Develop resource databases and institutional capability to ensure the conservation of biodiversity
    - Develop draft Management Plan for ‘Eua National Park
- Examine environmental impacts from forestry and land use change including watershed management and soil and water conservation. This objective to include:
    - Develop Forestry staff capability to manage and monitor integrated watershed plans (not started)
    - Undertake land resource assessment and characterisation of watersheds
    - Develop conservation and land management plans to improve soil and water systems in watersheds (Not started due to US Forest Service role for this activity)

LOCATION: ‘Eua, Ha’apai, Tongatapu and Vava'u islands. Project coordinated locally from Forestry Division, Nuku’alofa.

CLIENT: NZ Bilateral Aid Programme (Ministry of Foreign Affairs and Trade) with Forestry Division, Tonga MAFF

NO. OF NZ PERSON MONTHS: 15

DATE: February 1995 – June 2000

PERSONNEL:
Landcare Research staff: Dave Leslie*, Land Use Planner/Project Manager; Rob Allen, Forest Ecologist; Peter Bellingham, Plant Ecologist; Larry Burrows, Forest Ecologist; Susan Wiser, Plant Ecologist; Ralph Douglass*, Forester; Terry Savage*, GIS Specialist; Bill Sykes*, Botanist.
NZ Consultants: Donald Drake, Forest Ecologist (Victoria University); Ian McCracken*, Agroforester; Tony Ryan, Resource Economist; Gerald Fitzgerald*, Rural Sociologist; Ray Percy, Credit Specialist.

* Retired or deceased.

Tongan staff: Tevita Faka'osi, Forester/Director Forestry Division; Viliami Fakava*, Agricultural Economist; Leody Vainikolo, Agroforestry/Nurseryman; Haniteli Fa'anunu*, Director MAF; Lucy Lopeti*, MAF Training Officer; Viliami Tiseli, Planning and Policy, MAF; Isileli Aholelei, Agricultural Economist; Ketone Akau'ola, Agroforester; Taniela Hoponoa, Forester; Sione Kaufusi, Agroforester.

10.2 Publications from the Tonga Forestry Project

BURROWS, L.E.; DOUGLASS, R. 1996.
Inventory of the coconut palm resources.
Landcare Research International Business Group Report 92. 41 p.

FITZGERALD, G. 1996
Social and cultural considerations and issues in the management of the 'Eua National Park, Tonga.
Landcare Research International Business Group Report. 56 p.

RYAN, A.J.; DOUGLASS, R. 1996
Economic assessment of 'Eua Forest Farm (or Plantation).
Landcare Research International Business Group Report 85. 86 p.

BELLINGHAM, P.; FITZGERALD, G. 1997.
Management plan for 'Eua National Park.
Landcare Research International Business Group Report 90. 86 p.

WISER, S.K.; BURROWS, L. 1997
Design for a national forestry inventory for biodiversity assessment, forest product potential and plant protection implications.
Landcare Research International Business Group Report 112. 16 p.

FITZGERALD, G. 1997a.
Report on agroforestry sociological investigations 4 February – 12 March 1997.
Landcare Research International Business Group Report 115. 19 p.

FITZGERALD, G. 1997b.
Reference document for participatory agroforestry workshops.
Landcare Research International Business Group Report 116. 41 p.

DOUGLASS, R.; RYAN, A.J. 1997.
Final report on the commercialisation options for 'Eua Forest Farm.
Landcare Research International Business Group Report 118. 33 p.

DOUGLASS, R. 1997a.
Report on Cyclone Hina damage to 'Eua Forest Farm and National Park.
Landcare Research International Business Group Report 120. 120 p.

McCRACKEN, I.; FITZGERALD, G. 1997
Draft national masterplan for agroforestry.
Landcare Research International Business Group Report 121. 53 p.

* Retired or deceased.

DOUGLASS, R. 1997b.
'Eua Plantation management plan.
Landcare Research International Business Group Report 135. 128 p.

WISER, S.K. 1997.
Methodology for vegetation sampling.
Landcare Research International Business Group Report 138. 11 p.

McCRACKEN, I. 1998
Agroforestry information kit for the Pacific.
Landcare Research International Business Group Report 137. 25 p.

PERCY, R.; DOUGLASS, R.; LESLIE, D.M. 1998
'Eua Plantation business plan.
Landcare Research International Business Group Report 149. 83 p.

McCRACKEN, I.; FITZGERALD, G. 1998
National masterplan for agroforestry.
Landcare Research International Business Group Report 155. 65 p.

DOUGLASS, R. 1998a.
Pre-harvest inventory of the 'Eua Plantation timber resource.
Landcare Research International Business Group Report 164. 39 p.

DOUGLASS, R. 1998b.
Draft 'Eua Plantation fire plan.
Landcare Research International Business Group Report 167. 5 p.

McCRACKEN, I. 1999
Draft recommendations for the commercialisation of Forestry Division nurseries – A discussion paper.
Landcare Research International Business Group Report 175. 73 p.

SAVAGE, T.J. 1999a.
ArcView GIS ver. 3.1 training course (March 1998).
Landcare Research International Business Group Report 178. 39 p.

DOUGLASS, R.; FAKA'OSI, T.; ISHIZAKA, H. 1999
'Eua Plantation business plan.
Landcare Research International Business Group Report 180. 131 p.

WISER, S.K.; BURROWS, L.E.; SYKES, W.S.; SAVAGE, T.J.; DRAKE, D.R. 1999.
A natural forestry inventory of Tongatapu and nearby islands.
Landcare Research International Business Group Report 187. 75 p.

McCRACKEN, I.; FAKA'OSI, T.; VAINIKOLO, L. 1999
Recommendations for the commercialisation of Forestry and Conservation Division (MAF) nurseries, Vava'u.
Landcare Research International Business Group Report 192. 24 p.

McCRACKEN, I.; FAKA'OSI, T. 1999a.
Draft agroforestry rolling plan 1999–2000.
Landcare Research International Business Group Report 193. 26 p.

SAVAGE, T.J. 1999b.
ArcView GIS ver. 3.1 training course: training modules.
Landcare Research International Business Group Report 196. 73 p.

McCRACKEN, I.; FAKA'OSI, T. 1999b.
Recommendations for the commercialisation of Forestry and Conservation Division, MAF nurseries, Tongatapu.
Landcare Research International Business Group Report 197. 25 p.

DOUGLASS, R. 1999
'Eua Plantation: tender documents for road construction and maintenance contract (Draft).
Landcare Research International Business Group Report 198. 48 p.

SAVAGE, T.J. 2001.
Methodology for linking FMS (ver. 4.2) with MapInfo GIS (ver. 4.5–6.0) and ArcView GIS (ver. 3.1–3.2).
Landcare Research International Business Group Report. 26 p.

9 Management Services Contract Reports prepared by Dave Leslie.
20 Trip Reports prepared by the various NZ consultants.

11. Soils and Land Use of Western Samoa (1956-58)

11.1 National soil survey

SERVICES PROVIDED:
NZ Soil Bureau supplied a soil scientist, soil chemist and a cartographer to undertake the national soil survey of Samoa. Actual services provided include:

- Compilation of land resource information, including geology, climate, land use, land tenure, etc., and statistical information on land use, agricultural production, demography, etc.
- Soil survey and production of soil maps for Upolu (8 sheets) at 1:40,000 scale; Savai'i at 1:100,000 scale; and a generalised soil map of Upolu at 1:100,000.
- Land classification maps for Upolu and Savai'i at 1:100,000 scale.
- Soils sampled for characterisation, definition of soil series and provide fertility indicators for selected soils.
- Compilation of topographic base maps for Upolu and Savai'i and thematic maps for the above.
- Preparation and publishing of a comprehensive technical report that describes the soil environment, particularly those factors that influence soil management and sustainable land use practice.

TERMS OF REFERENCE:

- Present the results of the national soil survey in soil maps and a technical report that includes soil, land use and land capability information
- Include in the report sections discussing soil information, soil relationships and soil classification and that give a general description of the main groups of soils making up the soil pattern of Samoa
- Provide a description of fertility of soils and the way in which soil fertility can be used as a basis for land classification and land use options

LOCATION: Islands of Upolu and Savai'i, Samoa, and Tutuila (American Samoa)

CLIENT: NZ Bilateral Aid Programme (Ministry of Foreign Affairs)

NO. OF NZ PERSON MONTHS: 23

DATE: May 1956 – December 1958

PERSONNEL:
NZ Soil Bureau: Charles Wright*, Team Leader/Pedologist; Les Blakemore*, Soil Chemist; and Franz Tindall*, Cartographer (also UNDP/FAO Soil Chemist consultant attached to Alafua College, USP, Samoa for 20 months in 1970–1971).
(Note: Samoan counterparts not known)

* Retired or deceased.

11.2 Publications (includes other work before and after this project)

HAMILTON, W.M.; GRANGE, L.I. 1938.
The soils and agriculture of Western Samoa.
DSIR Bulletin 61 (extracted from NZ Journal of Science and Technology 19(10): 593–624).

SEELYE, F.T., GRANGE, L.I.; DAVIS, L.H. 1938.
The laterites of Western Samoa.
Soil Science 46(1): 23–31.

BIRRELL, K.S.; SEELYE, F.T.; GRANGE, L.I. 1939.
Chromium in Soils of Western Samoa and Niue Island.
New Zealand Journal of Science and Technology A21: 91–95.

WRIGHT, A.C.S. 1963.
Soils and Land Use of Western Samoa.
NZ Soil Bureau Bulletin 22. 192 p.
(includes Land classification map of Savai'i, Western Samoa (1:100,000); Land classification map of Upolu, Western Samoa (1:100,000); Soil map of Savai'i, Western Samoa (1:100,000); Soil map of Upolu, Western Samoa (1:100,000); and provisional soil map of Upolu, Western Samoa (1:40,000).

COWIE, J.D. 1974a.
Soils of Asau Block, Savai'i, Western Samoa.
NZ Soil Bureau, DSIR, *Soil Survey Report 21*. 38 p.

COWIE, J.D. 1974b.
Soil map of Asau Block, Savai'i, Western Samoa. Scale 1:20,000.
NZ Soil Bureau Map 150.[1]

[1] Map is on e-archive; print-on-demand service available.

12. Land Resources Planning Project, Samoa (1989)

12.1 Soils, land use assessment, tenure, GIS

SERVICES PROVIDED:
ANZDEC, in association with DSIR Division of Land and Soil Sciences, provided a Land Use Planner/Team Leader; Cartographer, Soil Scientist (2), GIS/Data Processing Specialist and Resource Economist. Actual services provided included:

- Soil survey, soil classification (according to US Soil Taxonomy); and soil interpretation for various land use suitabilities.
- Laboratory analysis for full characterisation of key soil series.
- Map design, cartography and collation of land tenure data.
- Land Use Capability (LUC) assessment.
- GIS design and installation of an operational system.
- GIS data entry and thematic map production (soil map, land use capability, and land tenure ×6 at 1:50,000 scale, a total of 18 maps).
- Hands-on training in land-use planning, cartography and GIS.

TERMS OF REFERENCE:

- Provide Samoa with a comprehensive database for planning the optimal and sustainable development of the nation's land resources
- Store in a PC-based geographic information system (GIS), soil and land capability information, together with crop production (including forestry) and gross margin information
- Produce 50 sets of hard copy maps off the GIS rather than by traditional cartographic methods
- Ensure the project study interfaces with a parallel study to identify environmentally sensitive areas (ESA); this information to be entered into the GIS
- Undertake on-the-job training in land-use planning, cartography and GIS
- Prepare a comprehensive technical report to accompany the maps
- Provide much needed institutional strengthening to the Department of Lands and Survey (DLS) and the Department of Agriculture, Forests and Fisheries (DAFF)

LOCATION: Apia, Samoa.

CLIENT: Asian Development Bank (a US$300,000 contract) with DLS and DAFF, Samoa

NO. OF NZ PERSON MONTHS: 21

DATE: June–December 1989

PERSONNEL:
NZ staff: Keith Leonard, ANZDEC, Project Director; Duncan McCormack*, Cartographer (retired from DSIR Cartographic Division); Dick Burgess, Resource Economist, Min. of Environment; DSIR Division of Land and Soil Sciences staff – Dave Leslie*, Team Leader/Land Use Planner; David Giltrap*, GIS specialist; Wim Rijkse*, Pedologist; Malcolm McLeod, Pedologist; and Bruce Trangmar*, Land Evaluation Specialist (home-based).
Department of Lands and Survey Samoa: Lealiifano J.T. Soon*, CEO DLS; Ioane Patelo*, GIS Operator.
Department of Agriculture, Forests and Fisheries, Samoa: Sione Faletoi, Economist.

12.2 Publications from Land Resources Planning Project

ANZDEC 1989
Western Samoa land resources planning study.
Land use/tenure map. 6 sheets 1:50,000
Soil map. 6 sheets 1:50,000
Land capability map. 6 sheets 1:50,000
Government Printer, New Zealand

ANZDEC 1990
Western Samoa land resource planning study – Final report. ADB TA No. 1065 – SAM.
DSIR Division of Land and Soil Sciences. 147 p.

* Retired or deceased.

13. South Pacific Agricultural Chemistry Laboratory Network (SPACNET) – South Pacific Regional (1996 – ongoing)

13.1 SPACNET laboratories

SERVICES PROVIDED:
Landcare Research provided a Project Manager, a Technical Coordinator and a Senior Laboratory Technician. SPACNET has been conducted in 3-year phases with the third phase running to 2009 after which the project will be managed by the Community of the South Pacific (SPC) as a core budget project. The actual services provided include:

- An initial overview and needs assessment of collaborating laboratories (1996) and repeated in 2006.
- Organisation and facilitation of three Laboratory Managers' meetings.
- Six customised training courses conducted for 2–4 trainees at each. Course themes dealt with standards, methodologies, quality assurance, data interpretation and reporting.
- Eight secondments (2–3 trainees each) at Pacific participating laboratories involving instrumentation and specific methodologies.
- Provision of recommended methods (soil, plant and water) manuals (two editions), generic quality assurance manuals (two editions), Generic Safety Manual and Data Interpretation Manual.
- Eight SPACNET newsletters produced and distributed plus a website developed for communication both within and outside the network.
- Association developed with the Australasian Soil and Plant Analysis Council (ASPAC) and the project funded SPACNET representatives to attend three ASPAC meetings.
- Eight rounds of the soil and plant sample exchange programme conducted as part of the QA process.

TERMS OF REFERENCE:

- SPACNET was designed to assist in the development of sustainable agriculture, forestry and livestock production systems in the South Pacific by ensuring laboratories provide quality and reliable soil, plant and water analytical data. The objectives of the project are:
- Develop and enhance the quality assurance programmes of the SPACNET laboratories
- Strengthen SPACNET laboratories through the soil and plant sample exchange programme and other appropriate activities
- Document standard methodologies for soil, plant and plant analysis and quality control in the region
- Identify three regional laboratories as centres for short-term secondments and customised training

LOCATION: South Pacific regional network of laboratories comprising three in Fiji (Institute of Applied Sciences, USP; Sugar Research Institute of Fiji; Fiji Agricultural Chemistry Laboratory, Koronivia, Ministry of Agriculture); two in PNG (National Agriculture Research

Institute, Boroko; UNITECH, Lae); Analytical Laboratory, MAFF, in Tonga; Analytical Laboratory, Alafua College, USP, Samoa; and Institute of Research for Development (IRD), New Caledonia. The Solomon Islands Ministry of Agriculture analytical laboratory at Dodo Creek was an inaugural SPACNET member but the laboratory was destroyed during civil unrest in 2001. The Analytical Laboratory, Landcare Research, Palmerston North, is the SPACNET coordinating laboratory.

CLIENT: NZ Agency for International Development (NZAID).
Since 2006 SPACNET Phase 3 has been funded under NZAID's Contestable Fund programme with a small contribution from SPC. From 2009 the client and funding will be solely with SPC.

NO. OF NZ PERSON MONTHS: 7 (field, laboratory editing)

DATE: July 1996 – ongoing

PERSONNEL INVOLVED IN THE TONGA SOIL AND LAND USE PROGRAMME:
Landcare Research staff: Dave Leslie*, Project Manager (1996–2006); Brian Daly, Technical Coordinator and Project Manager (2007 to present); Linda Hill, Senior Laboratory Technician

Key SPACNET technical staff:

- SRIF – Jai Gawander*, former Manager, now Hemraj Mangal; Shirley Samuni, Lab. Manager; Jeetendra Patel, Snr Technician
- IAS, USP – Bill Aalbersberg, Director; Kishore Chand for Lab. Manager, now Sereana Kubuabola
- Fiji NACL, MoA – Josua Wainiqolo*, former PRO Chemistry, now Miliakere Nawaikula; Apaitia Vakacego, SRO; Bill Magnus, STO
- Vaini Res. Stn, Tonga – Viliami Manu, Principal Soil Scientist; Vunivesi Minoneti, Lab. Manager
- Alafua College, USP, Samoa – David Hunter, Head of School of Agriculture; Loku Yapa, Lab. Manager; Daya Perera, Snr Technician
- IRD, Noumea – Jean Louis Deprey, Lab. Manager; Alain Plenecassagne, Snr Technician; Leocadie Jamet, Snr Technician
- NARI, PNG – Peter Corbett, Lab. Manager; Veronica Mangi, Deputy Lab. Manager
- UNITECH, PNG – Fred Grieshaber*, former Chief Chemist, now Ian Walsh
- Dodo Creek, Solomon Islands – Fred Peter, Research Officer
- SPC, Suva – Siosiua Halavatau, Team Leader, Crop Protection Section; Aleki Sisifa, Director, Land Resources Division

* Retired or deceased.

13.2 Publications from SPACNET

FITZGERALD, G. 1996
Social and cultural considerations and issues in the management of the ‘Eua National Park, Tonga.
Landcare Research International Business Group Report. 56 p.

FITZGERALD, G. 1997a.
Report on Agroforestry Sociological Investigations 4 February – 12 March 1997.
Landcare Research International Business Group Report 115. 19 p.

FITZGERALD, G. 1997b.
Reference Document for Participatory Agroforestry Workshops.
Landcare Research International Business Group Report 116. 41 p.

DALY, B.K. 1997a.
Trip report to Network member countries of the South Pacific Agricultural Chemistry Laboratory Network (a project component of the IBSRAM *PACIFICLAND* Network).
Landcare Research International Business Group Report 124. 15 p.

DALY, B.K. 1997b.
Technical report: South Pacific Agricultural Chemistry Laboratory Network (SPACNET) – a project component of the IBSRAM *PACIFICLAND* Network.
Landcare Research International Business Group Report 133. 39 p.

DALY, B.K.; RAYMENT, G.E. 1998.
Report on 1st International SPACNET Workshop for South Pacific Laboratory Managers, 6–10 July 1998, Fiji.
PACIFICLAND: SPACNET Laboratory Managers Workshop Report Series No. 1.
Landcare Research International Business Group Report 162. 34 p.

DALY, B.K.; WAINIQOLO, J.; DOWLING, A.J. 1998.
Report on SPACNET South Pacific Laboratory Technicians Training Secondment, 8 June – 10 July 1998, Fiji.
PACIFICLAND Report. Landcare Research International Business Group Report 170. 15 p.

DOWLING, A.J.; LESLIE, D.M. 1998.
Quality assurance for soil and plant testing in the South Pacific.
PACIFICLAND Report 98/03. 16 p.

DALY, B.K.; RAYMENT, G.E. 1999.
Report on 2nd International SPACNET Workshop for South Pacific Laboratory Managers, 22–27 March 1999, Brisbane.
PACIFICLAND: SPACNET Laboratory Managers Workshop Report Series No. 2.
Landcare Research International Business Group Report 185. 37 p.

DALY, B.K. 2000.
South Pacific Agricultural Chemistry Laboratory Network (SPACNET). Generic quality assurance manual Soil and Plant Laboratories.
Landcare Research International Business Group Report 208. 72 p.

DALY, B.K. 2002.
Report on 3rd International SPACNET Workshop for South Pacific Laboratory Managers, 20–24 May 2002, Fiji. South Pacific Agricultural Chemistry Laboratory Network (SPACNET).
Landcare Research International Business Group Report 297. 88 p.

DALY, B.K.; HILL, L.F. 2002.
Recommended methods for soil, plant and water analysis.
South Pacific Agricultural Chemistry Laboratory Network (SPACNET). 120 p.

DALY, B.K.; HILL, L.F. 2003a.
Generic quality assurance manual for Soil and Plant Laboratories (2nd rev. edn).
Landcare Research International Business Group Report. 106 p.

DALY, B.K.; HILL, L.F. 2003b.
Report on training course: Laboratory Quality Assurance Systems. (SPACNET).
Landcare Research International Business Group Report. 68 p.

DALY, B.K.; MANU, V. 2003.
Guide to interpretation of agricultural sample analysis results. Soil, plant & irrigation water. SPACNET.
Landcare Research International Business Group Report 315. 31 p.

DALY, B.K.; HILL, L.F. 2003c.
Generic laboratory quality manual. (SPACNET).
Landcare Research International Business Group Report 319. 102 p.

HILL, L.F.; DALY, B.K. 2003.
Generic laboratory safety manual. (SPACNET).
Landcare Research International Business Group Report 320. 29 p.

DALY, B.K. 2004.
SPACNET, summary of activities 1997–2004.
Landcare Research International Business Group Report. 25 p.

DALY, B.K.; HILL, L.F. 2004.
Report on training course: Water Analysis Methods and Laboratory Quality Assurance Systems.
South Pacific Agricultural Chemistry Laboratory Network (SPACNET). 83 p.

DALY, B.K.; LESLIE, D.M. 2004.
(SPACNET); a review of the project, 1997–2004.
Landcare Research International Business Group Report 365. 18 p.

DALY, B.K. 2006.
Report on the status and needs of the SPACNET Laboratories.
Landcare Research International Business Group Report 437. 47 p.

HILL, L.F.; DALY, B.K. 2007.
Generic quality manual for Soil and Plant Laboratories.
Landcare Research International Business Group Report 461. 98 p.

DALY, B.K. 2008.
Report on training course on Soil Analysis for South Pacific Laboratory Analysts.
Landcare Research International Business Group Report 474. 34 p.

DALY, B.K.; HILL, L.F. 2008.
Recommended methods for soil, plant and water analysis. 3rd edition.
Landcare Research International Business Group Report. 169 p.

DALY, B.K. 2009a.
Report on SPACNET Laboratory Managers' attendance at the Soils 2008 Conference, Planning and Review Meeting, and Calibration and other Procedures for Accreditation Training Course.
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