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Pig Husbandry in New Guinea

A Literature Review and Bibliography

Robin Hide

Australian Centre for International Agricultural Research

Canberra 2003

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Cover photo by Robin Hide shows large pigs assembled for display before slaughter at a pig festival at Gena Nogar, Simbu Province, 1968.

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Preface

Pigs are an integral part of the culture and political organisation of many New Guinea tribes. Pork is a significant protein source for local people and is in high demand as a traded commodity. In New Guinea as a whole there are estimated to be nearly 2.5 million domestic pigs, or approximately one animal for every three people.

ACIAR has supported projects in New Guinea to improve the productivity of traditional pig husbandry systems and to enhance productivity and efficiency of pig growth by nutritional improvement. It is hoped that this work will lead to greater access to protein, better nutrition and increased cash income, which will subsequently lead to economic development for the local population.

This publication provides a bibliography of the literature on New Guinea pig husbandry, and reviews that literature. It is intended as a guide to, and overview of, the current state of knowledge on pigs in New Guinea. It is the latest in ACIAR's monograph series, and is also available on ACIAR's website <www.aciar.gov.au>.

Peter Core
Director
Australian Centre for International Agricultural Research

Acknowledgments

In the preparation of this review I drew most importantly on that great body of reported observations by so many researchers, and villagers, that provides the foundations of our knowledge about pigs in New Guinea. I drew also on a background of past experience obtained when I was attached to several institutions involved in New Guinea research. In addition, I drew on responses to requests for information and clarification to a veritable host of individuals working in Papua New Guinea in particular, or on New Guinea material. The review could not have been done without the contributions of all of these.

There are many specific debts to acknowledge. In the Simbai Valley in 1962–63, the late anthropologist Roy ('Skip') Rappaport pointed the way to a naïve young visitor; and later in Sinasina during 1971–73, the research veterinarian George Malynicz provided much professional assistance and guidance about pigs from Goroka. For recent responses to queries about pig-related matters, I am grateful to: Jim Allen, Mathew Allen, Peter Bellwood, Robert Bino, Manuel Boissière, Michael Bourke, David Boyd, Florence Brunois, Lorenzo Brutti, Susan Bulmer, John Burton, Bill Clarke, Carolyn Cook, Barry Craig, Robert Crittenden, George Curry and Gina Koczberski, Gariba Danbaro, Jeanette Dickerson-Putman, Peter Dwyer and Monica Minnegal, Don Gardner, Deborah Gewertz and Fred Errington, John Gibson, Gillian Gillison, Shirley Lindenbaum, Maurice Godelier, Paul Gorecki, Larry Grossman, Nicole Haley, Simon Harrison, Phil Harvey, Terry Hays, Eric Hirsch, Garrick Hitchcock, Geoff Hope, Terry Hull, David Hyndman, Akira Ito, Carol Jenkins, Monique Judy-Ballini, Dan Jorgensen, Jean Kennedy, Christin Kocher Schmid, Yukio Kuchikura, Pierre Lemonnier and Pascale Bonnemère, Nancy Lutkehaus, David MacFarlane, Mary MacDonald, Scott MacWilliam, John McComb, Don Mitchell, Jane Mogina, George Morren, Markus Muntwiler, Janice Newton, Shingo Odani, Gene Ogan, Ryutaro Ohtsuka, Juliette Pasveer, Anton Ploeg, Ipul Powaseu, Alan Quartermain, Rebecca Robinson, Jim Roscoe, Chris Rose, Peter Saville, Paul Sillitoe, J. Ross Sinclair, Rose Singadan, Michael French Smith, Andrew Strathern, Glenn Summerhayes, Agus Sumule, Pam Swadling, Wayne Takeuchi, Bill Thomas, Pat Townsend, John Wagner, Wayne Warry, Paige West, Peter White, Harriet Whitehead, Andrew Wood, Debra Wright, Robin Yarrow and Michael Young.

I owe especial thanks to the doyen of New Guinea pig studies, Peter Dwyer, for his careful reading of the first version of the manuscript and his most useful comments and suggestions; to Jean Kennedy for her sharp eye on reading and commenting on a later version; and to Michael Alpers, Robert Attenborough and Ifor Owen for their valuable comments on chapters 11 and 12. Substantial assistance from my wife, Carolyn Hide, kept the initial reviewing task on track, and improved it in many ways.

My thanks also to John Copland for suggesting and contracting the original review, to Dai and Jo Peters for pig discussions, and to Gisela Murray and Astrid Jeffress for early administrative assistance. I am most grateful to the Department of Anthropology, and to the Resource Management in Asia-Pacific Programme, Research School of Pacific and Asian Studies, The Australian National University, for access to library and other invaluable resources, and for supporting the revision through an appointment as a Visiting Fellow during part of 2002.

About the author

Robin Hide met his first pigs in Papua New Guinea in 1962, when working with the British Voluntary Service Overseas in the Simbai Valley of Madang Province for a year. After completing a BA degree in anthropology in the UK he returned to PNG in 1967 to work with the New Guinea Research Unit on land tenure. Postgraduate study in ecological anthropology at Columbia University in New York then allowed extended field research on aspects of pig husbandry in the Sinasina area of Simbu Province from 1971 to 1973. Subsequent field work elsewhere in Simbu in 1975 and at Karimui in 1980–82 centred on issues in rural development and human ecology.

From 1984 to 1997, Robin Hide worked with, variously, research teams at the CSIRO, the Papua New Guinea Institute of Medical Research, and the Land Management Project in the Department of Human Geography at the Australian National University. Questions relating to the rural ecology of PNG, in particular, human nutrition and the distribution of subsistence agricultural systems, were the major research concerns. Since 1997 he has continued to pursue his interests in New Guinea human ecology as a Visiting Fellow in the Department of Anthropology, and the Resource Management in Asia-Pacific Program, at the ANU.

Definitions

National and other political—administrative units

Over the past 100 years, the names by which the various political entities within the borders of the main island of New Guinea and its offshore islands are known have changed frequently. The names used in this review are as follows:

- **New Guinea** refers generally to the whole island and usually its main associated off-shore islands such as New Britain, New Ireland and Bougainville; in short, the state of Papua New Guinea and the Indonesian Province now known as Papua.
- **Papua New Guinea** (PNG) refers to the current state of that name, and is also used as short hand for the combined Territories of Papua and New Guinea in earlier historical contexts.
- Where specific historical reference is necessary, the combined Territories of Papua and New Guinea are sometimes referred to individually as either **Papua** or **(German) New Guinea**.

The western half of the island, under Indonesian control since 1963 and officially a province of Indonesia since 1969, has been officially known as Papua since January 2002. However, use of that name here, without constant qualification as the ‘Indonesian Province of’ could lead to confusion with the eastern Papua; therefore, the previous name of **Irian Jaya** is used. This is what the area was called for the majority of the period covered by this review. Before the 1960s, it was variously known as West New Guinea, Dutch New Guinea or Netherlands New Guinea.

Within PNG, the political–administrative divisions known as provinces were called districts until 1975–76. The current provincial names and the abbreviations used in this study are shown in the list of abbreviations and acronyms.

For several purposes the Papua New Guinea provinces are commonly grouped into four regions, and the National Capital District (NCD). The regions are:

Region	Provinces
Papua (sometimes Southern)	Western, Gulf, Central, Milne Bay and Northern
Momase (sometimes Mamose)	Morobe, Madang, East and West Sepik
Highlands	Southern Highlands, Enga, Western Highlands, Simbu and Eastern Highlands
Islands	Manus, New Ireland, East and West New Britain, Bougainville

Map 1.1 shows the regional and provincial boundaries in PNG.

Within Irian Jaya administrative divisions, known as *kabupaten*, were relatively stable until January 2003, when major changes dividing it into several provinces were announced. The *kabupaten*, however, are the units for which earlier statistical data are available (see Chapter 5, Table 5.7), and their boundaries are shown in Map 1.2.

Name changes for ethnolinguistic groups or areas

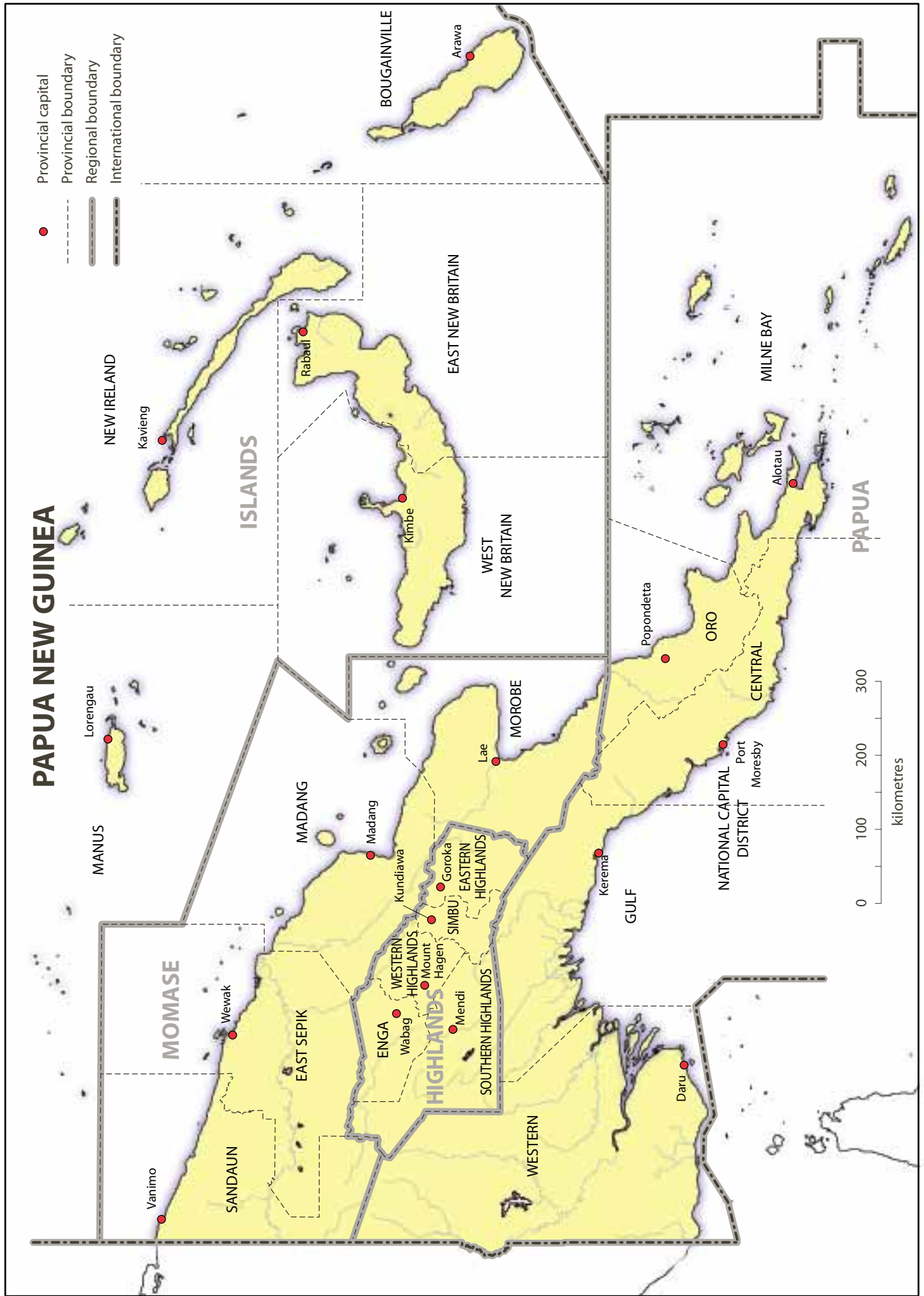
Over time, especially during the postcolonial period, several of the names of ethnolinguistic groups or areas have changed either in everyday or in official use, or both. As a general rule, where a new name has wide currency, it is used in this book. However, where a historical source uses the older spelling, this is retained. For example, Simbu is used rather than the previous name of Chimbu. In other cases, however, much of the historical ethnographic reporting used the earlier name, and in such cases the book generally gives both names, with the previous one in parentheses. An example of this situation is Kapauku, the previous name of an ethnolinguistic group in the Paniai Lakes area of Irian Jaya, which is now more commonly known in the literature as Ekagi, Me or Ekagi-Me.

Weights and measures

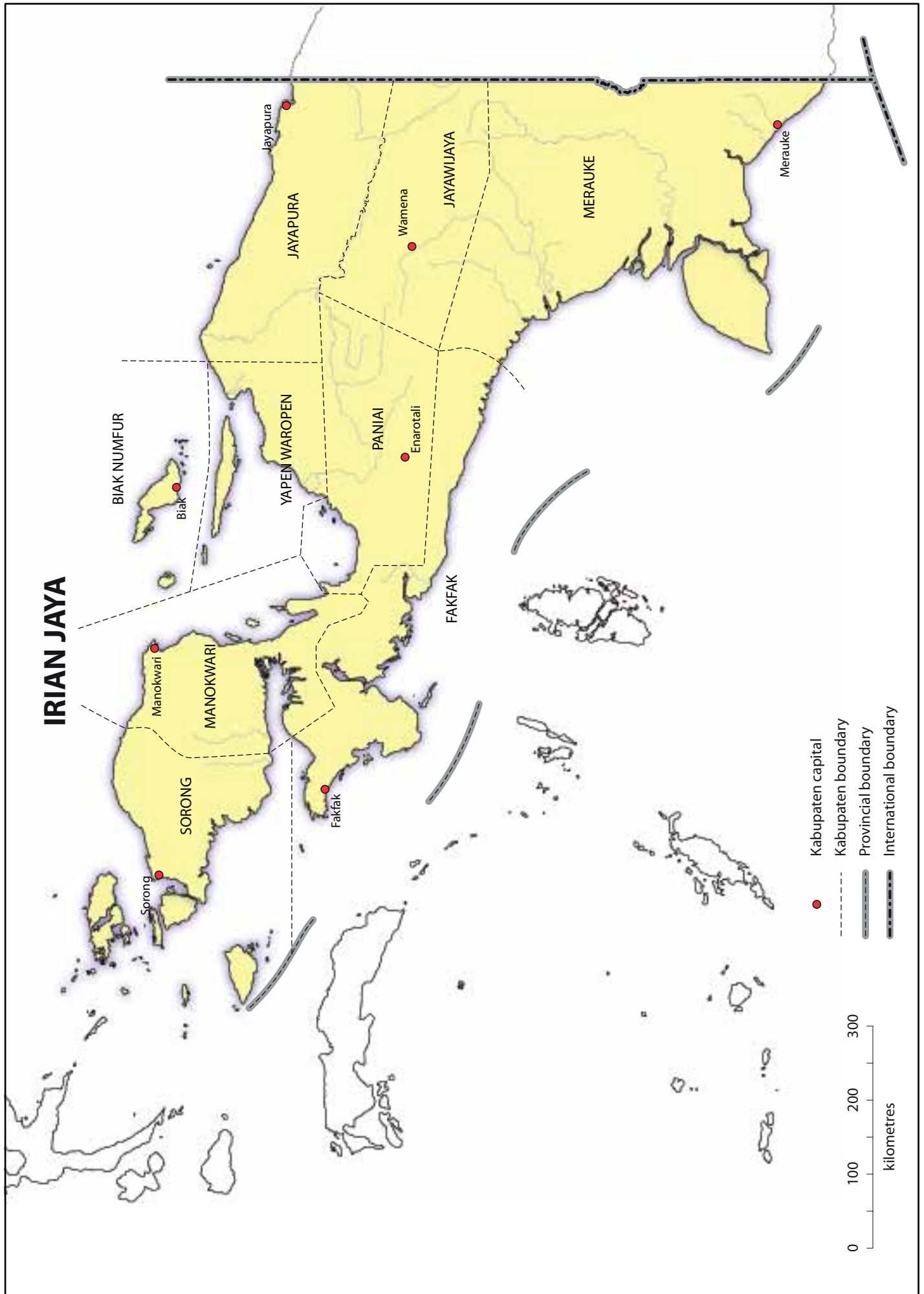
All weights and measures given in the book are metric, unless quoting historical sources, where original figures may be given, followed by metric conversions in parentheses.

Currencies

Where older sources refer to prices or values in previous currencies they have generally been retained. Until 1966, PNG used Australian pounds, shillings and pence; after 1966, and until 1975, Australian dollars and cents. Since 1975, the national currency has been kina and toea.



Map 1.1. Papua New Guinea: provinces and regions.



Map 1.2. Irian Jaya (until 2002, nw Papua, Indonesia): administrative districts (*kabupaten*) in about 1995.

Abbreviations and acronyms

ABPNG	Agricultural Bank of Papua New Guinea
ACIAR	Australian Centre for International Agricultural Research
ACNARS	Australian Contribution to the (PNG) National Agricultural Research System
AMS	accelerator mass spectroscopy (carbon dating technique)
ANU	Australian National University
AQIS	Australian Quarantine and Inspection Service
BP	before present
CSIRO	Commonwealth Scientific Industrial and Research Organisation
DAL	Department of Agriculture and Livestock
DASF	Department of Agriculture, Stock and Fisheries
DPI	Department of Primary Industry
FAO	Food and Agriculture Organization of the United Nations
IBP	International Biological Programme
IBSRAM	International Board for Soil Research and Management
JE	Japanese encephalitis
MASP	Mapping Agricultural Systems Project
NAQS	Northern Australia Quarantine Strategy
NCD	National Capital District
NGO	nongovernment organisation
NORS	Nucleolus Organizing Regions
PNG	Papua New Guinea
PNGRIS	Papua New Guinea Resource Information System
RSPAS	Research School of Pacific and Asian Studies
SDA	Seventh Day Adventist
TPBRC	Tropical Pig Breeding and Research Centre
TPNG	Territory of Papua and New Guinea
UNITEC	Papua New Guinea University of Technology

Abbreviations used in this book for provinces of PNG are listed below.

Abbreviation	Province
CEN	Central
EHP	Eastern Highlands
ENB	East New Britain
ENG	Enga
ESP	East Sepik
GUL	Gulf
MAD	Madang
MAN	Manus
MIL	Milne Bay
MOR	Morobe
NIP	New Ireland
NSP	Bougainville or North Solomons
ORO	Northern or Oro
SHP	Southern Highlands
SIM	Simbu or Chimbu
WES	Western
WHP	Western Highlands
WNB	West New Britain
WSP	West Sepik

1 Introduction

1.1 Summary

Pig production is the most significant part of smallholder livestock management in both Papua New Guinea (PNG) and Irian Jaya.¹ In New Guinea as a whole, there are estimated to be nearly 2.5 million domestic pigs, or approximately one animal for every three people. In PNG, more than half the rural population raises pigs, and, in 1996, pork was the most consumed meat, with an estimated 11 kg eaten per person each year. Village pig production throughout New Guinea is a smallholder activity that is part of household livelihood strategies aimed at fulfilling both customary and (to a limited extent) market goals. This publication provides a bibliography of the literature on New Guinea pig husbandry, and reviews that literature. It is intended as a guide to, and overview of, the current state of knowledge on pigs in New Guinea.

1.2 Background

In mid-2000, an Australian Centre for International Agricultural Research (ACIAR) project aimed at improving pig husbandry systems based on sweet potato in Vietnam and Irian Jaya was at the planning stage (CIP and ACIAR 2000; ACIAR 2002a). At this time, there was already a considerable body of literature on pigs in New Guinea. However, this literature was dispersed across a range of different disciplines — primarily agriculture, veterinary science, anthropology, nutrition and medicine. In addition, it included not only formal publications, but also a significant proportion of unpublished, or less accessible, materials. There was an obvious need for a bibliography, and an initial listing was compiled by the author. This exercise showed the extent of potentially relevant material, but was limited to a basic listing of references. ACIAR then suggested that a combined bibliography and review of this literature on New Guinea pigs would be worthwhile, and commissioned the publication in April 2001. Initial versions of the review and bibliography were submitted to ACIAR in June 2001.

Between 2001 and early 2003, I expanded and updated the bibliography. I also extensively revised the literature review while I was a Visiting Fellow in the Resource Management in Asia-Pacific Programme at the Australian National University for six months in 2002. The review and the bibliography were brought together in the present format in late 2002 and early 2003.

1.3 Purpose

This book has two main aims. First, it provides an up-to-date bibliography of literature relating to pig husbandry in New Guinea, replacing the previous one, which was published in 1981 (Cooper et al. 1981). Pig husbandry is interpreted in a broad sense; however, most of the material relates to husbandry under village or smallholder production regimes. Second, the book reviews a considerable proportion of this literature, identifying and describing the major information sources, and summarising the state of knowledge on a range of topics.

The review is not an overall synthesis, but is intended primarily as a research guide to those concerned with animal production, agriculture, food supply, nutrition, and animal and human health in New Guinea. In so far as smallholder pig husbandry practices are

¹ See 'Definitions' section for explanation of names used in this report

similar in neighbouring parts of the Pacific, it is hoped that the review will be of value at this regional level, and, perhaps, of some relevance elsewhere.

1.4 The scope of the bibliography

This bibliography compiles material on pig husbandry for the whole of New Guinea, with a cut-off date for inclusion of the end of May 2003. The bibliography was compiled using the bibliographic database software 'EndNote'.

No bibliography dealing largely with New Guinea pigs has been published since those of Talbot (1972a), Malynicz (1973d) and Cooper et al. (1981). The current bibliography lists over 1600 items, including published books, chapters, journal articles, unpublished or semipublished theses and reports, and a small amount of internet-based material. Generally, it does not include newspaper and other ephemeral magazine-type publications. References were assembled using the earlier lists, some of the standard New Guinea bibliographies (Filer and Chakravati 1990), and a wide range of library catalogues and other databases (including Agricola, Agris, CAB, Pubmed, Web of Science, the Pacific Index to Agriculture Journals, and others). Work on earlier, more general bibliographies dealing with PNG agriculture (Hide and Cuddy 1988; Stuckings et al. 1997) was drawn on. In addition to the specific New Guinea references, the bibliography also includes a number (about 200) of non-New Guinea items, either because they are referred to in the review text, or because of their regional (Pacific Island, Southeast Asia or Australia) or topical relevance.

Although this publication is a more comprehensive compilation on New Guinea pig husbandry than previous bibliographies, it makes no claim for completeness. It has several limitations. First, virtually all accounts of rural New Guinea include some mention, however slight, of pigs, and I have made no attempt to include all such passing references here. The presence of some significant, relevant, information content was the main criterion for inclusion. Secondly, coverage of the non-English language literature (in particular German, French, Dutch, Indonesian and Japanese) is by no means complete. I have attempted to locate and look at most of the recent material in these languages. I can read French and, to a much lesser extent, German, but cannot work directly in the other three languages. This means that the regional coverage is probably weakest for the literature on German New Guinea (before 1914), on Dutch or Netherlands New Guinea (before 1962), and on Irian Jaya. Finally, I did not visit the research institutions and libraries in New Guinea for this project: that would have required a larger exercise.

1.5 The literature review

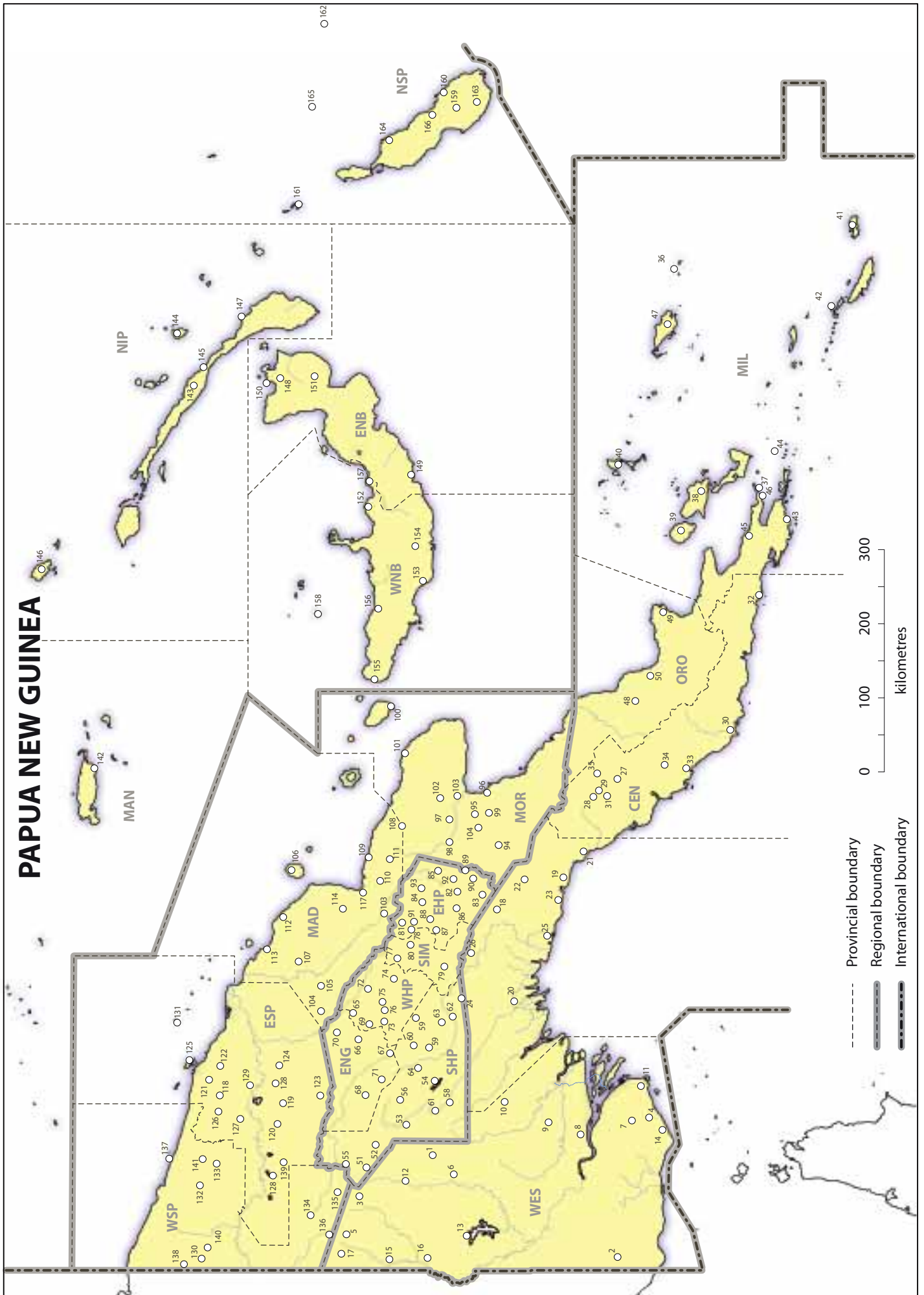
The review was prepared with two main aims. First, my intention was to identify and highlight those sources containing significant information and ideas about New Guinea pig husbandry, to provide a signposted guide to the literature. Second, I sought to review and partly summarise a selection of this literature on a range of topics, to make more available information that was otherwise scattered across not only a wide range of disciplinary sources, but also both published and unpublished formats.

Selection was involved at both these levels, identifying the more significant references, and determining the topics or subjects for more expanded review and discussion. Among the factors influencing these choices, my own disciplinary background of ecological anthropology was undoubtedly important. A major emphasis throughout has been to place pig husbandry firmly in some of its cultural, agricultural and biological contexts. This generalist, or multidisciplinary, approach is useful for appreciating the variety and complexity of relations between people, their animals and some environmental factors. However, it is limited, when applied by a single individual, to that person's grasp of a wide range of subjects. Obviously, a specialist livestock agriculturalist, veterinarian, medical scientist or cultural anthropologist would each have prepared reviews with rather

different emphases, and, undoubtedly, greater depth in their own specialities. In this review, my intention has been to provide the major contours of the wider landscape of pig–human–environment relations in New Guinea: from prehistory to present day husbandry, from distribution patterns to feeding regimes, and from older disease interactions through to emerging zoonotic disease threats. The review will have served its main purpose if it succeeds in directing readers to the original research reports in search of greater detail.

For a number of topics, I have attempted to include in the review some of the more useful information, in summary form, and thus make it more accessible. Examples include tabulations of litter size, summarised results of studies reporting weighed food rations fed to pigs, and listings of foraged food species.

Rural conditions in New Guinea, as everywhere, are constantly changing. This review covers a literature that spans roughly a hundred years, though much is concentrated during the last three decades. Most studies report information that is highly specific to place and time, and throughout the review I have attempted to ensure that both time and place are indicated prominently (see maps 1.3 and 1.4 for locations of most sociolinguistic groups referred to in the text). While this increases the burden of detail and numbers on the pages, it is intended to make explicit these framing contexts. I hope that this will also emphasise the rapidly aging profile of much of this intensive rural research, and thus highlight the value of follow-up studies to identify and chart the major trends of change in many aspects of husbandry across the country.



Map 1.3. Papua New Guinea: sociolinguistic groups or localities.

Index to Map 1.3: Papua New Guinea — sociolinguistic groups or localities

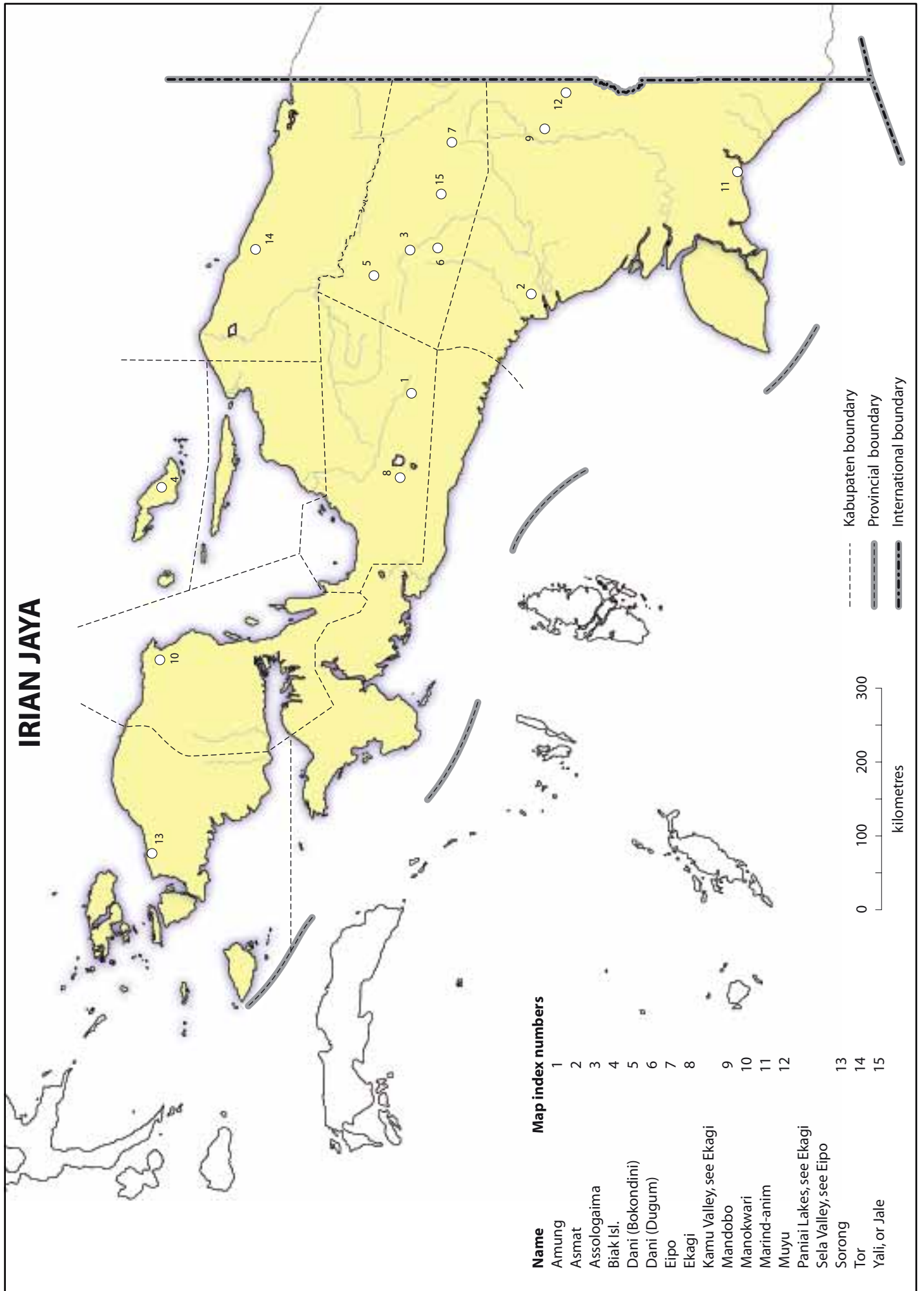
The map identification numbers run by province within region (see Map 1a), starting with Papua (Western, Gulf, Central, Milne Bay and Oro), the Highlands (Southern, Enga, Western, Simbu and Eastern), then Momase (Morobe, Madang, East and West Sepik), and finally the Island Region (Manus, New Ireland, East and West New Britain, and Bougainville). Map scale limitations restrict the number of locations, and mean some locations are generalised.

Name	Province	Map Index No.
Abelam	ESP	118
Abrau	WSP	132
Ambonwari	ESP	119
Amongabi	ESP	120
Anga	EHP	83
Anga	MOR	94
Ankave Anga	GUL	18
Arapesh	ESP	121
Asaro Valley	EHP	81
Auyana	EHP	82
Awa, see Auyana		
Baktaman, see Faiwol		
Balamuk, see Bensbach		
Baruya, see Anga	EHP	83
Bedamuni	WES	1
Beha Valley, see Gimi		
Benabena	EHP	84
Bensbach	WES	2
Bimin-Kuskusmin	WES	3
Binandere	ORO	48
Bine	WES	4
Binumarien	EHP	85
Bogaia	SHP	51
Boiken	ESP	122
Buang	MOR	95
Budibudi Isl.	MIL	36
Busama	MOR	96
Buou	MIL	37
Carteret Isl.	NSP	165
Chimbu/Simbu	SIM	77
Chuave	SIM	78
Daribi	SIM	79
Daulo see Siane		
Duna	SHP	52
Eivo	NSP	166
Elema	GUL	19
Enga, see Mae Enga		
Erap	MOR	97
Etoro	SHP	53
Faiwol	WES	5
Fergusson Isl.	MIL	38
Foi	SHP	54
Fore	EHP	86
Fuyughe	CEN	27

Name	Province	Map Index No.
Gadio Enga	ESP	123
Gagave	CEN	28
Gaikorobi	ESP	124
Garu	WNB	152
Gazelle Peninsula	ENB	148
Gebusi	WES	6
Gende	MAD	103
Gidra	WES	7
Gimi	EHP	87
Gnau	WSP	133
Gogodala	WES	8
Goilala	CEN	29
Goodenough Isl.	MIL	39
Gururumba, see Asaro		
Hagahai	MAD	104
Hagen, see Melpa	WHP	75
Hewa	SHP	55
Hula	CEN	30
Huli	SHP	56
Imbonggu	SHP	57
Jimi Valley	WHP	72
Jobakogl, see Sinasina		
Kaiapit	MOR	98
Kairi	GUL	20
Kairiru Isl.	ESP	125
Kaironk Valley, see Kalam		
Kairuku	GUL	21
Kalam	MAD	105
Kaluli	SHP	58
Kamanuku, see Chimbu		
Kamea	GUL	22
Kamula	WES	9
Kandrian	WNB	153
Kapaluk, see Garu	WNB	152
Kapanara, see Tairora		
Karimui, see Daribi		
Karkar Isl.	MAD	106
Kasanmin, see Faiwol		
Kasua	WES	10
Kaugel Valley	WHP	73
Kaulong	WNB	154
Kewa	SHP	59
Kialikmin, see Telefomin		
Kilenge	WNB	155
Kiriwina	MIL	40
Kiwai	WES	11
Korafe	ORO	49
Korfena, see Asaro		
Korofeigu	EHP	93
Kove	WNB	156
Kubo	WES	12
Kukipi	GUL	23
Kuma	WHP	74
Kuman, see Chimbu		
Kunimaipa	CEN	31
Kwanga	ESP	126
Kwoma	ESP	127
Kyaka Enga	ENG	65
Lake Kutubu, see Foi		
Lake Murray	WES	13
Lake Tebera	GUL	24
Lelet	NIP	143
Lihir Isl.	NIP	144
Lufa	EHP	88
Lumi, see Gnau		

Name	Province	Map Index No.	Name	Province	Map Index No.
Maenge	ENB	149	Sabarl Isl.	MIL	42
Mae Enga	ENG	66	Sambia (Simbari), see Anga		
Maian	MAD	107	Saniyo-Hiyowe	ESP	128
Mailu Isl.	CEN	32	Sawos	ESP	129
Madok, see Siassi Isl.			Seltamin/Seltaman, see Faiwol		
Mandak	NIP	145	Siane	EHP	91
Manga, see Jimi Valley			Siassi Isl.	MOR	100
Maprik, see Abelam			Simbu, Chimbu	SIM	77
Marient Basin	ENG	67	Sinasina	SIM	80
Maring, see Jimi Valley			Sio	MOR	101
Mawata	WES	14	Siuai, see Siwai	NSP	163
Melpa	WHP	75	Siwai	NSP	163
Mendi	SHP	60	Suau	MIL	43
Miyanmin	WSP	134	Sulka	ENB	151
Morehead, see Bensbach			Sursurunga	NIP	147
Motu	CEN	33	Tairora	EHP	92
Mulim, see Mendi			Takuru, see Wiru		
Mussau	NIP	146	Tanga	MAD	113
Nagovisi	NSP	159	Tari, see Huli	SHP	56
Nakanai	WNB	157	Tauade	CEN	35
Nasioi	NSP	160	Teop	NSP	164
Ndumba	EHP	89	Telefomin	WSP	136
Nebilyer	WHP	76	Tombema	ENG	70
Nembi, see Wola			Trans Gogol	MAD	114
Ningerum	WES	15	Tubetube Isl.	MIL	44
Nipa, see Wola			Tumleo Isl.	WSP	137
Nissan Isl.	NSP	161	Umeda	WSP	138
Nokopo	MAD	108	Unea Isl.	WNB	158
Notofena, see Korofeigu			Yafar	WSP	130
Nukakau Isl., see Kove			Yangoru, see Boiken		
Nukutapu Isl.	NSP	162	Yimar	ESP	139
Okapa, see Fore			Yobakogl, see Sinasina		
Oksapmin	WSP	135	Yonggom	WES	16
Ommura	EHP	90	Yumbisa Enga	ENG	71
Onabasulu	SHP	61	Yuro, see Daribi	SIM	79
Ontena, see Tairora	EHP	92	Wabo	GUL	26
Oriomo, see Gidra	WES	7	Wahgi/Mid-Wahgi, see Kuma		
Orokaiva	ORO	50	Wain	MOR	102
Papuan Plateau, see Kaluli			Wamira	MIL	45
Pangia, see Wiru			Wampar	MOR	103
Patep	MOR	99	Wamu	WSP	140
Peri/Pere	MAN	142	Watanou	MIL	46
Pinu	CEN	34	Watom	ENB	150
Polopa	SHP	62	Watut	MOR	104
Porgera	ENG	68	Wiru	SHP	63
Purari	GUL	25	Wogeo Isl.	ESP	131
Raiapu Enga	ENG	69	Wola	SHP	64
Rai Coast	MAD	109	Woodlark Isl.	MIL	47
Ramu Valley	MAD	110	Wopkaimin	WES	17
Rauto, see Kandrian			Wosera, see Abelam		
Rawa	MAD	111	Wulukum	WSP	141
Rempi	MAD	112			
Rossel Isl.	MIL	41			

IRIAN JAYA



Map index numbers

- | | |
|-------------------------|----|
| Name | 1 |
| Amung | 2 |
| Asmat | 3 |
| Assologaima | 4 |
| Biak Isl. | 5 |
| Dani (Bokondini) | 6 |
| Dani (Dugum) | 7 |
| Eipo | 8 |
| Ekagi | 9 |
| Kamu Valley, see Ekagi | 10 |
| Mandobo | 11 |
| Manokwari | 12 |
| Marind-anim | 13 |
| Muyyu | 14 |
| Paniai Lakes, see Ekagi | 15 |
| Sela Valley, see Eipo | |
| Sorong | |
| Tor | |
| Yali, or Jale | |

Map 1.4. Irian Jaya: sociolinguistic groups or localities

2 Historical overview of major research projects and themes

2.1 Government livestock policy and pig research

Before 1940, there was little research on livestock in New Guinea,² and no specific studies of pigs were published. There was, nevertheless, steady importation of exotic-type pigs to areas of expatriate settlement, and considerable interbreeding between these pigs and local stock, as described in Chapter 3. Limited extension information in the New Guinea Agricultural Gazette was directed to the intensive or semi-intensive management of exotic pigs (Gee 1937, 1938, 1939, 1941).

During World War II, the direction of postwar policy in New Guinea concerning agriculture and human nutrition was discussed and planned (Australian Archives A518/1). Starting in September 1945, and continuing into 1946, an army team carried out a major veterinary survey of animal disease in Papua New Guinea (PNG) (Australian Mobile Veterinary Survey Unit 1946). Also, in 1947, a multidisciplinary group carried out an intensive survey of village agriculture and human nutrition (Hipsley and Clements 1950). These surveys established information baselines that partly guided subsequent policy concerning pigs in the then Territory of Papua and New Guinea.

The main postwar policy objectives were to improve the quality, and increase the number, of village pigs, in order to improve human nutrition and restock local village herds affected by the war. The nutritional policy for increasing meat production grew out of the results of the 1947 Nutrition Survey, which showed low levels of protein consumption in the villages surveyed (Langley 1950). Pig herds in many locations in PNG had been decimated during the war, with the committee of enquiry into war damage in 1945 estimating overall losses at 100,000 pigs (Mair 1948:226). Local losses in the Maprik region of East Sepik Province are described by Lea (1964:126) and Roscoe (1989:220), and in the south of Bougainville by Connell (1978:179–180). A program of restocking local herds was instituted, with major imports from Australia (Department of National Development 1951:80). Between late 1945 and 1948, plans were in hand to transport Australian pigs to New Guinea, either by sea or even by airlift. Although Mair (1948:226) noted that, by 1947, the Department of External Territories had shown little urgency in this program (she pointed out that private imports had been arranged by two entrepreneurs in Lae and by the Lutheran Mission), and only some 250 animals had been imported, more were apparently sent later. One reason for the delay may have been a lack of suitable animals in Australia (Department of National Development 1951:92). By September 1948, lots of 150 pigs were on their way to Lae by ship. By the late 1940s, there were two government pig farms at Lae and Rabaul selling pigs, with a third under preparation in Papua (Department of National Development 1951:80). This program to distribute exotic stock pigs to villages ran from 1948 to 1972, with the explicit aim of improving productivity by introducing exotic pig stock (Hasluck 1976:135; Thompson and MacWilliam 1992). The history of this major program has not been fully written but is well documented (Australian Archives Accession No.12, Boxes 4080, 3899, 16 633–16 634, 16 635–16 637).

In 1958, the Minister for Territories commissioned an investigation of the pastoral industry in PNG, with the terms of reference including:

An attempt ... to estimate the numbers and value of the existing pig population as a contribution to total requirements. Advice is also desired on means of improving the

² See 'Definitions' section for explanation of names used in this report

present standard of production and expanding the industry to serve as significant factor in meat consumption requirements (Rose 1958:38).

In his report, Rose (1958:10, 30) recorded only 108 pigs on all government stations, and recommended that:

Pig production should be assisted and encouraged by all reasonable means, such as Government pig production projects for dispersion of stock, and the paying of freight subsidy on introduced stock.

He was scathing about the state of the Goroka farm (intended as the centre for improved pig distribution in the Highlands region), reporting that:

The pig-breeding project can only be described as scandalous. Two aged boars and four aged sows were sent to the farm in 1955 and the total increase from these has been six in over three years. With the addition of two more boars, the farrowings should have reached 400 in this period. The foundation stock were aged and past breeding age. As in the case with the cattle, 3 boars and 15 sows have remained unproductive, in quarantine at Kila since August 1957. They were imported for Goroka and it was suggested they be moved forthwith. The 85 acre block has been developed for pigs and includes 14 well constructed styes and ten paddocks — all empty. (Rose 1958:67).

From the 1950s on, there was an active veterinary service that reported on various aspects of pig disease (see in particular Egerton and Rothwell 1964; Rampling and Egerton 1965; Egerton 1965ab). In the mid-1960s there was a vigorous campaign to vaccinate pigs against anthrax, and cooperative research with the health department on the causes of pigbel (enteritis necroticans) (Egerton 1966; Harvey 1966). In terms of the productivity of local pigs, however, as late as 1964, the Government Veterinarian could report that ‘...Nothing is known of the performance of native pigs’ (Egerton and Rothwell 1964:7).

It is notable that during this period many of the practices associated with village pig husbandry in Papua New Guinea were viewed negatively by health officials (Tommerup 1955:73; Yelland 1955:30, 32; Spencer et al. 1956:111; Shoffner 1976:157), by agricultural officers implementing cash crop extension, and by a range of other government officials (Sorenson and Gajdusek 1969:291) and plantation owners. It was, according to Harvey (1966:66) ‘a common attitude even in the Department of Agriculture that strong measures should be taken to discourage pig raising’. During the mid 1950s, the intrusion of an expatriate plantation (and mission station) sector in the Eastern Highlands resulted in considerable agitation for administrative or legislative powers to limit highlanders freedom to free range their animals, agitation that finally resulted in the formation of a ‘Committee on the Pig Problem’ in Port Moresby.

During the late 1960s to early 1970s, fresh impetus to the development of the PNG livestock industry followed the report of the International Bank for Reconstruction and Development (1965). In the late 1960s, imports of pork were eight times larger than were provided by slaughter for commercial sale within PNG (Anderson 1972:646). From the early 1970s there was increased policy emphasis on food production, nutritional improvement and import replacement, with a consequent drive to expand the production of pigs and other livestock by smallholders (Densley 1981).

From the late 1960s, with the establishment of the Tropical Pig Breeding and Research Centre (TPBRC) at Goroka, a significant program of pig production research was undertaken. The directions of this research are described by Malynicz (1970b; 1971b), and the main publications are listed in Cooper et al. (1981). Work was done on pigs under conditions of both semi-intensive management and village husbandry (Davis 1973ab; Copland 1974ab, 1975, 1976abc). The chief aims of the research were to understand the main characteristics of the village pig, and to develop husbandry systems that would make the best use of village resources and the best performance characteristics of both

village and imported pigs (Anderson 1972). The research was centred at Goroka and the Highlands region, but also took place at Erap in Morobe Province and at Rabaul.

During the 1970s, a large number of small-scale piggeries were established throughout the country (though centred in the Highlands region), but by the late 1970s to early 1980s, these had failed. This failure roughly coincided with the collapse of the smallholder cattle projects that had dominated livestock policy during this period (Mandich 1991). Mandich considered that there was no evidence that villagers adopted the results of the pig research program summarised above. The failure, in his opinion, may have been the result of a lack of understanding of the social role played by pigs in rural society. Writing 20 years earlier, Purdy (1971:484) had seen that the development of a pig industry required 'bringing the pig into the cash economy and removing its social status'. By the late 1980s, there was increased understanding of that social or cultural role by some livestock specialists. According to the veterinarian Nunn (1988a:96):

... social obligations and social exchanges are vital to the whole economy and the whole structure of the society. The role of the village pig cannot be underestimated in this sense. You don't marry unless you have pigs, you are not a man of any status or wealth unless you have pigs, particularly so in the highlands. So the needs, priorities and objectives of the people in the village system are not necessarily those of advisers and planners.

The constraints to the commercialisation of smallholder pig production have been reviewed recently by Quartermain (1996, 2001).

In 1980, the first tripartite meetings between PNG, Indonesia and Australia were held to discuss common animal health matters; in particular, the lack of reliable epidemiological data on animal disease (Ningiga and Nunn 1985). This meeting resulted in the establishment of the Tripartite Committee on Animal Health and Quarantine to service the joint region of New Guinea and Torres Strait. It was followed by a joint feasibility survey in 1981 to consider a survey of major animal disease in the region. The survey was planned as an ongoing two-year activity. Subsequently, joint quarantine and survey arrangements between PNG and Australia were developed following the implementation of the Northern Australia Quarantine Strategy (NAQS) in 1989 (Wright et al. 1998:10–11). This involved regular veterinary surveys in the border areas of PNG, and is described further in Chapter 11 (Section 11.1).

While it was understood, from at least the early 1970s, that the previous policy of injecting exotic pig breeds into local village communities was a failure, as late as 1979 a thousand crossbred weaners were being distributed to smallholders from Goroka. Such stock failed to thrive under local conditions without changes to husbandry and feeding regimes. From the late 1970s, the nucleus estate system was being promoted with the aim of replacing pork imports.

The Goroka-based research program on crossbreeding pigs and feeding studies was terminated in the early 1980s, apparently because village-level piggeries were not considered to contribute to the national monetary economy, and because the tasks of supplying or importing commercial feed and breeds were passed from the Department of Agriculture to the commercial pig industry (Bakau and Galgal 1994:47). Loans from the PNG Agriculture Bank for pig (and poultry) projects declined steeply during the 1980s, from 9% of all loans to 0.4% by 1987–90 (Connell 1997:82).

By 1985, Bilong (1986) considered that two of three main livestock objectives, import replacement and the improvement of the nutritional status of the rural population, had been achieved through the establishment of commercial enterprises.

In a major review of the livestock sector in 1993, the Renewable Resources Sector Study Team (1993:7, 37) noted that no major attempts have been made to re-establish research programs in livestock or to develop technical innovations likely to affect pigs as breeding

material. In 1993, the Department of Agriculture and Livestock (DAL) had no specific programs directed to pigs.

2.2 Anthropological and other research themes and topics, 1960–2000

In 1960, at the same time as late Australian colonial policy began to markedly increase its efforts to change local husbandry practices, the major United Nations Educational, Scientific and Cultural Organization (UNESCO) Symposium on the Impact of Man on Humid Tropics, met at Goroka. The symposium devoted considerable attention to the place of pigs in New Guinea environments and ecosystems, and one of its recommendations focused on the urgent need for socioeconomic studies of customary pig husbandry practices (UNESCO 1960:123, 136, 168, 170, 235, 244–6). Although no specific research programs flowed from this initiative, the next forty years saw a massive expansion of cultural and socioeconomic research in New Guinea. As part of this wave, a significant set of research themes and questions emerged, both in theoretical discussion and field research investigation, which centrally involved the role of pigs in New Guinea. In summary, these include:

- The antiquity of pigs in New Guinea prehistory (Bulmer and Bulmer 1964; Bulmer 1966; Bulmer 1998).
- The process of pig domestication (Wieneke 1972; Collier and White 1976; Golson and Hughes 1980; Baldwin 1982; Morton 1984; Yen 1991; Dwyer 1996; Smith 2000).
- Analyses of the nutritional role of pork and the rationality of cyclical mass pig killings (Vayda et al. 1961; Rappaport 1967; Vayda 1972; McArthur 1974; Rappaport 1984; McArthur 1987). There is a large subsequent literature on these issues.
- Ritual regulation of environmental relations; in particular, pig numbers (Rappaport 1967; Buchbinder 1974; Lowman 1974; Rappaport 1984). Model simulation of human–pig–environment relations (Shantzis and Behrens 1973; Kampmann 1991; Ford No date).
- The role of pigs in ceremonial exchange systems (Criper 1967; Strathern 1969, 1971ab; Meggitt 1972; Schwimmer 1973; Meggitt 1974a; Rubel and Rosman 1978; Strathern 1978; Anere 1979; Brown 1979; LeRoy 1979; Sillitoe 1979; Feil 1982; Schulte-Tenckhoff 1983; Strathern 1983; Feil 1984; Josephides 1985; Lederman 1986; Lemonnier 1990, 1991, 1993ab; Welsch 1994; Wiessner and Tumu 1998; Lemonnier 2002).
- The role of pigs in the history of agricultural intensification (Golson 1977; Modjeska 1977; Golson and Hughes 1980; Modjeska 1982; Feil 1985, 1987; Kelly 1988; Golson 1990; Golson and Gardner 1990; Lemonnier 1990; Bayliss-Smith and Golson 1992; Feil 1995; Modjeska 1995; Golson 1997).
- The role of pigs in gender relations (Modjeska 1977; Feil 1978ab; Strathern 1979; Modjeska 1982; Josephides 1985; Sillitoe 1985; Feil 1987; Biersack 1995; Modjeska 1995; Minnegal and Dwyer 1997; Dwyer and Minnegal in press).
- The role of pigs in disasters such as droughts and food shortages (Wohlt 1978; Wohlt et al. 1982; Clarke 1989; Wohlt 1989; Robinson 1999; Dwyer and Minnegal 2000; Minnegal and Dwyer 2000; Robinson 2001).

3 Pigs in New Guinea: origins and breeds

3.1 Origins and prehistory

The antiquity of pigs in New Guinea³ is unknown, and has been the subject of considerable debate following the growth of archaeological evidence in the last forty years. Before such evidence was available, and as recently as 1964, there was still uncertainty as to whether pigs had arrived in New Guinea in prehistory with early human migration, or had been introduced by early European explorers (Stone 1880:96; Egerton and Rothwell 1964:7).

Early archaeological finds of pig material were interpreted to mean pigs had been in New Guinea for between 6000 and 10,000 years (Bulmer, S 1966; White and Allen 1980; Bulmer, S 1982; White with O'Connell 1982). Until the mid-1990s this was generally accepted (Bellwood 1979:16; Groube 1989:302; Yen 1990:264; Golson 1991b:51), with some discussion focused on whether such pigs were domesticated and on the implications of such husbandry for early root-crop agriculture. However, there is now considerable doubt about the reliability of such early dates. One alternative view, based on the linguistic evidence showing that several Papuan languages have words for pig that appear to be loans from later Austronesian languages, proposes that the pig was probably introduced to New Guinea by Austronesian speakers within the past 3500 years or so (Haberland and Seyfarth 1974:246; Blust 1976:14; 2002:93–4). More significantly, in the 1990s, six pigs' teeth from a range of New Guinea prehistoric sites that were believed to be of early date were sent to the United Kingdom for dating by the recent accelerator mass spectroscopy (AMS) technique. All were dated at less than 500 years old (Hedges et al. 1995).

Following the AMS dating results, archaeologists have been divided about how long pigs have been in New Guinea, with some arguing for a relatively recent arrival, others still supporting early dates, and some adopting a cautious approach to both the early dates and, apparently, the AMS results. Armed with the AMS dates, and Blust's linguistic argument, Spriggs (1996a:534) immediately suggested that pigs were possibly not introduced to New Guinea until the last 2000 years or so. Somewhat ambivalently, however, he noted that, since the early prehistoric record in the region shows evidence of transfers of other live animals between islands, it would be no surprise if pigs had arrived earlier. That said, he implied that such earlier arrivals were probably of wild pigs, and that only in Lapita sites (ie in the last 3500 years or so) do pig remains and their contexts suggest full domestication. His argument is repeated in several subsequent publications (Spriggs 1996b:335; 1997:93, 95; 2000:63). A less dramatic position has been taken by prehistorians such as Golson (1997:43–44), Harris (1995:853), Kirch (1997:43) and Green (2000:379–80), and others such as Bayliss-Smith (1996:500, 504–6), who have advised treating the early dates with caution. The strongest arguments for the earlier dates have been made by Bulmer (1998) in a review of the archaeological pig material in New Guinea, and by Allen (2000:157–9; 2001, see also Allen and Gosden, 1996:191) in several publications focused on data from both the Bismarck Archipelago and the Sepik area (Gorecki et al. 1991; Swadling, no date). Allen (2000:159) has concluded that he considers it 'more than likely than not that pigs were in New Guinea and parts of the Bismarcks before the mid-Holocene'.

The most recent information is from pig bone, dated by AMS to a minimum of 1840 years before present (BP), and possibly as old as c. 4000, from the Kria cave in the Bird's

³ See 'Definitions' section for explanation of names used in this report

Head at the western end of Irian Jaya, which represents the earliest ‘directly dated pig remains from New Guinea’ (Pasveer 2003:55–56, 326, 331).

Besides detailed prehistoric site descriptions, there is a considerable literature discussing pigs and pig husbandry in the prehistory of New Guinea. As well as the antiquity debate, other issues addressed include their role in human ecology and subsistence, questions about domestication, their role in relation to the development of agriculture — in particular agricultural intensification in the highlands — and their emergence as major items of exchange (Bulmer and Bulmer 1964; Wieneke 1972; Baldwin 1976; Allen 1977; Modjeska 1977; Morren 1977; Golson and Hughes 1980; Feil 1987; Kelly 1988; Kirch 1988; Baldwin 1990; Golson and Gardner 1990; Kirch 1990; Mountain 1991; Yen 1991; Bayliss-Smith and Golson 1992; Ballard 1995; Blanton and Taylor 1995; Dwyer 1996; Redding and Rosenberg 1998; Bellwood 2000; Smith 2000).



Large pigs on display at pig festival, Gena Nogar, Simbu Province, 1968.

Photographer: R. Hide.

3.2 Feral and domesticated pigs

Domestic and feral (or wild) pigs in New Guinea are considered to form a single genetic pool (Bulmer 1968a; Groves 1981). This is obvious in lowland and midaltitude areas, where a varying proportion of the pigs cared for by people originate either as piglets captured from the wild, and subsequently tamed, or as the offspring of matings between village sows and feral boars. Where feral populations are absent, however, increasing physical differentiation (eg in terms of colour or body shape) is evident, and the effects of interbreeding with exotic stock most pronounced (see below). While practices associated with domestic pig husbandry are the main focus of this review, the close association between domestic and feral pig populations means that the distinction should not be overdrawn, and some summary initial points are useful.

A classic example of the intimate association between domestic and feral pigs is that described by Hughes on Long Island in Madang Province during 1979 (Ball and Hughes 1982:483–4). Human population density was low, at only two persons per square kilometre, and there was a large population of feral pigs on the island, which provided a pool of young piglets for recruitment to the domestic stock. One practice, however, that was observed by Hughes and was said to be common, was of especial significance. While

walking through the forest, a small feral boar was captured alive. It was held down while it was castrated, its tail docked and its ear marked, and it was then released to grow to a mature size. Such markings were said to allow those involved to claim a share of the meat when the marked animal was later killed by a hunter. A somewhat similar form of 'farming' or managing feral pigs on small islands in the Philippines was contemplated by Thomas Forrest during his Moluccan and New Guinea voyages of 1774–76 (Forrest 1969 orig.1780:258). In the same vein, in 1928 Cilento (1928:48) recommended the stocking of unoccupied small islands with pigs in the Ninigo and Hermit groups of Manus. An aspect of the processes involved is aptly captured in Yen's evocative phrase about the introduction of pigs to New Guinea '... where feralisation is often as much part of the system of husbandry as domestication' (Yen 1990:269).

Feral pigs are found throughout New Guinea, with densities varying in relation to altitude, to vegetation, and to human density. In general, they are most common below about 900 m (Flannery 1995:61), or 1500 m (Bulmer 1968a). Numbers seem to increase quite sharply in lowland rather than in midaltitude locations (Akimichi 1998:172, 175). However they may also be locally abundant on some unoccupied alpine grasslands at over 3000 m, as on Mount Albert Edward (Hope 1975:5; Flannery 1995:61). Bulmer (1968a) noted that there was some evidence that the relationship of feral pigs to people was possibly symbiotic, with pigs favouring the disturbed ecological zones created by anthropogenic activity.



Returning from the hunt: wild pigs carried by two Pinai-speaking hunters, Upper Yuat River (c. 300 m altitude), Western Highlands Province, 1983.

Photographer: P. Gorecki.

Thirty years ago, Brookfield with Hart (1971:86) considered that, by comparison with domesticated pigs, hunted feral pigs were of only marginal significance to human subsistence. Subsequent findings from intensive research in lowland, and some midaltitude, areas have qualified this view. In areas of low human density (less than five persons per square kilometre), with access to the appropriate vegetation, hunting yields from feral pigs are (or recently have been) the major source of meat for many small New Guinea communities. In some of these areas, more meat per person is obtained from hunted feral pigs than is produced from domestic pigs in systems where pig husbandry provides the main source of meat. Some examples from the midaltitude zone include the Miyanmin in West Sepik Province (Morren 1986:55), and the Hagahai in Madang Province (Jenkins and Milton 1993:287); and from the lowlands, the Kubo (Dwyer and Minnegal 1991a; 1991b), and Bedamuni people (van Beek 1987: Appendix B) in Western Province, the Abrau in West Sepik Province (Kelm and Kelm 1980:88), and Garu village

in West New Britain Province (Liem 1977:289–90). Some quantitative details for these and other locations are given in Table 10.3 (Chapter 10).

No estimates for the numbers of feral pigs in New Guinea have been located.

3.3 Genetics and physical characteristics

New Guinea pigs are variously referred to as native, indigenous, local or village pigs, to distinguish them from more recently introduced exotic breeds. Descriptions of New Guinea pigs vary through time. On Goodenough Island in the early 20th century, they were described as:

... flat-ribbed brutes which have sharper backs and longer snouts than the pigs of Europe, and display an activity which the latter have long laid aside. Some are black in colour, some a dirty brown. The village pig is the same as the wild one, for every domesticated boar is mutilated (ie castrated) and the females are therefore compelled to wander off into the woods to find their mates. (Jenness and Ballantyne 1920:20).

According to the post-World War II Army Veterinary Survey team, the New Guinea pig:

...lacks uniformity and quality, it is leggy, slab sided, has a long straight snout, a slightly arched back, a coarse bristly coat and sometimes a distinct mane. The ears lie back close to the upper part of the neck. These pigs take up to 3 years to reach maturity; they are small and they carry only a moderate amount of flesh. Their colours are chiefly black, with an admixture of lighter coloured or ginger bristles. White pigs were rarely seen. Suckers and weaners are often striped; these peculiar markings run length-wise along the body and they are made up of alternating lighter and darker bands of bristles. The light coloured stripe is composed of longer bristles which stand more erect and form ridges, whereas the dark coloured stripe is made up of shorter bristles which lie flatter on the body. As the pig matures the coat tends to lose these marking(s) and becomes uniform in colour. (Australian Mobile Veterinary Survey Unit 1946:43).

More than two decades later, the New Guinea pig was seen as ‘short, dark brown or black, with coarse hairs. It possesses heavy forequarters, light hindquarters and fairly long snout. Tusks are not especially well developed, even in boars’ (Malynicz 1970a:201). For Anderson, ‘It is small, either black or grey in colour and with a light reddish bristle. The young have alternate light and dark bands along the length of their bodies’ (Anderson 1972:646). In her account of pig breeds throughout the world, Porter described the young New Guinea pig as:

... often born striped, like wild pigs, and the adults might be black, black spotted white, white, red, or grey — indeed they cover the full spectrum of domesticant colours, though most are black.they remind one more of razor-back wild species than south east Asian domesticants, though their straight profiles are less long in the snout. Their origins are a matter of some debate... (Porter 1993:201, adults illustrated on pp.64–5).

The domesticated and feral pigs in New Guinea are genetically continuous and, according to Groves (1981:64–6; 1983; 1995), are the result of hybridization between *Sus scrofa vittatus* and the Celebes Wild Boar (*Sus celebensis*). Many recent writers have agreed with this assessment (Flannery 1995:61; Quartermain 2002a:1), but Bulmer (1998) disputes it.

Popescu et al. (1982), reporting a chromosomal analysis of the genetic karyotype of 13 indigenous pigs from the Eastern Highlands, found that it was similar to that of European domestic pigs. They suggested that both shared the same original ancestor.

In a further genetic comparison of chromosomal banding patterns of 12 New Guinea village pigs with domestic pigs from elsewhere and European wild pigs, Popescu et al. (1989) found that the R-banding patterns were identical for all domestic breeds. This study confirmed earlier reports on the polymorphism of patterns of nucleolus organizer regions (NORs) in different domestic pig breeds.

Lauvergne et al. (1982) described coat colour variants from a series of deliberate matings at the Tropical Pig Breeding and Research Centre at Goroka and the University of Technology (UNITEC) at Lae, and from a survey of village pig coat colouration in the provinces of Eastern Highlands and Morobe. The village surveys showed a high incidence of the agouti phenotype relative to the black one, and a very low incidence of white designs. The latter were attributed to the influence of interbreeding with saddleback and berkshire pigs. However, the evidence of the village surveys suggested that the genetic influence of exotic pigs was still relatively small.

Hide (1981:590–1) described coat colouring and teat numbers for 53 Sinasina pigs in 1973, and compared them with frequencies reported from the Solomon Islands by de Fredrick (1971b). Randa (1994:96–114) surveyed 454 highland pigs and 351 lowland ones in Irian Jaya, and reported selected morphological characteristics (coat colour, coat pattern, body shape, tail length, tail shape and pattern). Sillitoe (2003:245–246) describes an elaborate classification of pigs, based on coat colour, by the Wola of the Southern Highlands Province.

Polydactylism in New Guinea pigs has been described for several areas (Franklin et al. 1978:118; Crittenden 1982:210; Malynicz 1982; Bergmann, no date: 110).

Descriptions of the physical characteristics and genetics of pigs in neighbouring regions are given by Hayashi et al. (1984) for Indonesian native pigs and Asian wild boars, by Groves (1997) for wild pigs in the Philippines, by McIntyre (1997) for intersexual pigs in Vanuatu, and by Pullar (1953) for feral pigs in Australia.

Early descriptions of some physical characteristics of New Guinea pigs by European visitors are given by Jukes (1847), Chalmers and Gill (no date), and Stone (1880).



Examples of the range of coat colour in modern village pigs, Samo village, Lihir Island, New Ireland Province, 2002. Photographer: Martha Macintyre.

Assessment by expatriate observers of the qualities of New Guinea native pigs as domestic animals and meat producers has varied. In general, it appears not to have been favourable, as evidenced by the enthusiasm for importing pigs of exotic type from the earliest days of colonial settlement (see Section 3.4). Similarly, a post-World War II official view considered that ‘the quality of native pigs is, generally speaking, poor’, though it was noted that there were, however ‘many areas in which hardy types [presumably meaning crossbreds] have been developed which are now well adjusted to local conditions and suited to native requirements’ [parenthesis added] (Department of National Development 1951:80).

Issues relating to the conservation of the genetic resources of pigs in New Guinea are discussed by Quartermain (2002a). For the native pig, he considered that more needed to be known about its genetic affinities, differentiation and purity, and that the reasons for its superior fitness over commercial breeds under village husbandry conditions needed definition. He recommended the establishment of a research herd of representative animals and the preparation of a proposal for external funding or collaboration for a genetic marker study. He also suggested that work on further characterisation should include assessment of the pigs’ digestive capacity and parasite resistance.

3.4 The historical introduction of imported exotic stock

From the earliest days of European settlement, exotic breed pigs were imported by planters, government officials and missionaries, and some of their offspring found their way to villages (Egerton and Rothwell 1964:7). In both Papua and New Guinea, it was explicit government policy in the first two decades of the 20th century to improve village breeding stock through imports (Black 1957; Sack et al. 1979; Hahl 1980:116). The role of planters and missionaries (Frerichs and Frerichs 1969:15) was also significant. In 1912 and 1913, in German New Guinea, the Administration recorded respective totals of 2866 and 3081 pigs held by European establishments (British Administration — (Late) German New Guinea 1916: Table 14). Before 1935 in Bougainville Province, one planter introduced six berkshire sows and one boar from Hawkesbury in Australia (Stuart 1977:71). A 1946 survey noted that before World War II most Bougainville Province plantations ran small numbers of pure bred pigs, though one (Numa Numa) was said to have had as many as 3000–4000 pigs (Australian Mobile Veterinary Survey Unit 1946:79), a number that seems unlikely. By 1938–39, domestic pigs in the Siuai area of southwest Bougainville Province were said to be observably different as a result of interbreeding with exotic types brought back by returned labourers from plantations (Oliver 1949b:7–8). In Papua, a planter in the Gulf Province imported berkshires as early as 1919 (Hope 1979). Before 1941, the berkshire was in fact the recommended exotic breed for New Guinea conditions because it was considered suitable for rapidly improving local stock (Gee 1937; 1941). Other breeds recommended included tamworths and yorkshires. Strathern (1980:52) notes that in the Mount Hagen area, local pigs were being crossed with black berkshires and red tamworths from the 1930s.

Pigs of exotic stock penetrated quite isolated areas early in the 20th century. They had reached the inland Kunimaipa area of the Papuan highlands by the early 1900s, presumably moving along lines of missionary activity (McArthur 2000:133 169), and, by the early 1930s, some had been introduced to the island of Wogeo off the East Sepik Province coast (Hogbin 1970:324). In 1938, only four years after establishment, the Catholic Mission station at Mt. Hagen had 36 pigs that were, according to Fr William Ross (cited by Mennis 1982:88) ‘...a great attraction. These little fellows are tamworths, red like no native pig ever is. Our pigs grow in one year as large as native pigs in four years, and people come from miles around to see them.’

There were two opposing trends during World War II. In many coastal areas, all pigs, village based and expatriate owned, were consumed by the military of both sides (but by the Japanese in particular) (Australian Mobile Veterinary Survey Unit 1946:36–7, 39, 77–8). In areas less directly affected by hostilities (eg parts of Manus) some observers believed that the considerable numbers of exotic animals (mostly berkshire and British

white yorkshire) owned by plantations and missions went bush during the war. These animals mixed with the village and feral populations, resulting in village stock immediately postwar showing excellent type and conformation (Conroy 1947:19). In his 1947 survey of Manus Province, Conroy reported seeing only one example of a true classic New Guinea pig (long nose, narrow black body). Interestingly, despite the major losses of livestock in rural areas where retreating forces lived off the land, on the Gazelle Peninsula itself, at the time of surrender, the Japanese Group Camps still had herds of up to 100 pigs for rations, of which the original animals had been brought from Japan (Australian Mobile Veterinary Survey Unit 1946:70–71).

Following World War II, there was a huge expansion in imported stock. The policy was first to restock areas that had lost all or most of their pigs during the War (Department of National Development 1951:80, 92), and secondly to improve performance and hence increase meat supply in local diets. In some cases, war-depleted areas were restocked by moving animals (it is not clear whether they were village or plantation based) from less-affected islands. For example, animals were moved from Unea to New Britain, and from Tabar to New Ireland (Australian Mobile Veterinary Survey Unit 1946:74, 77). The imported stock distributed to villagers included berkshire, saddleback, tamworths and large white/landrace (Lauvergne et al. 1982). In the Siwai area of Bougainville Province, it was said that there were only five pigs left after the war (Connell 1978:179–184). Attempts to restock from mainland New Guinea were unsuccessful, and pigs were imported from elsewhere with Buin Station using berkshire sows and tamworths for breeding. Boars were sold for five Australian pounds each. By early 1951, the shortage was over, by which time all the pigs were said to have a strong ‘European strain’. Similarly, in the Kunimaipa area of Central Province, the introduction of exotic stock intensified following 1947 to the extent that, by 1953–57, McArthur (2000:30, 133, 169) considered that all the local stock had been replaced. While this is unlikely (eg see Hallpike 1977:71), it implies a high degree of interbreeding.

By the early 1960s, the government veterinarian considered that the grading-up policy had had a noticeable effect in some places (Egerton and Rothwell 1964:7). Many mission stations participated actively in introducing exotic stock, and believed that interbreeding resulted in larger and faster growing animals (Schaefer 1991:119). Certainly, the presence of crossbred pigs or exotic pigs is reported widely through New Guinea from at least the mid 1960s (van Baal 1966:841; Fischer 1968; Shoffner 1976:157; Hauser-Schäublin 1983:338–340). In what was then Dutch New Guinea, by the mid-1950s the administration had established two pig-breeding farms from which breeding stock was supplied to both indigenous and migrant (Dutch-Indonesian) farmers, the latter especially in the vicinity of Hollandia (now Jayapura) and Manokwari (Verhoeff 1958:37–8). By 1974, in Papua New Guinea (PNG), the Department of Agriculture, Stock and Fisheries was recommending berkshires, tamworths, wessex saddlebacks and crossbreds for village conditions. Large whites, large blacks and landrace were unsuitable for village projects because they required a very high level of management, and the landrace also burnt in the sun very easily (Watt et al. 1975:20–22).

Throughout New Guinea, villagers were eager to acquire pigs of new stock, valuing their supposed qualities of growth, size and fertility (Freund 1968:8–9; Dalton 1988; Healey 1990:306, 375). Initially, at least, such pigs were often afforded special treatment in terms of housing and feeding (Meggitt 1958a:289–90; Meggitt 1965:239; Goodale 1995:83). In practice, the performance of purebreds under village conditions often fell far short of expectations, and it was not until crossbreds became more widely available that some benefits were gained.

Local evaluations of the new pig stock varied both by place and time. The Dani in the Baliem Valley of Irian Jaya initially admired the imported exotic white pigs so greatly that for a short time in 1963 some men argued that all native dark pigs should be slaughtered and replaced by the new ones (O’Brien 1969:51). The introduction of exotic stock in highland Irian Jaya had been underway since at least 1953 (Gotzen 1955:105). Rather differently, the distribution of exotic white pigs in the Kapauku area (now usually known as either Ekagi, Me or Ekagi-Me, see Ploeg (2000:401, 403)) in the Paniai Lakes

region of Irian Jaya was followed by disease among both people and pigs that was blamed on the new pigs (Dubbeldam 1964:302). Something similar apparently occurred further to the east in the Yali area around Angguruk where, in 1967, there was a move to kill all pigs born from crossbreeding with exotic pigs introduced from Jayapura on the grounds that they brought misfortune (Zöllner 1988:73). In the apparently different context of major pig losses from epidemics of possibly pneumonia and anthrax in 1943–46, a millenarian cult ran through the western Enga in PNG. The cult required the slaughter of large numbers of local animals in order to make way for the new large ones that were believed to be on the way (Meggitt 1958a:288; Meggitt 1974b:27; Biersack 1998:55–58).

In the early 1970s, in Sinasina (Simbu Province), people said they preferred nonwhite animals, as they considered the white ones too vulnerable to local conditions (Hide 1981). Similarly, Gibbs (1981:106) reported that highlanders in 1980 preferred dark-skinned pigs, and were said to pay more for them. By the late 1970s, Western highlanders in the Wahgi were contrasting unfavourably the lack of fat on carcasses of exotic pigs with those of local breed (O'Hanlon 1989:120). This difference is discussed further in Chapter 10 (Section 10.4).

In Irian Jaya, interbreeding also began early in the 20th century, if not earlier. Randa (1994:62–63, 54) commented that in coastal Manokwari and other lowland areas, mixed stock originated from interbreeding that began under the Dutch. The main varieties appear to have been yorkshire, Dutch landrace and Chinese pigs. By about 1956, the Administration had established two pig-breeding farms from which breeding stock was supplied to both indigenous and migrant (Dutch-Indonesian) farmers, the latter especially in the vicinity of Hollandia (now Jayapura) and Manokwari (Verhoeff 1958:37–8). In the main highland valleys such as the Baliem, new exotic types arrived in the 1950s and 1960s (O'Brien 1969:51; Ryan 1969:355–6; Heider 1970:51), and in more isolated areas, such as the Sela Valley in the east, rather later (Godschalk 1993:34, 115). According to Godschalk, interbreeding with new stock in the Sela Valley resulted in a larger and fatter strain of pigs that were referred to as *babi ras*. In Irian Jaya, recent (early 1990s) official introductions include yorkshire stock from Sumatra and duroc from PNG (Randa 1994:59).

Even in more isolated areas away from direct contact with centres from which exotic pigs were distributed, customary trade networks undoubtedly moved new animals across the country. There are accounts from the 1970s, for instance, of the biased movement of young female pigs through trade towards the periphery in the Eastern Highlands, as well as the movement of new pigs out of the Wahgi Valley into the more isolated parts of the Jimi Valley (described in Section 7.1.1). In isolated areas of the provinces of West Sepik and West New Britain also, pigs of exotic stock appeared from as early as the mid-1960s (Goodale 1995:83; Juillerat 1996:518).

The development of mines in several relatively isolated regions of the country has resulted in a more recent wave of introductions of exotic breeds of pigs to people living in their catchment areas, as described by Brutti and Boissière (2002:142, 146) for Oksapmin in West Sepik Province, in relation to the Ok Tedi mining town at Tabubil in Western Province.

Given the time depth of colonial (and later) introductions, and the possible extent of interbreeding, it is relevant to consider to what extent the current pig stock has been affected by exotic genetic influences. As noted above, as late as the early 1980s, Lauvergne et al. (1982) considered that the affect was still relatively small, even in parts of the provinces of Morobe and Eastern Highlands, which had been the target of distributions of exotic pigs during the previous 10–15 years. Others, however, even by the early 1960s, considered that the extent of interbreeding had proceeded so far that 'it is now difficult to find the classically described *Sus papuensis*' (Anderson 1972:646; see also McArthur 2000:30). More than a decade earlier, in 1947, agricultural officers visiting the Siassi islands in Morobe Province thought that most pigs were of imported stock (Freedman 1967:95). For Purdy (1971:482) also, writing generally of the whole country, there was 'no doubt that the genetic makeup of pigs in villages has been changed

[resulting in] a pig population in the villages showing much visual evidence of the introduction of the so-called improved breeds, particularly in characters such as coat colour and conformation, but without any noticeable improvement in productivity ...' During the last 25 years, the process appears to have continued in many parts of the country. Thus, Smith (2002:89), returning in February 1998 to Kairiru Island (East Sepik Province) which he had studied in 1975, noted that 'Fat, cream-colored pigs clearly descended from comfortable farm stock, had replaced the lean, dark, bristle-backed bush stock, although they still wandered freely about the village like the pigs of old.'

The question of the extent, and timing, of genetic change is important for fully contextualising accounts of pig performance under different husbandry regimes. For instance, Potter (no date (b)), in a small-scale study comparing customary village and supplementary feeding in a coastal Papuan village in 1975, noted that it was possible that her small samples were affected by differential amounts of interbreeding and hence growth potential. In the lowland Abelam area of East Sepik Province, Hauser-Schäublin (1983:338–340) reported two types of body form and growth among village pigs. Reviewing the possible effects of interbreeding on village pig productivity in Sinasina (Simbu Province) as of 1973, Hide (1981:583–594), following Purdy (1971:482) and Malynicz (1973c:21) concluded that, despite changes in potential, it was unlikely that average growth performance had changed because customary husbandry practices continued with little change. However, the last three decades have seen changes in husbandry practices in many parts of the country, particularly in areas close to towns and resource developments, and faster growth may be expected under such conditions.

3.5 Comparative studies of indigenous and exotic pigs

Fundamental to any understanding of productivity in village husbandry is knowledge of the relative potential of indigenous pigs. As late as 1964, the Chief Veterinarian in PNG considered that nothing was known of their performance (Egerton and Rothwell 1964:7). Over the next 15 years work advanced on several fronts.

Using breeding records from the piggeries at the Tropical Pig Breeding and Research Centre at Goroka, and from Erap in Morobe Province, Malynicz (no date (b)) compared the performance of exotic British, crossbred and indigenous sows. The mean litter sizes of the indigenous pigs (6.4 at Goroka, 6.0 at Erap) were significantly smaller than those of the crossbred sows (8.0 at Goroka, 9.4 at Erap), but no different from those of the British sows. The indigenous pigs had the lowest preweaning (8 weeks) mortality, though the only significant difference was at Goroka with the British pigs (1.23 deaths per litter versus 2.53). The mean weight at weaning (8 weeks) of the indigenous pigs was considerably less than those of the other crossbred and British pigs (approximately 7.4 kg for Goroka piglets with both sow and sire of indigenous stock, compared to 12–12.5 kg for crossbred piglets). There were no significant differences in gestation length or farrowing interval.

In an initial experiment, Malynicz (1973b) assessed the productivity of various types of pigs under village conditions. Fifteen pigs of four breed groups (3 British, 3 each of two crossbred groups, and 6 native pigs) were distributed to villagers in Okiufa village near Goroka for rearing under normal village husbandry conditions for 5 months. They were weighed and examined weekly. No weight gain occurred and 13 pigs died within five months. There was no apparent association between mortality and genotype. Subsequently, 129 exotic weaners were distributed to villagers in four highland districts (Malynicz 1973c). Mortalities approached 30% after 6 months and weight gains averaged less than 100 g daily.

Malynicz (1973e) compared the growth and carcass measurements of indigenous and exotic (berkshire or tamworth) weaner pigs (initial weights of 7.7–8.6 kg and 13.2–13.9 kg respectively) raised under two housing regimes (concrete or dirt floor) for a period of 100 days. The dirt floor regime consisted of the use of muddy fenced lots that had previously been stocked with village pigs and were known to be heavily parasitised.

Both groups received the same ad libitum feed and water. In summary, the indigenous pigs grew significantly more slowly, had a lower food consumption, a worse feed conversion ratio and smaller carcass measurements than the exotic pigs. On concrete, the exotic pigs gained 495 g/day, the indigenous pigs 236 g/day; whereas on dirt, the respective gains were 404 and 185 g/day. The indigenous pigs ate less food: 0.95 kg/day on concrete and 1.06 kg on dirt compared to 1.63 and 1.60 kg for the exotic pigs. The food conversion ratio of indigenous pigs was, however, poorer due to their slower growth rate. The carcass measurements (carcass length and weight, eye muscle, back fat) of the indigenous pigs were all less than those of the exotic pigs.

In a subsequent experiment at Goroka in 1974–75, Malynicz (1992) compared the growth performance of indigenous and exotic (berkshire) pigs under relatively modern intensive husbandry allowing both breeds to reach the same slaughter weight. The indigenous pigs grew at a much slower rate (281 days as against 178 to reach a slaughter weight of 65 kg), ate much more feed (279 as against 197 kg), and had much more back fat (3.8 cm compared to 1.7). Commercial butchers paid 10% lower prices for the indigenous pig meat. It is worth noting that these contrasts in potential to lay down fat, and in urban (or expatriate) preference for leaner meat, had both been remarked upon two hundred years earlier (Pennant 1793:142–43).

Copland (1976a) studied the normal haematological parameters of 'pure' native (ie indigenous) and crossbred native pigs over 12 months, and also surveyed village pigs at 5 and 11 months of age, to establish baseline data for studies of anthrax and pneumonia in pigs. All pigs were bled monthly. The haematological parameters for the native and crossbred pigs were similar, except that the native pigs had slightly higher haemoglobin and haematocrit levels than the crossbred pigs. The village pigs, on the other hand, had significantly lower haemoglobin, red blood cell counts and haematocrit values, and a higher white blood cell count, than the corresponding age groups of the native and crossbred pigs. Baseline biochemical information was also collected on native, native–British crossbred and village pigs (Copland 1976b). Except for cholesterol, there was no significant difference between the 'pure' native and the native–British crossbred pigs. Village pigs, however, had significantly lower serum alkaline phosphatase, inorganic phosphorus, total protein, urea, creatinine and calcium. Copland considered that the lower values were due to the malnutrition–parasite complex of village pigs.

4 Pig husbandry systems in New Guinea

4.1 Classifications of pig husbandry

Descriptions of pig production in New Guinea⁴ typically divide husbandry systems into two or more schema. At their broadest level they distinguish between village and modern husbandry systems. Holmes (1988a:107), for instance, distinguished between ‘Traditional village methods; sometimes not for meat production in Western World sense; with complex customary procedures and values often considered too hard to alter and thus ignored by development-oriented personnel’, and large-scale piggeries with large white-type pigs fed a grain-based diet and with modified ‘Australian’ management. In Willis’ (no date: 11) succinct phrasing, Papua New Guinea (PNG) has two distinct markets for pigs: an expatriate one requiring a lean pig that is rapidly grown and reaches killing size within three to six months, and a traditional or village one demanding a large, fat, slowly grown pig.

Other authors have made further distinctions. Nunn, for instance, distinguished three subsectors in the livestock industry: village subsistence, a smallholder subsector (often village based but with a commercial input such as a small loan or more animals), and a commercial subsector (Nunn 1988a:97). Isaacson and King (1987: II-32) use a similar typology. Watt and Michell (1975:7–11) distinguished between extensive and semi-intensive village systems and intensive husbandry.

Quartermain (1980:281) distinguished four levels of intensity in pig production:

- village or household free-range husbandry, characterised by traditional feeding, little or no capital investment, and low labour costs;
- husbandry enclosing pigs but with no improved feeding;
- husbandry using a variety of free-range, tethering and enclosed methods, with modified feeding;
- totally enclosed husbandry, with all nutrients supplied from off-farm sources.

These broad typologies — for similar ones in other developing country contexts, see Quuandria (1981) — are an attempt to understand a complex industry. The boundaries of the commercial sector, based on enclosed husbandry, imported foodstuffs and intensive management, are relatively easy to delineate, although some of the pigs produced commercially are sold into the village sector for customary use. The commercial sector is described further in Chapter 8.

Smallholder pig projects involving small-scale semi-intensive management and often supported by loans were common in much of PNG in the 1970s and early 1980s. However, the intensity of management in these projects, in terms of housing, feeding, investment and labour, varied widely. Most of these projects failed, and the present distribution and importance of pig projects in New Guinea is unknown. They were an attempt to bridge the commercial/village divide. Pig projects were an essential part of the centralised agricultural policy of the time and also an attempt by villagers to participate in the commercial pig sector. However, most pig project owners were still involved in the village sector, and owned and managed pigs for customary purposes and by traditional means, alongside the new business enterprise. It is also apparent that some pig projects were attempts to raise pigs, albeit using more ‘modern’ husbandry methods, for mainly customary purposes. This is discussed further in Chapter 8.

⁴ See ‘Definitions’ section for explanation of names used in this report

Village pig management is the least understood and documented of the husbandry systems. The characteristics of this sector, mainly free-range husbandry, traditional feeding, low or nil capital inputs and customary production goals, contrast strongly with those of the commercial sector. However, it is no longer the case that village-based husbandry is primarily concerned with raising pigs only for subsistence and customary purposes. The 1996 Household Survey showed that animal sales in rural PNG were a significant income source (Gibson and Rozelle 1998:76). In a recent survey of both lowland and highland farmers in Irian Jaya, more farmers responded that they were raising pigs for monetary income than for subsistence (Randa 1994:71). Only 15% of lowland farmers and 23% of highland farmers said that they did not produce pigs for sale, with most preferring to sell live animals.

Randa's survey also qualified the assumption that most village pig production in Irian Jaya remains free range. Very surprisingly, he found that only 12% of highland farmers and 17% of lowland farmers managed their pigs on a free-range system. Of highland farmers, 67% used semiconfinement, and 21% full confinement; whereas, 43% of lowland farmers used semiconfinement, and 39% full confinement (Randa 1994:74). Comparative data are not available for PNG but the proportion of pigs run on a free-range basis is probably much higher.

4.2 Village husbandry systems

4.2.1 Overview

In a brief general overview of pig management in New Guinea, Chowning (1977:26–27) distinguished three kinds of village husbandry system. In a very few areas, she noted, there was no breeding at all, all pigs were acquired by capture from feral populations and then tamed and cared for. In the second extensive system, domestic herds coexisted with feral populations, all domesticated males were castrated, and domesticated sows bred only with feral boars. In the third system (implicit only as the default in her description), there is only a domesticated population, with breeding boars maintained and no feral pigs.

Cooper (1976:157–160) distinguished three key variables for analysing the form of domestication in Melanesian husbandry systems. These were human control over the pigs in terms of their movement or living space, their food and their reproduction. Using these variables, she rated six ethnographic examples (Dani and Kapauku — Ekagi-Me in current usage — in Irian Jaya, and Enga, Siane, Siuai and Maring from PNG), and showed that, although some of the factors varied independently, there was a gradation of increasing control from the Siane to the Enga and the Dani.

Baldwin (1978) adopted a modified version of Chowning's classification. He distinguished two types of husbandry. The first was pig rearing, which he described as involving the castration of all males, and thus reliance on either captured wild piglets or occasional mating between domesticated sows and feral boars for acquiring pigs. Thus, pig rearing involved no intentional breeding, and both village and feral pigs constituted a single interbreeding population. The second was pig breeding, which involved intentional breeding and the separation of village and wild pigs. Baldwin plotted the distribution of these two types to show that pig breeding was mainly distributed in the highlands of both PNG and Irian Jaya, in Bougainville Province and East New Britain Province, and in some lowland areas on the south coast of Papua and in Morobe Province. He also suggested that the pig breeding husbandry type was associated with relatively high numbers of pigs per person (though subject to major fluctuations), relatively intensive agriculture mainly in the highlands, and Austronesian language speakers in lowland areas; in contrast, the pig rearing husbandry type was associated with low, and relatively stable, numbers of pigs per person. Some of his assignments of groups to the two husbandry types are problematic. For further discussion, see also Baldwin (1982; 1990:240–243).

Rosman and Rubel (1989) surveyed a wide range of husbandry forms in New Guinea, describing the variation in terms of a continuum of domestication. They viewed domestication as involving control over three aspects of the pig's life cycle: breeding, the location where the sow farrowed and feeding. After summarising a range of systems, they suggested that the domestication continuum was related to four variables: the intensity of crop production, the density of human and pig populations, the complexity of ceremonial exchange systems and hunting intensity. In broad terms, they suggested that the intensity of pig production was positively related to the first three, and inversely related to hunting.

In an important paper, Kelly (1988) identified a trend within anthropology and prehistory for writers (in particular Modjeska and Feil), to correlate the number of pigs per person with significant aspects of sociopolitical development, and to see the former as a key causal factor explaining some of the features differentiating the New Guinea highlands from other regions. Examining a selected sample of 14 societies, with the relative number of pigs per person ranging from 0.1 to 1.4, Kelly (1988:149–150) showed that the societies fell into two clusters: those with 0.1–0.6 pigs per person, and those with 0.9–1.37. Although the two clusters separated broadly in terms of population density and agricultural intensification, Kelly stressed that such an association did not explain the differences in per-person pig numbers within each cluster. In particular, the Etoro people on the Papuan Plateau in the highland fringe owned more pigs per person than many groups in highland areas. In explaining this, Kelly emphasized the low human population density of the Etoro and the availability of extensive forage on which the pigs depended. Expanding on such differences he distinguished between 'forage-based' and 'fodder-based' production systems.

This distinction has tended to be represented as a difference between fringe highland systems, where pigs are semidomesticated and depend 'almost entirely on foraging', and those in the central highlands, where pigs are fully domesticated and depend 'solely on fodder provided by humans' (Weiner 1988:31). Strathern (1988:198–9), in commenting on both Kelly and Weiner from a Hagen perspective, pointed out that the distinction should not be overdrawn: Hagen pig keepers used both strategies. However, others besides Weiner appear to exaggerate the fodder basis of central highlands husbandry. For instance, Baldwin (1990:243) has written that pigs in Simbu and other such highland groups, 'must be provided with the bulk of their food', for evidence of which he cited Malynicz (1970a) and Rappaport (1967). In fact, Malynicz specifically denied this. Describing pig fodder provided by people in the highlands (and citing Rappaport's data), Malynicz (1970a:201) noted that pigs are fed:

...a small amount of kitchen slops and sweet potato which is too small or stringy to be acceptable for human consumption. This amount is only large enough to ensure that the animal will return the following day...*Thus it is apparent that the pig provides himself with most of his nutrient intake during the day's grazing.* Shoots, leaves, tubers, insects and worms provide the bulk of its ration. A last item which enters the diet in the less enlightened areas of the Highlands is human faeces. (Emphasis added).

Yen (1991) has elaborated on the contributions of Baldwin and Kelly, and made a further distinction on the basis of altitude. As Dwyer (1996:481) pointed out, however, the categories and definitions proposed in much of this literature 'are not entirely congruent and, further, tend to conflate distinct dimensions of husbandry'. In particular, he showed that there is no continuum of pig domestication, and that the various terms used (rearing, semidomestication and quasihusbandry) are imprecise and confusing. Instead, Dwyer focused on the ways in which New Guineans manage the reproduction of their pigs, rather than the genetic status of these animals, to facilitate understanding of the processes of intensification in pig management.

Dwyer's categories were:

- Reproductive alienation — in which all captive pigs result from mating between wild boars and wild sows. The captive population is fully alienated from breeding.
- Female breeding — in which some (or all) captive pigs are the result of matings between wild boars and domestic sows. Some pigs are still captured from the wild.
- Male and female breeding.

In a recent unpublished paper, Dwyer and Minnegal (in press) have explored a further dimension of variability in pig management systems in New Guinea: the ways in which very young pigs are cared for. In particular, they have directed attention to the usual age at which piglets are removed from sows (weaned), the duration and intensity of the association between a domestic pig and its carer, and the extent to which domestic pigs closely associate with other pigs in their early lives. They identify three ways in which young pigs can be managed by their carers: by attachment to person, by attachment to place or by attachment to other pigs.

The above contributions have laid the foundations for an improved understanding of both the range of village husbandry systems, and some of the possible ways in which they have changed, and continue to do so.



Pigs may be virtual household members. Waidoro Village, Western Province, 2002.
Photographer: Garrick Hitchcock.

4.2.2 Community-wide changes in pig husbandry systems

While it is possible to make broad generalisations about the distribution of husbandry systems across New Guinea, in any one community or ethnolinguistic area, long-term cultural continuity in the relative emphasis on pig husbandry cannot be assumed. Not only are there accounts of the recent and historical (eg within the past 100 years or so) adoption of either the husbandry of domesticated pigs, or more intensive forms of husbandry, but, and perhaps more generally, there are also many reports of the abandonment (both short and long term) of pig husbandry. These accounts suggest that

there is considerable dynamism in village livestock management. While it is undoubtedly true that ‘village pigs continue to retain their nationwide importance both culturally and as a source of protein’ (Kambori 2001:879), it is important to recognise the amount of variation both in space and over time.

4.2.3 Adoption and intensification of pig husbandry

Examples of the recent adoption of husbandry, or significantly more intensive husbandry, include the following:

- the Kalam people of the Simbai area in the Schrader Mountains, who assert that they did not keep domestic pigs until the mid–late 19th century (Bulmer 1976:171; Majnep and Bulmer 1977:19–24; Riebe 1987:216–7);
- the Irakia Awa in the Eastern Highlands Province, who significantly intensified their pig raising in the 1960s (Boyd 1984; Boyd 1985a);
- the Gimi, also on the southern fringe of the Eastern Highlands Province, who say that they only began to acquire pigs in numbers several generations ago (Gillison 1993:38);
- the Baruya Anga, in the Eastern Highlands Province, who say that they increased pig production with the use of steel tools pre-1980 (Jablonko and Jablonko 1998),
- the Sambia (Simbari) Anga, also on the southern fringe of the Eastern Highlands Province, who claim that domestic pigs were only introduced within the past few generations (Herdt 1981:24).

To the north of Enga Province, in the foothills of East Sepik Province at 1070–1470 m altitude, people described by Dornstreich (1973:237–8, 240, 481–7) as ‘intermediate Enga’, appeared to have rapidly intensified their pig husbandry during the 1960s to the point where most families held between 3–15 pigs when visited in 1968. Intensification also appeared to be under way amongst even smaller groups at lower altitudes (Dornstreich 1973:236–238). Further east on the Enga Province fringe were people who, in the 1970s, still recalled the arrival of domestic pigs and sweet potato, according to Feil (1987:34). In Bougainville Province, there are reports of increases in the numbers of pigs kept and the replacement of marsupial meat by pork for customary purposes (Mitchell 1976:31).

Recent intensification of pig husbandry is reported from two areas of inland West Sepik Province. Morren (1986:107) described an increase in the number of pigs from 0.1 to 0.19 per person between 1969 and 1981 for at least some Miyanmin. By the late 1970s, Telefomin people said that the number of pigs had increased since the introduction of steel tools (Brumbaugh 1980:51, 305). More recently, Jorgensen (1990) has described a more dramatic change. As a consequence of rapid socioeconomic change following their involvement in the Ok Tedi mine development, combined with major changes in church rulings about the use of pork in the late 1970s, the Telefomin changed the aims of their pig production. By 1985, in order to secure access to cash income and commodities, pig numbers had risen steeply from 1.8 per household to 4.8, a nearly three-fold increase. In per person terms, pig numbers rose from 0.48 to 1.3 (D Jorgensen, University of Western Ontario, pers comm, August, 2001).

Among the Kalam in the Kaironk Valley, relative pig numbers increased from approximately one per person to considerably more in the early 1970s (Bulmer 1976:171–2). Kalam told Bulmer that ‘the introduction within the last two generations of new, heavy-cropping varieties of sweet potato which grow well at high altitudes has enabled them to make larger gardens and thus maintain larger numbers of pigs’ (Bulmer 1967:24–25).

In an isolated area north of Nomad in the Western Province, Minnegal and Dwyer (1997) have described major changes in both the intensity and the organization of pig production by a Kubo community between 1986–7, when people cared for an average 0.38 pigs per person, and 1995, when the number of pigs had risen to 0.88 per person.

4.2.4 Absence and abandonment of pig husbandry

There are a number of places where people have not customarily kept domesticated pigs (including captures from the wild), including the Oriomo Plateau occupied by the Gidra people in Western Province (Ohtsuka 1983; Akimichi 1998), some of the swampy areas around the Karawari and Blackwater tributaries of the Sepik River (WHO 1975:6–7, 10), Wuvulu and Aua Islands in western Manus Province at least in 1927 (Cilento 1928:17), and parts of the Watut area of Morobe Province (J Burton, consultant, pers comm, April 2001). In other locations, pig keeping has been abandoned, and in some rural sites, usually of modern or intrusive settlement, pig keeping is prohibited. During and after the colonial period, pigs were frequently banned from noncustomary settlements such as the mission hospital site at Yagaum near Madang (Jenkins 1989:193) and, more recently (in 1996), the East Awin refugee camp in Western Province, where camp authorities prohibited pig keeping for health reasons (Glazebrook 2001:84). Changes in the status (including absences) of pig husbandry on the neighbouring islands of the Torres Straits, from prehistory to the present, are reviewed by McNiven and Hitchcock (in press). In the wider Pacific context, Kirch's (2000) discussion of the abandonment of pig husbandry on islands is also relevant.

During the 20th century, pig keeping in parts of New Guinea was abandoned both for religious reasons, and for apparently pragmatic reasons of incompatibility with new forms of activity or land use. Pig keeping may also have declined (or at the very least altered) in significance in some areas as pigs have lost their formerly high customary value (Brookfield and Hart 1971:123; Christie 1980:153–6, 208), and as pig festivals or ceremonial exchanges have been abandoned or reduced in significance (Frankel 1986:44; O'Hanlon 1989:71).

The most common example of abandonment for religious reasons follows from conversion to the Seventh Day Adventist (SDA) Church, which prohibits its members from eating pork (citing dietary rules from the Old Testament), and strongly discourages pig raising. This has resulted in the abandonment of, or partial disengagement from, pig raising by community members across PNG. The SDA Church is, at the national level, a minority one, therefore, the effect on pig numbers overall is limited, but the local consequences can be significant. A number of examples illustrate this point.

In the 1930s, Mussau Islanders (New Ireland Province) converted to the SDA Church en masse and stopped keeping pigs (Kirch 1990:154–6; Kirch et al. 1991:154–6). In the 1960s to 1970s, the SDA expanded into several parts of the Highlands region so that, by the early 1980s, there were some communities with no pigs, and some communities within which SDA members were no longer raising pigs. At Takuru in the Southern Highlands, 66% of the settlement of Morapiko had become SDA by 1981 and Morapiko had an overall ratio of only 0.6 pigs per person. In contrast, the four other settlements at Takuru that were not SDA had ratios of 1.0, 1.2, 1.5 and 1.7 (Spore 1981:9, 13). Similarly, as early as 1962 and continuing until the late 1980s, some Eastern Highlands Province communities in the Kainantu area and elsewhere included SDA members who did not keep pigs (Robbins 1982:62; Caven and Gitai 1990b:27; Finch 1991:140). In the Benabena village of Kogoro in the early 1980s, six of a randomly selected 30 households did not keep pigs, and five of these belonged to the SDA church (JL Dickerson-Putman, Indiana University, pers comm, September 2001). A survey of seven villages in the Kainantu area in 1998–99, where the SDA church was becoming dominant, found that pig husbandry had been given up entirely in three villages (Iyagumo 2001:292–5). It was claimed that the resulting benefits included improved food production and supply, and declines in waterborne disease and soil erosion. In 1995, there were SDA villagers in the Asaro Valley near Goroka (amongst villagers who were not SDA) who, though they did

not eat pork, still raised pigs for exchange (Benediktsson 2002:248). Elsewhere in the Eastern Highlands Province, as at Maimafu in the Gimi-speaking part of Lufa, there were, in 1997–98, whole SDA communities (15 settlements) without pigs that had abandoned pig husbandry in about 1982 (West 2000:119–120). In 1996, at Lake Kapiago in the Southern Highlands where SDAs are a minority, 80 of 97 surveyed Duna adults owned pigs, while of the 17 who did not, seven were SDA members (Robinson 1999:65–68). Among the Enga in the early 1980s, a province-wide agricultural survey found that SDA families held fewer pigs (Wohlt 1986b:12). Elsewhere in the country, in places where pig husbandry is of less significance, conversion to the SDA Church may have resulted in a decline in the consumption of wild pork from hunted animals (Suda 1997:87–95). The absence of pigs in SDA villages is commonly associated with modernity and cleanliness (Josephides 1990:63; Brutti and Boissière 2002:155).

Communities that appear to have abandoned pig keeping for more pragmatic reasons are also spread widely across the country; for example, at locations in the provinces of Bougainville, Morobe, Milne Bay, Central and Northern. Documentation is usually fragmentary and thus it is by no means clear as to whether such abrupt changes in husbandry are long term. It appears that abandonment often took place during the major post-World War II expansion of smallholder cash crop development, usually in response to perceived technical problems of combining pigs with cash crops. Such abandonment was also often associated with the initial establishment of local government councils, with pig management rules featuring prominently in their early deliberations (Hide 1981:231 ff.). Examples from the 1950s and early 1960s include Mailu (Firth 1952) and possibly some Hula (Oram 1968:273) and Motu villages (Oram 1977:83) in Central Province; Goodenough (Young 1971:143, 147, 261), Fergusson (Spencer 1964:22) and Sariba Islands (Alaluku 1970:30) in Milne Bay Province; Korafe in Northern Province (Gnecchi-Ruscione 1991:184); several ethnic areas of Bougainville Province such as Nasioi (Ogan 1972), Teop — including both Tearaka village (Monsen 1977:48) and Teop Island (Shoffner 1976:156–7) — and Eivo (Rutherford 1977); and, in Morobe Province, the Wain area (Jackson 1965:52) and parts of the Buang area (Zimmerman 1973:34).

Firth's (1952:67) description of the pig debate in Mailu in the 1950s illustrates several of the issues:

The position of the pig is an index of the conflict between traditional and modern cultural values ... at Boru recently there has been discussion about the advisability of getting rid of their pigs. It is argued that they make the village untidy, and that they are uneconomic. When the people were persuaded by the Village Constable ... to put one coconut in the centre of the village for every nut given to the pigs it was discovered that each pig got about eight nuts a day. Considering the present high price of copra, it was concluded that this was waste. At a meeting of village councillors, opinion was divided between keeping the pigs in sties, and disposing of them altogether.

In the Nasioi area in Bougainville Province, pigs were very important up until as late as 1959, with an estimated 1.1 pigs per person. With the wide-scale planting of coconuts for cash cropping, pigs were abandoned, and by 1960–61 there were no pigs at all kept at one village (Ogan 1972:118–9, 185). When E Ogan (pers comm, May 2001) revisited the area in 2001, there were still no pigs in sight in the Aropa Valley, though there were many pigs in the upland area of Kongara (cf. Moulik (1977:31) for the effects of mining by 1973). At Teop Island to the north, the advent of major coconut planting saw all pigs killed in 1954, and only minor herd rebuilding from 1960 (Shoffner 1976:157–8). In Morobe Province, in the Wain area, there were an estimated 0.5 pigs per person in 1956, but by 1964 they were less than 0.1 per person (Jackson 1965:52). On Goodenough, the local government council ruled that pigs should either be enclosed or killed off: several villages opted for the latter option (Young 1971:143, 147, 261; 1984), albeit temporarily (MW Young, Australian National University, pers comm, July 2001). On Fergusson Island, this ruling was in place by at least 1959 (Spencer 1964:22). In the Northern Province, some villages also gave up pigs at this time (council rules were also involved in the mid to late 1960s at least (Radford and Bassett 1968:6; Schwimmer 1973:20;

Stephens 1974:42)), on the grounds that the time saved could be better spent in money-making enterprises, and with elders taking the opportunity to suspend competitive exchange feasts, arguing that:

This is not the time of pigs; that was our fathers' time. The time for pigs is finished. A new time has come, white man's and money's time has come. (Gnecchi-Ruscione 1991:184–5).

This argument takes on added significance when seen in the context of a statement made by a Kofena man from the Asaro Valley (a rural area of major articulation with the cash economy) in the Eastern Highlands Province in 1995:

Money and pigs are absolutely equal. Pigs do not make money less important. And money does not make pigs less important. The two are equal. If there were big troubles, and we compensated with money only, the other side would not be satisfied. (Benediktsson 2002:246).

In other parts of PNG where abandonment of pig husbandry has occurred, it took place later than the cases described above. For instance, in the Wosera (Abelam) region of East Sepik Province, the main decline seems to have been in the 1970s (Lea et al. 1988; Curry 1992). In some villages in central Wosera, a council rule banned the keeping of pigs in 1978, apparently with the intention of removing the need for garden fencing (Ross 1984:20). Although the decline is not dated, Derlon (1997:47–8) described a significant decrease in pig raising from perhaps six pigs per family to one or two on the Lelet Plateau of New Ireland Province, presumably in the post-World War II period before the early 1980s. This was said to have occurred because people did not want to waste time fencing their gardens, and preferred to purchase their pigs from coastal people where husbandry was said to be easier because pigs were located further from gardens and coconut was the preferred fodder.

In the Suau area of Milne Bay Province, pigs appear to have been ousted by major plantings of oil palm in the 1990s (Demian 1998). Most recently, complete abandonment by the Eastern Highlands Province community of Irakia Awa (though one located more on the fringe than in the central highlands proper), has been reported in detail (Boyd 2001). This represents a dramatic reversal from the Awa's earlier policy of trying to emulate the husbandry regime of their more northerly neighbours (Boyd 1984, 1985a). As the above examples indicate, the distinction between 'religious' and pragmatic reasons for abandoning pig raising may well be blurred: often millennial hopes appear to underlie even the most pragmatic justifications (Young 1974:65).

In this context it is also worth recalling, as described above (Sections 2.1 and 3.4), that during World War II people in many areas of PNG (and presumably Irian Jaya) under military occupation lost almost all their pigs. According to a national survey in 1945–46, some of the worst affected areas included Papua, the coastal zone of Morobe Province (including Wau), Madang Province and the Sepik, and parts of New Britain Province, New Ireland Province and Bougainville Province (Australian Mobile Veterinary Survey Unit 1946). Other reports refer to Bougainville Province (Shoffner 1976:157; Connell 1978), East Sepik Province (Roscoe 1989:222), and Morobe Province (Read 1947:222; Conroy and Bridgland 1950:86). According to Roscoe, in East Sepik Province the effects were still felt 10–15 years later, though in Bougainville Province recovery appears to have been much faster.

5 Pig numbers, distributions and ownership

5.1 Data sources on pig numbers

The main sources of information on numbers of domestic pigs in Papua New Guinea (PNG)⁵ are:

- estimates from the agricultural censuses in 1950 and 1961 (numbers of village pigs only);
- estimates in the Production Yearbook of the Food and Agriculture Organization of the United Nations (FAO) and the FAO database (numbers of live pigs, slaughtered pigs and weight of pig meat);
- estimates in consultancy and review reports (numbers of village and commercial pigs) and other records (expatriate-owned pigs);
- estimates from the 1996 PNG Household Survey (Gibson and Rozelle 1998) for the four main regions of Papua, Momase, Highlands and Islands (village pigs only);
- distributional information on the proportion of rural households engaged in pig raising collected by the national population censuses of 1980, 1990 and 2000
- a considerable number of community-level, or locality, counts (estimates) of pig numbers conducted by individual researchers and during local surveys.

For Irian Jaya, there are official Indonesian statistics on the numbers of pigs by *kabupaten* (administrative district). The basis of these figures is not known. By comparison with PNG, there are few community-level counts in the literature: these are included in Table 5.8, below. Figures from the above sources are presented in summary form below.

5.2 The PNG agricultural censuses of 1950 and 1961

PNG conducted agricultural censuses in 1950 and in 1961. Both of these early censuses were based on samples, but neither yielded fully satisfactory results in a statistical sense (Allen-Ovenstone and Williams 1954; Walters 1963). The 1950 figures (collected in fact between 1950 and 1953) were never formally published. The 1950 Census of Native Agriculture sampled 301 villages, stratified by approximate agroecological zone within provinces (which were then called districts). The original data sheets, one for each village, are held at the PNG National Archives, and documentation (including an unpublished table of data by village for the whole census) is held both there and at the National Archives of Australia. An account of this census (and of other agricultural surveys of PNG during the 1950s and 1960s), including the data on numbers of pigs per person for all villages, is under preparation (Hide in prep.). The fact that pigs were counted at this census corrects the 1958 statement that 'So far there are no provisions for census enumeration of livestock numbers kept by the natives' (Long 1958:22).

The sample for the much more ambitious and rigorous 1961 Survey of Indigenous Agriculture, which was also stratified by agroecological zones, was 100 villages (Walters 1963), but, most unfortunately as regards information about pigs, none of the original village data sheets nor any village-level tabulations seem to have survived. Table 5.1

⁵ See 'Definitions' section for explanation of names used in this report

shows the basic figures from each of these censuses for Papua, for New Guinea, and for the whole country.

Table 5.1 Estimates of human population and pig numbers in Papua and New Guinea in 1950 and 1961

	Papua		New Guinea		Totals	
	1950	1961	1950	1961	1950	1961
Population ('000)	192.3	441	517	1256	754.8	1697
Pigs ('000)	70.6	149	224.1	816	294.7	965
Pigs per person	0.4	0.34	0.4	0.65	0.39	0.57

Sources: for 1950, Allen-Ovenstone (1954); for 1961, Walters (1963).

5.3 The FAO Production Yearbook

National-level estimates by year for live pigs, slaughtered animals, and 'indigenous pig meat' for PNG are presented in the FAO Production Yearbook. The live pig figures are derived from the FAO database (see Macfarlane 1999–2002:5). The 1999 figures were respectively 1,500,000 live pigs, 1,400,000 slaughtered animals and 42,000 t meat (FAO 1999:209, 223, 229). The figures for village pigs are thought to be based on extrapolations of the 1961 agricultural census data noted above, rather than new data. The basis of the figures for slaughtered animals and meat is not known, but does not appear to be related to nationally published statistical data (Department of Agriculture and Livestock 1991; 1993; 1996; 1998).

The FAO data from 1996 appear to have been the basis for the low figure of just over one million pigs in PNG used in Saville and Manuelli's (2002:34) useful comparative table for pig populations in the Pacific.

5.4 Consultancy reports and other records

Some other recent estimates of both village and commercial pig numbers given in consultancy reports and reviews are shown in Tables 5.2 and 5.3. Similar estimated figures appear in the most recent literature. For example, the 1.6–1.8 million village pigs, and 2150 commercial sows (Maika 2001:632), and, for 2001, 1.8 million village pigs and 23 500 pigs under commercial production (Quartermain 2002b:11). The changes estimated for pigs under village husbandry in Tables 5.2 and 5.3 cannot be assumed to be reliable.

Table 5.2 Estimated pig numbers in PNG (1980–91)

Husbandry type	1980	1985	1988	1991	1980–91 % change
Village	1,500,000	1,500,000	1.5–2.0 M	1,850,000	+23
Commercial (sows only)	1100	1800	2000	2700	+145

Source: Renewable Resources Sector Study Team (1993:7). Original sources: 1980, 1985 and 1988 data from Nunn (1988b). The 1990 commercial pig data (shown under 1991) from ANZDEC (1990); 1991 subsistence pig estimates from Department of Agriculture and Livestock, Policy Programming and Budgeting Division (1992).

Table 5.3 Estimated pig numbers in PNG (1988–93)

Husbandry type	1988	1991	1992	1993	1988–93 % change
Village	1,600,000	1,635,000	1,717,000	1,760,000	+10
Commercial	5300	5570	6010	6280	+18

Source: Levett and Bala (1995:152, citing ANZDEC 1989). Change column corrected from original.

If commercial husbandry conditions are interpreted broadly to include pigs under expatriate ownership, there are also other earlier figures. As noted above, the German official records for New Guinea reported 2866 and 3081 pigs held on plantations and other stations in 1912 and 1913 respectively (British Administration — (Late) German New Guinea 1916: Table 14). A few years later, there are figures, with some information on sex and size, for the expatriate-owned pigs that in 1925–28 were held on the expropriated plantations of German New Guinea (Custodian of Expropriated Property 1925–28). There are also unpublished figures for livestock holdings from plantation and mission returns for government agricultural censuses during the 1950s at least. These were probably the source for data on ‘non-native’ holdings of pigs given in an overview for the United States Department of Agriculture in 1958 (Long 1958:14, 21): 7222 pigs pre-World War II (6222 in New Guinea, 1000 in Papua), and then rising from 2720 in 1951 to 5687 in 1956. There are other published, but unsourced, figures (undated but presumably c. 1970), such as 7000 pigs on commercial holdings (Purdy 1971:483), that seem considerably larger than the estimates for later years shown in Tables 5.2 and 5.3.

5.5 The 1996 PNG Household Survey

The 1996 Household Survey (Gibson and Rozelle 1998) was based on a small, stratified, two-stage, random sample of 830 rural households representing the four main regions (Papua, Highlands, Momase and the New Guinea Islands — without Bougainville Province due to political conditions), and 314 households in the urban sector (National Capital District). Table 5.4 shows data on pig holdings per household and per person in the four rural regions. There are two sets of per person figures: ‘all’, which includes all sampled households, and those ‘with agriculture’ (either growing some crops or raising livestock), which included 83% of all households.

The range of variation in the numbers of pigs held by villagers in the three nonhighland regions is limited (1.3–1.9 pigs per household, 0.17–0.27 per person). Households in the Highlands held a significantly larger number of pigs (3.3 pigs per household, or 0.51 per person) (Gibson and Rozelle 1998:2, 6, 84). Interestingly, for the whole country, there was no difference in pig holdings between households classified as poor and nonpoor.

Table 5.4 Estimated pig holdings (average number per household and per person) in four regions of PNG (1996)

	Papua	Highlands	Momase	NG Islands	All PNG
Pigs per household	1.9	3.3	1.7	1.3	2.4
Pigs per person (all)	0.27	0.51	0.25	0.17	0.34
Pigs per person (with agriculture)	0.31	0.56	0.31	0.22	0.41

Source: For pigs per household, Gibson and Rozelle (1998:84); for pigs per person, J Gibson (University of Waikato, pers comm, June 2001). Note that the Islands region excluded Bougainville. For the National Capital District, at the level of all households, there were no pigs; for agricultural households only, there were 0.01 pigs per person.

As regards total pig numbers in PNG, the survey estimated a village-based population of 1.7 million pigs.

The 1996 PNG Household Survey may have underestimated pig numbers. For example, comparison with other, earlier, community-level data from the Highland region (Table 5.8) suggests that the Highlands figure of 0.5 pigs per person may be too low, unless there has been a regional decline in pig numbers. Further, comparison of the overall number with an estimate of the number of pigs slaughtered obtained from the survey's estimates of annual pork production (see Chapter 7, Section 7.2 and Chapter 10, Section 10.1), also suggests that the 1.7 million pig figure may be too low. J Gibson (University of Waikato, pers comm, December 2001) considers that the production figures may be more robust than those for pig numbers.

5.6 Pig raising information from the 1980 and 1990 population censuses

Table 5.5 summarises, at the level of provinces, answers to questions about pig raising that were asked in the 1980 and 1990 national population censuses. Provinces are politico-administrative units rather than environmental or agronomic entities. However, they are important for planning and other purposes, and thus have a statistical function. A question in the 1980 census asked whether anyone in the household raised pigs. In 1990, the question was changed to ask whether anyone in the household (i) raised pigs for cash and own use, (ii) raised pigs for own use only, or (iii) did not raise them. In addition, the 1990 census redefined the rural sector and thus the kind of households included. For both these reasons, it is not valid to directly compare the results for the two censuses (Bellamy and McAlpine 1995:126; National Statistical Office 1994:181–2). They are included here for indicative purposes only. Unfortunately for comparative purposes, the relevant question was again changed at the 2000 census to refer to generic 'livestock' instead of specifically pigs (National Statistical Office 2002:48).

Aggregation of the 1990 census results by the four main regions gives the following pattern: 77.5% of Highlands households raised pigs, 48.6% of Papuan, 47.1% of New Guinea Islands households, and 44.1% of Momase ones (Macfarlane 1999–2002:3). Table 5.6 summarises Table 5.5, grouping provinces by classes of relative pig husbandry significance. The data from the two censuses confirm the common view that pig raising is more significant in the Highlands region than elsewhere, with over 70% of households in each of the Highlands provinces (except the Eastern Highlands Province in 1990) raising pigs. Next, with 50–69% of households raising pigs, is a set of provinces from all three other regions: Papua, Momase and the Islands. Of the provinces in the lowest two classes, 30–49% and less than 30%, Manus Province consistently had the fewest pig-raising households with less than 20%, while Gulf Province and Western Province from the western part of Papua, and East Sepik Province in Momase also have low scores, though with some difference between the two censuses. Four other provinces (West Sepik, New Ireland, East New Britain and Bougainville) fell between 30 and 49% in either 1980 and/or 1990.

5.7 Official Indonesian statistics for Irian Jaya

Table 5.7 lists, for *kabupaten* (administrative district) within the province of Irian Jaya (as it was then known), official data on pig numbers relative to people for both 1981 and 1995. Details of how the pig data were collected are not available. The overall figures of 0.29 pigs per person in 1981, and 0.33 pigs per person in 1995 are slightly lower than the comparable (1996) data from PNG (Table 5.4, above). Haynes (1989:93) lists a sequence of summary annual totals of pig numbers for Irian Jaya as a whole for the period 1980–1988. While his 1981 figure agrees with that given in Table 5.7, his total of 609,608 pigs as early as 1988 is considerably greater than the later figure of 548,746 for 1995 in Table 5.7. As in PNG, pig holdings in the highlands (Jayawijaya and Paniai *kabupaten*) are markedly higher (0.4–1.08 pigs per person) than those in the lowlands (0.03–0.18 pigs per person).

Table 5.5 PNG: Pig raising by province in 1980 and 1990: numbers and percentages of households stating that someone in the household raises pigs

Province	1980		1990	
	No. of households	%	No. of households	%
Western	5141	34	3653	25
Gulf	2729	22	3555	34
Central	12,035	57	11,792	53
Milne Bay	15,993	59	15,694	58
Northern	5979	52	8021	58
Southern Highlands	34,871	73	41,969	82
Enga	28,018	77	34,870	89
Western Highlands	43,453	81	50,832	82
Simbu	35,610	80	32,571	81
Eastern Highlands	42,141	79	37,928	60
Morobe	23,469	50	27,343	53
Madang	19,969	52	21,644	56
East Sepik	11,231	25	12,412	27
West Sepik	8174	33	9210	39
Manus	523	13	926	19
New Ireland	5888	44	8012	50
East New Britain	8309	42	13,622	44
West New Britain	7898	66	10,659	57
Bougainville	9065	45	NA	NA
Total	320,496	58	344,713	54

NA = not available

Source: PNG Resource Information System (PNGRIS); for description of the census questions, see, for 1980 Census Question 11, Bellamy (1986); and for 1990 Census Question 17, see Bellamy and McAlpine (1995). For 1980 hard copy data, see Cuddy (1987). For 1990, see Department of Agriculture and Livestock (1993:106). 1990 figures are also given in National Statistical Office (1994:186–190), though totals in this source differ slightly.

Table 5.6 Distribution of PNG provinces by proportion of pig-raising households in 1980 and 1990

Households raising pigs (%)	1980	1990
	Provinces	Provinces
< 29	Gulf, East Sepik, Manus	Western, East Sepik, Manus
30–49	Western, West Sepik, New Ireland, East New Britain, Bougainville	Gulf, West Sepik, East New Britain
50–69	Central, Milne Bay, Northern, Morobe, Madang, West New Britain	Central, Milne Bay, Northern, Eastern Highlands, Morobe, Madang, New Ireland, West New Britain
> 70	Southern Highlands, Enga, Western Highlands, Simbu, Eastern Highlands	Southern Highlands, Enga, Western Highlands, Simbu

Source: Table 5.5, above

Table 5.7 Pig numbers in Irian Jaya, by *kabupaten*, in 1981 and 1995

<i>Kabupaten</i>	1981			1995		
	Population	No. of pigs	Pigs per person	Population (1990)	No. of pigs	Pigs per person
Lowland						
Merauke	174,290	21,254	0.12	243,722	8,874	0.04
Jayapura	158,561	26,054	0.16	246,467	7,437	0.03
Fak-fak	65,517	1,289	0.02	89,395	7,397	0.08
Sorong	145,702	899	0.01	199,085	7,758	0.04
Manokwari	86,386	8,105	0.09	129,964	18,700	0.14
Yapen Waropen	59,196	2,395	0.04	70,333	6,390	0.09
Teluk Cenderwasih	72,628	11,974	0.16	90,843	16,023	0.18
Highland						
Jayawijaya	269,024	240,620	0.89	355,562	385,756	1.08
Paniai	180,223	43,420	0.24	223,337	90,141	0.40
Totals	1,211,527	356,000	0.29	1,648,708	548,746	0.33

Sources: for 1981, Kantor Statistik Propinsi Irian Jaya (1981:29, 127), and for 1990–95, Kantor Statistik Propinsi Irian Jaya (1995:71, 247). Some *kabupaten* boundaries may have changed between these dates. Cenderwasih was renamed Biak Numfur by 1995.

5.8 Other parts of the Pacific: a comparative note

There are survey data on pig numbers from both the Solomon Islands and Vanuatu that may usefully be compared to the New Guinea figures, allowing for the time differences, and noting that the 1996 PNG figures may have been underestimated, as discussed above in Section 5.5.

In 1967, de Fredrick (1971b:6–7; 1977a:117–118, 121) surveyed 181 villages in all four districts of the Solomon Islands, and estimated an overall figure of 0.11 pigs per person for the whole country (or 0.17 for those areas keeping pigs). The range was large, from a high of 2.5 pigs per person in Sikaiana (Malaita district) to a low of 0.005 on Ontong Java.

In contrast, the Vanuatu numbers appear to be considerably greater. The 1983 Agricultural Census of Vanuatu listed numbers of pigs per household in 11 island groups with an overall figure of 3.3, and a range from 6.7 in the Shepherds region to a low of 1.9 in the Banks/Torres Group (National Planning and Statistics Office 1986:8.3). If household size is assumed to be about five, the overall figure is about 0.7 pigs per person, and the range 0.4–1.3. A decade later, figures from the 1993 Agricultural Census of Vanuatu were higher, at 5 pigs per household for the country as a whole, and a range per island group of 3–7 (Statistics Office 1994:21, 132, 138).

Thus, the broad picture suggested for Melanesia is 0.1 pigs per person for the Solomon Islands, 0.3 for Irian Jaya, 0.4 for PNG and 0.7 for Vanuatu. A broadly similar pattern of variation, though with data from different countries, is suggested by de Fredrick (1977a:121). FAO data displayed by Macfarlane (1998:9) on proportions of households with pigs and numbers of animals per household also imply a similar ranking from the Solomon Islands with the least pigs per person to Vanuatu with the most. However, and most interestingly, the figures indicate that the Polynesian islands of Tonga and Samoa appear to far outstrip their western Pacific neighbours in relative numbers of pigs. This pattern is confirmed by the comparison of Pacific pig populations (absolute numbers, as well as both per person and per km² figures) made by Saville and Manuelli (2002:34). While their PNG figures are probably far too low (at 0.23 pigs per person) and out of date, many islands to the east have far higher pig densities and pigs per person. Niue,

Tonga, the Cooks, Samoa, Tuvalu, Tokelau and Wallis and Futuna are all reported to have more than 0.73 pigs per person.

5.9 Community-level data on relative pig numbers

This section discusses community-level data on relative pig numbers, mainly for PNG but with some Irian Jaya figures.

For many years, researchers in rural New Guinea have documented pig numbers for small samples of owners or households, or for whole communities or localities. Such figures, often expressed as the number of pigs per person, have provided a useful (albeit rough) index of the quantitative significance of pigs. Table 5.8 lists over 150 of these, from all provinces of PNG except Manus and New Ireland, as well as from parts of Irian Jaya. They date from pre-World War II until the 1990s, but are predominantly from the period 1960–1989 (9 were collected before 1950, 10 during 1950–59, 33 in 1960–69, 60 in 1970–79, 41 in 1980–89, and only 16 in 1990–99). Some previous compilations of per person pig numbers are given by Eele (1983:87), Feil (1987), Kelly (1988), Weiner (1988:34), Bourke (1988:18–19; 1999b) and Kuchikura (1994a). Table 5.8 does not include the set of approximately 300 village figures from the 1951 Agricultural Census (see Section 5.2).

There are also many other descriptions of relative pig numbers that, while not quite reaching the level of precision required for inclusion in Table 5.8, are nonetheless of considerable use. These range from broad descriptive statements such as the Kwoma (East Sepik Province) ‘do not keep pigs in any number’ (Bowden 1983:11–12), to much more quantitative descriptions. Examples include:

- about one pig per adult person for the Kaulong of West New Britain Province (Goodale 1995:82);
- 38 pigs among 83 households (only 31 of which owned pigs) in a Balif Arapesh village in East Sepik Province (Macdonald 1995:100);
- about 10–15 adult pigs per village for four Usino villages (Upper Ramu, Madang Province) with a total population of about 250 (Conton and Eisler 1976:135);
- 8.8 pigs per household for a small sample from four villages on Karkar Island in 1991 (ANZDEC Consultants Limited 1991b:14);
- an average 2–3 pigs per woman among the Gende of Bundi (Madang Province) in 1982–83 (Zimmer 1985:118);
- about 10 pigs cared for by the average Kunimaipa (Central Province) family (McArthur 2000:29);
- 3.2 pigs per Sinasina (Simbu Province) family for a sample of 36 families from Iobakogl village three months after a pig festival in 1975 (Lambert 1975:36);
- 3.7 pigs per adult Iobakogl Sinasina man in 1978 (Christie 1980:148);
- 4.8–4.9 pigs per owner among the Kawelka (Melpa, Western Highlands Province) in 1965 (Strathern 1983:78);
- 4.4 pigs per household in the Central Hagen area and 5.1 near Kagua in the Southern Highlands Province in 1991 (ANZDEC Consultants Limited 1991a:14);
- 7.1 and 4.1 pigs per owner among the Wiru (Southern Highlands Province) in 1967 and 1971 respectively (Strathern 1978:96–97);
- 4.5 pigs per Wahgi man (Western Highlands Province) in 1980 just prior to a pig festival (O’Hanlon 1989:150);

- at least 2 pigs killed per ‘man, woman and child’ (not counting ‘unusually numerous pigs’ also used) at earlier Wahgi (Kuma) festivals in the 1950s and 1960s (Reay 1984:75).

For the Gimi-speaking people in the Beha Valley near Lufa (Eastern Highlands Province) in 1969, the average pig herd of a married couple 7–8 months before a pig festival was 6.7 (range 1–21), while after the festival it was 5.4 (range 1–18). In contrast, the average herd of a widowed person was 3.4 pigs before the festival and three afterwards (Bragginton 1975:69–70). In the Telefomin area, Craig (1969:193, fn 20) recorded an average of three pigs (range 1–11) per Kialikmin family in the 1960s, while Brutti and Boissière (2002:145) described 1.9–3.6 pigs per ‘hearth’ between 1995 and 2001 at the Oksapmin hamlet of Mekiawa. For the Dugum Dani of Irian Jaya, Heider (1979:35) has noted that the pigs were ‘almost as numerous as people’, although earlier, in a personal communication to Waddell (1972b:211), he estimated that Dugum Dani pig numbers rose to three pigs per person before major pig festivals.

For the Kalam in the Kaironk Valley (Madang Province) in the decade 1960–70, ‘the number of domestic pigs present appeared, on average, to equal the number of humans, though still increasing. By 1973, the gross number of pigs present appeared to exceed considerably the number of humans ...’ (Bulmer 1976:171–172). Among the Rawa of Madang Province, in 1982–84, ‘...virtually every adult man, or woman and some children have at least one domesticated pig. Most have two or three, and some men raise many more which they sell to people outside their own group’ (Dalton 1988:91).

There is an obvious wealth of additional information in such accounts, even though they lack the full quantitative detail of pig and person numbers for ready conversion to a precise per person basis (though approximate conversion is possible in some cases).

Although quantitative concern with pig matters is not universal in New Guinea communities, it is certainly common. Newman’s account from the Asaro Valley near Goroka is especially telling. He described how:

... the most frequent topic of conversation among the adult men in a village concerns the number and size of pigs ... How many piglets of each sex in a new litter, how fat a man’s sow, how many pigs are owed a man ... are matters the Gururumba never tire of hearing or talking about. Men carry little sticks with them marked so as to demonstrate the thickness of fat on their sows or the length of tusks on their boars, and every man’s house has a rack outside for displaying the jaws of all pigs given the members of that house for many years past. (Newman 1965:52).

Similar accounts of the centrality of pigs in community discussion and cultural focus have been given by Reay (1959:20–21) for the Kuma (‘... a mental preoccupation with pigs amounting almost to an obsession: they use pigs as a medium and symbol ...’), and by Hirsch (1987:52) for the Fuyughe of the Goilala area in Papua (pigs were the most common topic of conversation).

In some places a focus on counting pigs seems to have been a government initiative. At the village of Kurtatchi in northwest Bougainville Province in 1930, Blackwood described how:

All the pigs belonging to a village are recorded — or are supposed to be recorded — on one stick ... These records are required by the Government and the bundles and sticks are given to the District Officer at his official visit. I do not think any record would be kept except for this requirement, and its accuracy is open to considerable doubt (Blackwood 1935:457).

The figures in Table 5.8 are a very ‘mixed bag’, with considerable variation in reliability. They were collected by a great variety of means, including exact animal counts, owner surveys and estimates, or a combination of two or more of these. Some were collected by long-term researchers in small communities (sometimes of just a few households), others

during rapid or sample surveys of much larger units (several thousands). They also cover a considerable period of time, and, as discussed both above (Chapter 4, Sections 4.2.2-4.2.4) and below (Section 5.10), continuity over time cannot be assumed. There are, as many workers have noted, a number of problems with counting or censusing pigs (Bulmer 1960:94; Wohlt and Goie 1986:160; Hirsch 1988:52), and with the ratio of pigs per person.

First, different cultures differ widely as regards the appropriateness of counting other people's pigs, or asking questions about the number of pigs owned or held. In some places it is impossible (Boissière 1999:65); in some, an attempt to census pigs may be greeted with hilarity (Townsend 1969:50); in others, it appears to be unproblematic (Healey 1990:142). People may be as concerned to hide pig numbers from fellow community members as from outside researchers (Meggitt 1974b:60; Clay 1986:103; Robinson 1999:64). Second, it is often not easy to physically count animals, and many censuses rely upon the claims of owners. As Feachem (1973a) demonstrated clearly, initial answers to an unknown researcher may well be spurious. Third, raw pig numbers alone hide the complexities of animals of different age and sex (although some of these listed surveys collected such information). Fourth, numbers say nothing of the way in which such pigs are fed, and the relative significance of human-provided fodder as opposed to pig-located forage — of crucial importance for many questions. For these and other reasons, the numbers in Table 5.8 are provided as a useful index only. Note in particular that, as described above, they mainly date from the period 1960–1989, and thus cannot be regarded as necessarily accurate for the contemporary period following the apparent end of much large-scale ceremonial and exchange activity that used to be centred on pigs. Nevertheless, they allow a basic overview and sorting of a broad range of variation, as well as demonstrating the relative wealth of documented information across the country. Table 5.9 shows the frequency distribution of groups/locations by the number of pigs per person.

There are two or three immediately useful points from Tables 5.8 and 5.9. In terms of regional distributions, there is, as expected, a strong emphasis on greater numbers of pigs per person in highland areas. Further, within the PNG Highland region, there appear to be more western areas, from the provinces of Southern Highlands and Enga in particular, with high numbers of pigs than eastern areas. Nevertheless, there are also several areas within the Eastern Highlands Province with relatively high numbers of pigs (Feil 1995). Of the 35 groups or localities with more than 1.2 pigs per person shown in Table 5.8, the provincial distribution in PNG is: 11 in the Southern Highlands Province, 7 in Enga Province, 8 in the Eastern Highlands Province, 3 in Simbu Province, 1 in West Sepik Province, 1 in the Western Highlands Province, 1 in Madang Province (the Finisterre highland area), and 2 in Central Province (Goilala highlands). There is also one case from the Baliem Valley in Irian Jaya. Finally, while Kelly (1988:150) was able to show, with a small sample of 12 sociocultural groups, a possible bimodal clustering into two groups (those with < 0.61 and those with > 0.93 pigs per person), this larger data set shows no evidence of such a distribution.

The number of pigs per person is useful, but by itself says nothing directly about the numbers of pigs relative to land area for which an index of pig density, or a stocking rate, is required (Feachem 1977:153; Hide 1981:563–5; Strathern 1988:208; Lemonnier 1990:139–140). Lemonnier (1990:139–140) tabulated some 14 PNG ethnolinguistic groups by pig density as follows:

- very low densities (< 5 pigs/km²) (Baktaman, Gadio Enga, Yafar, Etoro, Miyanmin);
- low to medium densities (5–49 pigs/km²) (Maring, Siane, Wola);
- high densities (50–99 pigs/km²) (Melpa, Mendi, Kuma);
- very high densities (> 100 pigs/km²) (Chimbu, Mae Enga, Raiapu Enga).

Table 5.8 Pig holdings per person in New Guinea communities (by province)

Group/location name	Pigs per person		Source	Year
	No.	Range		
Western Province				
Kiwai, Mawatta	0.02		Suda 1996:90	1990
Kubo	0.38	0.27–0.54	Dwyer 1993:126	1986–87
Kubo	0.88	0.74–1.04	Minnegal and Dwyer 1997:51	1995
Bedamuni	0.28	0.25–0.40	van Beek 1987:25	1978–79
Gebusi, Gasumi Corners	0.15		Knauft 2002:209, 268	1998
Kasanmin, Fakobip	0.56		Kuchikura 1990:129	1986
Seltaman, Woktembip	0.4		Kuchikura 1990:129	1986
Seltaman	0.5		Whitehead 2000:46	1988
Kamula	0.61		Wood 1982:2	1987
Kasua	0.4		Brunois 2001:169, 291	1997
Gogodala	0.1		Baldwin 1982:38	1975–76
Wopkaimin	0.15	0.14–0.16	Hyndman 1979:212, 235	1973
Baktaman	0.26	0.19–0.34	Barth 1975:15, 37	1968
Gulf Province				
Elema	1.00		Williams 1940b:12	1923
Ankave Anga	0.53		Bonnemère 1996:47	1988
Koravagi	0.05		Conroy and Bridgland 1950:86; Julius 1950:67	1947
Central Province				
Kairuku, Nabuapaka	0.42		Monsell-Davis 1981:1, 11	1973–77
Tauade, Aibala Valley	2.6		Hallpike 1977:54, 175	1971–72
Fuyuge, Udabe Valley	1.6		Hirsch 1988:53, 89	1983–85

Table 5.8 Pig holdings per person in New Guinea communities (continued)

Group/location name	Pigs per person		Source	Year
	No.	Range		
Milne Bay Province				
Tubetube Island	0.3–0.5		Macintyre 1984:109–110	1979–81
Sabarl Island Maho village	0.03–0.13		Battaglia 1990:14–15, 227	1976, 1986
Fergusson Island Bwalalea Taupolo Bwabwadaba	0.08	0–0.16	Spencer 1964:20	1959
Wamira	0.25	0–0.55	Kahn 1986:75–6	1977
Watanou	0.07		Moulik 1973:23, 27	1970–71
Buu	0.16		Moulik 1973:23, 27	1970–71
Oro Province				
Orokaiva, Sivepe	0.47		Rimoldi 1966:20–22	1962–63
Orokaiva, Sivepe	0.44		Waddell and Krinks 1968:40, 44	1964
Orokaiva, Inonda	0.36		Crocombe and Hogbin 1963:45	1962
Orokaiva, Inonda	0.06		Waddell and Krinks 1968:53, 58	1964
Orokaiva, Koropata 2	0.46		Newton 1985a:106	1978
Southern Highlands Province				
Hewa	0.20		Steadman 1971:54	1967
Duna, Horaile, Tumbudu Valley	1.02		Modjeska 1977:138	1970
Duna	1.10		Modjeska 1982:53	1972
Duna, Hagino	1.00		Bell 1984:53	1984
Duna, Kopiago Basin	1.78		Robinson 1999:70	1996
Etoro, Kaburusato	1.26	1.26–1.38 (1.32)	Kelly 1988:150	1968–69
Etoro, Bobole	0.89	0.52–1.39	Dwyer 1990:59	1979

Table 5.8 Pig holdings per person in New Guinea communities (continued)

Group/location name	Pigs per person		Source	Year
	No.	Range		
Southern Highlands Province				
Nembi, Puit	0.77		Bourke 1984b:59, 66	1978
Polopa	0.75		Brown 1988:101,104	1972
Huli, Debi floodplain	1.71		Wood 1984:198; 2002:35	1980
Huli, Haibuga swamp	2.17		Wood 1984:198; 2002:35	1980
Huli, Wabia plains	2.14		Wood 1984:198; 2002:35	1980
Huli, Tari plains	1.71		Wood 1984:198; 2002:35	1980
Huli, Poro plains	1.56		Wood 1984:198; 2002:35	1980
Huli, Andowari plains	1.21		Wood 1984:198; 2002:35	1980
Huli, Paijaka plateau	1.08		Wood 1984:198; 2002:35	1980
Huli, Wenani	1.6		Kuchikura 1999:71	1993
Huli, Wenani	1.9		Umezaki et al. 2000:372	1994
Huli, Heli	0.6		Umezaki et al. 2000:372	1994
Wiru, Tunda	0.9+		Strathern 1970:63; 1978:95-7	1967
Wiru, Takuru	1.2	0.6-1.7	Spore 1981:13	1981
Mendi, Waparaga	1.36		Lederman 1986:240-2	1978
Mulim	1.11		Simpson 1978:25, 102	1976-77
Kaluli, Sibalama	0.6+		S Odani, National Museum of Japanese History, pers comm, June 2003	1999
Onabasulu	0.67		Ernst 1984:113	1971
Foi	0.38	0.13-0.63	Weiner 1988:33-34	1984
Kewa, Koiari	0.60+		LeRoy 1979:189	1971

Table 5.8 Pig holdings per person in New Guinea communities (continued)

Group/location name	Pigs per person		Source	Year
	No.	Range		
Southern Highlands Province				
Wola	0.5–1.0		P Sillitoe, University of Durham, pers comm, July 2001	1973–1997
Bogaia	0.86		Sillitoe 1994:44, 62–3, Appendix II	1984
Enga Province				
Marient Basin	0.96		Clarke 1989:242	1972
Marient Basin	0.46		Clarke 1989:242	1973
Marient Basin	0.12–0.35		Clarke 1989:244	1976
Mae Enga	1.0		Meggitt 1958a:288, 298	1955–57
Kyaka Enga	1.6		Waddell 1972b:61; Bulmer 1960:95	1955–56
Raiapu Enga, Modopa	2.29	(1.37)	Waddell 1972b:61–2, 118	1966
Raiapu Enga	2.0	1.1–3.1	Feachem 1973a:29–30	1971
Tombema	3.78	2.96–4.52	Feil 1984:243	1976
Lagaip, Tukisenta	0.64		Sinnett 1975:19, 28	1966
Enga, Yumbisa (1)	0.77		Wohlt 1978:150	1973
Enga, Yumbisa (2)	0.62	0.52–0.69	Wohlt 1978:151–4	1973
Porgera district	0.6		Wohlt 1986b:11	1984
Kandep district	0.9		Wohlt 1986b:11	1984
Lagaip district	1.0		Wohlt 1986b:11	1984
Wabag district	1.3		Wohlt 1986b:11	1984
Wapenamanda district	1.5		Wohlt 1986b:11	1984
Kompam district	1.9		Wohlt 1986b:11	1984
Whole Province	1.2		Wohlt 1986b:11	1984

Table 5.8 Pig holdings per person in New Guinea communities (continued)

Group/location name	Pigs per person		Source	Year
	No.	Range		
Western Highlands Province				
Melpa, Roni Pingeri	2.10		Malynicz 1977:202	1975
Manga, Jimi Valley	1.0		Cook 1967:465–66	1962
Maring, Kundagai	1.1		Healey 1990:145	1974
Jimi Valley	0.71	0.08–0.97	Joughin and Thistleton 1987:106	1987
Simbu Province				
Chimbu	0.74		Venkatachalam 1962:4	1956
Central Chimbu	1.5		Brookfield and Brown 1963:58–9	1958–60
Sinasina, Kere	1.5		Hughes 1966:95–96	1966
Sinasina, Kere	0.8		Hughes 1966:95–96	1966
Sinasina, Gunangi	1.18		Hatanaka 1972:96	1969
Sinasina, Nimai Waula	0.86	0.83–0.89	Hide 1981:408	1972–73
Sinasina, Dom Barikane	0.52	0.27–0.77	Hide 1981:408	1972–73
Sinasina, Nimai Gunakane	0.9		Wohlt and Goie 1986:79	1982
Dom, Alaune	1.0		Wohlt and Goie 1986:111	1981
Chimbu Valley, Bongugl	1.32	1.32–1.62	Wohlt and Goie 1986:45, 53	1982
North Simbu	1.04	0.58–1.40	Wohlt and Goie 1986:161	1980–81
Kerowagi, Keruveku	1.14		Malynicz 1977:202	1975
Kerowagi, Upper Koronigl	1.1		Rambo 1993:105	1989
Gumine, Yani-Boromil	0.6	0.42–0.72	Ghodake and Kalit 1986:16	1986
Daribi/Pawaia, Yawio, Yuro	0.69		Hide et al. 1984:225–6	1981
Daribi/Pawaia, Yuro, Kilibari, Boisamaru	0.49		Finlayson et al. 1991:61–62	1987

Table 5.8 Pig holdings per person in New Guinea communities (continued)

Group/location name	Pigs per person		Source	Year
	No.	Range		
Eastern Highlands Province				
Siane	0.62		Salisbury 1962:80, 92	1952–53
Daulo	0.85		Sexton 1986:39	1977
Asaro, Korfena, Fondiwei	1.0		Howlett 1962:142	1959–60
Asaro, Manto	1.20		Moulik 1973:56	1970–71
Asaro, Lapegu	0.88		Malynicz 1977:202	1975
Asaro, Kasena	0.95		Benediktsson 2002:245	1994
Notofena, Makiroka	2.44	2.44–3.16	Howlett 1962:202	1959–60
Benabena, Korofeigu, Nupasafa	2.86		Howlett 1962:158, 171	1960
Benabena, Hofagaiyufu	2.39		Moulik 1973:56	1970–71
Benabena, Mohoweto No.1	1.48		Moulik 1973:56	1970–71
Benabena, Namaro	0.95		Malynicz 1977:202	1975
Benabena, Kogoro	1.91		JL Dickerson-Putman, Indiana University, pers comm, September 2001	1983–84
Tairora, Abiera	2.39		Watson 1983a:52, 89	1963
Tairora, Batainabura	0.65		Watson 1983a:52, 89	1963
Tairora, Barabuna	0.67	0.48–0.85	Grossman 1984:160	1977
Binumarien	1.10		Hawkes 1976:16, 175–6	1971–72
Ommura, Yonura,	0.40		Mayer 1987:27	1975
Auyana	2.19		Robbins 1982:62, 248	1962
North Fore, Awande	0.85		Jeffries 1979:18, 29	1977
Ontena	0.63		Finch 1991:140	1987
Awa	0.62	0.55–0.70	Boyd 1984:37–38	1971–72

Table 5.8 Pig holdings per person in New Guinea communities (continued)

Group/location name	Pigs per person		Source	Year
	No.	Range		
Eastern Highlands Province				
Anga, Baruya	0.6		Lemonnier 1990:139–140	1985
Anga, Simbari	0.11		Herdt 1981:24	1974–76
Morobe Province				
Siassi Isl., Mandok	0.14		Freedman 1967:1, 98	1966
Busama	0.01		Conroy and Bridgland 1950:86; Julius 1950:35	1947
Kaiapit	0.23		Conroy and Bridgland 1950:86; Julius 1950:44	1947
Patep	0.65		Conroy and Bridgland 1950:86; Julius 1950:51	1947
Wain, Gaiaren	0.09		Jackson 1965:52, 58	1964
Wampar, Tararan,	0.71		Lütkes 1999:34, 94	1991
Madang Province				
Nokopo	3.9		Kocher Schmid 1991:101	1987
Maring, Tsembaga	0.56	0.29–0.83	Rappaport 1967:57	1962–63
Maring	1.1	0.9–2.0	Buchbinder 1973:131	1968
Maring, Bomagai,	0.51		Clarke 1971:19, 84	1965
Maring, Bomagai	1.02		Clarke 1980:187	1977
Rempi, Aronis	0.13	0.12–0.15	Moulik 1973:39, 41	1970
Bogia	0.45	0.3–0.6	Connell 1980:116	1979
Trans Gogol, Sehan	0.50		De'Ath 1980:78, 86	1977
Hagahai	0.57		Jenkins and Milton 1993:285	1990

Table 5.8 Pig holdings per person in New Guinea communities (continued)

Group/location name	Pigs per person		Source	Year
	No.	Range		
East Sepik Province				
Gadio Enga	0.83	0.57–1.48	Dornstreich 1973:36, 233, 238, 317	1968
Yimar, Ratoma	0.02		Haberland and Seyfarth 1974:248	1963
Sawiyono	0.09		Guddemi 1992b:7, 49	1987
Ambonwari	0		Telban 1998:24	1990
Saniyo-Hiyowe	0.12		Townsend 1990:374	1966–67
Sawos, Gaikorobi	0.05		Schindlbeck 1980:130, 143	1972
Abelam, Yenigo	0.47		Lea 1965:204–5	1962
Abelam, Stapikum	0.03		Lea 1965:204–5	1962
Arapesh, Ilahita	0.06		D Tuzin 1976:7; pers comm, University of California at San Diego, February, March 2002	1970
North Kwanga, Tauhundur	0.18	0.16–0.20	Obrist van Eeuwijk 1992:113–5	1984–85
West Sepik Province				
Miyanmin	0.10		Morren 1977:294	1967–69
Miyanmin	0.19		Morren 1986:107	1980–81
Oksapmin, Divanap	0.40		Cape 1981:189	1980
Oksapmin, Mekiawa	0.39	0.32–0.43	Brutti and Boissière 2002:145; L Brutti, Maison des Sciences de L'Homme, pers comm, March 2003	1995–98
Telefomin	0.48		D Jorgensen, University of Western Ontario, pers comm, August 2001	1973
Telefomin	1.3		D Jorgensen, University of Western Ontario, pers comm, 25 August 2001	1985
Umeda	0.02		Gell 1975:17, 49	1969

Table 5.8 Pig holdings per person in New Guinea communities (continued)

Group/location name	Pigs per person		Source	Year
	No.	Range		
West Sepik Province				
Yafar	0.08	0–0.22	Juillerat 1996:209	1970–1981
Au, Wulukum	0.37		Fountain 1966:53	1964
East New Britain Province				
Maenge	0.02	0.02–0.03	Panoff 1972:30	1967
West New Britain Province				
Kilenge, Ongaia	0.57	0.47–0.68	Zelenietz and Grant 1982:17	1977–81
Bougainville Province				
Nissan Isl., Balil	0.10		Nachman 1978:7, 36	1971
Teop	0.23	0.03–0.37	Shoffner 1976:145–6, 156	1973–74
Eivo	0.5	0.36–0.5	Hamnett 1977:53	1976
Nasioi	1.1		Ogan 1972:118–119, 185	1959
Nasioi	0		Ogan 1972:118–119, 185	1960
Siuai	0.5		Oliver 1955:357	1938
Siuai	0.84		Oliver 1949b:13	1938
Siuai	0.60	0.35–1.0	Connell, no date	1975
Nagovisi	0.28		Mitchell 1971:199–202	1970
Irian Jaya				
Ekagi-Me, (Kapauku), Kamu Valley	0.17	0.07–0.5	Pospisil 1972:54, 216–7, 396–7	1955
Amung, Tsinga	0.64		Cook 1995:286	1992
Dani, Bokondini	0.6		Ploeg 1989:61	1962
Dani, Assologaima Subdistrict	1.48		Wandra et al. 2000:47	1993
Eipo, Moknerkon	0.25		Michel 1983:19, 77, 79	1976
Marind-anim, Mewi	0.29 (killed)		van Baal 1966:850	1914

Table 5.9 Frequency distribution of groups/localities by the number of pigs per person

Pigs per person	No. of groups
< 0.39	47
0.40–0.79	50
0.80–1.19	35
1.20–1.59	15
1.60–1.99	7
2.00–2.99	11
> 3.00	2

Source: Table 5.8 Duplicate figures from the same locations not included

This general distribution was confirmed and refined in a quick and approximate analysis (for the present provisional purposes) using some of the pigs per person data in Table 5.8, converted to pig densities through the use of human population densities (as of 1980, taken from the PNG Mapping Agriculture Systems Database, see Vovola and Allen, 2001:469–470). In this analysis, Raiapu Enga and the Huli around Tari emerged with the highest pig densities (> 200 pigs/km²), a larger group of 17 groups or locations had very high densities (100–199 pigs/km²) (including parts of Western Highlands Province, Southern Highlands Province, Simbu Province and Eastern Highlands Province, and the odd case of Nokopo village in the Finisterres), 12 fell into the 50–99 class (including parts of the Southern Highlands Province, Enga Province, Simbu Province and Eastern Highlands Province, and one case, Telefomin, in West Sepik Province), over 50 appeared in the low to medium density class, and some 35 or so in the very low density class. Such an index of domestic pig density may be useful for investigations of the environmental impact of overall human activity on New Guinea landscapes.

At the national level, Saville and Manuelli (2002:34) have provided a valuable listing of pig densities for most Pacific countries. Their PNG figure of 2.2 pigs/km² should probably be two to three times greater, but still contrasts markedly with those from many smaller Pacific islands where densities of over 100 (and up to 500 in the case of Tuvalu) are recorded.

5.10 Trends in pig numbers

Unfortunately, while the available data offer many insights into distributions and other features, they are particularly weak for longitudinal or time-series analysis. The earlier PNG census data on pigs cannot be compared with any reliability to the 1996 PNG Household Survey results. Even the PNG population censuses asked different questions concerning rural economic activity in 1980, 1990 and 2000. In short, the present data sources are not sufficient to indicate reliable trends in pig numbers over time at the national level or at any sizeable regional level. Summary statements such as that by Connell (1997:47), that pig numbers have not declined, are not based on firm evidence. This lack of data is a major weakness given the importance of livestock information for questions about long-term trends in population change and intensity of land use. Extrapolating from the mainly 20–40 year old data on pig numbers (of the kind shown in Chapter 5, Table 5.8) to establish current mean pig per person figures for broad ecoregions for planning purposes (Bourke 1999b) may entail some risks.

There are occasional reports from different areas suggesting trends in change in pig numbers. Examples of increase include:

- the Siane area of the Eastern Highlands Province between 1933 and 1940 (Salisbury 1962:119);

- Enga by the late 1960s (Freund 1968; Waddell 1972b:111, 129, 197);
- the Jimi Valley in 1987 (Joughin and Thistleton 1987:63);
- the Bimin Valley (Oksapmin) in the 1960s to 1970s (Bayliss-Smith 1985:111, 113);
- the Telefomin area in the 1980s (Jorgensen 1990);
- parts of the Miyanmin area between 1969 and 1981 (Morren 1986:107);
- the Yonggom area of Western Province between the early 1950s and the late 1980s (Kirsch 1991:321);
- the Mandak area of central New Ireland Province post-World War II (Clay 1986:164–5).

Cases of declining pig numbers include: Enga between 1943 and the 1950s (Meggitt 1958a:288); and, in the Southern Highlands, the Tari area between 1980–94 (Frankel 1986:44; Umezaki et al. 2000:373), possibly the Wola area during the 1980s and 1990s (Sillitoe 1996:398), the Kewa area between 1955 and 1971 (LeRoy 1979:182), and the Foi area around Lake Kutubu between the 1950s and late 1970s (Weiner 1988:34–5). Decreases have also been described in the Eastern Highlands Province: both the Goroka area in the early 1970s (Malynicz 1977), and the Benabena region by the early 1980s (Dickerson-Putman 1986:231). In the Northern (Oro) Province, Newton (1985a:238) documented a rapid drop from 2.8 pigs per household in 1978 to 0.75 in 1982 in one village during the initial stages of oil palm block establishment. Haberland and Seyfarth (1974:248) considered that pig numbers owned by the Yimar had declined (no reason given) in the Upper Korowori area of East Sepik Province between contact and the early 1960s. There are also, as noted above (Section 4.2.4), documented areas where numbers have declined dramatically following major religious or sociopolitical decisions about the status of pig husbandry.

It is a reasonable assumption that the expansion of market relations in association with the decline over the last two or three decades in the relative significance of major, wide scale, customary ceremonial and exchange events (eg pig festivals and Tee or Moka exchanges in the highlands) is likely to have reduced (‘drastically changed’ according to Umezaki et al. (2000:374)) the cultural importance of pig husbandry in many areas (Wohlt and Goie 1986:211; Umezaki et al. 2000:374). To what extent this is reflected in overall pig production, and hence stock and slaughter numbers, is largely unknown. However, to the extent that it has occurred, it is likely that it has resulted in the decline, or disappearance, of the large-scale coordinated pig production strategies that stamped unique demographic signatures on the pig populations of major participating groups (see Section 6.7).

5.11 Microdifferentiation in pig numbers within regions or localities

The figures in Table 5.8, which generally show a single figure against a location or group name, are indicative only. In many cases they hide considerable variation, some of which may be long term and based on underlying differences in access to resources. Natural resources are usually unevenly distributed across the terrain, with the consequence that social groups, or parts of them, may have unequal access to the most advantageous opportunities for agriculture and livestock raising. Several studies have revealed significant differences in pig ownership within localities, or between nearby locations, which correlate with differential access to land types. Other resource-based factors, such as location to trade routes, have also been suggested as related to marked regional variation in pig husbandry (Oliver 1949b:27–8). Such differentials appear to operate independently of factors related to household size and organization, and hence labour supply, that have been described by others as determining cultivated areas and hence pig production (Sillitoe 1993b:251).

The importance of resource access differentials was suggested in some early studies in the Highlands region. At three different locations around Goroka in 1959–61, Howlett (1962:142, 171, 202) found fewer pigs per person in the higher, steeper country in the Asaro Valley at Fondiwe'i (about 1 pig per person), than in the grassland areas at Korofeigu (2.8–3.9 pigs per person), or at Makiroka in the central Goroka Valley on fertile alluvial fans (2.62–3.2 pigs per person). Similarly, further east (Tairora area) in the Eastern Highlands Province in 1963, Watson (1983a:52–53, 88–9) reported 2.4 pigs per person in the grassland community of Abiera compared to 0.6 pigs per person in the nearby community of Batainabura with forest access.

In the high altitude Kaugel Valley of the Western Highlands Province in the early 1960s, Bowers (1965:34) correlated land types, marital status and pig holdings for the men of the constituent subclans of a single clan (Table 5.10). In the upslope hill area, subclans had less access to the preferred terraces and riverine areas, lower numbers of pigs and a higher proportion of unmarried men.

Table 5.10 Kepaka clan, Kaugel Valley: pig holdings and marital status by environment (1961–63)

Environments	No. of adult men	Per cent bachelors	Mean no. of pigs per adult man
River	77	9.1	4.8
Terrace	49	14.3	2.7
Hill	59	25.4	2.4

Source: Bowers (1965:34–35).

In the Tari Basin in Southern Highlands Province, Wood (1984:198, 201; 2002:35–36) reported fundamental differences between agricultural systems on the wetland and dryland environments, in particular, longer cultivation periods and higher sweet potato yields on the former. These correlated with higher human population densities and larger relative pig holdings (see Table 5.11). In addition to the higher agricultural productivity of the wetlands, the swampland is considered prime foraging for pigs.

Table 5.11 Tari Basin: pig holdings and population density by environment (1980)

Environments	Swampland as per cent of area	Pigs per person	Population density (person/km ²)
Floodplain/swamps	28	2.0	143
Plains/plateau	2	1.4	83

Source: adapted from Wood (1984:198, 201; 2002:35). The wetland category includes the Debi, Haibuga and Wabia zones; the dryland class, the Tari, Poro, Andowari and Pajjaka zones from the original. The pig data were collected for small samples of households in each of the zones: 34 for the wetlands and 35 for the drylands (AW Wood, Colonial Sugar Refining Company Ingham, pers comm, May 2001).

Recent work in the same Tari region in 1994 showed a continuing differential in pig holdings (eg 1.9 pigs per person at a wetland site and only 0.6 pigs per person at a dryland site), correlated with major differences in land and labour productivity, in diet intake, and in the amounts of sweet potato fodder given to pigs (Umezaki et al. 1999; Umezaki et al. 2000).

At a wider scale, drawing on a set of extensive surveys of the whole northern part of Simbu Province between 1980 and 1981, Wohlt and Goie (1986:160–163) categorised seven large environmental zones in terms of population density, pigs per person (range 0.7–1.1) and an index of agricultural stress. They found an association between fewer pigs and increased stress. Within one of their zones (Gumine), a subsequent rapid survey suggested that soil type was correlated with the size of pig holdings (Ghodake and Kalit 1986:13).

A number of other studies have suggested similar links between differential resource endowments and pig production, including Buchbinder (1973; 1977) for the Maring in the Simbai Valley (Madang Province), and Robinson (1999:63–73) for the Duna with and without access to the wetlands of Lake Kopiago.

For the West Sepik Province, there are also broad survey data that show major differentials in pig raising between districts: from less than 4% of households in Vanimo and Aitape districts with pigs, to 19–32% in others (Monitoring and Evaluation Unit 1987:20–21). In East Sepik Province, at the microlevel of intervillage differences in 1984–86, Brison (1999:156, 252, fn. 2) has described villagers from the Kwanga village of Inakor commonly purchasing pigs from two neighbouring villages, where greater pig production may have been due to access to larger forested areas.

5.12 Distributions within communities: the sociology of pig ownership

Besides major differences in pig numbers between regions and localities, there are also significant differences in the number of pigs owned between individuals within communities. This situation has received little attention, though there are a number of studies that provide basic details of distribution between households or individuals. In a Sinasina example, approximately 10% of households owned no pigs, 50% owned only 20% of all pigs, while the 10% of owners with the most pigs owned 30% of all pigs (Hide 1981:319–327). Similar patterns were shown in communities in the Western and Eastern Highlands provinces (Meggitt 1958a:287; Salisbury 1962:92; Cook 1967: Appendix 14; Bowers 1968:101; Warry 1987:107–8), although another Sinasina example revealed a much more even distribution (Hatanaka 1972:96). Distributions are also given in several other sources, with some analyses by the age, status and household composition of pig owners (Oliver 1949b:14–15; Moulik 1973:27, 41, 56–57; Hallpike 1977:72–73; Hornabrook et al. 1977:378; Hide 1981:323–4; Modjeska 1982:76–80; Robbins 1982:62; Watson 1983a:53; Newton 1985a:106, 206–7; Kelly 1988:143–149; Finlayson 1989:64; Healey 1990:143–5; Obrist van Eeuwijk 1992:113; Sillitoe 2003:301–305). For the Mae Enga in the 1950s, Meggitt (1965:39) suggested that nonagnatic immigrants to clans held slightly fewer pigs than agnatic members. In three Purari villages in Gulf Province in 1955, Maher (1961:81–33) found that men of high status owned significantly more pigs than ordinary men in the two more traditional villages, but not in Mapaio where custom was being rejected in favour of support for Tommy Kabu's modernist development program.

Where overall numbers of pigs are low, there may be large numbers of households not caring for pigs: examples include 92% of Kukipi households in Gulf Province in 1979 without pigs (Morauta 1984:49), 79% of Ilahita Arapesh households with no pigs in 1970 (Tuzin 1976:7; and pers comm, University of California at San Diego, March 2002), 58% of Kamea households (Gulf Province) without pigs (King 1999:92); nearly 50% of adult men without pigs in Kaul village on Karkar Island in 1969 (Hornabrook et al. 1977:373–4); 45% of Eivo (Bougainville Province) households with no pigs in 1975 (Hamnett 1977:53), and similar examples from Milne Bay Province and Madang Province, given by Moulik (1973:27, 41).

Given the significance of pigs as wealth, major variation in pig ownership between households within communities raises the possibility of significant relationships with other indices of social and health status. Some examples of associations between pig ownership and nutritional or health status are described in Section 10.6. In this context, it is of relevance that, as noted above in Section 5.9, pig counts (of animals held or owned at any one moment) are difficult, if not impossible, to carry out in some areas due to the sociopolitical sensitivity of such information: visible success leading not only to claims on one's animals in exchange, but also to accusations of supernatural assistance — at the expense of others — as well as invitation to witchcraft attacks. While a transactional index (such as numbers of pigs, or gifts of pork, given or received) might well measure social success more accurately than a count of animals on hand, it would probably be equally difficult to achieve.

5.13 Pig ownership: rights and claims

As one of the most important items of movable property in New Guinea, rights in pigs are a major focus of interest. In many cultures, pigs are primarily regarded as the property of men (Meggitt 1958a:294–5; Pospisil 1963:11), though women are recognised as also holding some rights to them (Strathern 1972:27, 48, 136–138). At Chuave in Simbu Province in 1979–80, only 4 women, out of 91 couples interviewed, claimed ownership of pigs (Warry 1987:107, 149). In a few cases, however, such as the Nasioi area of Bougainville Province, women are explicitly recognised as the major rightholders (Mitchell 1976:35). In some places, ownership may be divided or joint. For example, among the Baktaman in the late 1960s, pigs that were born to sows fed from a couple's gardens were regarded as being the joint property of both spouses, while pigs that were acquired by capture from the wild, or by trade, were considered as belonging to a man (Barth 1975:35). For the Telefomin in 1977–78, Brumbaugh (1980:48–50) reported that pigs could be owned by men, by women or jointly, and that, at that time, the number owned by women outnumbered those owned by men.

At Nupasafa, Korofeigu, near Goroka in 1960, Langness reported that 78% of the pigs were owned by adult men, 10% by adult women, 6% by boys and 7% by girls (Howlett 1962:171–172). Similarly, in the case of the Dani of the Baliem Valley, Irian Jaya, in the 1960s, women and children could own pigs, though not as many as men, and men retained rights over all pigs in terms of disposal (O'Brien 1969:49).

In some areas, rights to pigs are described explicitly as shared, for instance in the Daulo region of Eastern Highlands Province in the 1970s (Sexton 1986:62–4). Sexton, however, noted that pigs may have lost some of their customary value there by the late 1970s. Similarly, at Kogoro in the Benabena area (Eastern Highlands Province) in 1983, of 24 households with pigs, men were said to own the pigs in nine, ownership was shared by men and women in eight, and women were the principal owners in seven (Dickerson-Putman 1986:232). Like Sexton, Dickerson-Putman considered that this pattern might have been due to the declining value of pigs in exchange. Elsewhere, however, there are reports that indicate that the rights of women in pigs are likely to have predated recent cultural change: examples include the Kunimaipa of Papua in 1953–57 (McArthur 2000:30–1, 48–9), the Kaulong of West New Britain Province in the 1960s (Goodale 1995:84) and the Mandak of New Ireland Province (Clay 1986:165).

In his classic account of Melanesian pig husbandry, Oliver described the problematic nature of defining rights in pigs held by different members of Siuai households in South Bougainville Province in the late 1930s:

the Siuai male householder will call the pigs 'mine' ..., his wife will also say 'mine' ..., and their offspring will generally say 'ours' ... [I]t would not be misleading to claim that pigs are owned by all members of the household, but there are some distinctions which are significant ... There is, therefore, a hierarchy of claims of pig-ownership, with the male head of household possessing the strongest claims, his wife next ... (Oliver 1949b:26).

The strongest claims are often most apparent when decisions concerning a pig's allocation or deployment are taken. In the Duna area of the Southern Highlands Province, men were very sure of having the final word on such matters during the 1970s.

In the context of tending pigs both husband and wife may say that the woman is *aua*, 'father', of the pig. But in the contexts of decisions concerning allocation only the man is *aua*: 'Women don't argue. Why? Because a woman knows it's not her pig; it's my pig. Where did she get it from after all? That's right, I gave it to her to look after. There's no argument; the woman does what the man says. (Modjeska 1982:268).

It is not just the various rights of household members that are important; claims to pigs are often distributed beyond the immediate bounds of a household. Not all pigs owned by a person are necessarily cared for at any one time by that person or his household; nor, conversely, need all the pigs in a household's care belong to them. This may be partly a matter of agistment (ie putting one's pigs out in the care of others, or taking care of other's animals) (Oosterwal 1961:72; Newman 1965:55; Waddell 1972b; Feachem 1973a; Hide 1981:418–433). Alternately, such practices may involve rather more complex rights, as have been well described for two groups in the Southern Highlands Province, the Wola by Sillitoe (1979; 2003:295–297) and the Mendi by Lederman (1986).

In the case of the Baktaman, as many as two-thirds of pigs are held in what Barth (1975:35) described as fosterage by nonowners. Pigs were given to foster carers for a variety of reasons: to benefit from the skill or luck of the carer, to recognise a significant relationship, or to allow one to eat the meat from that animal (because the person who raises a pig cannot eat it). The foster person who raises another's pig provides all its food and care, and in return may receive either a piglet or meat from a slaughtered animal.

In much of New Guinea, the relationship between people and their pigs is partly indexed by the practice of naming (Powdermaker 1971:292; Brown 1986; Kahn 1996:186–7; Sillitoe 2003:249–250). Significantly, it is in parts of the Enga, where the transfer of live animals in exchange is probably most pronounced, that pigs are not usually identified by personal names (Meggitt 1958a: 287). Names are however used in the east of Enga (Bulmer 1960:92), and among the Sulka people of East New Britain Province, who also transact live pigs in exchange (Jeudy-Ballini 2002:199–200, 207–208).



Butchering pigs at Dom pig festival, Kagul, Sinasina, Simbu Province, 1972.
Photographer: R. Hide.

6 Pig production under village husbandry

6.1 Pig housing

Under customary village husbandry, pigs are housed in a very wide range of conditions. At the most extensive level, and mainly in lowland areas, no shelter at all may be provided. In other lowland areas (and some midaltitude ones), pigs may return to settlements in the evening and sleep, either tethered or untethered, under houses raised on piles (Fischer 1968; Hirsch 1988:54), or elsewhere. Those sleeping under Kaluli longhouses on the Papuan Plateau served as guard animals in earlier, less peaceful, days (Schieffelin 1976:34). More elaborate pig housing is related partly to altitude and thus temperature. In many places in the highlands, pigs sleep in the houses of their caretakers (Strathern 1972:10, 47). This level of housing therefore includes both insulated walls and heating from domestic fires. The floor is usually covered with a grass litter, changed relatively frequently. Highland housing may or may not have separate stalls for individual pigs (O'Brien 1969:49; Heider 1970:49–50, 26, 270; Feachem 1977:168–175; Steensberg 1980). Purwanto (1997:145–7, 256–7) provides a detailed description of the construction (including wood types) of the separate pig houses, with stalls, built by the Dani in the Baliem Valley of Irian Jaya.⁶

In a minority of lowland cases, pigs are permanently (or semipermanently) confined in small pens, for example in the Morehead area of Western Province (Ayres 1980), in some of the coastal pile villages built over the sea in Manus Province (Mead 1977:68), and in other parts of New Guinea (Murray 1912:107). According to Conroy (1947:19) the coastal Manus pigs were kept in:

... wooden cages, constructed over the water, usually as extensions to their houses. The average dimensions of such a cage are about 6' long by 4' deep by 3' wide. Pigs are never bred, usually purchased as piglets from the Usiai. They are raised on a diet of fish and *sac sac* (sago) and are outstandingly active and healthy.

At Pere village in 1928, Mead (1977:68) noted that:

Even the pigs have become water animals. During the day they are kept fenced up in small pens on piles, but at night they are let out and wallow and swim peacefully about in the low water, only to be hoisted back into their pens, amid much grunting of pigs and shouting of men, in the early morning.

Ohnemus (1998:271) has reproduced a photograph, taken by Alfred Bühler in the early 1930s, that shows such a Manus cage or pen. A rather similar pen, but on land, was photographed by Ohnemus on the island of Kali in southwest Manus Province in 1994 (Heintze and Ohnemus 1997:46). Pig pens built over the sea were also characteristic of conditions on the artificial islands in the Malaita lagoon in the Solomon Islands (de Fredrick 1977a:116). In the lower Sepik area, where there is considerable wet season flooding, temporary penning has also been reported (Australian Mobile Veterinary Survey Unit 1946:41). Temporary or occasional penning is also reported from the midaltitude zone occupied by the Onabasulu of the Papuan Plateau (Ernst 1984:112, 114), where it appears to have been associated with keeping a few domestic pigs in the vicinity of longhouse settlements and their neighbouring but poorly fenced gardens.

⁶ See 'Definitions' section for explanation of names used in this report



Pig at pig house door, Koge, Sinasina, Simbu Province, 1971.
Photographer: R. Hide.



Pig pens under coconut shade, Tubetube Island, Milne Bay Province, 1994.
Photographer: R. Hide.

6.2 Pig feeding: fodder and forage

6.2.1 Introduction

In general, village pig husbandry regimes in New Guinea are extensive, with most pigs allowed to forage freely during the day, and receiving some supplementary rations from their caretakers. Examples involving more confinement and more substantial fodder are

usually associated with modern, semicommercial systems, though there are some older precolonial exceptions. Understanding of the relative extent to which pigs are provisioned by their own foraging efforts or by the fodder provided by their caretakers is inadequate. The last general summary statement of village pig feeding in New Guinea was that of Quartermain (1977:56), who noted that detailed information was not then available. In terms of fodder, he listed the various crops reported as fed to pigs, and noted that only two studies had attempted the quantification of rations. Regarding forage, he emphasised the almost total lack of information on foraged items, in particular, their identification, relative importance, and their possible seasonal occurrence. He considered that old (or resprouting) human food crops in bush fallow were likely to be important forage items. Five years later, as part of a United Nations Development Programme (UNDP) overview of subsistence food production in Papua New Guinea (PNG), Eele (1983:91) briefly summarised the fodder situation (using data from three PNG highland studies and one from Irian Jaya) as:

‘In highlands communities...on average between one-third and one-half of the total harvest of root crops are fed to pigs. The actual amount consumed appears to be between one and two kilograms of root crops per pig per day...’

Two decades later, there is considerably more information, with many more at least partially quantified studies of pig fodder (some thirty are summarised below), but information on forage is still scarce.

As described in Chapter 4, there has been a tendency for some authors to overestimate the extent to which pigs in parts of the central highlands are dependent on fodder provided by their keepers (Weiner 1988:31; Baldwin 1990:243). However in the 1970s, Copland and Malynicz demonstrated that the fodder rations provided by highland pig keepers were by no means sufficient to result in well-nourished animals. Copland compared the health status (in terms of biochemical and haematological parameters) of village-raised pigs with that of exotic pigs. He showed that the former had lower values than the latter for several key parameters and interpreted these differences as due to the chronically poor nutritional status of village raised pigs (Copland 1976a; Copland 1976b). Similarly, his study of acute pneumonia in the pigs of two Eastern Highland Province villages suggested that low nutritional status and heavy nematode infections were related to the high incidence and mortality from the disease (Copland 1976c). Based on observations of modest fodder rations in Sinasina in 1971–73, Hide (1980) pointed out that domesticated pigs in the central highlands were clearly obtaining a major part of their food from foraging. One significant aspect of foraging was studied in detail by Rose (1981a), as described below in Section 6.2.6. Thus, the feeding regime under village conditions of ‘customary’ husbandry in highland PNG is probably best described as supplementary, rather than one of complete feeding by caretakers.

Interpretation of the information presented below needs care. Determining the size of average rations from short-term surveys using small samples of households or pigs is clearly problematic. The sources of possible variation are large and include, most importantly, household size and composition, the ratio of pigs to people, the state of food supplies, and the state of pig production goals. As regards the latter, rations may well vary during the course of a cycle. For instance, Bowers (1968:93) noted that in the Upper Kaugel Valley (Western Highlands Province), pigs received an extra meal per day as the pig exchange cycle neared completion. Conversely, Bragginton (1975:44) reported that, in the Beha Valley (Eastern Highlands Province), the extra number of pigs in the prefestival population meant that each pig received less fodder. Even more extreme is the account from the Siane area (Simbu Province), in which Salisbury (1975:131) reported that no sweet potato fodder at all was fed to pigs in villages that had recently completed a pig festival: apparently pigs there had to rely on forage only. Further, with the increase in commoditisation of village economies in recent years, it is likely that pig fodder (small and broken tubers) now often changes hands for cash, as reported for the Asaro Valley in 1994–95 (Benediktsson 1998:169).

A note of clarification on the use of the terms ‘fodder’ and ‘forage’ is useful. Generally, fodder consists of cultivated food items fed to pigs, while forage, at least as used recently in the New Guinea context, refers to items located and eaten by the pigs themselves. However, in one dictionary definition (Onions 1966:731), forage can mean cattle or horse food, especially dry winter food as opposed to grass, and thus material that has been collected by people for their animals. The fodder–forage distinction as regards New Guinea pigs can hide two possible sources of ambiguity. People not only provide their pigs with foods (fodder) that they have grown themselves, or purchased, but also with wild items, that they collect expressly to give their pigs. Such items can include wild grasses and leaves, a ‘waterweed’ (possibly *Ipomoea aquatica*) specially collected by Iatmul women in the Middle Sepik (Bateson 1958:145), earthworms specifically dug by pig carers in Sinasina (Hide 1981) and a nest of young rats carefully collected and fed to a pig in Sinasina (Hughes 1970:276). Elsewhere, they included for some piglets owned by the Seltaman in Western Province, a whole range of small birds, frogs, lizards, snakes and other animals (Akimichi 1998:173), and similarly for the Gadio Enga, small snakes, pig skin, fish tails, small frogs and rats (Dornstreich 1973:245). Thus fodder in this wider sense of anything provided by carers, can include wild items that are otherwise foraged by the animals themselves. Conversely, especially in the highlands, people commonly put pigs, sometimes on tether, into old gardens to forage for old or small tubers, which are more usually dug up and transported to pigs as fodder.



Woman herding her pigs for their evening feeding, Gumine, Simbu Province, 1998.
Photographer: R. Hide.

Since at least the classic study of Siuai (Bougainville Province) husbandry in 1938 (Oliver 1949b), it has been understood that adult pigs in New Guinea may receive more food per day than a person. The implications of this were not fully explored until the major expansion of field studies in the highlands after the 1950s. In the following sections, information on fodder is described for three broad altitudinal regions (lowlands, midaltitude, and highlands). Forage foods are discussed below in Section 6.2.6. The use of water by pigs is not described because information is lacking, with the exception of Feachem’s account (1977:155) for a location in Enga in 1973.

6.2.2 Lowlands

There are few quantified accounts of pig feeding from lowland areas in New Guinea, a fact that may have misled Rubel and Rosman (1978:341) to conclude, somewhat rashly, that lowland pig keepers fed no agricultural produce to their pigs as fodder. A handful of studies are summarised below. In contrast to the highlands, where fodder is dominated by sweet potato tubers (and leaves), pigs in lowland areas receive a much more varied diet. While a wide range of tubers, where grown, is reported, two major items in the lowlands are coconut and sago. Conroy's (1947:19) summary account of pig feeding in Manus Province just after World War II, for instance, noted that fodder included taro, sago and coconut meat in whatever quantities available, while foraging was focused on roots like *Hedychium*. The exceptional pigs of the coastal Titan people, penned over the water, were fed fish and sago.

On islands, in particular, coconut is a very important component of pig diets. On Tabar Island in New Ireland Province, coconut and tuber peelings were significant (Fergie 1985:81, 84). In the Siassi Islands (Morobe Province), in 1965–66, where there were approximately 0.14 pigs per person, pigs were fed on cooked cassava unsuitable for humans (rotten, ropey, small and overripe), on coconut husks, taro skins, inedible tubers, fish refuse and grass (Freedman 1967:1, 95, 98). In 1969–70, Carteret islanders (off Bougainville Island), were feeding their 'very plentiful' pigs with bags of copra (Mueller 1972:81). The varied islands of Milne Bay Province support a range of pig-coconut systems. On Tubetube Island, the role of coconut was so important that Macintyre (1983:66–67; 1984) reported that pig numbers, in 1979–80 averaging 0.4 per person, depended on the price of copra: when copra prices were high, few pigs were kept, but when copra prices were low, pig numbers rose. Pigs were penned (though with some access to foraging), and fed 4–8 coconuts daily per pig, as well as food scraps, cassava, yams, pawpaw and occasional fish (Macintyre 1983:66–67). A figure of 8 nuts/pig/day was also mentioned for Mailu (Central Province) in the early 1950s (Firth 1952:67). In addition, Tubetube pigs received food scraps, cassava, pawpaw, yams and occasionally fish. Pigs were sometimes let out of pens and allowed a minor amount of foraging. Coconut was perhaps even more important as fodder on the isolated Budibudi Island group where, in the 1970s and previously, large pigs were raised primarily on coconut for trade and exchange with Woodlark Island (Smith 1985:2; Damon 1990:231–4). Elsewhere in Milne Bay Province, on Sabarl Island in the 1970s, pigs' diets included arrowroot (*Canna edulis*), a minor cultigen (Battaglia 1990:91).

The 4–8 coconuts/day on Tubetube contrasts with Potter's (no date (a)) account of pigs at Pinu in Central Province in the mid-1970s, where pigs foraged freely by day, and the coconut ration varied from 1–2 nuts/day/pig. At Pinu, pawpaw was apparently the only crop deliberately cultivated for pig consumption. Other items included mixed food peelings, and cooked taro, yam and banana. In the Gogodala area of lowland, riverine Western Province in 1975, where there were only about 0.1 pigs per person, Baldwin (1982:36) estimated that pigs received less than 5% of their food from humans, and this was mostly in the form of coconuts.

Undoubtedly the role of coconut as pig fodder in lowland areas has altered in relation to historical changes in the economic significance of the coconut, not just to the relatively short-term price fluctuations of copra described by Macintyre for Tubetube. In this context, the impact of the various colonial policies that directly required villagers to plant coconuts (Mair 1948:83–90), as well as of more local planting initiatives (Swadling 1983:25, 35), clearly altered substantially the potential conditions of husbandry in many areas. Writing of Pinikidu in the Mandak area of central New Ireland Province, Clay (1986:164–5) reported that coconut became much more significant as pig fodder in the late 1960s following the maturation of large cash crop plantings of the palm. Before the 1950s, she described taro as the main fodder, with sweet potato increasingly added during the 1960s. Pigs at Pinikidu were said to grow faster on a coconut diet. One consequence of this was that husbandry declined among the people of the inland Lelet Plateau (see Section 4.2.4), as they turned to coastal people with access to coconut as their pig suppliers (Derlon 1997:47–8).

In lowland areas further inland with low human population densities and few pigs, coconut is either absent or minimal and there may be a wide range of food used as pig fodder. The diminishing role of coconut (in human diets) within a relatively short distance from the coast is documented on the south coast of Irian Jaya (Luyken and Luyken-Koning 1955). The Bedamuni of Western Province feed their pigs with garden refuse as well as foods grown for them, including sweet potato, some yam cultivars, ripe banana, sugar cane ('sweet' crops not regarded as proper human food) plus some live food items such as larvae (van Beek 1987:26–27). More usual is an emphasis on sago in various forms, as has been commented on by European visitors since at least the 18th century (Pennant 1793: Vol. 2, 142–3). The Kubo in Western Province use cooked banana and the pith from sago (Dwyer 1993:129), and in the Yafar area of West Sepik Province, pigs are fed inferior sago (Juillerat 1996:206–7). In the latter case, the Yafar are said to have deliberately given up sweet potato as a crop as it was considered too attractive to pigs.

In the Upper Korowar (Yafar) area of East Sepik Province, the very few pigs kept were occasionally fed items such as fish and sago grubs (Haberland and Seyfarth 1974:249). Also in East Sepik Province, at Gaikorobi (Sawos culture area) where few pigs were kept in the early 1970s, piglets were sometimes fed the milk and flesh of coconuts, but grown pigs received only sago, usually in the form of baked flatcakes (Schindlbeck 1980:131–132). In the lowland foothills of Western Province and Irian Jaya occupied by the Muyu, during the 1950s, food given to pigs included roasted bananas and prepared sago (Schoorl 1993:75), but it was recognised that they needed to forage for worms. In the Tor area of Irian Jaya, young pigs were fed sago mash, while older animals were given unprocessed sago pith (Oosterwal 1961:70).

The use of taro (*Colocasia* in particular) as pig fodder is important. In the Gazelle Peninsula (East New Britain Province), where taro was traditionally the staple, specific varieties of taro were recognised as important for pig food (Rangai 1982). Unlike sweet potato and some other foods, almost everywhere that taro is reported as used as pig fodder, it is cooked first (Oliver 1949b:32; Lawrence 1984:16). While taro corms are not generally provided raw to pigs, taro gardens still usually require fencing from foraging domestic and feral pigs that can destroy a crop by eating all above ground material (Waiko 1982:103; Goodale 1995:75). Exceptionally, at Senemsi village in the Kandrian area of West New Britain Province, villagers in 1994 said that they fed their pigs both cooked and raw taro as the main fodder: a secondary seasonal food in December–March was the skin of breadfruit, after the flesh and seeds had been eaten by people (Hide 1985:15–16).

As regards root-crop fodder in Irian Jaya, Randa's (1994:83) wide-scale questionnaire of highland ($n = 141$) and lowland ($n = 110$) farmers, under apparently quasi-trial conditions, showed that while 89% of highlanders fed their pigs sweet potato, and only 11% cassava, in the lowlands, cassava, taro and sweet potato were fed to pigs by respectively 66, 27, and 25% of respondents. At the lowland site, the fodder included cassava, taro (tubers, leaves and stem), rice, leaves of *kangkong* (*Ipomoea aquatica*), grated coconut and salted fish, and averaged 2.79 kg/day (for further details see below in Section 6.3.4). A similar fodder diet for village pigs was described for the Solomon Islands by de Fredrick (1977a:116–177), based on sweet potato, cassava and coconuts, but also including sago palm pith (from palms felled for roofing material not starch), fish and shellfish, a wide range of foliage including the leaves of sweet potato and cassava, *Hibiscus manihot*, *Pisonia grandis*, *Rhaphidophora* sp., *Piper* sp., *Ficus copiosa* and *Ipomoea aquatica*, as well as most of the common fruits such as pawpaw, breadfruit, banana, pineapple and watermelon. His account emphasised a great range in quantities, with only pigs in the most favoured areas receiving rations of over 3 kg/day.

In apparent contrast with the emphasis from the highland literature, in which the substandard size of sweet potato fodder features strongly, there are reports from some lowland areas that pig fodder includes foods of human standard (Hauser-Schäublin 1983:340–342; McEldowney 1996:32).

Siuai, Bougainville Province (1938)

Oliver (1949b:32) reported that Siuai pigs were fed once a day, during the late afternoon, and otherwise allowed to forage freely. People said that a full-grown pig should receive 4–5 lbs (1.8–2.3 kg) of food daily to keep it properly domesticated. They considered that pigs' rations should be a mixture of boiled taro or sweet potato base, with some cooked greens and coconut meat, and also some peelings. Individual rations should be provided for each animal.

Wosera, East Sepik Province (1962)

In the Wosera area (Abelam culture) of Maprik district (East Sepik Province), a one-week survey in 1962 of the total food given to three pigs showed a very mixed diet (Table 6.1), especially by comparison with the normal highlands diet, which is dominated by sweet potato alone (Lea 1964:126).

Not only are these Wosera rations more varied than the highland diet, they are also surprisingly large, averaging 2.7 kg/pig/day. In a later publication, Lea et al. (1988:26) calculated that these pigs (numbering overall 1.6 per household) were consuming approximately 33% of total village food production. By the late 1980s, however, after many Wosera villages had abandoned pig raising (as discussed above in Section 4.2.4), pawpaw, and soups of taro leaves when pawpaw was in short supply, were the only pig foods mentioned in a report from the Wosera village of Miko (Koczberski 1989:84).

Table 6.1 Food given to three pigs at Yenigo village (East Sepik Province), over seven days (September 1962)

Food type	Weight (kg)
Pawpaw	13.4
Sago (usually old)	10.6
Yam (old and rotten)	9.1
Banana (mostly overripe)	5.8
Taro	5.6
<i>Gnetum gnemon</i> (tulip) leaves	5.0
Green leaves	4.2
<i>Xanthosoma taro</i>	3.7
Total	57.4

Source: Lea (1964:126)

The magnitude of Abelam pig fodder rations is confirmed by Hauser-Schäublin (1983:340), who described pigs receiving amounts suitable for one to two humans. She noted that they received particularly large amounts when tubers (presumably yam) were harvested, and that when root crops were short the fodder consisted of sago and bananas. Fodder was usually cooked, and Abelam people told her that the neighbouring Arapesh usually only gave their animals raw food. D Tuzin (pers comm, University of California at San Diego, February 2002) commented that Ilahita Arapesh people did not systematically cook pig food, though they feed pigs leftovers from human meals, including cooked yam soup and roasted yam tubers, as well as the uncooked yam tubers that constitute their main rations. Further to the west, the Northern Kwanga, who also keep few pigs (less than one per five people), feed them similarly well with evening meals of cooked taro, banana and yam in clay pots reserved for this use, morning feeds of human leftovers, and quantities of pawpaw (Obrist van Eeuwijk 1992:110).

Gadio Enga, East Sepik Province (1968)

In the upper drainage of the Karawari River at 450–900 m altitude, where the population density was only 0.8 persons/km², and the staple foods sago and tubers (taro and sweet

potato), Dornstreich (1973:244–247) weighed the pig food brought to Kombotowa hamlet over three and a half months in 1968 by some 13 Gadio adults. The total pig rations were 1162.6 kg raw sago pith and 771.6 kg of garden produce (all weights originally in lbs). The latter was composed of 353.4 kg taro (11% of the taro harvest), 193.7 kg sweet potato (24% of the harvest), 157.4 kg cassava (80% of the harvest) and 67.1 kg of highland pitpit (44% of the harvest). The combined root-crop ration was about 19% of the total root crops harvested. Other miscellaneous items totalling less than 11 kg included snakes, pig skin, fish tails, frogs, rats, wild yam, pandanus seed and banana. The pig food carried to the settlement represented 20–35% of the total weight carried in by the carers over the sample period. The precise number of pigs receiving these rations was not recorded, but for Kombotowa hamlet may have been as high as 1.5 pigs per person at the time (Dornstreich 1973:36, 128, 236–8, 317).

Nagovisi, Bougainville Province (1972)

A most useful study is that of Mitchell (1976; 1971) from the Nagovisi area of Bougainville Province, where sweet potato was the staple crop in the late 1960s to early 1970s. Mitchell studied the gardening activities of seven households intensively, and weighed their sweet potato harvests for 10 weeks. Analysis of production showed that the amounts of sweet potato harvested per trip and per week correlated most closely with a household biomass figure that consisted of the total human and pig (estimated) bodyweight. Pig bodyweight was adjusted to 50% because pigs derived a proportion of their food from foraging (Mitchell 1976:75–76). Pig numbers were not given in Mitchell (1976) but the total pig bodyweight of the sample was approximately 33% of total household biomass. The original data for six of the seven households showed that they held 0.28 pigs per person (Mitchell 1971:199–202).

Mitchell (1976:73) also suggested that pigs, at least at this level of pig production, may not have been competing directly for food with humans, because a considerable proportion of sweet potato tubers were considered either too small or too large for adult human consumption. His detailed analysis of the distribution of sweet potato tubers by size showed that 35% of overall production (with variation according to garden age and the number of times crops had been planted) weighed less than 50 g. Tubers of this size were only considered suitable for pigs or children. Very large tubers (eg those over 0.5 kg) were also considered unpalatable for people. Tubers weighing more than 300 g comprised some 9% of production. For his sample overall, Mitchell estimated that the pigs received 33% of the sweet potato harvested (Mitchell 1971:214).

Orokaiva, Northern Province (1978)

In the late 1970s, in the Orokaiva village of Koropata, with less than 0.5 pigs per person, pigs received fodder (sometimes cooked, but often raw) from almost the whole range of crops produced: peelings, small taro, sweet potato, pawpaw, coconut, watermelon, old bananas, *Xanthosoma* taro and small yams (Newton 1985a:106–7). Individual rations seemed modest, with four pigs (one large, one medium and two small) receiving typically 3 kg of root crop nightly (ie 0.75 kg/pig/day), and finding the rest of their food through foraging.

Solomon Islands, collected pig food

In the neighbouring Solomon Islands, Henderson and Hancock (1988) recorded a range of foods collected for pigs from both wild and semicultivated plants. These included: the corm of a wild *Colocasia esculenta* (pp. 29, 260); tubers of wild swamp taro, *Cyrtosperma chamissonis* (pp. 183, 260); the trunk-core or pith of such palms as *Caryota rumphiana* (pp. 152, 183, 260) and *Metroxylon salomonense* (pp. 36, 183, 261); the leaves, shoots, and young stems of *Ficus storckii* (pp. 183–4, 261); the leaves of *Epipremnum amplissimum* and *Epipremnum pinnatum* (pp. 183, 261), and of pawpaw, *Carica papaya* (p. 260).

6.2.3 Midaltitude zone

Located between the highlands proper and the lowlands, this intermediate zone is characterised by relatively low human population densities, and in most cases, extensive pig husbandry regimes. Detailed information on pig food is limited. The zone includes both communities dependent upon root crops, and at lower altitudes, those for whom sago is an important food, if not the major staple.

Tsembaga Maring, Madang Province (1962)

In the Simbai Valley in 1962–63, Rappaport (1967:59–62) weighed the rations set aside for pigs by four Tsembaga Maring households for three months. They were caring for approximately 0.93 pigs per person. The pigs received 54% of harvested sweet potato, and 82% of harvested cassava, in total some 36% of all root crops, or, allowing for peelings, perhaps as much as 41%. Individual pig rations could not be weighed, but the average daily ration of tubers per adult/adolescent pig was estimated (extrapolating from data on modern rations by size) at 1.18 kg, or 1.36 kg (allowing for garbage), with smaller pigs getting respectively 0.39 and 0.79 kg per pig. Since Rappaport measured garden areas over two years, he was able to estimate that the sample households, planning for a reduction from 14 to 3 pigs due to slaughter at a pig festival, reduced their cultivated area by 36% in the second, postfestival, year of study. The extra area cultivated per pig was estimated at 0.06 ha (Rappaport 1967:61–62).

At a slightly lower altitude in the Simbai Valley, fodder fed to pigs by the Bomagai-Angoiang Maring during 1964–65 included small sweet potato, cassava and *Xanthosoma taro* (Clarke 1971:85, 155, Appendix C). Both the cassava and *Xanthosoma* were introductions during the previous 30–40 years and in both cases were mostly eaten by pigs. Further, pigs ate the large mother tuber of *Xanthosoma* that was regarded as inedible by humans.

Irakia Awa, Eastern Highlands Province (1972)

In a low density (13 persons/km²) area of the Eastern Highlands Province, the Irakia Awa kept few pigs until the mid-1960s and invested little effort in their care (Boyd 1984:28). Pigs obtained most of their food by foraging, and until the 1960s pigs roamed the village eating scraps and refuse. They were fed tuber peelings and small tubers infrequently (rarely more than once a week), though pregnant sows might be fed more often. By 1972, when 0.5 pigs per person were cared for, most pigs were fed a daily ration of tubers and scraps, with large pigs getting about 1 kg of small, raw, sweet potato (Boyd 1984:34–35). During the 1990s, as described above in Section 4.2.4, pig husbandry was abandoned.

Anga, Gulf Province and Eastern Highlands Province (1987–8)

The small Ankave Anga population, located in inland Gulf Province, occupy territory between 500 and 1400 m in altitude at a very low density (1 person/km²). With about 0.5 pigs per person in 1988, pigs received a maximum of 1 kg of cooked *Xanthosoma taro* per day per pig (Bonnemère 1992:43, 310), though most were only fed about twice a week (Bonnemère 1996:47, 197). In contrast, other, more densely settled, Anga groups such as the Baruya to the north in the Eastern Highlands Province were providing rations of 0.8 kg cooked sweet potato per pig twice a day (Bonnemère 1992:310 fn.1).

Seltaman and Kasanmin, Western Province (1986)

Further to the west, the Seltaman, who also keep about 0.5 pigs per person on a free-range basis, feed their pigs twice daily, either raw sweet potato, or cassava and cooked taro. Adult pigs are said to eat 2–4 times the ration of a person (Whitehead 2000:46), which seems surprisingly high. Nearby, the Kasanmin, with 0.56 pigs per person in 1986, were, on the basis of a 5-day survey, feeding 26% of their garden production, mostly in the form of small tubers of cassava and sweet potato to their pigs (Kuchikura 1990:122; 1994a).

Miyanmin, West Sepik Province (1967—69)

According to Morren, the Miyanmin, who had only 0.1 pigs per person in the late 1960s, were feeding about 16% of their garden production to their pigs. This was mainly undersized taro corms and scraps, which required no extra cultivation (Morren 1977:289, 294; 1986:107).

Etoro, Southern Highlands Province (1968)

For the Etoro on the Papuan Plateau, where more than one pig per person may be kept, estimates of production fed to the animals are very low: less than 5% of sweet potato production (Kelly 1988:119; Dwyer 1990:57–8).

Other midaltitude locations

Other areas in this zone where pigs mainly receive root crops include the Gende in Madang Province (Zimmer 1985:114), and both the Hewa and Bogaia in Southern Highlands Province (Steadman 1971:33; Sillitoe 1994:34, 62). For the Bogaia, there are no quantitative data, though Sillitoe (1994:34, 62) extrapolated, from highland data, that 50% of sweet potato production was fed to pigs. He also noted the use of wild banana as pig food.

Poole's account of the Bimin-Kuskusmin (West Sepik), who keep few pigs, is not easy to interpret. Though taro is an important crop, pigs are never fed taro, but receive some supplementary amounts of sweet potato (Poole 1976:279). Elsewhere he emphasised attempts to direct the foraging of pigs 'in forest and fallowed gardens, the deliberate cultivation of stocks of earthworms and grubs as pig fodder in rotting stumps of felled trees, and secret preparations of sago, bananas, yam and *Pueraria*' (Poole 1994:191, 208).

At Lake Kutubu (Foi area) in the Southern Highlands Province, piglets taken from sows a few weeks after birth were initially fed sago and wild taro leaves, and later, when tamed and released to forage, were fed sago pith (Rule 1993:13).

One of the lowest cost systems is that described by Hughes (1970:723), for the karst zone below 1000 m around Lake Tebera in Gulf Province, where people use 'natural physical barriers and planted stands of sago to maintain domesticated pigs on a permanent basis in areas remote from human settlement'. The reliance on unprocessed sago for fodder results in a minimum of human effort. Some very similar practices, with the addition of some tuber inputs and the carriage of raw sago pith to pigs, were recorded for the Gadio Enga by Dornstreich (1973:244–247), as described above (Section 6.2.2).

6.2.4 Highlands

In contrast to the relatively mixed (at least where sago does not dominate) fodder diet given to pigs in the lowlands and midaltitude zones, throughout the PNG highlands, the main fodder given to pigs is usually sweet potato tubers with additional leaves and vines. A similar predominance of sweet potato is reported for the highland area of Irian Jaya. Randa's (1994:83) wide-scale questionnaire of highland ($n = 141$) and lowland ($n = 110$) farmers in Irian Jaya showed that 89% of highlanders fed their pigs sweet potato, and only 11% cassava, while in the lowlands only 25% of respondents fed sweet potato to their pigs (further details are given below in Section 6.3.4). In at least two cultural areas, Eipo in Irian Jaya (Michel 1983:81) and Bimin-Kuskusmin in West Sepik Province (Poole 1976:279), it was forbidden to feed taro to pigs.

Twenty studies in the PNG highlands (including the Finisterres), and three studies from Irian Jaya, are summarised below. Tucker (1986–87) provided a generalised account of Irian Jaya agricultural systems, with some information on pig husbandry, but included no quantitative data on pig feeding (see also Kelempok Penelitian Agro-ekosistem (KEPAS) (1990).

In most parts of the highlands, people identify a considerable number of sweet potato cultivars, though, as shown by several field investigations, relatively few cultivars make up the majority of plantings in a garden (Hide 1981:296–7; Sillitoe 1983:148; Bourke 1984b:60; Bayliss-Smith 1985:115). In some cases, people describe a number of the cultivars as good for feeding pigs (Heider 1969:83; 1970:33; Brookfield with Hart 1971:87; Reay 1984:72). For the Mount Hagen area (Western Highlands Province), Powell et al. (1975:15–19) has noted that these tend to have excellent leaf growth and produce heavy crops, but have poor flavour. Similar characteristics (high yield, poor taste and soft-textured flesh) are reported for two recent varieties described as grown solely for pig food by Huli people at Haiyapugwa in the Southern Highlands Province (Powell with Harrison 1982:63, 65). For the Dani in the Baliem Valley of Irian Jaya, Purwanto (1997:380–1), who lists at least 11 cultivars as pig food types, reports that the tubers of these varieties are characteristically larger, more fibrous and less tasty than those preferred for human food (though pig varieties are also eaten by people). Similarly, Sillitoe (1983:31) described the tubers fed to pigs by the Wola of the Southern Highlands Province as coarse, fibrous and unpalatable. Describing the Mendi area of the Southern Highlands Province, French (no date: 14) noted that people preferred tubers with a high dry matter while the soft kinds were fed to pigs. In the Kewa area (also Southern Highlands Province), the types of sweet potato fed to pigs were ‘bitter’ or ‘not sweet’ (Franklin et al. 1978: 124, 227, 244, 249–250, 272).

With the exception of these accounts of the criteria people use to determine the suitability of ‘pig’ cultivars for pigs, little or no work has been done on the extent to which such ‘pig’ cultivars are specifically grown for pigs. In the Nembi Plateau area of the Southern Highlands Province, it was noted in 1980 that one pig variety that was not liked as human food, made up 10% of plantings (Crittenden 1982:402). In the Wiru area of the Southern Highlands Province in 1981, a recently introduced (from Kiburu Agricultural Station) high-yielding, disease-free, cultivar known as *Nivefa* was initially rejected by villagers on the grounds that they disliked its taste, but it was subsequently much in demand as pig fodder (Spore 1981). At Lake Kapiago in the Southern Highlands, Robinson (2001:198) has reported that following the 1997–98 drought, Duna people specifically chose sweet potato cultivars that were known to produce ‘numerous small tubers’ for use as pig fodder.

Almost everywhere some or all of the sweet potato tubers fed to pigs are said to be small, stringy or otherwise unfit or unsuitable for human consumption (Reay 1959:11; Strathern 1972:18, 46; Wohlt and Goie 1986:210; Sillitoe 2002:445–6), although as Waddell (1972b:62, 120) has discussed, the distinction drawn between pig and human tubers is not necessarily always a qualitative one. The proportion of a harvest composed of such tubers is discussed further in Section 6.6.1 (see also Section 6.2.2 on the Nagovisi).

Most of the field studies summarised below, and presented here in chronological order, are now 20 or more years old. While sweet potato undoubtedly remains the main fodder in the region, new foodstuffs have appeared and are under-represented here. For instance, in the North Baliem Valley, Irian Jaya, a demonstration farm experimenting with terracing on steep slopes planted a mixture of red and white clover and temperate grasses to prevent soil erosion. The clovers and grasses were harvested regularly for feeding to pigs (and rabbits) (Askin 1996:267). It is also notable that there is relatively little information on the use of taro as sweet potato fodder (in any altitude), despite the importance of that food in areas such as the Ok speaking region of West Sepik and Western provinces. One partial exception is Bayliss-Smith’s account of cultivation in the Bimin Valley, which noted that among the 108 named taro cultivars, a number were ‘reserved’ as pig foods (although considered edible by humans) and two of these when analysed had below average energy values (Bayliss-Smith 1985:108–9).

Compared to the lowlands, many more of the highland studies have involved measurement of pig fodder rations. The majority however did not weigh the rations of individual animals, instead relying on pig carers separating pig from human rations at the household level. Information on the extent to which fodder rations are cooked is also not always complete. In the interesting case of the Kunimaipa of upland Central Province in

the mid-1950s, sweet potato rations were cooked, apparently with the stated aim of preventing pigs from developing a taste for raw tubers and thus raiding gardens (McArthur 2000:30). Similar reasoning is reported for the Watut of Morobe Province who fed their pigs cooked tubers of sweet potato, taro and yam (Fischer 1963:62–64), and the Mandak of lowland New Ireland Province (Clay 1986:164).

Aiyura, Eastern Highlands Province (c. 1950)

In his account of agriculture at Aiyura, Schindler (1952:306) noted that two families, one with 16 pigs and the other with 7, were feeding about half their sweet potato production to the animals.

Kyaka Enga, Western Highlands Province (1955–56)

For one closely observed Kyaka Enga settlement (Baiyer River area) in 1955–56, in which the number of pigs was relatively low following a major Moka exchange or slaughter ceremony one year earlier, Bulmer (1960:94–98) estimated that the average household of two adults and two children looking after four yearling pigs consumed a total of 14.52 kg sweet potato/day, with the pigs receiving 50% of the raw tubers, as well as household scraps. This translates to an estimated production of 3.63 kg sweet potato/person/day, and a ration of 1.81 kg sweet potato/pig/day.

Auyana, Eastern Highlands Province (1962)

Robbins (1982:64) described in approximate terms the frequency and size of sweet potato rations fed to pigs by five households during 1962. Frequencies ranged from once daily to twice a week, with most people feeding their pigs every other day. Rations ranged from about 0.03–0.05 kg/pig/day for the lower frequency regime, to about 0.86 kg/pig/day for the daily ration. Pregnant sows and young pigs apparently were fed most. Overall, for the whole community, there were 2.2 pigs per person but the ratio of pigs per person for the feeding sample households was not given.

Upper Chimbu Valley, Simbu Province (1964)

For the Upper Chimbu Valley in 1964, Criper (1967:64) described a small survey of one household (4 people, 6 pigs) for 11 days. The average daily harvest of sweet potato was 14.51 kg, of which an average 8.16 kg, or 56.2%, was given to the pigs. The mean pig ration was 1.36 kg.

Raiapu Enga, Enga Province (1966–1967)

Waddell (1972b:117–121) reported the pig rations for a sample of three households studied for two 10-day periods. Data were aggregated for the whole sample; therefore, no examination of interhousehold or interpig variation is possible. For the sample as a whole, the number of pigs per person was 1.7. Average daily sweet potato production per person was 3.79 kg. Pigs consumed 64% of all sweet potato. The average daily ration per pig was 1.4 kg of sweet potato, and 0.1 kg of *Setaria* leaves and peelings. Pigs also received small amounts of sweet potato leaves, tomato, sugarcane, Irish potatoes and other crops, as well as refuse and peelings.

Sinasina, Simbu Province (1972–73)

In Sinasina (Hide 1981:361–377), pigs received daily rations of sweet potato, either raw or cooked, and some green leaves (sweet potato vines, the grasses *Pennisetum clandestinum* and *Setaria purpurea*, and leaves and peelings of *Setaria palmifolia*). Other occasional items provided by pig keepers included rats, earthworms and titbits from human meals. The amounts fed to pigs were weighed for seven households over 4–8 days during November 1972 and March of 1973, both of which are periods when sweet potato production may have been lower than normal due to the effects of the 1972 drought (Hide 1981:36–44, 363, 465, 473, 624–6).

The sweet potato rations fed to individual pigs were measured for a small sample of 12 pigs belonging to 3 households. These rations ranged from 0.6–2.6 kg sweet potato/pig/day, and averaged 1.2 kg (Hide 1981:365). Notably, the small animals of 15–17 kg live weight received relatively large rations (0.6–0.9 kg). There was a trend for rations to rise to about 2 kg/day for pigs of 80 kg size.



Pigs feeding on sweet potato and pitpit (*Setaria palmifolia*) peelings at pig house, Kuai, Sinasina, Simbu Province, 1968. Photographer: R. Hide.

The rations given to household pig herds (not individual pig rations) were weighed for seven households (1.8 pigs per person for the sample as whole). Of an average daily total of 96.6 kg sweet potato produced (or 105.2 kg including purchases and gifts), 51.1 kg sweet potato/day was fed to pigs. The average daily sweet potato production was 3.86 kg/person, similar to the figures reported by Waddell for the Enga sample and by Cripser for Upper Chimbu. Pigs received 53% of total sweet potato production (or 48.6% of all sweet potato produced, purchased or received by households). The average ration per pig was 1.14 kg sweet potato/day, calculated for the sample overall (ie 51 kg/45 pigs). This relatively low figure is the result of one household caring for 19 pigs, many of which were piglets. With this household excluded, the average ration per pig was 1.27 kg/day, calculated for the reduced sample values of 36.94 kg/29 pigs. Alternatively, the average daily ration per pig calculated by averaging all seven household means was 1.67 kg sweet potato.

There was considerable variation between households in terms of both the proportion of sweet potato production fed to pigs (25–68%), and the average amount received per pig (0.74–3.20 kg/day). The former was related to the relative numbers of pigs and people within each household, the latter to both absolute and relative pig numbers.

Limited weighing of green fodder rations suggested a daily portion of about 0.36 kg leaves per pig.

Duna, Southern Highlands Province (1972)

At Horaile settlement in 1972, Modjeska (1977:140) weighed the pig rations of sweet potato at one homestead, with a herd of two large sows and nine piglets, for 23 days, and also weighed the rations set aside for 22 pigs in four other homesteads on one day each. The average daily consumption per pig was 2.14 kg of sweet potato. As he noted, this seemed high, though he also calculated (from yield and area measurements, not weighed

production) that the average production of sweet potato per person per day was a high 5.6 kg (Modjeska 1977:136, 143).

Yumbisa Enga, Enga Province (1972—75)

At the high altitude location of Yumbisa (over 2500 m above sea level) in Enga Province, in 1972–5, where pigs were free to forage during the day, the pigs were fed daily, usually with the small sweet potato from the day's harvest, and, when available, some greens (Wohlt 1978:150, 157). In good times, the daily sweet potato ration was up to 2 kg maximum for large pigs, though, on average, Wohlt's (1978:157, 161) food intake surveys suggested that each pig received about 1 kg/day. Garden surveys of potential food supply, however, suggested a higher figure of about 1.7 kg/pig/day. The intake surveys indicated that pigs were consuming about 55% of sweet potato tubers, though this proportion varied with availability (Wohlt 1978:162). In addition, pigs received very minor quantities of Irish potatoes and some greens in the form of sweet potato leaves and *Setaria palmifolia* leaves.

During the 1972–73 food shortage, although pigs were provided with almost no food by their owners, they appeared not to suffer, indicating that foraged foods were adequate. Fifty-six households that migrated to lower altitudes left 14% of their herds behind, and significantly these animals survived well on natural forage without supplementary feeding for several months (Wohlt 1978:150-1,170; Wohlt 1989:229).

Wola, Southern Highlands Province (1973—74 and 1976—78)

Sillitoe (1983:228–239) conducted two very extensive studies of production and consumption in the Nipa area, which both provide data on pig fodder. In neither case were individual pig rations weighed: all data were described at the level of households and the total sample. Apparently only raw sweet potato tubers were fed to pigs (Sillitoe 1983:37). In an initial survey of crop yields (regarded as less rigorous than the second survey), 10 households, with 0.79 pigs per person overall, were investigated for 1–17 days. Overall, the sample produced 2.70 kg sweet potato/person/day, considerably less than the figures for Raiapu Enga and Sinasina described above. For the whole sample, 48.5% of sweet potato production was fed to pigs at an average daily ration of about 1.7 kg per animal. Sixty-seven per cent of *Setaria* was fed to pigs, at an average daily ration of 0.16 kg, though, since not all households produced *Setaria*, the ration of those pigs that received it was higher.

In the second survey focused on consumption, 12 households were investigated for 12–92 days. Overall, there were 0.87 pigs per person (Sillitoe 1983:234–5, calculated from Tables 38 and 39). The sampled households produced approximately 2.75 kg sweet potato/day/person (minus children under 1 year of age), and 48.7% was fed to pigs. The daily ration of sweet potato per pig was 1.54 kg, with 0.10 kg of *Setaria*. There was considerable variation by household, with the proportion of household sweet potato production fed to pigs ranging from 31–56%, and the daily average received per pig from 0.83–3.01 kg. Some secondary sources (eg Shaw 1985:16) have cited these data as showing that adult pigs were given 2.8 kg/pig/day; however, this figure was an estimate only. To refine his estimates of consumption levels, Sillitoe (1983:238) divided pigs into four age categories (piglets, shoats, adolescents and adults), and assigned assumed relative consumption values of 0.2, 0.4, 0.8 and 1.0 respectively to each class. From this, he estimated that an adult pig ate an average 2.75 kg/day. His data (Sillitoe 1983:234–5, Tables 38 and 39), however, indicate that the average ration size may have been dependent more on the relative numbers of pigs in a household than their size, as was also the case with the Sinasina material described above. In a recent re-presentation of part of his data, Sillitoe (2003:323–325) argues that this relationship did hold.

Sillitoe (1996:397) has argued that, in general, the sweet potato tubers fed to pigs by the Wola are byproduct ones unsuitable for human consumption, and that it is 'unusual to see people feeding large tubers suitable for human consumption to pigs.' Elsewhere, he described the tubers fed to pigs as those that are 'coarse, fibrous and unpalatable' (Sillitoe

1983:31). Besides sweet potato and highland pitpit, Wola also feed the lateral sucker tubers of *Colocasia* taro, described as often bitter and inedible (to humans), to their pigs (Sillitoe 1983:38, 42).

Mendi, Southern Highlands Province (1975)

Harrison (1976:35), working at two locations near Mendi, noted that piglets were fed lizards, snakes and house rats as well as tubers. Sweet potato and *Setaria* were the main fodder items for older pigs. Tubers were small, usually weighing less than 60 g, and were taken mainly from older gardens that yielded larger numbers of such small tubers. Adult pigs were fed 2–3 kg of sweet potato per day. When fodder was short, elephant grass was included.

'Kapanara' village, Kainantu District, Eastern Highlands Province (1976)

A detailed survey of pig feeding was carried out by Grossman (1984:168) at 'Kapanara', a Tairora-speaking village, in 1976 for three 1-week periods. The study covered 43 pigs belonging to four, six and four households respectively in the three periods. Of the 43 animals, 31 were fed at the main settlement hamlets and 12 at more distant sites. Results were presented by site for all pigs, without household breakdowns (with only one range exception). The hamlet-fed pigs received 1.6 kg/raw sweet potato/day/pig (range per household 0.5–2.86 kg/pig/day), and an additional 0.24 kg of scraps per pig. The more distantly located pigs received a much smaller ration of 0.65 kg/raw sweet potato/day/pig, and 0.11 kg of scraps per pig. The overall mean daily sweet potato ration per pig was 1.3 kg.

Nembi Plateau, Southern Highlands Province (1980–81)

In a community in which there were then 0.5 pigs per person (described as probably lower than normal due to anthrax epidemics), pigs were receiving 38% of sweet potato production, and an average ration of 1.3 kg sweet potato/pig/day (Crittenden 1982:474, 476). Total sweet potato production per person was a very low 1.7 kg/day, which, after subtraction of the pig ration of 1.3 kg for the average one pig per two persons, left a mere 1.1 kg/person/day for human consumption. (The pig ration was averaged from the weights of fodder given to 51 pigs belonging to 7 households over 1–3 days of survey (R Crittenden, Anutech, pers comm, June 2001).)

Dom Alaune, Simbu Province (1980)

Preliminary diet intake studies conducted at Dom Alaune in March–April 1980, showed that, for four households, with an overall 0.61 pigs per person, surveyed over three days, 61% of harvested sweet potato was fed to the pigs (Harvey and Heywood 1983a:195). The studies also showed that for two subgroups of two households each, with 0.87 and 0.38 pigs per person, surveyed over 7 days, 62% and 50% of harvested sweet potato respectively was fed to pigs (Harvey and Heywood 1983a:196–8; Wohlt and Goie 1986:178).

Sinasina Yobakogl, Simbu Province (1981)

Harvey undertook a larger scale survey of food intake at Yobakogl in 1981 of 12 households with overall 0.79 pigs per person for five or six consecutive days, at a time when food was said to be short (Harvey and Heywood 1983a:111). The average proportion of harvested sweet potato fed to pigs for 9 households was 42%, with a range from 23–55% by household (Harvey and Heywood 1983a:104, 183–4; Wohlt and Goie 1986:178). At the household level, there was a rough positive correlation between the relative numbers of pigs per person and the proportion of sweet potato fed to the pigs. Using these and other Sinasina data, Wohlt and Goie (1986:178–9) later derived values for an equation to predict, for the northern half of Simbu Province, the relative amount of sweet potato going to a pig, where the ratio of pigs per person is known.

Hagini, Lake Kapiago, Southern Highlands Province (1984)

In a brief study, Bell reported that Duna people at Hagini in 1983, when food was said to be short, produced 3.87 kg sweet potato/person/day, with people consuming 1.47 kg/person/day (Bell 1984:35, 47). Pigs consumed an average 1.9 kg sweet potato/pig/day (Appleby et al. 1985:23). Overall, there was one pig per person, but the ratio for the sample of households surveyed for production was not reported.

Yani and Boromil villages, Gumine District, Simbu Province (1987)

The results of this study contrast so markedly with all other highland ones that they are summarised only. Carried out as part of the Highland Food Crops Research Team's wider investigations at Gumine, the fieldwork was conducted by a locally resident technician over four survey rounds during several months of 1987–8. Data from 8 (or 6?) households from a wider sample of 40, with 0.46 pigs per person, indicated that pigs were fed on average 4.1 kg sweet potato/pig/day (Ghodake 1989). Given the results from all other highland sites, this seems much too high for an average result over several months and the data require further scrutiny.

Nokopo, Finisterres, Madang Province (1987)

At Nokopo, in the Finisterres, during a 1-week survey of one household (6 adults, 4 children) with 16 pigs (6 adult and 10 piglets), the pigs were fed a total of 82.5 kg of fodder, with some additional sweet potato vines and leaves (Kocher Schmid 1991:101; C Kocher Schmid, University of Kent, pers comm, June 2001 for additional details). This fodder total included 45.5 kg of food held over from the previous week (made up of 26 kg sweet potato, 11.5 kg scraps — mainly sweet potato peelings — 7 kg pumpkin and 1 kg English potato: only the English potato was cooked). The fodder harvested during the survey week included 10 kg of sweet potato (of a total 87.5 kg harvested), 9 kg of a total 13 kg English potato, 10 kg of squash and choko fruit, and 7.5 kg of peelings and leftovers. The rest of the week's food harvest, not used for pig fodder, included 22.5 kg of vegetables, 13 kg of banana and 114 (unweighed) corn cobs. In summary, with 1.6 pigs per person, this household harvested during one week, a minimum (minus the corn) of 145.2 kg of all food, or 2.07 kg food/person/day. During the survey, the pigs received a total of 11.79 kg food/day, or 0.74 kg/pig. This average daily per pig ration consisted of 0.32 kg sweet potato, 0.09 kg English potato, 0.16 kg squash/pumpkin and choko, and 0.17 kg peelings and leftovers.

Tari, Southern Highlands Province (1993, 1994)

A detailed study of two contrasting locations at Tari in 1994, Wenani on favourable swampland at Haibuga, and Heli at a poorer site on the Paijaka Plateau, showed that, for a 7-day survey period, pigs were fed respectively 1.7 and 1.2 kg sweet potato/day/pig (Umezaki et al. 2000:372). (Food weights here converted from kcal in original at 122 kcal = 100 g). The percentages of garden production, primarily sweet potato, fed to the pigs were 70% at Wenani and 52% at Heli, though production may have been affected by an extended rainy period (Umezaki et al. 2000:360, 363). At Wenani, the study included 9 households with 1.9 pigs per person and, at Heli, 12 households with only 0.6 pigs per person.

A study the previous year by Kuchikura (1999:74–5) of a Wenani sample with 1.5 pigs per person, showed that the pigs then received 60.5% of harvested sweet potato, and 57.8% of the total energy value of the harvest, over a 6-day survey period. Despite more 'normal' climatic conditions (Umezaki et al. 2000:360), the average pig ration was a similar 1.71 kg of sweet potato per day (converted from kcal).

Mekiawa village, Oksapmin, West Sepik Province (2001)

In December 2001, Boissière (Brutti and Boissière 2002:151–2) measured the pig rations of five Oksapmin pig owners over 10 days, but the data were not complete for the first

five days or for the last day. For the other four days, the owners fed their pigs an average 2.83 kg sweet potato/pig/day, with a range per owner from 0.62 kg/pig/day (by an owner with two pigs) to a very high 6.25 kg/pig/day (by an owner with one pig). Small additional amounts of cabbage leaves and other vegetable items were only given by two of the five owners on, respectively, one and two of the four days surveyed (giving an overall average per owner of 0.08 kg/pig/day). There was considerable variation between owners, with some feeding their animals twice a day, others only once, and some missing several days. Usually only small sweet potato tubers were included, raw for most animals, but sometimes cooked in the case of young ones.

Irian Jaya: Kamu Valley, Paniai Lakes (1955), Baliem Valley (1961) and Eipo (1976)

In 1955, the Ekagi-Me (Kapauku), in the Kamu Valley, kept only 0.17 pigs per person, but apparently fed them very large rations. Pospisil (1972:207) described (no measurement basis given) fodder of approximately 4 kg sweet potato/pig/day, with most tubers undersized. He also estimated that the 31 pigs of Botukebo community consumed some 37.2 tonnes of sweet potato over 8 months, or 5.4 kg/pig/day (Pospisil 1972:196, 218, 395–6). This constituted 26% of sweet potato production, which was an estimated 3.4 kg/person/day.

Conversely, the fodder rations of the Dugum Dani in 1961 seem to have been small. With about one pig per person (though possibly as high as three at times, see Waddell (1972b:211)), the Dugum pigs were reported as eating almost exclusively waste, with only minor food production especially for them (Heider 1979:36; 1970:50).

In the Eipo region in 1976, where there was approximately one pig per three people, very small piglets were fed pre-masticated sweet potato, and their diet was gradually changed from cooked sweet potato and sugarcane to raw sweet potato tubers (Michel 1983:81). On average, pigs received about one kg of sweet potato/day.

6.2.5 Sweet potato fodder in the highlands

The relationships between total and relative amounts of sweet potato production and the proportions received by people and pigs indicated by these local level studies, are fundamental to understanding both the dynamics of pig husbandry, and also the wider nature of agriculture in the highlands. Discussion of the development of intensive agriculture and pig husbandry in the New Guinea highlands has often stated or implied that expansion or intensification of pig husbandry in the highlands followed the introduction and adoption of sweet potato as the staple crop, because of particular advantages of this crop for pig fodder over other root-crop staples such as yam, taro and cassava (Watson 1977; Watson 1983a:328–334; Morton 1984:55). For example, Watson (1983a:328) wrote of sweet potato's 'greatly enlarged potential for both food and fodder', and suggested that an expanding supply of fodder would result in a sharp increase in the regional pig herd. This argument seems to have developed largely from observation of the general correlation between sweet potato and higher relative pig numbers in the highlands compared with lower numbers in lowland areas where other staples are used as fodder (see Sections 5.9 and 6.2.1–6.2.4). Two points are worth noting. First, Kelly (1988) has argued that high relative pig numbers (ie more than one pig per person) are possible without dependence on sweet potato as the main fodder. To support this argument, the author cites two examples — Etoro and Gulf; however, the latter is perhaps problematic, given the lack of quantified evidence. In these two cases, extensive forage and the availability of sago as pig feed were significant factors. Second, there is also evidence from Pentecost Island in Vanuatu that as many as 1.4 pigs per person can be raised in a system where the fodder is not sweet potato, but rather a typical lowland mix of poor quality taro and yams, overripe banana and pawpaw, and dry coconut gratings (Jolly 1984:86–7). Such high pig per person ratios may occur elsewhere in Vanuatu and, to a lesser extent, the Solomon Islands (see Section 5.8).

Recent analysis of sweet potato production data at the national level from the 1996 PNG Household Survey, however, seems to present a different picture of the key relationship described by the highland microstudies summarised in Section 6.2.4. With an average national household size of just under six persons, caring for 2.4 pigs, daily production of sweet potato averaged only 4.5 kg/household/day, or 0.75 kg/person (Gibson 2001c:18–21). The strongest relationship between household production and other variables was with household size. Sweet potato production was weakly, if at all, related to pig numbers: each additional pig owned appeared to increase harvested production by about 0.07 kg/day. In short, with 2.4 pigs per household, the estimated consumption of sweet potato by pigs was only 0.2 kg/day — a mere 4% of daily production. As Gibson comments, this means that the survey did not measure much of the sweet potato destined for pigs. In a subsequent analysis, applied only to the highlands data, the average production of sweet potato was almost twice as great, at 1.35 kg/person/day (J Gibson, University of Waikato, pers comm, June 2001). This is almost three times less than the amounts recorded by the microstudies in Raiapu Enga, Upper Chimbu and Sinasina described above. In this analysis, sweet potato production was not correlated with the number of pigs held by households. The Household Survey appears therefore to add little to understanding about the use of sweet potato as pig fodder.

6.2.6 Forage foods

As Quartermain (1977:56) noted over 20 years ago, the forage component of pig feeding has been neglected by researchers. In pioneering work on highland agriculture, Brookfield (1966:49) guessed that as much as one third of the feed requirements for domestic pigs in central Simbu Province might be obtained by foraging. For the lowland area of Gogodala, Baldwin (1982:36) estimated that adult village pigs were foraging 95% of their food, with no empirical basis for this estimate. The major advance during the last 20 years is the work of Rose (and others) on pigs and earthworms in the Southern Highlands, discussed in more detail in Chapter 9 (see Section 9.4).

Rose (1981a) studied village pigs that were kept under an intensive system of outdoor management. Using 3-month-old village pigs, he compared tethered pigs foraging on grassland without access to sweet potato, with those in two treatments foraging on harvested sweet potato. The liveweight gains of the pigs on fallow areas were considerably less (140 g/day compared to 191–205 g/day), than those foraging on the sweet potato treatments. In the latter, with sweet potato tubers and leaves fed ad libitum, the amounts of sweet potato consumed daily ranged from approximately 1.05 kg/day for piglets of 10 kg liveweight to 2.40 kg/day for small pigs of 30 kg (tuber weights converted from dry matter figures, Rose 1981a:138, Fig. 3). With the pigs foraged on completely harvested sweet potato mounds (treatment 1), Rose found major differences between the apparent protein intakes and the recommended levels (61% and 68% respectively for 17 and 27 week old pigs), implying that a large proportion of their protein requirement was obtained from foraging. He suggested that earthworms, of which the pigs ate large numbers, may have accounted for the difference. He reported the crude protein content of the earthworms as 42.3% of the dry matter (which was 21%), with lysine and methionine contents of 6.0 and 1.4 g per 16 g of nitrogen respectively. A second paper, Rose (1981b), which described the results of carcass dissections and energy and protein analyses of tissue components of some of the pigs in the trial, supported the suggestion that foraging yielded food of a high digestible protein content. In a third paper, Rose (1982b) reported detailed observations of the behaviour of the pigs at tether during the same trial. Between 60 and 87% of their time at tether was spent rooting in the soil, and of this, 54% to 76% was spent specifically rooting for, and eating, earthworms.

To follow up these findings about the probable importance of earthworms, Rose and Wood (1980) carried out a trial at Piwa Agriculture Station in the Southern Highlands Province on earthworm populations under sweet potato cultivation, to identify the species of earthworm present and investigate environmental relationships. Both the predominant species (*Pontoscolex corethrurus*) and the other species (*Amyntas corticus*) found were

exotic, recently introduced, species. The Huli people in the region claim that the former earthworm is responsible for improvements in pig feeding and growth rates. Earthworm populations under mounded cultivation were large: 93–302 earthworms/m² (equivalent to 45.6–127.7 g freshweight/m²). In a subsequent trial, Rose and Williams (1983–84) investigated the effect of earthworm consumption by village pigs under village conditions. They compared the growth rate of pigs foraging on tether in harvested sweet potato gardens with those with no access to soil. The former group gained 147 g/day compared to the latter group, which lost weight and exhibited signs of protein malnutrition. Close observation of 10 foraging pigs showed that each pig ate between 414 and 1224 earthworms daily (half the daily amount was eaten in the first hour of foraging). The pigs only ate *Pontoscolex corethrurus* and avoided the other species *Amyntas corticus*. The significance of exotic earthworms in the diets of (feral) pigs has also been reported from Hawaii (Stone and Loope 1987:247).

Sillitoe (1996:259) has described the spread of the introduced earthworms into other parts of the Southern Highlands since the early 1980s. Wola people say that the new earthworms replace the existing worms and lead to poorer soil fertility. However, they are recognised as being very attractive to pigs, which are said to grow quickly if fed on them, and to lay down a thick layer of fat. The same introduced species of earthworms (*Pontoscolex corethrurus* and *Amyntas corticus*) were also widely distributed in Simbu Province by the early 1980s (Humphreys 1984:33–38).

The deliberate targeting of pig forage areas known for their yields of earthworms and other grubs is commonly reported (Meggitt 1958a:285). Howlett (1962:126, 143) noted that Asaro men at Fondiwe'i said that the reason pigs foraged in the forest fringe was for a variety of grubs and earthworms. A similar preference for the tree line at the lower forest margin was expressed in Raiapu Enga (Feachem 1973a:30). Piglets among the Seltaman were taken to forest near the village or the garden to forage for small earthworms and other things. This was said to prevent sickness caused by eating only scraps in the village (Akimichi 1998:173).

There is a unique report from the Yali area around Angguruk in the east of the Irian Jaya highlands that links pigs closely in myth and ritual to earthworms, and relates how ancestors are said to have tended worms before they tended pigs (Zöllner 1988:75–79). The cultural significance of this association is unclear.

Preferred environments in the highlands for pig foraging include swampland, swampy grasslands and riverine terraces (Reay 1959:3; Strathern 1972:12; Waddell 1972b:62, 120; Powell with Harrison 1982:37), and a range of areas that are important on a seasonal basis as different palms or trees fruit. These include pandanus, oaks and other species. Feral, and perhaps some domestic, pigs forage to altitudes of up 3750 m on alpine grasslands: on Mount Albert Edward, they were reported to apparently feed preferentially on the tap roots of *Potentilla* (Hope 1975:5).

In the highland regions, the forest margins containing planted and wild pandanus of the *karuka* type (*Pandanus julianetti* and *P. brosimos*) are widely recognised as seasonally important foraging grounds, with pigs targeting the fallen fruits and nuts (Hallpike 1977:70; Cape 1981:157; Hide 1981:281; Bonnemère and Lemonnier 2002). According to Cape (1981:157), Oksapmin pigs were eating the 'outer meat' of the nut, presumably referring to the mesocarp, which he described as a 'free feed' because it was not eaten by people. Elsewhere, however, it is. In some cases, pigs are moved to the high-altitude areas of pandanus groves with the onset of a good harvest (Wohlt 1978:126, 170; Hide 1981:327–350; Wohlt 1989:225). In the Tari area, parts or whole fruits may be fed to pigs (Rose 1982a:162). Similarly, in the Eastern Highlands Province, Gimi people apparently fed pandanus nuts to young pigs (Gillison 1993:37). Gillison (1983:145) also noted that Gimi pigs usually foraged in the pandanus zone as the dry season (June–September) 'progresses', favouring in particular the 'larvae which infest the rotting pineapple-shaped clusters of white, nut-like fruit that falls from huge wild pandanus trees'. This may be *P. antarasensis*. In the Nokopo area of the Finisterre Range, on the other hand, pigs were deliberately excluded from the pandanus groves during the main harvest, and only

allowed to forage the zone afterwards for nutshells and other debris (Kocher Schmid 1991:180).

In the Gimi region, pigs forage mainly in the 1500–2000 m zone. At Ubagubi village (1600–1800 m), women took their adult pigs at the end of the dry season in September to October, further down to the 1400–1500 m zone, into groves of *ugami* trees (possibly *Castanopsis* or *Lithocarpus* spp., see below) to fatten them on the nuts that littered the ground (1983:145; Gillison 1993:37–8, 42). In this zone Gimi pigs also foraged in the orchards of *marita* pandanus (*P. conoideus*), rooting for grubs and wild taro (Gillison 1983:145). New Guinea oak trees have also been specifically emphasised as forage by Kelly (1988:116) in the secondary forests on the slopes of Mount Sisa on the Papuan Plateau. On the slopes of Crater Mountain to the south of the Gimi area, pigs eat the acorns of at least two *Lithocarpus* species (*L. rufovillosus* with 1–2 cm diameter acorns, and *L. cf. lauterbachii* or *cf. celebicus* or *cf. megacarpus?* with 3–4 cm diameter acorns) (D Wright, Wildlife Conservation Society, pers comm, September 2001). Thomas (1999:118) reports that the Hewa, living between 500–2000 m in the Southern Highlands Province, describe some 30 plant species as eaten by pigs. These include (provisional identifications): *Calamus* species, *Calophyllum* species, *Caryota rumphiana*, *Castanopsis accuminatissima*, *Conandrium polyanthus*, *Diospyros* sp., *Ficus drupacea*, *F. microcarpa*, *F. nodosa*, *F. villosa*, *Garcinia* sp., *Lithocarpus* sp., *Manihot esculenta*, *Meliosma* sp., *Pandanus* sp., *Pangium edule*, *Pometia pinnata*, *Semecarpus magnifica* and *Syzygium* sp. (WH Thomas, Montclair State University, pers comm, July 2001). *Pangium edule* is also noted elsewhere as a preferred pig food (Morren 1986:121; Goodale 1995:67–8, 83; Strathern and Stewart 2000:80, 86), and, in the lowland (300–1500 m) forest of the Western Province, Bedamuni people used the pith of either sago palms or *Caryota urens* and the fruit of *Semecarpus curtissi* as bait to trap wild pigs (van Beek 1987:76–77). Also in the Western Province, Frodin and Hyndman (1982:272, 274–5) recorded wild pigs in the foothill rainforest below 1000 m of the Mountain Ok people eating presumably the fruit of trees such as *F. copiosa*, *Litsea* sp., *Duckera taitensis* and *Duabanga moluccana*, as well as the sedge *Cyperus* sp.; in the Ningerum and Awin areas also of foothill rainforest, pigs favoured the acorns of *Lithocarpus* sp. and the leaves of *F. pungens*.

In the Kaironk Valley (Madang Province), domestic pigs are said to eat parts of a wide range of plants: these include the roots of a bracken-like fern (*Pteris* sp.), a cordyline, a wild taro (*Colocasia* sp.), a wild yam (*Dioscorea* sp.), grassland orchids (especially after grass has been burnt off), *Pueraria lobata* and a large type of kunai (*Imperata cylindrica*) growing in the Jimi Valley; pigs also eat grasses such as *Ischaemum polystachyum*, *Ischaemum barbatum*, *Isachne* sp., *Dimeria ciliata* and *Paspalum conjugatum*, as well as fern leaves, and the acorns of *Lithocarpus* sp. (Pawley and Bulmer, no date: 27, 32, 52–53, 64, 69, 81, 94–95, 103, 112–113, 129, 136, 229, 242, 282, 289, 290, 312, 328, 350). Also in the Kaironk Valley, in 1980 pigs were said to eat the fruits of the introduced passion-fruit (*Passiflora* sp.) and Cape gooseberry (*Physalis peruviana*), and they were considered responsible for the wide rapid dispersal of both plants (Bulmer, R 1982:287). They also ate the foliage of watercress (*Nasturtium officinale*) and dug up the tubers of choko (*Sechium edule*). Elsewhere, Lawler (1984; 1999:106) records pigs eating the tubers and leaves of ground orchids such as *Habenaria* and *Spathoglottis*.

There are a few reports of ecological work, particularly concerned with lakesides and swamplands, that discuss pig foraging (Walker 1966; Walker 1972; Kawalga 1975; Conn 1979; Powell with Harrison 1982:37, 41–42). At Haiyapugwa (Southern Highlands Province), the preferred pig forage in swamp fallow was described as the young sprouts of *Leersia hexandra*, *Coix lacryma-jobi* and *Coix gigantea*, and the seeds of *Coix* (Powell with Harrison 1982:37). As described in Chapter 5 (Section 5.11), there is evidence that, in the highlands at least, swampland and riverine environments are associated with higher than average pig holdings (Bowers 1965:34; Wood 1984:198, 201; Robinson 1999:63–73; Umezaki et al. 1999; Umezaki et al. 2000). Around Mount Hagen, Melpa people in the 1960s showed a preference for the flat swampy grasslands for pig foraging (Strathern 1972:12).

Other environments or foods favoured by pigs include a number of species of tree fruits (eg *Pasania* sp., *Leca* sp. and *Elaeocarpus* sp.) eaten by pigs in lower montane rain forest (abundant seasonally between June and August and perhaps December–January) (Morren 1979:5–6; 1986:144–5), the use of fallow and other vegetation (Spencer 1955; Mitchell 1971:202, 212–214; Hide 1980), and also the use of high altitude forest (Smith 1990). In the Asaro Valley (Eastern Highlands Province), pigs were said to prefer the zone between 2300 and 2500 m for foraging (Newman 1965:22). In the lowland forest of Northern Province occupied by the Binandere people, wild pigs are said to collect in groups in the period May to August to eat seasonally ripening fruit (Waiko 1982:93). A *Terminalia* and five other, unidentified, species of seasonal fruit, both tree and vine, are listed as preferred pig food for the Kairi area of Gulf Province (Rhoads 1980: Table III-8). In the neighbouring Solomon Islands in the early 1880s, Guppy (1887:159, 294–301) observed that pigs preferred the young fruit of sago palms before the outer shell hardened, and the fruit of *Gomphandra* sp. The Gidra of the Oriomo area of Western Province say that wild pigs get fat during the November–May wet season (Akimichi 1998:172). At Gavuvu village (Nakanai, West New Britain) in 1994, villagers said that wild pigs were plentiful in the November–March wet season (Hide 1985:6). Without indicating seasonal variation, Baldwin (1982:37–38) described Gogodala (Western Province) pigs eating a range of (unidentified) wild foods, including fruits, roots, worms, grubs, reptiles (including snakes) and small mammals.

There is an extensive body of local knowledge about the uncultivated plant (and to a lesser extent animal) species eaten by both feral and domesticated pigs. Some of this is recorded in most works on ethnobotany, as some of the material cited above indicates. For information on Simbu Province, see Sterly (1997:Vol III, 89) for the Upper Chimbu Valley, Hide et al. (1979:111) for Sinasina, and Hide (1984) for the Karimui area in the south of the province. For the Wopkaimin area of Western Province, Hyndman (1982:239) has listed 10 plant species named by villagers as eaten by feral pigs (*Hornstedtia* sp., *Hornsfieldia* sp., *Lithocarpus nufovillosus*, *Mackinlaya schlechteri*, *Myristica subalutata*, *Pavetta platyclada*, *Podocarpus* sp., *Palmae* sp., *Syzygium* sp., and *Taluama areadum*). There is further information on highland Irian Jaya in Boissière (1999:439–456); on the Papuan Plateau in Brunois (2001: Annexe 2, 45); on inland West Sepik Province in Morren et al. (1992); on lowland West Sepik Province in Juillerat (1996:170); on the East Sepik Province island of Kairiru (Borrell 1989:60), and on inland West New Britain Province in Goodale (1995:67–8, 83). Such sources often also include information on plants (leaves usually) collected or grown to feed pigs, to ensure growth or fatness (eg see Hays (1980:123; 1981:125–128) for the Ndumba of the Eastern Highlands Province).

There is little information from specifically coastal areas. On Nukakau Island (West New Britain Province), pigs were often seen rooting in the beach sand that slopes down to the coral reef platform, in search of the small bivalve shellfish *Atactodea striata* (1.5–2.0 cm long), which they crunched and ate (Swadling and Chowning 1981:160). This is a shellfish that Kove adults do not eat, although children do. In the coastal area of central New Ireland Province, pigs are also reported as foraging for shellfish, as well as for land snails, toads and chickens (Clay 1986:165). In Morobe Province, pigs were reported as eating ducklings, killing more than either hawks or dogs (Abdelsamie 1979:45). In Irian Jaya, pigs have been reported eating the eggs of leatherback sea turtles (Starbird and Suarez 1994). Similarly in Australia, feral pigs are said to eat almost all the eggs laid by the turtle *Chelonia depressa* on mainland beaches on western Cape York Peninsula (Limpus and Parmenter 1986:97).

Interestingly, despite the known presence of pigs, both wild and domestic, in areas in New Guinea used by megapodes for egg-laying (either in mounds of vegetation, or in sand or soil heated either thermally or by solar radiation: the eggs are an important source of food for some people), there is mixed evidence that pigs represent a significant threat as predators on the eggs. Pigs thus apparently contrast with large monitor lizards that are widely recognised as preying on megapode eggs (Bergman 1963:352–3; R Sinclair, Wildlife Conservation Society, and P Dwyer, University of Melbourne, pers comm, 2001). Accounts of specific predation by pigs on megapode eggs in New Guinea include

those of Brunois (2001:Annexe 2, 45) for the Kasua area of the Papuan Plateau, Sinclair (2000:11) for Crater Mt (Simbu Province/Eastern Highlands Province), and JC Pernetta (University of Papua New Guinea, pers comm, 1982), for the Jimi Valley (Western Highlands Province). At Nokopo in the Finisterre Range, Kocher Schmid (1993:5, 29) reported that megapodes (*Talegalla* and *Aepyodius*) were ‘constantly disturbed by roaming pigs’, and thus mounds were only found more than an hour from major settlements. In lowland West New Britain Province, Kisokau (1976:22) listed pigs as one predator of megapode eggs, and, writing of the lowland forest in that area, Bishop and Broome (1980:76) observed that wild pigs were more common in areas where the soil was soft and damp, than in dryer areas.



Pigs foraging near beach, Rehuwo, Sudest Island, Milne Bay Province, 1994.

Photographer: R. Hide.

6.2.7 Feeding and survival of pigs under emergency conditions

The most significant and widespread threats to human food security in New Guinea agricultural systems originate from adverse climatic conditions impacting on crop growth (droughts, frosts and excess rainfall), from disease of both humans and (potentially at least) crops, and from political unrest. In the latter half of the 20th century, the El Niño phenomenon has been the major cause of significant food shortages. Pigs under such conditions face both a decline in their fodder supplies (especially sweet potato and other root crops, and coconut), and possibly in the forage available to them (Allen and Bourke 2001:160). Besides reducing rations, pig keepers can also shed animals, through gift, sale or slaughter (Wohlt and Goie 1986:210), with conversion into currency or food being a significant food security strategy (see Section 10.7). Ultimately, pigs may die. Although much evidence of actual outcomes for pigs during periods of food shortage is anecdotal — the problem of interpreting rhetorical accounts under aid distribution conditions is severe — there are some accounts with greater detail.

During the 1970 drought and food shortage in the Eastern Highlands Province, pigs were not killed but their rations were cut back (Shannon 1973:10). In Sinasina (Simbu Province) during the widespread 1972–73 drought, sweet potato availability was apparently reduced, but pig rations continued (perhaps at reduced levels), though pig growth rates may have slowed (Hide 1981:363, 473–479). During the same drought, pigs at the high-altitude site of Yumbisa in Enga Province were apparently able to survive by foraging for several months after their owners had migrated to lower altitude areas, and

fewer animals than usual (rather than more) were reported killed (Wohlt 1978:150, 170). Similarly, in Irian Jaya during the very severe 1997 drought, the Jali people did not kill their pigs but stopped feeding them and left them to fend for themselves (Boissière 1999). The outcome in this case is not known. At Gagave village in the highlands of Central Province during the 1997–98 drought, pigs died of starvation, although numbers were not reported (Igua 2001:239).

For the Wola of the Southern Highlands, there is some information covering almost 70 years, including the major El Niño events. In a major 1930s drought, people recall that whole household herds died of starvation (Sillitoe 1993c:173). In a period of food shortage in 1974 (perhaps related to the 1972–73 drought?), a ceremonial pig kill was held in part to reduce the burden of supporting pigs (Sillitoe 1979:257; 2001b:20). In the 1982 drought, several pigs belonging to Wola people died ‘for lack of fodder’ (Sillitoe 1993c:173). During 1997–98, a reduction in the number of young animals was interpreted by Sillitoe (2001b:20) as the result of drought-related deaths.

In the Oksapmin (West Sepik Province) hamlet of Mekiawa, for a small sample of 10 ‘hearths’, pig numbers declined from 25 in 1995 to 19–21 during the 1997–98 drought, and then climbed rapidly to 38 by 2001 (Brutti and Boissière 2002:145). Interestingly, the percentage of female pigs rose from a rather typical 56% (see the discussion of sex ratios in Section 6.4) in 1995 to 62–63% in 1997–98, possibly reflecting the removal of male animals during the drought: by 2001, however, females represented only 40%, an unusually low figure.

At Lake Kopiago, where the 1997 drought was the most severe that people could recall, Duna people progressively reduced the sweet potato component of pigs’ fodder, substituting instead cooked cassava, boiled wild taro leaves, sweet potato rootlets and leaves, and the occasional chopped and cooked swamp grasses (Robinson 1999:79, 85–87; 2001:194–6). They also slaughtered more pigs than usual, both to raise cash for purchases of food and fodder, and to remove animals that could no longer be fed. Many pigs were also said to have died from heat exhaustion and starvation. Of 11 households investigated in depth, five apparently lost no pigs during the drought, whereas six suffered a variety of losses (eg extra slaughter and drought-related deaths). With such variable outcomes, it is clear that even under the most severe conditions, generalisations are not made easily. In the less densely populated neighbouring area of the Hewa people, domesticated pigs were reported as having either died or been slaughtered as the drought progressed, and wild pigs became scarce (Haley 2001:195–6).

In Western Province, Minnegal and Dwyer (2000:506–8) made a detailed comparison of the pig-related responses of two communities from two language groups (Kubo and Bedamuni) in the face of the 1997–98 drought and food shortage. The Bedamuni stopped feeding supplementary food to their pigs, which then foraged further afield. The pigs were stressed by the drought, and became competitors with humans for food. In January 1997, the Bedamuni community was caring for 20 pigs, with 0.27 pigs per person. Two years later, by January 1999, seven pigs had been killed and eaten, five had died, one had been lost and was presumed dead; and there were only seven surviving recruits, leaving 0.14 pigs per person. Both the number and biomass of pigs were therefore substantially less following the drought than before. Further, during the drought, the rate at which domestic pigs were killed and eaten was higher than usual, and more piglets born during the emergency period were killed and eaten rather than retained. In contrast, the Kubo pigs did not lose their main foraging opportunities, and unprocessed sago pith remained available as food. Between January 1996 and January 1999, the number of pigs per person rose from 0.94 to 1.0, and there was no evidence that the pigs were seriously affected by the adverse climatic conditions.

6.2.8 Nursing piglets

Piglets in many relatively intensive husbandry systems are often left with their mothers until naturally weaned (Dwyer and Minnegal in press) (see Section 6.4.2). Under certain

circumstances, however, in such intensive systems, and also across a wide range of less intensive ones, piglets are removed from their mothers at a much earlier age either deliberately, or as a result of being orphaned. In such cases, people are more closely involved in raising the piglets, requiring, in particular, special efforts with feeding. Women have sometimes nursed piglets (Brandes 1929; Smedts 1955:115; Bulmer 1960:92; Bergman 1961:99, plate 40; Venkatachalam 1962:13; Bulmer 1967:20; Bragginton 1975:68–69; Aufenanger 1979:60; Baldwin 1982:36; Simoons and Baldwin 1982; Rule 1993:13; Schoorl 1993:75; Goodale 1995:33, 83; Lutkehaus 1995:141–2; McArthur 2000:28; Dwyer and Minnegal in press), though this practice has all but disappeared today, with some rare exceptions (Brutti and Boissière 2002:146–7). Indeed, in the central highlands it was no longer common, even in the mid-1950s (Bulmer 1960:92; Venkatachalam 1962:13). However, the practice was reported to still occur in mid-1975 at Hoai village near Mendi (Harrison 1976:35), and was observed, and photographed, at Kuk near Mount Hagen in 1977 by P Gorecki (consultant, pers comm, June 2003).

In some areas, such as among the Saniyo-Hiyowe of East Sepik Province, piglets removed from sows (either domestic or wild) were not allowed to be suckled by either a sow or a woman (Townsend 1969:49). An absence of human nursing is also reported for some other Sepik groups (Abelam and Kwanga) (Obrist van Eeuwijk 1992:111), although it appears to have been practiced in the late 19th century on the Madang coast (Mikloucho-Maclay 1975:199).

The care of very small piglets frequently required the premastication of solid foods such as root-crop tubers or sago (Oliver 1955:32; Townsend 1969:49; Boram 1980:3; Baldwin 1982:24; Michel 1983:51; Obrist van Eeuwijk 1992:110; Dwyer 1993). Townsend (1969:50) reported that although piglets did not eat much, they were given good food, not just scraps or peelings, and they might get occasional special tidbits such as frogs or sago grubs.

In the Kaugel Valley in Western Highlands Province, Bowers (1968:95) noted that only a few piglets received special treatment ('pet' pigs), and these were normally ones that had been orphaned. They were fed premasticated sweet potato or even nursed. In contrast to other pigs, they were much more tractable and obedient. Amongst the Amung in Irian Jaya in the 1990s, Cook (1995:281) reported that women nursed only orphaned piglets or runts, and that this was still current practice. Earlier in 1952, according to Burrige (1969:50, 179), Tanga women in Madang Province often put piglets (which were frequently captured from the wild), as well as dog pups, to the breast 'simply to relieve themselves when, for instance, a new-born child had died'. Given infant mortality rates as high as 500 per 1000 before the widespread use of modern medicine from the 1950s, such instances presumably were not uncommon. It has also been suggested that, due to the high valuation placed on pigs' teeth as ornaments, nursing may have been undertaken as a strategy to prevent pigs breaking their milk teeth (Cavalli-Sforza et al. 1994:346).

6.2.9 Tonics and other ritual foods

There are reports from several parts of the highlands, and from the highlands fringe, of people feeding special substances to their pigs that were said to make them grow fat. The Gende people of Bundi (Madang Province) used to trade, and still did in 1968, a whitish powder known as *mondo* into the Upper Chimbu Valley where it was fed to pigs with cooked sweet potato (Hughes 1977:112–114). This was the natural weathering product of granodiorite, the local rock, and consisted mainly of quartz. Hughes noted that a similar substance was used by the Daribi in the south of Simbu Province. Another tonic of scraped quartz and petrified corals was also used for fattening pigs at Nokopo village in the Finisterre Range (Kocher Schmid 1991:298). The Bedamuni of the Western Province were still acquiring small clear crystals (possibly rock salt) by trade from the Haibaso to the north of Nomad River in 1978–79, that was fed to their pigs to make them grow (van Beek 1987:35). This apparently replaced the previous use of human semen for the same purpose.

The Kalam of the Kaironk Valley (Madang Province) are reported as feeding eel bones to their pigs to improve their fatness (Bulmer 1976:179); their neighbours, the Maring, also feed their pigs eel bones, as well as the bones of pigs and wild game for the same reason (Healey 1991:238). The Kalam also added various wild plant materials to sweet potato fodder to improve the fatness or growth of their pigs: these included a resin or gum from *Araucaria* spp. trees, the blossom and fruit of a vine (*Mussaenda* sp.), and a tree gum, dug from underground, from an unidentified tree (Pawley and Bulmer, no date: 91, 99–100, 218, 377).

A ritually significant food of marsupial bones smeared in ash from a special fire was fed to pigs prior to ceremonial slaughter by the Kunimaipa of highland Papua (in the Central Province) apparently in order to ensure that pigs remained tame (McArthur 2000:146–7). The Duna of the Southern Highlands Province used to sprinkle ash from the singed hair of a marsupial over sweet potato fed to pigs in order to make them grow well (Stewart and Strathern 2001:90; Stewart and Strathern 2002:58). At Auyana in the Eastern Highlands Province, chewed up barks and powdered stones were sprinkled over sweet potato fed to pigs, and pregnant sows received special preparations of fermented, mashed wild banana skins and the leaves and bark of a tree (Robbins 1982:65). Other ritually important plants related to pig care by the Mountain Arapesh of East Sepik Province are described by Mead (1970:364, 368). Similar plant uses are mentioned above in Section 6.2.6 (see also Section 6.3.3).

In the Baktaman area of Western Province, a ritually important white earth was also traded in and used to assist the growth of fat pigs, although in this case it was not ingested by the pigs (Barth 1975:35).

6.3 Pig growth

Growth rates are a function of both breed, which determines an animal's potential performance, and feeding regime. Although interbreeding has gradually altered the potential of the indigenous pig, the distinction between indigenous and exotic is still useful for describing many research results (see Chapter 3, Section 3.4).

6.3.1 Customary size classes and measurement

In many New Guinea societies, pigs of different size and, to some extent, of different sex, are commonly distinguished linguistically by different terms. For example, the Tsembaga Maring in 1962 recognised five categories of pig, grading through from 'soft child' (small pigs of either sex, under 18 kg) through to 'very large' (pigs weighing more than 75 kg) (Rappaport 1967:60). Similar classifications have been described by Franklin et al. (1978:177, 311) for the Kewa of the Southern Highlands Province, by Robinson (1999:69) for the Duna of Lake Kopiago, by Sillitoe (2001b:21; 2003:244–245) for the Wola (Nipa area, Southern Highlands Province), by Akimichi (1998:171) for the Gidra and Seltaman of Western Province, and by Battaglia (1990:85) for Sabarl Island in Milne Bay Province. In the Irian Jaya highlands, the Dani recognised four stages or sizes, piglets under 25 cm high (inches in original), small pigs up to 38 cm, pigs between 38 and 61 cm, and adult animals (O'Brien 1969:49).

Less common, apparently, are explicit measures of size. In the Siuai area of Bougainville Province, before the Second World War, pigs of different size were graded by girth measurements based on 10 fractions of an armspan. Each fractional size was evaluated in terms of the common shell currency of *mauai* (Oliver 1949b:11). This system was still retained, though with monetary values, in the 1970s (Connell, no date). A similar form of measurement related to shell currency value was described by the Archbold Expedition to Irian Jaya in 1938–39. There, a cowrie shell band was used to measure the heart girth of pigs, and the price in cowrie shells was linked to each marked segment of the band (Heider 1970:292, citing Anon (1940)). In Milne Bay Province, in the coastal and inland

region of Cape Vogel and Goodenough Bay, reciprocal pig exchanges at feasts (*poraga*) required that exact measures of the sizes of pigs given and received were kept by means of girth measurements. These measurements were taken using a strip of calamus cane (*ruba*), copies of which were retained by both donor and recipient for reference at the time of the return exchange (J Mogina, University of Papua New Guinea, pers comm, June 2001). (Newton 1914:140–143; Caswell 1945:146). Similar methods of measurement appear to have been used further south along the coast at Wamira village in the course of *torela* exchanges (Kahn 1986:83), and at Bwaidoga on Goodenough Island in *abutu* exchanges (Young 1971:195–7). Girth measurements with string for similar exchange purposes were also made by the Sulka of East New Britain, though less commonly in recent years (Jeudy-Ballini 2002:197, and pers comm, Centre National de la Recherche Scientifique, February 2003). On New Ireland, in the early 1990s, the Sursurunga continued to measure with rattan both the length and girth of pigs given in mortuary feasting exchanges, and then retained the measures in the men's houses of the feast sponsor so that exact equivalence was later possible (Bolyantz 2000:119).

At Sio in Morobe Province, for *wena* exchanges involving pigs and ceremonial yams, pigs were measured at shoulder height using knotted cords (Harding 1985:44). In the highlands, it is not clear whether the 'rough' measurements of pig size by height in relation to a man's knee and thigh heights described by Strathern (1971a:104, note 4) refer to explicit Melpa statements or the ethnographer's judgement. To the east, in Simbu Province, customary pig transactions in both the Kuman (Bergmann, no date: 206), and Sinasina (Hide 1981:519) areas, commonly required measurements made with string, though whether of girth, length or height is not recorded.

In the Mandak area of central New Ireland, the growth of a special pig ('the eye or center of my house') raised by a big man sponsoring a large mortuary ceremony was seen as the living expression or model of his intentions (Clay 1986:171).

6.3.2 Field methods for estimating pig weights

Beyond the safe boundaries of research farms and intensive piggeries, few field workers in New Guinea have weighed live pigs successfully, at least those larger than piglets. There are indirect methods for estimating wild and domestic animal weights (Brody 1945:365, 398; McCulloch and Talbot 1965; Davies 1983) but these seem to have been used rarely in New Guinea. Three methods that have been employed are summarised below.

In the 1970s, Hide (1981:642–652) weighed and measured the heart girths of village pigs in Sinasina ($n = 238$), and used correlations from these measurements and a further set from Goroka ($n = 18$ pigs) to establish a table of estimated weights from heart girths. These were used for a Sinasina village study where domesticated pigs, although often too large for easy field weighing, generally tolerated a heart girth measurement. The basic equation was:

$$\log \text{ weight (kg)} = 2.82696 \log \text{ girth (cm)} - 3.7773$$

These estimates were also used by Malynicz (1977) in a subsequent study of multiple village sites in the highlands.

In a study of lowland husbandry among the Kubo in Western Province in the 1980s where live domesticated pigs would not tolerate measurement of any kind, Dwyer (1993:125) weighed, and measured the mandible length (length of horizontal ramus of mandible), of 16 wild pigs ranging in size from 1.5 to 74.5 kg, yielding the equation:

$$\log \text{ weight (kg)} = 2.91 \log \text{ mandible length (mm)} - 5.07$$

Dwyer suggested this equation would tend to underestimate the weight of domestic pigs, which usually carried more fat than wild ones.

In a midaltitude location (Seltaman, in the Western Province) in the 1990s, Whitehead (2000: Appendix C) estimated pig weights in the field by measuring a number of pigs in four size categories (fullgrown, medium-sized, shoat-sized and piglets) and then applying the American pig farmer's formula of (heart girth \times heart girth \times length) divided by 400.

6.3.3 Growth rates of indigenous pigs under village husbandry conditions

The first report with measured growth rates of indigenous pigs in New Guinea under village conditions was published in the 1970s. Possibly the earliest description of growth, at least for the highlands, was that of Vicedom and Tischner (1983 orig. 1943–48:219–220). They noted that indigenous pigs took two years to reach a weight of about 150 kg (three hundredweight in original). This seems very rapid in the light of later accounts, and it may reflect conditions of intensive feeding on mission stations. Indicative of relatively slow rates were early observations from the fringe Simbai Valley (Madang Province), where Rappaport (1967:60, 156) described pigs as taking 2–3 years to reach maximum size, and implied that small pigs (c.16 kg) could gain perhaps 0.62 kg/month over 8 months. Perhaps more realistically, a government veterinary officer observed that 'Because of the stresses placed on them by disease, poor nutrition and poor management, native pigs can take up to six years to reach maturity and a satisfactory killing weight' (Harvey 1966:66). The description from the Kewa (Erave) area of the Southern Highlands Province, presumably referring to the 1970s, that pigs can reach 100 kg in about 6 months (Macdonald 1991:180), cannot be describing village performance. It is likely that it is referring to potential rates under commercial husbandry conditions (MN Macdonald, Le Moyne College, pers comm, January 2003).

The low growth potential of indigenous New Guinea pigs suggested by experimental work (see below) has been amply confirmed by the small number of studies of pig growth under village conditions. An unpublished study by Moore near Goroka obtained a mean of only 0.22 kg/week for 26 small pigs over a 2-month period (Malynicz 1970a). This was presumably the source of Purdy's (1971:482) statement that growth rates were seldom above 27 kg/year. A 1-year study of village pigs at three highland locations reported mean rates all within the range of 0.3–0.65 kg/week (Malynicz 1977). These were very similar to the rates reported for village pigs from a number of Solomon islands (all presumably at lowland altitude) at this time: an average of about 22.7 kg for the first year, or 0.44 kg per week (range: 0.28 kg/week to 0.66 kg/week) (de Fredrick 1971b:26). In a later publication de Fredrick (1977a:119) gave the mean weight as 28.4 kg at one year for all pigs studied, the higher figure presumably due to the average calculated on individual pigs, rather than on village or district means. A study of the growth of Sinasina (in highland Simbu Province) village piglets during their first 12 months, in 1972–73, found a mean rate of 0.36 kg/week, and a range of 0.19–0.49 kg/week (Hide 1980; Hide 1981:474). The average growth rates of larger, older pigs in the same study were estimated, by conversion from measured heart girth change, as less than 0.5 kg/week.

For the Huli community of Wenani in Southern Highlands Province, Kuchikura (1999:77) has recently estimated an annual weight gain of 36 kg (0.65 kg/week). However, this estimate was based on an extrapolation from Sinasina data, using the incorrect assumption that Wenani pigs were fed twice as much as Sinasina pigs and thus might be expected to grow at twice the Sinasina rate. In fact, the pig rations may have been similar at the two locations (1.2–1.67 kg in Sinasina, 1.7 kg at Wenani: see Section 6.2.4).

Kelly (1988:119, 138) described piglets in the Etoro area of the Great Papuan Plateau (Southern Highlands Province) growing in 1968–69 from a weight of about 3.6 kg to 9.1 kg (all weights in original in lbs), during a period of 10–12 weeks after weaning (age at weaning not given, but possibly about three months). This gives a growth rate of 0.46–0.55 kg/week. By about one year, according to Kelly (1988:133) they weighed approximately 31.8 kg. This means a growth rate of more than 0.87 kg/week in the second six months of life, and, overall during the first year, of about 0.58 kg/week. After one year, castrated males gained at approximately 13.6–18.1 kg a year (Kelly 1988:138),

or a weekly rate of 0.26–0.35 kg. These rates, especially those for the second 6 months and overall for the first year, seem high, especially by comparison with all measured data from elsewhere. Unfortunately, the basis for these figures is not given. Small samples and estimates seem likely, since a note indicates that the annual weight-gain figures are ‘a rough estimate’ (Kelly 1988:179, footnote 13).

For the small Kubo community of Gwaimasi in Western Province during 1986–87, Dwyer (1993) estimated, though the numbers of animals under observation was small, that weights greater than 27.5 kg were achieved at 60 weeks of age, giving a growth rate of about 0.44 kg/week.

A 1975 study of husbandry in Pinu, a coastal Papuan village 100 km west of Port Moresby, found, for eight pigs under nine months old, an average growth rate of 0.28 kg/week over a four-month period (Potter, no date (a); Potter, no date (b)).

In summary, the village studies in the highland area indicate rates of weight gain of between 0.2–0.5 kg/week for small pigs, with perhaps 0.3–0.6 kg/week for larger pigs. The figures, though they are mainly estimates, from the more extensive husbandry systems at lower altitudes (Etoro and Kubo) suggest rates at the upper end of this range for younger pigs (0.4–0.6 kg/week), and a similar 0.3 kg/week for pigs aged over one year.

The average growth rates in the studies summarised above undoubtedly hide considerable variation in the rates achieved within particular communities or regions. No study has examined the sociocultural correlates of such variation, though Gillison (1993:43) suggested that for Gimi women (Eastern Highlands Province) success with pigs appeared to be correlated with their success in raising children, and hence related to such personal characteristics as temperament and ambition (Gillison 2001:293). The 1969 International Biological Programme study in the neighbouring Lufa area also found, for adult women, a statistical association between the number of surviving children and the number of pigs cared for (Hornabrook et al. 1977:380). However, for the Saniyo-Hiyowe (East Sepik Province), Townsend (1969:49) considered that women who were childless or whose children were grown up were most successful as pig raisers.

Under customary conditions, there is much evidence of significant cultural concern with pig growth. This is not only expressed in terms of the pragmatics of feed and other material conditions, but also by considerable ritual activity and frequent resort to magic aimed at increasing growth (Meggitt 1958a:293; Bulmer 1960:93–4; Glasse 1963:25, 27, 34–36, 41, 47–48; Heider 1970:51, 226; Mead 1970:364–8; Feachem 1973a:28; Barth 1975:158, 237; Bragginton 1975:69; Franklin et al. 1978:217; Lowman 1980:94–5; Strathern 1984:74; Clay 1986:166; Frankel 1986:55,99; van Beek 1987:35; Watson 1990; Macdonald 1991:176; Kyakas and Wiessner 1992:109–11; McArthur 2000:30, 212; Stewart and Strathern 2001:83–4, 90, 103–7; Stewart and Strathern 2002:8, 35–6, 73, 83; Sillitoe 2003:263–277). According to Gillison (1993:172–4) pig growth was the subject of more magic spells than any other activity among the Gimi. Magical procedures may be embedded in a wider frame of specialist knowledge, as described by Leach (2000:169) for the Reite of the Rai Coast area in Madang Province: ‘Growing pigs likewise is accomplished speedily when a man has knowledge of esoteric names, procedures and specific mythic places from which substance for the pigs’ growth is drawn’.

To increase the fatness of their pigs, Hays (1980:123; 1981:125–128) records that the Ndumba of the Eastern Highlands Province fed their pigs leaves from at least one wild plant (*Elatostema* sp.), and from five cultivated plants (*Cordyline fruticosa*, *Cyanotis* sp., *Euphorbia buxoides*, *Hemigraphis* sp., and *Homalomena* sp.). The leaves and fruit of *Psychotria* spp. were added to pig food by the Nimai people (Sinasi, Simbu Province) to fatten thin pigs or ensure growth, and sticks of *Psychotria dolichosepala* were used to mash pig food (Hide et al. 1979:63). Similarly, Maian speakers of the Josephstaal area of Madang Province mixed the mature fruits of *Psychotria amplithyrsa* and the leaves of *Psychotria membranifolia* with pig food to promote fattening (Takeuchi 2000:59). In a modern twist, Clark (2000:159) has recorded that Wiru people stole holy water from the church at Takuru in Southern Highlands Province to rub on the skin of pigs to make them grow.

6.3.4 Growth rates of indigenous pigs under improved (or trial) husbandry conditions

The low growth potential of indigenous pigs was widely recognised by the late 1960s. Malynicz (1970a:201) considered that highlands pigs in general would probably not weigh more than 22.7 kg at 12 months (eg representing a growth rate of 1.8 kg/month). This was similar to the growth rate range of 1.5–3.1 kg/month described from different regions of the Solomon Islands at about the same time (de Fredrick 1971b:26, 27–30; 1977a:119–120).

Such rates were confirmed by experimental work. In an early study, Malynicz (1973b) described weight gains, during the first 9 months of life, of only about 0.48 kg/week for a small group of indigenous pigs at the Goroka Research Centre ($n = 8$, one sick animal excluded). In contrast, young animals distributed as an experiment to villagers failed to grow at all.

Later studies indicated faster rates under trial conditions. In a trial at Goroka in 1974–75, Malynicz (1992) compared the performance of indigenous and exotic (berkshire) pigs under relatively modern intensive husbandry and feeding regimes. The indigenous pigs took 281 days to reach the slaughter weight of 65 kg, as against the 178 days of the berkshires: eg growth rates of c. 1.57 and 2.48 kg/week respectively.

Potter's experimental feeding of additional supplements of coconut, soybean and coral to eight village pigs in the Papuan coastal village of Pinu resulted in a three-fold increase in weight gain, giving an average rate of 1.22 kg/week (Potter, no date (b)).

Rose (1981a) studied the weight gain of young, recently weaned, village pigs under three treatments of intensive management for 140 days. In two treatments, pigs were tethered at sweet potato mounds with access to sweet potato tubers and vines, and, in a third treatment, pigs were tethered on grassland with no access to sweet potato. In the evening all pigs received rations of raw chopped sweet potato and 20 g of proprietary protein concentrate. The weight gains of the first two treatments did not differ (1.3–1.4 kg/week), but they were significantly greater than the rate achieved under the third treatment (0.98 kg/week).

In a study of the production performance of indigenous pigs in Irian Jaya, Randa (1994) measured the growth and food consumption of 20 pigs at two coastal villages and 20 pigs at an 'upland' village (upland only in a relative sense: probably no more than 200 m), in Manokwari district for five months. At both locations, 10 farmers with two pigs each were involved, with the pigs apparently distributed to the farmers for the purpose of the research. It seems also that management was supervised by the researcher. All pigs were confined to pens. At the upland site, feeds included cassava, taro, sweet potato, sago, grated coconut, *kangkong* (*Ipomoea aquatica*), salted fish, cabbage, amaranth and pawpaw (fruit and leaves) and averaged 2.94 kg/day. At the lowland site, foods included cassava, taro (tubers, leaves, stems), rice, *kangkong*, grated coconut and salted fish, and averaged 2.79 kg/day. Animals weighed an average 6.8 kg when the study began, and 19.9 and 21.7 kg respectively at the upland and lowland sites after five months. The average daily gain was significantly higher at the lowland site (0.099 kg/day; or 0.69 kg/week) than at the upland site (0.087 kg/day; or 0.61 kg/week).

During 1967–69 in the Solomon Islands, de Fredrick and Osborne (1977) investigated the effects of breed, diet and housing on growth in a trial involving 124 piglets belonging to 16 litters, with five piglets from each of the first eight litters followed to 30 weeks of age. By 8 weeks, both breed and diet had significant effects, with the exotic breed–commercial diet combination giving superior growth to the village breed–commercial diet, and the latter growing faster than the village breed–village diet combination. Similar results were achieved to 16 weeks, but between 16 and 30 weeks, breed had little effect and the dietary effect declined. De Fredrick and Osborne concluded that pig growth in Solomon island villages was constrained more by diet than by genetic factors.

6.4 Reproduction

6.4.1 Males

Castration

Throughout New Guinea, most young male domesticated pigs are castrated between about two and four months of age, though it is sometimes earlier and, less frequently, later (Meggitt 1958a:290–1; Heider 1970:50; Malynicz 1970a; Pospisil 1972:204; Wohlt 1978:151; Boyd 1984:35; Bonnemère 1996:188; Bergmann, no date: 112). At Auyana in Eastern Highlands Province, for instance, it was done at 4–7 months of age in the early 1960s (Robbins 1982:65). The stated purposes of castration are usually to render the animals more docile, and to improve or hasten their growth and/or the development of fat (Reay 1959:12; van Baal 1966:408; Sillitoe 1979:147; Brumbaugh 1980:47; Baldwin 1982:36). Castration, according to the Saniyo-Hiyowe of East Sepik Province, is ‘to make them lie around and get fat’ (Townsend 1969:49).

As regards the supposed effect on the rate of growth, in commercial husbandry in Europe at least, young entire males in fact grow faster than castrates (Goodwin 1973:24), and presumably it is the type of growth (ie greater fat), that is intended by New Guineans. In Irian Jaya, Randa (1994:77–79) recorded that castration is equally common in both the lowland and highland areas (85% and 89% respectively), and noted that farmers said that it was done to prevent males breeding with their neighbours’ female pigs. In a unique report from northwest Bougainville in 1930, Blackwood (1935:133) recorded an instance of a man who, having castrated his newly purchased exotic European pig, responded to her query in such a way that it appeared he was ignorant of the role of testicles in reproduction.

In Peri village in Manus Province in 1928–29, castration was reported to be carried out by one person with the requisite hereditary magic (Fortune 1969 orig. 1935:363).

Retention of boars

In areas with no, or restricted, access to feral or wild boars, which means mainly highland areas, (but also apparently in some lowland areas with such access, ie Teop, (Shoffner 1976:156)), some male pigs are left entire for breeding purposes. In areas in which all males are usually castrated, occasional, but often short-lived, experiments with retaining an entire boar have been reported, as for instance among the Ankave-Anga (Gulf Province) in 1988 (Bonnemère 1996). Quantitative data on aspects of the ratio of boars to females are available from several locations. At Yumbisa (Enga Province) in the early 1970s, there were five boars in a total population of 322 pigs, of which 111 were males (52 of which were large animals) (Wohlt 1978:152). The population included 82 fertile females and possibly another 35 soon to be fertile or bred; in short, one boar to 16–23 mature females. The Yumbisa boars were the ‘less promising members of the litter ... decidedly smaller pigs’ (Wohlt 1978:151). The provincial survey of Enga in the early 1980s reported 70 mature boars overall in a total sample of 2239 pigs (3%), with the proportion ranging from 1–5% by district (Wohlt 1986b:11, 70–73). In Sinasina (Simbu Province) in 1972–73, an estimated 70 of an average 119 female pigs were fertile (Hide 1981:449). At any one time there were three or four active boars in the population (which averaged 213 pigs), giving a ratio of one boar to 17–23 females. The Sinasina boars were generally small, with two weighing under 25 kg and one or two weighing over 25 kg, though it was said that larger size was the main criterion when deciding which of a litter to retain for breeding. In the Kamanuku area of Simbu Province some years earlier, boars were also described as lean, skinny, ‘stunted runts’ that were so small they could hardly serve the larger sows (Bergmann, no date: 111–112). In the absence of any data on the actual age when sexual maturity is reached, size is the only proxy, suggesting perhaps about 12 months, and a little earlier in some cases.



Castration of young male pig, Koge, Sinasina, Simbu Province, 1971.
Photographer: R. Hide.

At Lake Kopiago (Southern Highlands Province) in 1996, there were nine boars in a total of 526 pigs (Robinson 1999:63), which is a similar ratio to the other two cases. Extensive data from nine pig censuses across 24 years in the Wola area of the Southern Highlands Province collected by Sillitoe (2001b:21) showed an average of two boars for a total population of 255 pigs (38 sows, 69 gilts). The mean ratio of boars to sows was 1 to 20 (Sillitoe 2003:255). Sillitoe implied that they were small, noting that the Wola were breeding with 'juvenile boars'. For the isolated Bogaia area (Southern Highlands Province) in 1984, Sillitoe (1994:62–63; also P Sillitoe, University of Durham, pers comm, July 2001) recorded 19 boars (entire males) of which approximately four (two large and two medium-large animals) were sexually mature in a total pig population of 135. An even higher proportion of boars is recorded for the Huli Wenani (Southern Highlands Province) community in 1993 by Kuchikura (1999:71): 10 boars for 143 pigs. In comparison with ratios from elsewhere, it seems unlikely that all these were sexually mature. Similar doubt seems justified in the case of ambiguous data from Auyana (Eastern Highlands Province, in 1962), that described 39 fully grown boars to 127 mature sows, in an area where castration was said to be the norm (Robbins 1982:62, 65). It is possible such figures may be explained by the use of the term 'boar' to include any mature male, as appears to be the case in an account from West New Britain Province (Zelenietz and Grant 1982:17).

For four pig populations in the Eastern and Western Highlands and Simbu provinces in 1975, Malynicz (1977:205) graphed boars and castrates by size classes: only in the Simbu and Western Highlands Province populations were there any boars over 45 kg. In the two Eastern Highland populations there was probably only a single boar over 30 kg, and very few over 20 kg.

Reports by Poole for the Bimin-Kuskusmin (West Sepik Province) are contradictory. His first account (Poole 1976:209) described them as keeping few pigs, with no domestic breeding and all recruitment from wild captured piglets, but retaining one entire boar in each of two main occupied valleys (population of 1100 people) 'for reasons of religious concern and public safety'. A subsequent publication, however, records that all domestic boars are castrated without reference to the earlier statement (Poole 1994:205).

Limited data from the Irian Jaya highlands are difficult to interpret. They describe one or two boars only in a Dugum Dani neighbourhood of about 360 people in 1961–63 (Heider 1970:51, 81), and, in the case of the Ekagi-Me (Kapauku), one to two boars held by the members of a confederacy of about 700 people (Pospisil 1972:204). In the Dugum case, with about one pig per person (Heider 1979:35), this implies one boar to 350 pigs, which seems a very low ratio. In the Ekagi-Me case, with only 0.17 pigs per person (but perhaps rising to 0.5 before feasts) (Pospisil 1972:54, 216–7), this implies one boar to 119–350 pigs. These ratios seem on the low side for breeding dependence on domestic boars. Elsewhere, they might imply some reliance on feral boars for breeding, but feral boars were absent in the Dugum Dani area (Heider 1970:55), nor were any located within several hours walking of the major Botukebo (Ekagi-Me) settled area (Pospisil 1972:231). The absence of further reproductive or fertility data prevents interpretation of these low ratios.

Explicit breeding aims in terms of selection are not usually reported (Randa 1994:80–1; Sillitoe 2001b:18, 29), which adds support to the observations of the actual size of breeding boars described above. There are, however, some contradictory statements, including those of Sinasina villagers above. Among the Dani in Irian Jaya, only the ‘largest and most promising’ shoats are said to escape castration (Heider 1970:51). This is possibly the source of Baldwin’s statement (1978:23) that ‘only the most promising male piglets’ are not castrated in New Guinea. In the Wahgi Valley in the early 1950s, Reay (1959:12) reported that Kuma pig raisers were only using boars ‘that approximate to the type introduced by Europeans...for breeding, as these produce more meat and fat than the indigenous types’. In the case of the Amung of Irian Jaya, Cook (1995:289) also reported that some selection was practiced, but no details were given. In short, the evidence for widespread selective retention of quality (or simply of larger size, see below) boars is not apparent in the literature.

In at least one region, even those boars retained for breeding were not left entire. In the Kaugel Valley of the Western Highlands Province in the early 1960s, one testicle was removed from breeding boars, apparently in order to strengthen the powers of the remaining one (Bowers 1968:95). This is also reported for the adjoining Ialibu area of the Southern Highlands Province in the mid-1970s (Wormsley 1978:47).

Generally, boars do not appear to be retained long. In Sinasina (Simbu Province), the largest boar at the time of castration weighed only 45 kg (Hide 1981:451). In Enga Province in the 1950s, breeding boars were usually gelded at 18–24 months old (Meggitt 1958a:291). This was said to be to avoid compensation claims for damage to gardens, stock and children caused by intractable older boars. The Kalam (Kaironk Valley, Madang Province) in the 1970s gelded those males kept (very) briefly as breeding boars (all others were gelded as piglets) when they were only 8–10 months old (Bulmer 1976:172). In Irian Jaya, Ekagi-Me (Kapauku) retained boars to about two and half years (Pospisil 1972:205). In the Jalemo area further to the east in highland Irian Jaya, people preferred not to keep boars long because of the inconvenience of having to pen them or keep them tethered (Koch 1974b:45). Should they be allowed to forage freely, the owner would be liable for unwanted pregnancies (cf. Randa 1994:77–79) and injuries inflicted on other pigs.

Commonly, the use of a boar was repaid by a service fee consisting of a piglet from a litter, or a minor payment (Meggitt 1958a:290).

Where entire boars were retained for breeding, there is surprisingly little information about their daily management. According to Reay (1959:12; 1984:72), describing the Wahgi Kuma of Western Highlands Province in the 1950s, boars were cared for by men at the men’s house, and by day were kept on tether, and hence their access to sows was carefully controlled. This contrasts strongly with Meggitt’s (1958a:291) account of Mae Enga husbandry in 1955–57. He reported that they did not attempt to segregate their breeding boars from sows, because there was no fear that the sows would suffer from too frequent farrowing, and owners wished to acquire as many litters per year as possible.

According to Strathern (1984:76), presumably describing the mid 1960s to 1970s, boars in the Hagen area were kept penned.

6.4.2 Females

Age at breeding of gilts

In the PNG highlands, Malynicz (1970a:453) reported that indigenous pigs kept at the Goroka Research Station reached puberty at about 18 months. In Sinasina in 1972, the age of female pigs at first farrowing was estimated at 18–24 months (Hide 1981:452). In coastal Solomon Islands during 1967–69, it was just over 79.1 weeks for a sample of 24 pigs (de Fredrick 1977a:119). (In an earlier publication, this was given as 15 months (de Fredrick 1971b:23), in a later publication, approximately 20 months, (de Fredrick and Osborne 1977:203)). In the Southern Highlands Province, Sillitoe (2001b:18) has suggested about two years for the age at first farrowing.

Information from Randa (1994:61), who interviewed farmers (49 upland, 31 lowland) in Irian Jaya concerning the reproductive performance of 66 and 51 adult female pigs respectively is problematic, because the ages seem young by comparison with other information from PNG. Farmers were queried concerning the ages at first breeding and at first farrowing. Unfortunately, no details are given concerning the reliability of farmer's use of recall for such ages. Possible discrepancies between the answers (ie more upland farmers answering 7–7.5 months for age at first breeding, and 13–13.5 months for the age at first farrowing (12–12.5 months for the latter in the lowlands), suggests that there may have been problems.

Gestation length

There are no village data, except for a descriptive statement of four lunar months from Mae Enga (Meggitt 1958a:290). Observed values for New Guinea sows at Goroka and Erap agricultural stations yielded means of 116.4 and 117.3 days (Malynicz, no date (b)).

Birth

Under most customary husbandry regimes, birth occurs away from pig housing, and the sow constructs a nest. Downer (1991:112–113) shows two clear photographs of a sow nest-making in the Tari area of the Southern Highlands Province.

Retention of breeding sows

In Sinasina, there was little retention of breeding sows beyond the first farrowing. Only 25% of pregnancies in 1971–73 were by sows that had previously farrowed (Hide 1981:453). Also, there was high mortality of breeding sows: 6 of 19 (37%) sows breeding for the first time died shortly before, during or after birth, or within six months after birth. Bergmann (no date: 111) noted earlier that only very young, small sows were used for breeding by the Kamanuku in Simbu Province. This is similar to reports from the Ekagi-Me area of Irian Jaya (Pospisil 1972:208), although for one exception at least see the following paragraph. For the Telefomin, Brumbaugh (1980:48) noted that female pigs were not killed until they had had their first litter. Although this suggests little retention, he further noted that some very prolific old sows that lived to old age were long remembered. For the Kaulong area in West New Britain Province, Goodale (1995:83) noted that some sows were kept for several litters.

Randa's data (1994:64) on the number of times Irian Jaya sows (all of which had farrowed at least once) had farrowed, suggest longer retention of sows than is normal in PNG. Of 66 upland sows, 19 had farrowed three times and 45 twice; of 51 lowland sows, 24 had farrowed three times, 40 twice (but see also his Table 15, p. 68, for apparently contradictory information). Some other Irian Jaya sources lend support to such evidence of retention. Cook (1995:289) described retention of sows by the Amung after one or two

litters, and Pospisil (1972:216) recorded one sow among the Ekagi-Me (Kapauku) having four or more litters. Elsewhere, however, as noted above, Pospisil suggested that only young sows were used for breeding.



Newborn piglets suckling on sow in nest in grassland, Kuai, Sinasina, Simbu Province, 1972. Even in relatively intensive husbandry regimes in the Highlands, sows make their own nests in fallow near their housing where they give birth and remain for several days. Photographer: R. Hide.

For the Hagahai people, who live at a very low population density in a fringe area of the Madang Province highlands where a feral pig population coexists with a domestic one, there is a report that pregnant sows are slaughtered as a means of controlling pig population increase (Jenkins and Milton 1993:284–5). There, pig foetuses were regarded as a delicacy, particularly by women. The lowland Saniyo-Hiyowe in East Sepik Province also had no constraints on slaughtering domesticated sows, even pregnant ones, with Townsend (1969:53) reporting that, in 1966–67, of three killed, one had just farrowed and two were about to farrow.

Litter size

Table 6.2 lists all available data on average litter size from New Guinea village studies, including one data set from the neighbouring Solomon Islands. Theoretically, these are litter size at birth but, because many sows farrow away from settlements and may not be seen until a few days after birth, there is clearly time for some postpartum losses to have occurred before counting took place. Mean litter sizes range from 3.6 to 6.4. In most cases, there is no information on parity.

There is also other partial or incomplete information: for the Simbai Valley in 1962–63, where Rappaport (1967:70) recorded 14 litters, with 32 surviving piglets at the completion of research; and for the Wiru region of the Southern Highlands Province in the mid 1970s, Fullingim (1988:29) gave a figure of 3–4 per litter. A record of litters of 9–10 piglets at birth for the Siane area of Eastern Highlands Province is dubious if this was meant as typical (Salisbury 1975:130): earlier he had described three litters of six piglets each (Salisbury 1962:91). Occasional litters of 10–12 of course are possible, especially where introduced stock is common, as on Kiriwina (Milne Bay Province) in 1945–46 (Australian Mobile Veterinary Survey Unit 1946:37). However, rough contrasts between litter sizes of 10 with improved stock, and two or three with unimproved sows, made by field officers in Bougainville Province during the post-World War II enthusiasm

of the 1950s (Connell 1978:183) perhaps need to be treated with some caution. For Irian Jaya, Randa (1994) presented litter size data only as proportions within certain ranges: for the upland sows, litter size of 4–6 at birth was most common for first, second and third farrowing. For the lowland sows, litter size of 7–9 was equally common for first and third farrowing, but 4–6 was most common for second farrowing.

Table 6.2 Litter sizes of New Guinea pigs from various locations

Location/group	No. of litters	Mean litter size	Reference
Goroka, EHP	na	3.6–3.8	Malynicz 1977:204
Lapegu, EHP	24	3.67	Malynicz 1977:204
Irakia Awa, EHP	15	4.1 ¹	Boyd 1984:42
Wola, SHP	321	4.74	Sillitoe 1985:512
Sinasina, SIM	37	4.8	Hide 1981:460
Kasena, EHP	na	4.8	Davis 1973a, cited by Malynicz 1977:204
Yumbisa, ENG	16	4.9	Wohlt 1978:152
Gadio, ESP	7	5.0	Dornstreich 1973:238
Solomon Islands	54	5.1	de Fredrick 1971b:24; 1977a:119
Etoro, SHP	9	5.6	Kelly 1988:136, 138
Kapanara, EHP	82	5.93 ²	Grossman 1984:170
Ekagi-Me, IJ	8	6	Pospisil 1972:205
Erap ³ , MOR	na	6.04	Malynicz, no date (b)
Goroka ³ , EHP	na	6.43	Malynicz, no date (b)

EHP = Eastern Highlands Province, ENG = Enga Province, ESP = East Sepik Province, IJ = Irian Jaya, MOR = Morobe Province, SHP = Southern Highlands Province, SIM = Simbu Province.

¹ Includes two litters with no live births recorded; mean litter size of 4.6 if these two excluded (D Boyd, University of California at Davis, pers comm, June 2001).

²The original has 79 litters (12 of which were second litters during the 17 month research period), and a mean litter size of 5.91. Grossman corrected this to 82 litters, 15 of which were seconds, and a mean litter size of 5.926 (L Grossman, Virginia Polytechnic Institute and State University, pers comm, June 2001).

³These litters were from sows of parity 1–4 in the case of Goroka, and 1–3 at Erap. In both places, there was the usual parity effect of smaller litter size for parity one. At both stations, husbandry was intensive and nutrition good.

The figures in Table 6.2 are similar to data on captive feral pigs in Hawaii, where the average litter size for 15 litters was 5.5 (Kramer 1971:191).

Weaning age

Dwyer and Minnegal (in press) have recently identified practices associated with weaning as significant for distinguishing different husbandry regimes. As they note, there is very little published data on the age of pigs at weaning in New Guinea. They distinguish between areas where piglets may be removed from sows at anything from as short as one or two weeks, those where weaning may occur at one or two months, and those, such as many parts of the highlands where it seems likely that most piglets are left with their mothers until weaning is accomplished naturally at about three months, as is reported from the Western Highlands Province (Watt et al. 1975). In Enga Province, Freund (1968:8) considered that piglets were left with sows until anything up to six months, by which time weaning presumably had occurred. For the Ekagi-Me in Irian Jaya, Pospisil (1963:11; 1972:205) described weaning as between at least four weeks and no more than three months, on average six weeks. In Irian Jaya in the early 1990s, the most common age at weaning for both upland and lowland pigs was three months (Randa 1994:66–67). (Randa reports the most common litter size at weaning to be 4–6 piglets — see the similar size at birth in Section 6.4.2 — which implies that mortality is considerably lower than is common in rural PNG: this reinforces the view that his data were primarily obtained under semitrial conditions).

Outside the highlands, Dwyer and Minnegal (in press) note that piglets may be removed from sows as early as two weeks of age amongst the Kubo. In other lowland (and midaltitude) areas, separation may occur even earlier: 'immediately after farrowing' amongst the Saniyo-Hiyowe according to Townsend (1974:250), and 'soon after birth' among the Myanmin (Morren 1986:88). For such systems, Downer (1991:114) is incorrect in asserting that piglets are never removed from the sow in PNG, though his subsequent statement that piglets stay with their mother until they reach an independent age 'or are nursed by human foster parents' implies some qualification.

Litter intervals

In terms of litter interval potential, it is unlikely that New Guinea pigs differ from other breeds. Examination of breeding records of sows under intensive management at Goroka and Erap research stations showed mean farrowing intervals of 199 and 211 days respectively for New Guinea sows, compared to 202 days for British pigs (at both locations), and 187 and 194 days respectively for crossbred pigs (Malynicz, no date (b)). A farrowing interval of 200 days allows 1.85 litters/year.

Information on litter intervals under village conditions is limited. In Enga Province, Freund (1968:8) considered that it was rare for sows to farrow more frequently than once a year, partly due to the length of time their piglets were left with them and the resulting emaciated condition of the sows. At Yumbisa in Enga Province, in the early 1970s, Wohlt (1978:157) calculated a farrowing interval of 17 months. In Sinasina, during 17 months of 1972–73, 45 sows became pregnant 48 times: ie only 3 of 45 sows had 2 pregnancies. The litter intervals for these were 30, 57, and 60 weeks (Hide 1981:457). However, calculation of the birth interval of an average female in the population during 1972–73, (gestation time divided by the average pregnancy ratio, see (Petrušewicz and Macfadyen 1970:70)), gave an extraordinarily long interval of 3.7 years. Clearly, such a regime is not concerned with maximising the production of young animals. Note, however, that this contrasts with Meggitt's descriptive account of Mae Enga husbandry in 1955–57 (summarised in Section 6.4.1), that emphasised a lack of breeding control (Meggitt 1958a:291).

In the Tairora area of Eastern Highlands Province in 1976, 67 sows produced 82 litters in 17 months, 15 (22%) of the sows farrowing twice (Grossman 1984:170) (for additional information see Table 6.2 note 2). On the Papuan Plateau (Southern Highlands Province) in 1968, no sows produced second litters in a survey period of seven months, but Kelly (1988:136) estimated that the average interval might be as short as nine months. According to Hauser-Schäublin (1983:342) sows in the lowland Abelam area (East Sepik Province), where all mating of domestic sows is with wild boars, 'normally' have more than one litter per year.

In Randa's Irian Jaya study, respondent farmers claimed that 14–15% of sows farrowed more than once in 12 months (Randa 1994:68). In the Solomon Islands, in the late 1960s, the litter interval for 24 village sows was calculated at 10.4 months, but this did not include sows that had only one litter in their life or none (de Fredrick 1971b:24; 1977a:119; de Fredrick and Osborne 1977:203). In a subsequent experiment testing the relative influence of breed, diet and housing on reproduction (and growth) in the Solomon Islands, de Fredrick and Osbourne (1977:206) found that litter intervals were strongly effected by nutrition: sows fed a commercial ration had a mean litter interval of 185.2 days, those on a village diet averaged 274.5 days.

This suggests that the normal dietary regime of village husbandry is likely to mean long intervals. In systems depending on domestic sows mating with feral boars, and where access to boars is unimpeded, it seems likely that intervals are shortest. This appears to be the situation on the Papuan Plateau, and some of the Eastern Highlands Province areas where pig populations are distinguished by large proportions of young animals. Conversely, where all breeding is with domestic boars, and production goals focus on periodic kills of many large animals, intervals are likely to be longest.

Sow reproductive rates or pregnancy ratios

There is relatively little quantitative data recorded for these variables. At Yumbisa in Enga Province in 1972–73, with 15 pregnant females of a total 186 female pigs, Wohlt (1978:152) calculated a pregnancy ratio of 0.08. This is the same as the average rate calculated for a Sinasina population also in 1972–73 (Hide 1981:458). In the early 1980s, a team led by Wohlt (1986b:70–73) surveyed pigs in all Enga districts and reported an overall pregnancy ratio of 0.08, varying between districts from 0.04 to 0.24, and by altitude from 0.01 at lower altitudes to 0.10 at higher altitudes. In 1955, in a small Ekagi-Me village in Irian Jaya, there were four pregnant females among 18 females (6 fully grown, 6 medium and 6 small), or a pregnancy ratio of 0.22 (Pospisil 1972:217, 396). This high figure is probably explained by the fact that the herd had been depleted in a pig feast in 1953, and had only numbered 12 small animals in early 1955. The rapid expansion of pig numbers during 1955 was accomplished by purchasing mature animals

For the Awa, the sow reproductive rate was only 27%, with 15 pregnancies in 56 sows over a 12-month period (Boyd 1984:42). This is similar to the 24% recorded by Rappaport in the Simbai Valley. In contrast, data from one year in a Goroka village showed that 63% of females over 25 kg became pregnant, and at Lapegu, also near Goroka, the rate was 32% (Malynicz 1977:207).

The lack of information on variables such as these is a major gap, particularly in the light of data from studies of wild pig populations in Europe that indicate significant year to year variation depending on environmental conditions. For instance, in the Maremma National Park in Italy, in March–April 1992, 90% of wild adult female sows gave birth, with litter sizes of 4–6; the following year, only one fifth of females gave birth, to 2–3 piglets each (Massei Smith 2001:59). Given the close relation that obtains in many New Guinea husbandry systems between domestic sows and wild boars, it is interesting to speculate that variation of this type, even if not so pronounced, may operate.

Breeding management, reproduction control and culling

In systems where breeding is reliant upon domestic sows mating with feral or wild boars, the options for control of reproduction are limited to the regulation of sows' movements (Rappaport 1967; Boyd 1984), to the culling of excess recruits from litters, or even to the slaughter of pregnant sows (Jenkins and Milton 1993:284–5). In systems of husbandry that use domestic boars, there is considerably more scope for breeding management. In systems where there is no access to feral boars, the statement that 'in Papua New Guinea the sow is allowed to mate naturally' (Downer 1991:114) is incorrect.

To achieve production goals of large, fat animals on coordinated slaughter occasions, pig owners throughout the highlands are widely reported to attempt to prevent their sows mating freely: see, for the Western Highlands Province (Bowers 1968:95), for Simbu Province (Hide 1981:468–70), for the Southern Highlands Province (Lederman 1986:223; Sillitoe 2001b:17), and for Enga Province (Wohlt 1986b:10–11). Malynicz (1977) also infers control of breeding in pig populations in Simbu Province and Western Highlands Province. The explicit aim in some cases is said to be to avoid having skinny sows (the result of farrowing and lactation) on hand at the time of slaughter (Lederman 1986:223).

The wish to avoid their sows breeding and hence losing condition is not restricted to communities involved in large-scale production cycles. The Yangoru Boiken of East Sepik Province asked Roscoe whether contraceptive pills would work for pigs (Roscoe and Roscoe 1988:111), and Randa (1994:69) has noted that in Irian Jaya farmers reported feeding medicinal plants to sows to prevent conception. Similarly, in Eastern Highlands Province, Glasse (1963:45) reported that the Fore fed a contraceptive plant to their sows 'when it is nearly time to slaughter them to prevent pregnancy'.

Even with substantial mortality (see Section 6.5) reducing litter sizes severely, there is still the potential for pig numbers to grow rapidly. The culling of young animals is a strategy that is probably practised rather more frequently than has been reported. The

Gimi in the Eastern Highlands Province are reported to kill a part of every litter (Gillison 1993:42; 2001:293). For other specific accounts see Salisbury (1975), Hide (1981:488) and Dwyer (1993). As noted above, the culling of pregnant sows has also been reported (Jenkins and Milton 1993:284–5).

Seasonality of breeding

It seems unlikely that there is any regular seasonal pattern to domestic pig breeding in New Guinea, although possible sources of variation (eg climate, availability of forage or fodder) have been discussed (Hide 1980). Data on farrowing from Sinasina and Tairora in the 1970s both displayed strong clustering: December to April in the case of Sinasina, and April to November in the case of Tairora, but climatic seasonality is unlikely. On the Papuan Plateau in 1968, no clustering was apparent (Kelly 1988:136). The lowland Abelam in East Sepik Province told Hauser-Schäublin (1983:342) that breeding was not seasonal, but she noticed a peak in May. Sillitoe (2003:253) asserts that pig breeding is not seasonal in the Wola area of the Southern Highlands Province.

In Australian commercial pig production, there is some seasonal infertility in the period from late spring to mid autumn (November–April?), which may be associated with photoperiod (Greer 1986).

6.5 Mortality

Reviews in the 1970s of village pig husbandry indicated that pig mortality was high under customary conditions (Malynicz 1970a; Densley with Purdy et al., no date). Although detailed village studies are still scarce, more information is now available from a range of studies across the major altitude zones.

The most commonly reported data on mortality are those for litters during the first few weeks or months after birth. However, comparisons are often difficult, as the period of survival is not always given. For broader comparative purposes, it may be noted that by 1990 one of the most commercial piggeries in PNG reported 12% mortality by the age of weaning (ANZDEC Consultants Limited 1990).

6.5.1 Highlands

In Kasena village near Goroka in the early 1970s, there was 37.5% mortality among piglets between birth and four weeks of age (Davis 1973a) cited by Malynicz (1977:204). Another Goroka study showed 47% mortality between birth and (undated) weaning (Malynicz 1977:204).

In Sinasina in 1972–73, the pigs from 14 litters (mean live litter size at birth 4.71) were followed for 12–17 months, during which time 42% of the piglets died and a further 16% were slaughtered (Hide 1981:462–3). The piglets from a further 23 litters (mean live litter size 4.09) were followed for between 0–11 months, over which period 12% died and 14% were slaughtered.

In a high altitude Enga Province location in the early 1970s, 16 litters (mean litter size 4.94) were followed from birth for periods varying between none to a few months, during which time 22% died (Wohlt 1978:152, 157).

Sillitoe (1985:17; 2001b:17) reported 22% piglet mortality (before an unspecified age in the earlier publication; 6 months in the later one) from a retrospective survey amongst Southern Highlands Province villagers in the 1970s.

In the Ekagi-Me area of Irian Jaya in 1954–55, Pospisil (1972:205, 207) estimated, on the basis of a small sample (probably 8 litters), that about 27% of piglets died ‘in infancy’ and an additional 25% either died of disease or were killed prior to maturity.

The performance of indigenous pigs kept under intensive conditions at Goroka indicated that mortality in the first few days after birth was low compared to that for exotic breeds (Malynicz 1977:204).

Mortality amongst larger (or older) animals in the highlands appears generally modest. In Sinasina over 12 months in 1972–73, of a total of 57 pigs that died, 2 were sows during pregnancy or at birth, 19 were piglets at or very soon after birth, 6 were animals said to have suffered climatic extremes (too hot or too wet), 5 were due to accidents or injuries, and 11 were said to be due to disease (Hide 1981:479–83).

Malynicz (1977:208) described incomplete data from three highlands locations for 1975. The mortality losses ranged from 3% to 14%.

6.5.2 Midaltitude zone

Higher mortality rates for newly born piglets have been reported in the zone between the highlands and the lowlands.

For the Papuan Plateau area of the Southern Highlands Province in 1968, Kelly (1988:120, 138) indicates that litter size averaged 5.6, and generalised that ‘Half of these animals (or litters) will not survive the suckling period and one-fourth of the remainder will fail to survive the next thirteen weeks. This reduces the litter to 2.1 animals, of which another quarter will perish in the next thirteen weeks, leaving 1.6 shoats’. In summary, this averages mortality of about 74% before about 9 months of age. He considered that such a pattern of mortality, characterised by the loss of entire litters, was likely to have been due to disease. For older, mature animals, mortality was ‘only about 19 percent annually’ (Kelly 1988:138, 140). These are very high rates for both young and mature animals.

Similarly high mortality rates are reported from the Seltaman area of Western Province in 1987–88. There, 54% of piglets died before the fourth month, and 66% were dead in the first year (Whitehead 2000:148, 288 fn. 3).

Rather different figures are reported from the south of the Eastern Highlands Province in 1971–72, with an approximate annual mortality rate of 17% among small and medium-sized pigs (Boyd 1984:41–2). However, this was a minimum only as it did not include recently farrowed piglets dying before sighting by owners. His data confirm higher mortality rates among smaller (younger) animals, and include, besides disease, snake bite (five pigs) and drowning as the causes of unexpected deaths.

6.5.3 Lowlands

There are few data from the lowlands. In a general statement for the Saniyo-Hiyowe (East Sepik Province) in 1966–67, Townsend (1969:50) described a very high mortality rate in litters such that rarely more than one piglet per litter survived the first week, and more pigs died later while juveniles. From a slightly higher altitude in East Sepik Province among the Gadio, Dornstreich (1973:238) noted from general observations in 1967–68 that it was rare for more than two or three piglets of an average litter of four to six to survive infancy. Of 35 piglets born from seven litters over 14 months, 12 (34%) had died when the research period ended. His records, covering 14 months, for the pigs owned by one hamlet showed that there were 17 deaths amongst 38 animals: 10 of which (59%) were from 17 newborn piglets, with deaths due about equally to illness and human culling (Dornstreich 1973:243–4, 319). He also noted that Gadio hunters never reported more

than two piglets seen with feral sows, suggesting high mortality amongst the wild or feral pigs.

Dwyer (1993:126) described the husbandry of a small group of Kubo people at Gwaimasi (Western Province) in 1986–87. During that time, there were only four natural deaths, all of very small, or small, pigs (estimated live weights of 1.0, 1.5, 4.0 and 12.5 kg). For the Bedamuni, van Beek (1987:25) described significant losses of piglets to predation by hungry village dogs. Baldwin (1982:36) similarly described high mortality of piglets born to village sows among the Gogodala in the mid 1970s, which he considered due to neglect, poor diet and attacks by village dogs.

Under trial dietary conditions in the Solomon Islands in 1967–69, de Fredrick and Osborne (1977:206) reported 22.6% mortality amongst 124 piglets in 16 litters by the age of weaning at 8 weeks.

A recent investigation of pig deaths at Putput village near the mine on Lihir found that they were due to poor nutrition, high loads of internal parasites and too high a density for free-foraging husbandry strategy, rather than mine-related pollution (Kirsch 2001:150–152).

6.5.4 Disease

Disease is discussed more fully below (Chapter 11), but has important effects on mortality patterns. In 1964, anthrax was described as widespread in the highlands, with a further enzootic area of about 100 square miles in the Sepik district (Egerton and Rothwell 1964). Egerton considered that epizootics of anthrax occurred in local pigs each year, usually in the wet season and that mortality of up to 25% was common. High mortality rates in pigs exposed to anthrax that was confirmed bacteriologically were described for the Nebilyer (Western Highlands Province), with 400 deaths from an estimated 4000 pigs, and for Ningil Village in the Sepik district, with 51 deaths of 255 pigs (Egerton 1965b:142).

Davis (1973a) noted in a survey of two Eastern Highland Province villages that a lung worm (*Metastrongylus* spp.) — pneumonia complex caused the deaths of 14.4% of the total pig population in one year.

6.5.5 Summary

The village studies from the highlands suggest mortality from birth to about one year of about 40%. In the midaltitude zone, mortality appears to be even higher, perhaps 66% to 74% in the first year. Lowland data are unfortunately inadequate for generalisation. Although the mortality rates of older pigs are considerably less, it seems likely that they may be higher outside the highlands. Information on causes of death under normal conditions is minimal. Certain diseases such as anthrax erupt as epizootics with very high mortality. Under customary village conditions, only basic ethnoveterinary knowledge was available to treat illness amongst animals (Sterly 1978/79, and see Chapter 11, Section 11.6).

6.6 Labour and other costs

The main labour and time costs associated with pig husbandry in New Guinea are:

- direct care of animals, including the special care of piglets removed from sows, the management of breeding (castration of males, care of boars, putting sows to boars, locating and retrieving sows and new litters), veterinary tasks, grooming and delousing, and searching for lost animals

- provision of housing
- feeding, including the collection or cultivation of foods for fodder, transport of fodder to pigs, preparation of fodder (eg cooking and felling sago palms) and herding in relation to foraging (eg leading pigs to foraging areas and watching over them).
- control of pig movement through fencing or other enclosure systems, primarily to protect crops from pigs
- disputes concerning pigs
- deployment decisions and actions in exchange
- time and travel costs required in trade.

There are two main sources of detailed information on the labour (and other) costs of pig husbandry in New Guinea: studies of the fodder component of husbandry, and studies of labour allocation. There are also many other accounts that provide more qualitative information: for instance, on Goodenough Island in the early 20th century, Jenness and Ballantyne (1920:206) reported that men bathed pigs in the sea, and the animals were said to receive as much care as children.

6.6.1 Fodder provisioning

Fodder provision is also discussed in Section 6.2. In terms of fodder, the major sources of variation in labour costs are the numbers of pigs held and the type of fodder used. For instance, Morren (1977:279) compared the levels of energy (as a percentage of total human energy production) received by pigs as fodder in three New Guinea systems: the Myanmin with 0.1 pigs per person (16.2%), the Tsembaga Maring with 0.8 (27%) and the Raiapu Enga with 2.3 (64.7%). Some of the implications of the energy costs of such differences are discussed by Bayliss-Smith (1977:345–353). In many places where the numbers of pigs kept are small, the extra time (if any) invested in growing food for pigs is modest. However, where sweet potato is the main crop, and where the relative numbers of pigs are large, a very substantial proportion of total sweet potato production is fed to pigs (see Sections 6.2.2–6.2.4, above, for details). A certain amount of this fodder consists of substandard tubers unsuitable for human consumption and therefore requiring no extra labour costs in production, except for harvest and transport. However, customary peak levels of pig production (for exchange and ceremonial purposes) in many highland areas appear to require extra production of the staple sweet potato, over and above the level required for human provisioning. Contrary to this view, Sillitoe (2002:445–6; 2003:315) has argued recently that Wola people of the Southern Highlands Province studied in the 1970s (who were looking after almost one pig per person and feeding them half their sweet potato harvest, see Section 6.2.4) ‘do not clear gardens to feed pigs, rather they feed them rejected produce ... People would undertake more or less the same garden work to feed themselves whether or not they had to fodder pigs’. This provocative argument, stated rather than elaborated in this context, is difficult to evaluate because Sillitoe did not engage with other highland studies that have attempted to calculate the extent of extra pig-related cultivation (see below), did not discuss whether his statement was supported by household-level data on cultivated areas and pig holdings, and did not consider possible reasons for such a high proportion (50%) of substandard tubers in the Wola sweet potato harvest.

Studies elsewhere in the highlands have not determined with precision the amount of extra cultivation undertaken for pig production, but the range appears to be about 20–50%. There is a significant body of research that, besides other aims, has attempted to analyse the area cultivated by households (or groups), and to identify the extra area of garden land cultivated specifically to provide fodder for pigs (Brookfield and Brown 1963; Rappaport 1967; Brookfield 1973; Mitchell 1976; Wohlt 1978; Hide 1981; Crittenden 1984; Wohlt and Goie 1986; Rambo 1993). There are problems, however, in extrapolating directly from the proportions of food fed to pigs, to extra areas cultivated. This, for instance, is what Kelly (1988:119) appears to have done in his contrast between

the minimal fodder rations characteristic of the Papuan Plateau environment of the Etoro, and those central highlands 'societies in which one-half to two-thirds of the land under cultivation is devoted to the production of sweet potato that are fed to pigs'. However his citations of Rappaport and Waddell were of their accounts of the proportions of harvest fed to pigs, not to extra land areas cultivated.

The problem here is that the tubers the pigs receive are often mainly small-sized ones that are considered unsuitable for human consumption, a byproduct of production for human consumption (see Section 6.2.4). Rappaport himself noted that over 80% of all tubers fed to Maring pigs were substandard, and that 30–50% of the sweet potato harvest was of this size (Rappaport 1967:60, 260). Information on the size of that byproduct is limited, but it is known that it varies by cultivar, by garden age (and hence presumably soil fertility), by harvesting technique and, presumably, by climatic conditions during crop maturation (Mitchell 1976; Rose 1979:62). Overall estimates vary between 20% and 50% (or more) of total harvest (Hide 1981:372–377).

There is also ambiguity in some accounts as to the extent that pigs are dependent on fodder. This is particularly the case with the Dugum Dani of Irian Jaya, described by Heider (1970; 1979). According to Heider (1979:35), the Dugum Dani look after about one pig per person, although he has also indicated to Waddell (1972a:211) that numbers may rise to as high as three pigs per person before a festival. Most surprisingly, however, he reports (Heider 1979:36) that pigs live almost exclusively off waste, with only minor food production done especially for them. Earlier, he described pig fodder as merely a few kilos of the smallest sweet potato thrown to them (Heider 1970:50).

The size of customary fodder rations per pig (see Section 6.2) is a significant factor in evaluating the failure of many semi-intensive pig projects. These projects required feeding levels many times greater than customary ones (Watt et al. 1975; Watt and Michell 1975). Forty years ago, Anderson recognised this as a major limit on the expansion of pig production:

If the native were to raise pigs as a source of protein food, then he would have to more than double the present production of his subsistence gardens. This, of course, would place an impossible burden on native agriculture. The essential function of the native's meat animal must be to convert otherwise useless fodder into meat. (Anderson 1960b:170).

6.6.2 Time allocation

The most detailed information of the labour requirements of pig husbandry is that available from community-level studies of time allocation. Material from some highland studies is summarised here.

In a Raiapu Enga settlement in 1967, where there were 1.7 pigs per person, direct work in pig husbandry by adult men and women occupied only 0.8 and 0.7 hours per week respectively (Waddell 1972b:101). However, other work in food production required approximately 15 hours per week for men and 26 hours for women. Since the great proportion of this time was taken by sweet potato cultivation (clearing and fencing by men; planting, weeding, and harvesting by women), and since more than half this crop is fed to pigs, the total proportion of time, both direct and indirect, devoted to pigs is very considerable.

In Sinasina in 1972–73, among a sample with 1.8 pigs per person, adult men and women spent an average 3 hours per week each on direct pig tasks, and a further 12 and 20 hours respectively on food production (Hide 1981:260). In the Daulo area of Eastern Highlands Province in 1977, with 0.8 pigs per person, adult men and women spent respectively 2.5 and 5.3 hours per week in direct pig tasks, with an additional 4.7 and 16.7 hours in overall

food production (Sexton 1986:46, 49, 148). A detailed breakdown of the proportions of time spent on specific pig related tasks by men and women is shown in Table 6.3.

Table 6.3 Gender division of labour in direct tasks in pig husbandry, Daulo, Eastern Highlands (1977) (percentages of observations)

Activity	Men	Women
Feeding/sheltering	44.1	68.9
Travel to/from pig house	8.8	13.5
Pig housing	20.6	1.4
Searching for lost pigs	17.6	6.8
Other	8.8	9.5

Source: Sexton (1986:148)

These studies show a range from about one to five hours weekly per adult in direct pig work, much the same as the figure of 35 minutes per woman per day (for women looking after pigs) reported for the Eipo in Irian Jaya by Michel (1983:145), where there were only 0.5 pigs per person. Low labour figures (16 minutes per woman per day, 8 minutes per man) have been shown by a recent (1994–1995) study in the Tari area of the Southern Highlands Province (Yamauchi et al. 2001:262), and similar ones by Sillitoe's detailed presentation of 1970s data from the Wola region of the Southern Highlands Province. In the latter study, direct work in pig husbandry required, on average, 28 minutes per women per day and 7 minutes per man (Sillitoe 2002:443, 445; 2003:313–314). Given different methods of surveying time allocation, and variation in husbandry regimes, such differences cannot be evaluated in detail, for instance in relation to different numbers of pigs per person. Rather they are useful as illustrative of the modest place of direct pig husbandry tasks in the overall time budgets of highland farmers in locations in which most households raise some pigs.

These studies also highlight the problems involved in determining the full labour costs of village pig husbandry, including those tasks, or a proportion of them, not directly associated with pig care (Kuchikura 1990:121–122; Sillitoe 2002:443–7). The latter include, most significantly, work involved in sweet potato production, as discussed briefly in the preceding section in terms of fodder provisioning, and work required for fencing gardens against pigs. The latter is a pronounced feature of most New Guinea agricultural systems, and a major labour cost to pig husbandry for systems above the altitudinal range of feral pigs (Lemonnier 1990:141; Dwyer 1993:136). It appears to be underestimated in Sillitoe's (2002; 2003:313–314) recent analysis of Wola husbandry costs, though he acknowledges that inclusion of such labour would dramatically increase men's labour contribution to pig keeping (Sillitoe 2003:314). In many attempts to adapt pig husbandry systems to modern conditions throughout the country, the goals of reducing the demands of fencing on both labour time and timber resources, and of decreasing the vulnerability of crops to the depredations of pigs, figure prominently (Koma 1992; Brutti and Boissière 2002).

The studies are instructive in terms of differences between the husbandry tasks of men and women. All New Guinea agricultural systems are characterised by marked gender divisions of labour. While both the Raiapu Enga and Sinasina studies show relatively equal amounts of time spent by men and women on direct pig tasks, the Daulo study indicates women spending more than twice as much time as men in pig raising. A similar imbalance is suggested by another study from the Kainantu region of the Eastern Highlands Province (Grossman 1984:268–275). In the Nipa area of the Southern Highlands Province, Wola women appear to spend as much as four times as much labour as men in such tasks (Sillitoe 1985:513; 2002:443–5). Undoubtedly, there is variation both by place and by time in such gender patterns. For instance, in contrast to most accounts that emphasise the female domination of most work in pig husbandry, Christensen (1975:25) observed in the early 1970s that in the Wurup Valley near Mount Hagen it was men who had begun to undertake much husbandry work. In the Daulo case,

however, Sexton (1986) suggested that men were withdrawing from pig husbandry in favour of more modern and prestigious development activities, with the consequence that pig husbandry was undergoing feminisation. In contrast, in the Benabena area of Eastern Highlands Province in 1983, Dickerson-Putman (1986:231) considered that, compared to past Benabena practice, men were participating more in pig care. On Tubetube Island in Milne Bay Province, Macintyre (1984:111) warned that generalisations about gender patterns in pig husbandry were difficult to make, with interhousehold variation related to the age of pig carers and the composition of their households.

In the highlands, in particular, the implications of sweet potato cultivation and pig husbandry in terms of gender roles have been the subject of considerable discussion by anthropologists, including Modjeska (1977; 1982; 1995), Feil (1987), Lederman (1986), Lemonnier (1993b), M. Strathern (1972) and Sillitoe (2001a).

The closeness of the relationship between numbers of pigs, the use of the staple crop sweet potato as the main fodder item and the work loads of their carers has resulted in several attempts at estimating approximate limits to the numbers of animals that can potentially be managed by a single woman or a household. Describing the Kyaka Enga in the mid-1950s, Bulmer (1960:96) considered that a married couple could care for up to six adult pigs and two litters, rarely more than 10 pigs over six months old. Rappaport (1967:158) suggested that the average Tsembaga woman could probably support only four pigs in the Simbai Valley (maximum observed was six), while Waddell (1972b:191) considered that 8–9 might be the maximum for an Engan woman. At Pangia in the Southern Highlands Province, Strathern (1984:83) suggested that a woman, assisted by regular male help, could care for up to ten pigs of varying size. Sillitoe, while not specifying a particular limit, charted actual Wola numbers in 1977 showing no woman supporting more than four large and six medium and small pigs (Sillitoe 1985:512–4), noting subsequently that there were limits to the number a woman could support (Sillitoe 1996:395–6). For the Imbonggu area in the Southern Highlands Province in 1976–77, Wormsley (1978:226) believed that a woman could support only about 6–7 adult pigs. For the Goilala area of the Papuan highlands, Hallpike (1977:72) described Tauade women as able to look after about eight pigs as the ‘average maximum’. In somewhat cavalier terms (fodder, for instance, receives no mention), Reay (1984) wrote that she knew some Kuma (Western Highland Province) women who could care for 21 pigs without neglecting other tasks. Unless these women were relying on fodder from other than their own production, this seems unlikely. Comparing highlands with coastal areas, Quartermain (1977:58) described limits of 4–9 pigs per owner in the highlands, with three pigs per owner in coastal regions.

6.7 Demographic dynamics

Although the prime unit of domestic pig management is, in most parts of New Guinea, the household, the pig herds of individual households usually only number a few animals. However, it has proved useful to describe and analyse the aggregated pigs of all households composing one or more local communities, to identify significant differences in wider population dynamics. What is of specific interest is the extent to which the households that make up a community follow similar management strategies, resulting in the pig populations displaying distinctive demographic structures. Where the local group or groups under study do not coordinate their husbandry strategies in terms of slaughter or exchange events, no such clearcut demographic signature can be expected, and thus choice of the appropriate social unit or level of analysis is of critical importance.

Generally, studies of pig husbandry in New Guinea have not been able to determine in detail the age structure of pig populations. Elsewhere, studies of feral pigs have used patterns of teeth eruption (Choquenot and Saunders 1993), but this technique has not been used in New Guinea, except for interpreting bone material from archaeological sites. Instead, animals are usually classified by size, either in terms of broad descriptive classes (eg small, medium and large) or, more rarely, by measurement or estimation of specific sizes (see Section 6.3.2). A minority of studies present these groups in terms of live

weight. Sometimes, instead of broad size classes, groups are defined in terms of maturity. At minimum, two classes are distinguished (with or without sex defined): piglet or juvenile, and mature, although these are not described in terms of specific age (Clarke 1971:84; Hallpike 1977:73; Robbins 1982:62). Some studies give more specific size and sex information (Pospisil 1972:396; Dornstreich 1973:233–4, 319; Wohlt 1978:152; Wohlt 1986b:70–73; Kelly 1988; Sillitoe 1994:62–63; Sillitoe 2001b; Sillitoe 2003:281–291). Even in these studies, however, ages or sizes tend to be descriptive only, rather than exact. The lack of precise ageing is an unfortunate gap in our understanding of important biological and cultural aspects of pig demography under different husbandry regimes.

The older, partly implicit, view (Vayda et al. 1961) was that the dynamics of domestic pig herds or populations in New Guinea were primarily under natural ecological controls. This view was replaced in the 1970s and 1980s by a perspective emphasising the importance of human control and direction (Brookfield 1973; Malynicz 1977; Hide 1981). In one of the strongest statements, Lederman (1986) argued that the periodicity of major pig production events (large scale pig kills, pig festivals and ceremonial exchanges) in the highlands would be better understood not in terms of cycles, which imply over-determined regularity, but more as historical events, the outcomes of specific sequences of political action and decision making.

The specific production aims of a husbandry system entail a particular demographic profile or structure of pigs of different ages and sex. In a commercial production system, where the goals are to manage pigs to grow fast and efficiently in terms of feed costs, there are optimal proportions of sows and young pigs. New Guinea customary production systems, however, have very different characteristics. Underlying their strategies are distinctive features; for example, that pigs grow very slowly, that survivors may be retained until they are five or more years old, that fertility may be controlled (either through managing breeding or by culling piglets) and that mortality, especially of the young, is very high.

Of special importance, however, is the relationship between the production goals of pig keepers and the demographic structure of the aggregate pig herds of households whose activities are coordinated. The two main extremes that have emerged from empirical studies over the past 30 years stand in marked contrast. On the one hand, there are areas where herds are managed in a coordinated way to produce mainly adult pigs ready for slaughter in major exchange or ritual events, such as pig festivals. In such systems, the associated demographic structure at the final stage before slaughter is an inverted pyramid dominated by older animals, with a variety of different structures at other stages. At the other extreme are those management regimes characterised by the absence of a long-term production goal, shared by many participating households and focused on a single slaughter event. Instead, such regimes appear to be managed with the aim of delivering a steady take-off of pigs for a relatively continuous series of small-scale events. In such systems, the demographic structure is that of a normal pyramid with a wide base, tapering to a narrow top.

The latter kind of structure was first described, at least implicitly, for the Siuai area in Bougainville Province in 1938. Oliver (1949b:13) tabulated all 27 pigs owned by nine households in a Siuai village in terms of their customary shell (*mauai*) currency values, which were established in terms of the girth size of animals. The demographic pyramid revealed by this is classic: a broad bottom base of 19 small pigs (worth 10 *mauai* each), with six medium-sized pigs (20–30 *mauai*) and only two large ones (over 50 *mauai*).

The first anthropologist to describe a highland pig ‘population’ in terms of age classes was Bulmer (1960:95), for a group of 12 households in a Kyaka Enga settlement in late 1955, a year after they had disposed of large numbers of pigs in a Moka ceremonial exchange event. There were 18 pigs aged more than 18 months, 25 aged 6–18 months, and 50 below 6 months, a demographic pyramid implying a phase of relatively rapid increase.

The first ethnographic account explicitly emphasising quantitative aspects of pig demography was that by Rappaport (1967) in his ethnography of the Tsembaga Maring on the highland fringe of Madang Province. The Tsembaga people celebrated the end of a cycle of production with a major ritual (and exchange) pig festival during the period of his research. For the festival, pig herds had been built up to produce large animals, in total, some 169 animals averaging 64–68 kg each (Rappaport 1967:57). Although the age or size structure of the total herd was not given, that of the pigs belonging to one constituent clan was given, and is shown in Table 6.4.

Table 6.4 The size distribution of pigs belonging to one Tsembaga clan, 1963

Size class (kg)	No. of pigs
> 73	4
64–73	2
36–64	1
18–36	4
< 18	2
Total	13

Source: Rappaport (1967:61).

Not only does this structure differ markedly from that described for the Siuai and Kyaka pigs above, it is also very different from the postfestival Tsembaga structure that Rappaport summarised as consisting of 60 juvenile and 15 adult pigs (although all the adults were scheduled for imminent killing), with an average live weight of only 27–32 kg.

Rather similarly, Pospisil (1972:396–7) described the post-pig-feast (held in late 1953) herd of the Ekagi-Me (Kapauku) village of Botukebo in Irian Jaya as consisting in early 1955 of only 12 small pigs (7 female, 5 male); eight months later in September, the herd had almost trebled to 31 animals (6 large and 12 small females, and 4 large, 2 medium and 7 small males). In this case the rapid increase was due to trade.

Describing low intensity husbandry in the lowland Sepik foothills occupied by a small Gadio population located in five hamlets, where no pig festivals or cycles occurred and there was much hunting of wild pig, Dornstreich (1973:233–3, 319) noted that 60% of the pigs were either newborn or small, and overall some 60% were female, though the proportion of females rose to 70% amongst the larger animals. He contrasted one hamlet where husbandry was under intensification and the sex ratio was even, with other hamlets where there were almost 70% females overall. Such sex bias in favour of females stands in stark contrast to the account of the Marind-anim on the south coast of Irian Jaya, where traditionally there was no pig breeding (all animals were those obtained by capture from the wild): only castrated males were retained as tamed animals on the grounds that they were said to grow bigger and fatter (van Baal 1966:4–7). It seems, however, characteristic of the New Guinea highlands generally, where reported sex ratios in pig populations tend to slightly favour females (Malynicz 1977:203); for instance, 58% females in a small Ekagi-Me (Kapauku) herd in 1955 (Pospisil 1972:396), 56% females in a Sinasina population in 1972–73 (Hide 1981:415–6, 449), 57% in an Enga survey in the early 1980s, with a range from 52–63% by district (Wohlt 1986b:11, 70–72), and 58% for the Irakia Awa in 1971–72 (Boyd 1984:37). In the midaltitude fringe occupied by the Etoro, Kelly (1988:134–5) reported a more even ratio of 51% female. For pigs from 181 villages throughout coastal Solomon Islands in 1967–69, de Fredrick (1977a:117–118) reported 53.5% female overall, with a slightly lower proportion (52.8%) for animals aged more than eight months.

Using the size (weighed, or estimated by measurement) of pigs as a proxy for age, Hide (1981:407–18) analysed the aggregate pig populations of two central highland Sinasina groups in 1972–73 at different stages of their festival cycles: between festivals, and

immediately before, and after, a festival. A population in a midcycle phase (ie 3–4 years before the next planned pig killing) was characterised by a typical relatively broad-based pyramid. In such a population, most animals weighed less than 25 kg, with few larger pigs. Conversely, a population on the eve of a festival had a minority of small and medium pigs (under 25 and 50 kg), and a majority weighing more than 75 kg. Their average liveweight was over 70 kg, compared to just over 30 kg for pigs in the midpoint population. Immediately after the festival, the average liveweight was down to just over 30 kg, and the normal, broad-based, pyramid reappeared.

Similar demographic profiles were found by Malynicz (1977), who compared the pig populations of four highland groups. Two were located in the Eastern Highlands Province and did not traditionally stage major pig festivals. Both of these displayed broad-based pyramids with no pigs weighing more than 75 kg. Very similar structures have been described also from further east in the Eastern Highlands Province in the Tairora area (Watson 1983a:52; Grossman 1984:171). Of the other two groups studied by Malynicz, one was located in Simbu Province and showed a thin vertical structure (ie with no excess of either smaller or large animals), and one was located in the Western Highlands Province, with a large proportion of very small animals, but even proportions of other sized pigs. As Malynicz noted, such distinctive differences in demographic structure resulted from very different strategies of pig management. One of the major factors involved in producing such profiles is the control of breeding. To produce inverted pyramids, or top-heavy demographic structures, it is necessary that either sows are not bred, or all or most young are disposed of at or very soon after birth. Thus Boyd (1984), who described a 1971–72 Awa pig population (on the southern fringe of the Eastern Highlands Province) as also showing few smaller animals, though with no festival-type production cycle involved, suggested that this may have resulted from an unintentionally low rate of breeding. Reproductive control is discussed further below in Section 6.4.

Further demographic data would be particularly welcome for those areas where other specialised production regimes are found. For instance, in the south of West New Britain Province, one aim of pig husbandry is to produce special curved pigs' tusks for the manufacture of important ornaments. These are produced by removing the upper canine teeth of male pigs, thus allowing the lower canines to grow in a curved form, even to the point of achieving a complete circle and reentering the lower jaw (Goodale 1995:83). This requires many years of growth, with figures of 5–6 years reported from the Siassi in Morobe Province (Harding 1967:48), 6–10 years from Rauto in West New Britain Province (Maschio 1994:134), and 10–12 years from the neighbouring Kaulong (Goodale 1995:83). From Vanuatu, there is also a figure of 7–16 years (Jolly 1984:84). Such long life spans appear to contrast with estimates of four or so years for the highlands before slaughter (Reay 1984:73). However, in the nearby Jimi Valley, Maring pigs in the 1960s were said to take 5–7 years to grow to full slaughter size (Lowman 1980:91). In the Nipa area of the Southern Highlands Province, maximum adult size is also reported to have taken 5–6 years in the 1970s, though some pigs were kept for '10 years or more' (Sillitoe 2002:451). Somewhat differently, pigs in the Morehead region of Western Province spent their lives in constricted pens, until finally achieving an 'amazing size', an 'almost incredible fatness' (Williams 1937:18–19, 224–5): for photographs, see Ayres (1980). Rather similarly, the Marind-anim in Irian Jaya used to keep castrated, captured male pigs (and only male pigs) for as long as five years before they had grown into the desired state of stoutness and fatness (van Baal 1966:4–7, 407–8). What demographic signature such extreme systems inscribe we can only speculate in the absence of quantitative information about any from New Guinea. However, in the case of tusker production in Vanuatu, evidence from Pentecost Island (Jolly 1984:87) reveals what appears to be a distinctive structure dominated by older animals, and with a predominance of males.

Understanding of the demographic structure of extant domesticated pig populations may also provide important models for the analysis of pig material from archaeological sites. Because of the genetic similarity of wild and domesticated pigs, evidence for domestication is usually sought in the demographic structure of pig remains, with a preponderance of younger animals usually regarded as symptomatic of domestication (Wieneke 1972; Collier and White 1976; Golson and Hughes 1980; Smith 2000). Thus,

for instance, discussing the Watom site in East New Britain Province, Smith (2000:145) recently argued that hunting would be expected to yield a more diverse age structure of remains, in contrast to domesticated husbandry which would be expected to involve the selective culling of most pigs at relatively young age (under two years?), while maintaining a small number of older animals for breeding. It is notable that these expectations of domestic age structure are not met by the standing crop age structures of the specialised domestic populations characteristic of New Guinea highland periodic pig festivals, nor perhaps of tusker-producing populations of the Vanuatu type described above. As Collier and White (1976:100–101) concluded, ‘... societies can utilize their domestic animals in very different ways, resulting in very different slaughter patterns....when the only evidence for domestication is a high proportion of immature animals, there is no evidence for domestication’.

7 Transfers of live pigs and pork: trade and exchange

Everywhere in New Guinea⁷, pigs are of great importance as customary valuables, in festivals and in exchanges. Understanding the social and symbolic significance of pigs is essential, because such customary valuations underpin the purposes and goals of many pig production systems. Before the recent historical period, these customary goals were all important. Currently, conditions are more mixed, following 50–100 years or more of increasing monetisation and globalisation. Although many major changes have occurred, it is still the case that most production systems combine both the older ‘gift’ type of exchange system and the emerging market-type relations of commodity production. In most places pigs are used as both gifts and commodities.

As a valuable, the pig has certain unique characteristics that contrast with other customary valued objects such as shells or plumes. Everywhere, pigs were one of the most important valuables in traditional society. Their prime status was a function of their relative scarcity and, usually, the many years of work embodied in their adult form. Significantly, in areas where wild or feral pigs were available for hunting, their exchange (and symbolic) value as pork was usually markedly different from that of their domestic fellows (Mosko 1985:174–5; Clay 1986:164; Dalton 1988:71, 119; Tuzin 2001:24, 88–89). Similarly, the skulls and jawbones of domestic and feral animals were often afforded different treatment after death: amongst the Yimar, for instance, the former were hung in women’s houses, the latter in men’s houses (Haberland and Seyfarth 1974:250), and Ok data are reviewed by Hyndman (1990). While many other customary valuables, such as shells, plumes, salt or stone axes, have lost their status or value over the last 100 years, pigs almost everywhere have remained valuable. In the 1970s, the cash price of pigs in the Mount Hagen area increased fourfold (Strathern 1983:78). In the 1990s, prices of over 1000 kina (K) were reported for large animals in the highlands, and recently prices of several thousand kina have been reported from the mine-inflated economy of Lihir Island (Kirsch 2001). Of course, new items from the modern sector, such as alcohol, cattle and motor vehicles, have also become exchange objects, thus altering the relative significance of pigs. Nevertheless, pigs, at least until recent years, have remained essential for many customary transactions.

There are major contrasts in the form of ceremonial exchange events throughout New Guinea. Those commonly described as pig festivals (pig kills) are characterised by a concluding climactic slaughter of many pigs and the distribution of pork in a multitude of exchange transactions. Such festivals vary in scale from involving just a few animals to huge events of many thousand pigs. The explicit purposes of these festivals include ancestral sacrifice, aimed at ensuring continuing fertility for gardens, people and pigs, and major rituals focused on initiation ceremonies (Heider 1972; Yoshida 1972; Yoshida 1973; Gande 1974; Hallpike 1977; Knight 1979; LeRoy 1979; Schaefer 1981; Clark 1985; Hays 1986; O’Hanlon 1989). They are everywhere associated with major exchange transactions of pork between groups and individuals (Luzbetak 1954; Criper 1967; Brown 1978; Brown 1979; Rappaport 1984; Lederman 1986; Lemonnier 1990; Lemonnier 1993b). Of a similar, or even larger, scale are the huge cycles or sequences of delayed exchange involving the movement of live animals known as the Tee in Enga and Moka in Western Highlands Province. These huge coordinated cycles have involved many thousands of people and pigs integrating large parts of the Enga and Western Highlands provinces (Strathern 1969; Strathern 1971a; Strathern 1971b; Meggitt 1972; Meggitt 1974a; Strathern 1978; Wiessner and Tumu 1998).

Major social, economic and religious changes have affected most of these systems since at least the 1950s (if not much earlier). By the mid to late 1960s, there were widespread

⁷ See ‘Definitions’ section for explanation of names used in this report

signs that their maintenance under modern conditions was unlikely (Editorial 1966; Brookfield with Hart 1971:123). In much of Simbu Province, at least, it seems that no major pig festivals have been held for the last 15–20 years (A Goiye, Project Design Management, pers comm, November 2002; P Hardie, Australian National University, pers comm, August 2001). For the region as a whole, the current status of many of these practices is poorly known, and an up-to-date review would fill a major information gap.

7.1 Live pigs

Throughout New Guinea, live pigs are transferred extensively between individuals and communities both by trade or sale, and by social and ceremonial exchange. The relative importance of these two kinds of transfer varies by area, and often cyclically through time in any one area. In the past, trade mainly involved smaller pigs, and exchange tended to move larger ones, but modern transport has resulted in the movement of larger pigs in trade.

7.1.1 Trade

In most areas where pigs were husbanded, they were traded. But the importance of trade varied (and still varies) widely. In 1947, for instance, at the three locations studied by the New Guinea Nutrition Survey in Morobe Province, trade in pigs was then important in only two. At Kaiapit in the Markham Valley, some people traded pigs southwest specifically for locally produced salt. More importantly, at Patep, pigs were traded both to neighbouring Buang Hill communities and also to the coast (Julius 1950:45, 53). Even in 1947, pigs in these areas were apparently mainly traded for money. At the third location, Busama on the Morobe Province coast, people had previously traded pigs inland to communities in the Buang Mountains in return for root crops, but this important trade was destroyed during World War II (Julius 1950:38). Bradshaw (2001:291), tantalisingly, has recorded that the neighbouring village of Lababia, to the southeast of Busama, was described to him as previously the site of a periodic pig market.

The importance of pigs in traditional trade systems (continuing into the mid-late 20th century at least) has been documented for many regions (Blackwood 1935:380–1, 445; Meggitt 1958a:289; Brookfield with Hart 1971:314–334; Keil 1974:63–64; Chowning 1978:298; Aufenanger 1979:72–73; Baldwin 1982:40; Crittenden 1982:210–214; Baldwin 1983; Damon 1990:231–4; Harding 1994). In his major account of trade in the Siassi area of Morobe Province, Harding (1967:35–36, 55–56) has described the substantial flows of pigs from the Morobe mainland and islands to the small islands of Siassi. In the early 1960s, pigs were the most valuable item traded, their cash values ranging from one pound for a piglet to 15 pounds for a three-year-old animal.

Healey (1990:278–294) has documented in detail the major historical movements of pigs in the extensive trade networks of the Maring in the Jimi Valley of the Western Highlands Province. He showed that the directional pattern of trade in pigs remained relatively stable throughout the first 75 years of the 20th century, but then changed in several significant ways. Most pigs started to come from the Wahgi Valley and adult pigs, rather than small animals only, began to be traded. The cash value of traded pigs rose from about K9 (originally in pounds) in the late 1960s to K69 in the period 1979–1985. After 1974, the proportion of imported animals which were subsequently exported in trade declined significantly, and, for at least one Jimi group, the rate at which live pigs were imported increased nearly fivefold from the mid 1950s. The location of the Jimi Valley on the northern fringe of the central highlands, with good access to the major populations of the Wahgi Valley and beyond, is clearly important in understanding the continuing importance of trade in pigs. As a relatively marginal area in terms of many major sources of cash income, pig trade offers opportunities for people in such locations. By the late 1980s, a rapid evaluation survey of agriculture and nutrition in the Jimi found that pig sales throughout the valley were an important source of cash income, with prices ranging

from K30 to K400 (Joughin and Thistleton 1987:28). Ten years later, settlers from the Jimi, living in the northern lowlands of the Ramu Valley, were raising pigs which they walked up to Simbai to sell (van Helden 1998:197). It is interesting to compare this account from the Jimi Valley with the results of a survey amongst several settlements in the Wahgi Valley in late 1973, which suggested that people did not, at that time, perceive pigs to be an important source of cash income (Jackson and Kolta 1974:31–32).

In parts of Eastern Highlands Province, a rather different pattern of trade in pigs was apparent in the 1970s, as indicated by detailed studies in a northern Tairora community, Kapanara, and in a southern fringe group, Irakia Awa. In the case of Kapanara in 1976–77 (Grossman 1984:164, 170–171), no live animals were transferred except by trade, and almost all trade was restricted to export. Only five female pigs were acquired by trade, in contrast to the 110 small pigs traded out of the village, 88% of which were female. These 110 animals represented 23% of the 486 piglets born in Kapanara between July 1976 and November 1977. Most were traded south to the Obura area, where demand had emerged in the 1970s, based partly on the perception that pigs coming from the north had a higher proportion of hybrid stock and were superior. The average prices were K40–50 per piglet.

A few years earlier in 1971–72, the Irakia Awa, located to the southwest, imported 45 pigs, of which 29 (64%), were female. In contrast, the Irakia only exported seven pigs, of which five were male, by means of exchange and compensation transactions (Boyd 1984). Of the 45 pigs acquired, 30 were bought in trade, 8 acquired by barter between affines, and 7 by other exchange transactions. As Boyd noted, during this year Irakians were actively trying to expand their herds by trading for small female pigs (Boyd 1984:40–1). They were, in short, end users of the export trade conducted by more northerly communities such as Kapanara described above.

Information from small communities much further west on the southern fringes of the highlands also shows flows of young pigs moving southwards from more populated areas in the north. In the case of the Foi in the Mubi Valley near Lake Kutubu, substantial proportions of their pigs (perhaps as many as 50%) came by trade from their northern neighbours (Langlas 1974:29). Further east, Kelly (1988:134–141, 178) described the Etoro people in the Southern Highlands Province importing, in 1968, 16 shoats in trade from the Huli to the north (and only a further one pig by other means). Kelly was not able to obtain full details of the shoats, but in six of the cases, there were equal numbers of male and female animals, suggesting that the imbalance in favour of females characteristic of the Eastern Highland Province data was not apparent here. Kelly suggests that these trade flows were traditional, with some older animals moving in reverse from the Etoro north to the Huli. During 1968, the Etoro only exported three live pigs, for compensation and other transfers.

Further to the west, in a Baktaman community in Western Province, 30% of the pigs held in 1968 had been acquired by trade (Barth 1975:37), and none by exchange transactions. In Irian Jaya, trade may have been more important than local production in building up local herds among the Yali in the 1960s and 1970s (Zöllner 1988:80).

In the recent past, there has been an increase in many areas in the acquisition of mature pigs by purchase for immediate use in social and ceremonial events. While this increase has built, at least in some locations, on customary 'finance' practices (Strathern 1969; Powdermaker 1971:122, 133, 201–2; Strathern 1978) by which actors in exchange events have been able to draw on the productive efforts of others beyond their own home production base, it is also a consequence of the spread of monetisation and commoditisation. There are examples from both the Western Highlands (Strathern 1982a:115–117; Reay 1984:74; Strathern and Stewart 1999:177–178) and Eastern Highlands provinces (Finch 1991:144; Benediktsson 2002:248), from East New Britain Province (Jeudy-Ballini 1987–88:23), from New Ireland Province (Clay 1986:123, 167, 186–7), from East Sepik Province (Lea et al. 1988:27; Kulick 1992:47; Brison 1999:156), from Central Province (Belshaw 1957:136, 138; Maleva 1978:12), from Morobe Province

(Harding 1985:76), and from Bougainville Province as early as 1930 (Blackwood 1935:281, 446).

In contrast to these cases of trade accounting for the majority of all intercommunity transfers of live animals, are those systems, in many cases located in the central highlands, where, although trade may be a significant component of the movement of live pigs, it is overshadowed in quantitative terms by customary exchange or gift transfers.

7.1.2 Exchange transfers

In the central highlands there is characteristically a whole range of exchange events and ceremonies that require transfers of live animals between individuals and groups (Lemonnier 1990). In general, the flows of animals these generate far outweigh those moved in trade. In addition, since the size and structure of herds is very often shaped by the demands of the exchange events, variations in the importance of trade may in turn be largely determined by the occurrence of exchange events.

For example, data from two communities in Sinasina in 1972–73 are described here. In the case of Nimai Waula, a community midway between pig festivals, and with an initial pig population of 208 animals (23% of which had been acquired by trade, 28% by exchange), trade was a relatively minor part of transfers over one year. Trade was in balance for that year, with only 14 pigs traded in and 13 traded out. Unlike the flows described above in Section 7.1.1, that were strongly biased in favour of females, these flows were evenly balanced, with females only slightly outnumbering males (55%). In contrast, exchange transfers accounted for 67 animals transferred in and 36 transferred out. The traded animals were considerably smaller than the ones exchanged (15–17 kg lighter). In the case of Dom Barikane, a Sinasina community surveyed just before and after a pig festival, with an initial pig population of 80 animals (25% of which had been acquired by trade, 45% by exchange), trade was a very important part of rebuilding the herd after the festival. Of the postfestival herd of 27 pigs, 44% had been acquired by trade. Over nine months, Barikane traded in eight animals, and traded out three; and in exchange transfers, acquired 14, and disposed of 26 (Hide 1981:446). On a comparative basis, through exchange Waula acquired and disposed of 0.3 and 0.2 pigs per person respectively; Barikane 0.3 and 0.4 (Hide 1981:446).

A broadly similar pattern is apparent from detailed data on the Kapii clan at Yumbisa in Enga Province over 2.8 years between 1972 and 1975 (Wohlt 1978:155). There, 398 people maintained a herd that fluctuated between 220 and 276 pigs. Over the 2.8 year period, they received 303 pigs in imports (only seven, or 2%, by trade), and disposed of 808, of which 662 were live (10, or 1.5%, in trade). On an annual basis, these figures convert to 0.3 pigs received per person, and 0.7 pigs exported. The magnitude of the latter is surprising and it is not clear if such an imbalance is long term.

Similar significant flows of live animals were described for the central Mae Enga in 1955–57 by Meggitt (1958a:287). Over a period of about 16 months, 89 men of one clan (who owned an estimated 365 pigs), disbursed some 170 animals (and 46 cooked half sides), and received 202 pigs (and 22 half sides). In contrast to the Sinasina evidence, Mae Enga appeared to prefer to exchange males, selectively retaining breeding females (Meggitt 1958a:288), as did Melpa in a series of six exchange events in 1964–65 involving 582 live pigs (58% males) analysed by Strathern (1983:76).

Lederman's (1986:204–5, 221–3) description of the movements of pigs between groups in the Mendi area of the Southern Highlands Province in relation to major pig kills is particularly important. Her analysis of how pigs were acquired showed that 73% of a population in 1978, 22 months before a pig kill, had been acquired by exchange. Significantly, of the pigs held on the eve of the pig kill, 47% had only been held for less than a year, and of these about one half, or nearly one quarter of all pigs, had been obtained within the previous month. In short, exchange was as significant as production in composing a pig population on the eve of a major pig kill.

7.1.3 Pig trade as a source of cash income

At a national scale, there are no figures to delineate the movement of village-based pigs in trade. The above examples indicate that the numbers involved are undoubtedly significant. There is some very broadscale, partial information collected by rapid survey techniques on the relative significance of pigs (and pig meat) as cash income sources in rural Papua New Guinea (PNG) during the period 1990–1995. This is shown in Table 7.1. This is rough information (the size of the agricultural systems varies hugely), and there are undoubtedly many other smaller locations or communities in which trading in pigs is important. The longer term significance of income from pigs in parts of the Southern Highlands Province, however, is confirmed by a socioeconomic survey of the Tari area in 1984, which found that the sale of pigs, as both live animals and as meat, was probably the single most important source of income at the time (Vail 2002:114, 118). Elsewhere, there may be cases where the significance of income from pigs is likely to have changed since 1995, as for instance in the two areas of Buin in Bougainville Province where cocoa and other crops are likely to have replaced pig meat following the reestablishment of peace (Bourke and Betitis 2003:88, 92). It is also likely that pig-related income may undergo short-term boom–bust fluctuations when it is closely related to mining developments and difficult transport conditions, as shown by the brief 1994–96 history of pigs exported from Lake Kopyago to Porgera described by Haley (2002:31).

Table 7.1 Locations (agricultural systems) where the sale of pigs (or pig meat) was a minor cash income source (1990–1995)

Province	District	Location	Agricultural system	Population
Milne Bay	Samarai	Ware Island	0513	498
	Misima	Deboyne Island	0514	3297
	Misima	West Misima	0515	2165
	Misima	East Misima	0516	4930
	Misima	East Calvados	0517	1475
Southern Highlands	Koroba, Tari		0704	14,281
	Koroba, Tari		0705	25,939
	Koroba, Tari		0706	12,493
Enga	Kandep		0807	17,813
Morobe	Kabwum		1211	16,826
	Siassi	Umboi Islands	1216	390
West New Britain	Kimbe, Kandrian		1907	2087
Bougainville	Buin		2008	23,122
	Buin		2009	13,528
Total				138,844

Source: PNG Mapping Agricultural Systems Project (MASP) Database: see Vovola and Allen (2001:469–470) for an account of the database. Minor income sources were defined at an estimated K11–50 per household per year.

At the scale of a single province, extensive survey data on income sources collected in Enga Province in the early 1980s found the significance of pig sales varying widely between districts: from none in Kompiam to 30% in Porgera, with an overall average of 10% (Wohlt 1986b:56, 59). In general terms, pig sales were less important in lower altitude areas.

7.2 Pork

Currently, the most useful pork production estimates for PNG at the national level are those produced from the 1996 PNG Household Survey, conducted as part of the World Bank Poverty Assessment (Gibson and Rozelle 1998:19; Gibson 2001a). These suggested a rural production figure of 60,000 t/year, valued at some K243 million. Relative to the monetary value of all produced foods, this was second only to the estimated K290 million for some 1.286 million t/year of sweet potato. Pork production constituted an estimated 19% by value of the aggregate value of all food production (K1.3 billion).

There are two sets of other relevant figures. Earlier monetary evaluations of livestock and food crop production for PNG differ considerably from these 1996 figures. Although not comparable in any statistical sense, they are useful for defining orders of magnitude. In 1988, all marketed livestock (including but not exclusively pigs) was valued at approximately K45 million, and subsistence livestock production at K110–145 million (Nunn 1988a:97–98). Food crop production was estimated at K350–400 million. The other annual pork production estimates are those from the FAO Production Yearbook (FAO 1999), which gave 42,000 tonnes pig meat in 1999. While this is substantially less than the household survey figure, it is believed to be based on extrapolation of figures from the 1961–62 Survey of Indigenous Agriculture (Walters 1963), and is not considered reliable.

7.2.1 Pork distribution in the rural sector

As with transfers of live pigs, throughout New Guinea there is a huge range in the extent to which transactions of all kinds, and pork in particular, are monetised. At one end, pork approaches the status of a commodity produced primarily for market sale, while at the other, it is transferred as a gift in a multitude of social exchange transactions. There are no national-level data to indicate the relative importance of the two transfer modes. While they obviously vary by region and location, it is reasonable to assume that, overall, gift exchange is still quantitatively most important.

7.2.2 Pork sales

Somewhat surprisingly, the series of market surveys conducted by the Department of Agriculture and Livestock (DAL) in the late 1980s in many of the major urban markets included no separate category for pork sales (publications for Madang, Mount Hagen, Lae, and Koki in Port Moresby examined; see, for instance, Rural Statistics Section (1992)). Presumably, pork sales were surveyed and included in the more general category of 'meat, fish and poultry', though the internal evidence does not fully support this assumption.

Nevertheless, there is little doubt that pork sales occur with some frequency, and the trend is presumably one of increase. Scattered information on the significance of sales of meat from livestock range from 13% to 46% of smallholder cash income in parts of the highlands and lowland Madang Province (Renewable Resources Sector Study Team 1993:19). Earlier studies of markets document modest levels of pork sales at several locations (Jackson and Kolta 1974:7; Hide 1975; Finch 1991:139). The local sale of cuts of meat from a single animal is a very common response to meet the need for sudden or major cash demands, such as for school fees or compensation payments. These kinds of monetary sales apparently began about 40 years ago in the highlands (Waddell 1972b:199; Feachem 1973a; Du Toit 1975:98, 198–9; Densley with Purdy et al., no date), but possibly earlier (Watson 1983a:55). Indeed, for the Urapmin in West Sepik Province, Robbins (1999:90) describes such pork 'markets' as traditional. In coastal Milne Bay Province, customary precedents are also evident on Rossel Island (Liep 1999:141). By 1987, in the Eastern Highlands Province, Finch (1991:139, 143–4) noted that pork had become the 'most commoditized of village products' with regular small markets offering

pork for sale within the village of Ontena. He considered that the returns were not good, at least by comparison with the prices for live pigs. This discrepancy has been widely reported, for instance from the Rawa area in Madang Province (Dalton 1988:128), the Hagen area of the Western Highlands Province (Strathern 1984:85, 97), and Oksapmin in the West Sepik Province (Brutti and Boissière 2002:147).

Survey data on the regional prices of meat and fish in 1996 given by the PNG Household Survey (Gibson and Rozelle 1998:42) show that pork at K3–4/kg was priced similarly to lamb and mutton, that it was generally more expensive than fresh fish at K2–4/kg (except in the highlands where fish was most expensive), and that it was cheaper than chicken at K4–5.60/kg. Pork was much cheaper than tinned meat (K6.5–7.8/kg), and slightly cheaper than tinned fish (K4.1–5.0/kg).

Two special customary situations are worth noting. In the Paniai Lakes area of Irian Jaya in the 1950s, pork was regularly sold in exchange for cowrie currency at periodic pig feasts (Pospisil 1972:331–333). Similar transactions appear to have been customary further east among the Muyu, Yonggom, Ningerum and Mandobo peoples in the upper Fly-Digul area of Irian Jaya and across the border in the Western Province of PNG (Welsch 1994). Throughout this area there was an elaborate cycle of pig feasts that were hosted primarily as a means of obtaining cowrie shells. Rather differently, elsewhere in the Western Province, traditional barter market exchanges of meat from the inland people, such as the Bine, to the coastal Kiwai are now transacted with money and see substantial amounts of pork from wild pig bought by Kiwai people (Suda 1996:98–99).

7.2.3 Pork in exchange transactions

Social relations between individuals and groups (and between persons and supernatural beings) in PNG are constantly established, maintained, reshaped, renewed and broken through the medium of gift exchange. Gift exchange involves the transfer of a wide range of goods, amongst which pork has been, and in many places remains, one of the most valuable items. In relations between people and supernatural beings, the ritual killing or sacrifice of pigs was often of major significance (Lawrence and Meggitt 1965).

The control of pigs and pork as wealth items in exchange has been (and remains), in most cases, strongly patterned by gender, with women rarely acting as formal transactors (Strathern 1972; Josephides 1985; Nihill 1991). There are two main contrasting accounts from Enga Province and the Southern Highlands Province, which emphasise the ability of women to control wealth (Feil 1978a; Feil 1978b; Lederman 1986).

The scale of exchange events ranges from the distribution of the meat of a single slaughtered pig by one household, to the massive regional disbursement of the carcasses of hundreds or thousands of animals ceremonially despatched at the climax of major festivals. In the case of the Enga Tee, in the mid-1950s, Meggitt (1958a:298) estimated that as many as 15,000 pigs might be slaughtered at the end of a cycle. The range of occasions requiring sacrificial or exchange slaughter of pigs varies widely. The major exchange events include marriage payments and affinal exchanges (that is, to relatives by marriage, which thus become part of continuing relationships between groups and networks of relatives), mortuary or death payments and exchanges and compensation exchanges. Feasts to celebrate births or to mark menarche are common. A further set of exchange events relating to compensation for accidents, injuries to persons and property, and illness are also often marked by slaughter and exchange. The contexts of exchange vary from the competitive to an emphasis on equivalence or symmetry (like for like). Often, the consumption of pork as meat is not part of ceremonial exchange events (Rubel and Rosman 1978:305), but instead, as Nihill (2001:277) has discussed in relation to the meaning of different exchanges in the Anganen area of the Southern Highlands Province, pork may be given 'raw, undercooked or in portions too large for individual consumption'.

Information from three varied examples illustrates the extent and significance of the movements of pork in exchange transfers.

The first example is that of the pigs managed by a small community (Nimai Waula) of 302 people in the Sinasina area of Simbu Province in 1972–73 (Hide 1981:485–503). Over 12 months, the number of pigs owned rose from 221 to 245, and the community slaughtered 55 pigs (mean live weight 33 kg) on 42 separate occasions. Of a total of 67 households, 20 killed one animal each, seven killed two, four killed three, one killed four and another five. The main exchange events for which these pigs were killed were: marriage (4 events, 15 pigs), visits by relatives by marriage (affines) (10 occasions, 10 pigs), and customary exchanges between maternal relatives (mother's brother/sister's son) (2 events, 5 pigs). The rest of the pigs were killed for other minor events (16 occasions, 17 pigs), and for a variety of other reasons such as to cull litters, to dispose of injured pigs and in response to sickness (10 occasions, 10 pigs).

Although more than a third of the total number of pigs slaughtered during the year were distributed mainly within households of the community, these were only small pigs, averaging 15 kg live weight, and accounted for only 17% of the total weight of pork from slaughtered animals. In contrast, the pork from 34 pigs, comprising 83% of all pork, was distributed by exchange outside the community. These exchanges linked members of the community to other groups in all major neighbouring locations in Sinasina (41% of pork), to other areas in Simbu Province (25%) and to individuals in both Western Highlands Province (10%) and Eastern Highlands Province (2%).

This pattern of relatively small-scale events occurring throughout the year stands in sharp contrast to that characteristic of the major pig festivals. While the Nimai Waula community were not themselves holding a festival in 1972–73, they received major pork gifts from three groups who were. Summary details of the most important set of gifts illustrate the scale of such events. Sixty Waula households received some 255 pork gifts directly from 141 donors in the celebrating group on a single occasion. Forty-six of the recipient households then redistributed some of this pork in 130 exchanges to 52 other households within their own community. Sixty-seven households then gave away a further 306 pork gifts to 195 recipients in other communities.

The redistribution of gifted pork means that any one significant-sized portion of pork may change hands several times before consumption (Jeudy-Ballini 2002:200): six times over four or five days in the case of the Enga (Meggitt 1958a:297), and five to seven transfers on Wogeo Island off Wewak (Hogbin 1970:323).

The second example comes from a community (Irakia Awa, 272 persons) in the southern fringes of Eastern Highlands Province (Boyd 1984). During 1971–1972, their pigs increased from 148 to 191. Over 12 months they slaughtered 23 pigs: 16 for ceremonial feasts, 3 for illness, 3 because pigs had broken into gardens and 1 for a brideprice repayment. The ceremonial feasts included events such as the climax of male initiation, marriage presentations, and payments to kin following deaths. Details of the proportions of pork sent outside the community are not available.

The third example comes from the small Kubo community (26 people) of Gwaimasi (Nomad area, Western Province) during 1986–87. It illustrates how, even in very small communities with extremely low population densities, exchange transactions still channel pork between people and groups (Dwyer 1993). Over about 14 months, pig numbers varied between 7 and 13 and Gwaimasi people slaughtered 24 domestic pigs totalling some 443.6 kg on about 13 separate days. Six pigs were killed for one feast (63% of pork given to nonresidents), three pigs were killed for a curing ritual (39% of pork given to nonresidents), one pig was killed to repay a spirit medium (61% of pork given to nonresidents), 14 pigs or piglets were killed in relation to pig management (2 nuisance pigs and 12 piglets culled — only 24% and 14% respectively of pork given to nonresidents). In all, nonresident visitors received over 53% of the pork. The major contexts in which these gifts occurred were 'statements of intracommunity solidarity,

reestablishment of intercommunity relations, the needs of curing, death-compensation, and ... initiation' (Dwyer 1993:132).

Besides information on the social contexts of the use of pork in exchange, these three examples also illustrate the relatively low rates of slaughter, or take-off, during a year that seem to be characteristic of village customary pig management. Estimating such rates is problematic due to the irregular periodicities of major social events such as pig festivals or intergroup conflict, but rates of between 10–30% of initial population numbers have been reported (van Beek 1987:26; Healey 1990:146–7).

In addition to the above examples, there is a large literature on the use and movement of pork in exchange, including: (Oliver 1949b; Vayda et al. 1961; Salisbury 1962; Rappaport 1967; Malynicz 1970a; Steadman 1971; McArthur 1972; Pospisil 1972; Strathern 1972:19, 101–120, 331–338; Vayda 1972; Lowman 1974; Barth 1975; Sillitoe 1979; Grossman 1984; Rappaport 1984; Lederman 1986:174; Mayer 1987; Meigs 1987; Kelly 1988; Healey 1990; Welsch 1994; Suda 1996.; Akimichi 1998; Whitehead 2000; Densley with Purdy et al., no date).

8 Commercial and project smallholder pig production

In contrast to the wealth of documentation on village husbandry, commercial pig production in New Guinea⁸ is poorly described in published accounts. Most information is found in brief summary form in government documents, or in somewhat more detail in consultancy reports and other 'grey' literature.

8.1 The commercial pig industry

In the early 1960s, commercial piggeries were located mostly near towns and ran a total of about 5000 pigs (Egerton and Rothwell 1964:7). They supplied the urban market of mainly expatriate consumers, and they also sold considerable numbers of pigs to villagers. By 1970, they ran approximately 7000 pigs, with about 2500 animals slaughtered annually at abattoirs, and sales to the village sector continued (Purdy 1971:483).

In the early 1970s, commercial pig numbers were projected to rise from a figure of 8780 in 1970 to 20 900 by 1980 (Malynicz 1974f:28, citing Sillano 1972a). This growth never happened. By the late 1970s, 10 piggeries had been set up by overseas-owned companies based in PNG, the largest of which ran 200 sows at Lae (Densley with Purdy et al., no date:53–55). The latter soon closed, and a 100 sow piggery at Lae became the principal source of supply to periurban smallholder piggeries near Lae. It was estimated that there were some 750 commercial sows in 1976, producing 5000 pigs a year both for slaughter through abattoirs, and for direct sales to village consumers in the 'customary' market. In the latter, prices were high, up to 150 kina (K) for a pig of 70 kg, and up to K800 for a large pig.

During the 1980s, the commercial pig industry declined continuously with little or no local production (Mandich 1992). In response, a large piggery was established outside Port Moresby by the Department of Agriculture and Livestock (DAL) and the Development Bank in order to supply the National Capital District (NCD) market and to provide good breeding stock. These objectives were not achieved. Subsequently, as a result of the imposition of government import restrictions in 1983, the commercial pig industry increased its output to the point where, by 1991, it was supplying more than 90% of the apparent market (ie urban) demand.

The total meat market in PNG in 1991 was 51 044 tonnes: of this, 1150 tonnes was delivered by local commercial pork production. This had increased from 330 tonnes in 1982. Imported pork fell from a high of 691 tonnes in 1981 to less than 100 tonnes in 1991 (Department of Agriculture and Livestock 2000a:91; slightly different figures are shown in Renewable Resources Sector Study Team 1993:21–23). However, protection did not improve efficiency and local production simply increased to replace imports. The absence of growth was apparently related to the price of pork relative to other meat. In mid-1992 the weighted average price of fresh pork at Port Moresby supermarkets was K7.66/kg, the highest of all meats.

By 1989, according to the Renewable Resources Sector Study Team (1993:37),

There were 9 commercial piggeries of 100 breeding sows or more in PNG ... mainly located near urban centres. One piggery accounted for 40% of total output ... breeding sow and gilt numbers were about 2700. One piggery operated an outgrower scheme with 16 smallholders ... At present commercial pig production is decreasing

⁸ See 'Definitions' section for explanation of names used in this report

because of lack of markets. A previous 1,200 sow operation has been reduced to 600 sows. The ABPNG (Agriculture Bank of PNG) Piggery is to close.

In 1991, Mandich pointed out that the commercial pig industry was essentially controlled by such bodies as the Agriculture Bank, the Investment Corporation and the Livestock Development Corporation (ANZDEC Consultants Limited 1990; Mandich 1992).

By 1992, there were an unknown number of commercial piggeries operating in Papua New Guinea (PNG), including at least two with more than 4000 animals according to McQueen (1992:131). By about 1996, the largest was probably that belonging to Sir Harry Pelgren in Morobe Province. This was established on two older plantations, Singaua and Abunaka, and was described as the most 'modern and efficient piggery' in the country, running about 9000 pigs, and with a monthly throughput of 1100 head (Sinclair 1998:426–7).

While the industry was largely self-sufficient in terms of producing retail pig meat for the restricted commercial market by then, it was dependent on imported feedstuff. As of 1993, the Livestock Development Corporation/PNG Holdings Corporation operated two piggeries (one a joint venture at Rabaul) and managed five abattoirs at Lae, Port Moresby, Mount Hagen, Goroka and Rabaul (Renewable Resources Sector Study Team 1993:20). According to Livestock Development Corporation statistics, the five abattoirs in 1990 slaughtered some 20 462 pigs (Lae 9597; Tiaba (NCD) 9480; Goroka 646; Rabaul 643; and Mount Hagen 96) (Department of Agriculture and Livestock 1991:57).

According to the ANZDEC Report (ANZDEC Consultants Limited 1990), most commercial pig producers market porkers of about 60 kg liveweight. Of the retail price, producer costs accounted for about 48%, with abattoir, wholesalers' and retailers' costs accounting for 4%, 5% and 5% respectively. At one of the most efficient commercial piggeries, a sow produced 18 weaners per year with 12% mortality, weaning at four weeks, and growing to 50 kg in 20–26 weeks.

Local commercial pork production in 1998 was estimated at 1013 tonnes, with only five tonnes imported (Quartermain 2001, citing Vincent and Low 2000).

8.2 Smallholder pig projects

During the 1970s, and to a certain extent into the 1980s, smallholder pig projects, involving small-scale, semi-intensive pig management often supported by loans, were common in much of PNG. Although there are a number of partial accounts and overviews of aspects of this program (Kimber 1967; Purdy 1971; Malynicz and Asare 1976; Quartermain 1980; Gibbs 1981; Goodman et al. 1987:82; Densley with Purdy et al., no date; Densley, no date), there is a lack of detailed published documentation. This is particularly the case as regards subsequent developments.

A very broad picture of the state of smallholder project pig husbandry throughout PNG was given by the summary provincial agricultural reports published in *Harvest* between 1975 and 1978. An overview of this subsector at the provincial level (by the four main regions), based on this source and supplemented with a little other documentation, follows.

8.2.1 Highlands

Eastern Highlands Province

The Department of Agriculture, Stock and Fisheries (DASF) was assisting about 100 village pig projects, involving some 350 pigs, mainly in the Goroka, Asaro, and Wabung areas (Haley 1976:27–28). None were supplying meat to provincial retail

stores and all the stores sold imported pig meat. Expansion of village piggeries was not encouraged, due to the high price of protein feed, although advice and assistance to existing projects continued.

Southern Highlands Province

There were some 114 pig projects, with 581 pigs, and a pig breeding centre at Kagua (Kahata 1976:104). Projects failed due to the cost of protein feed. There were plans to trial the use of soyabean for pig feed, and sweet potato grazing trials were underway (see Section 9.3). Assistance in the form of management advice was provided to projects, and it was hoped to maintain existing numbers.

Enga Province

The provincial program consisted of 13 semi-intensive commercial projects with about 60 pigs, and approximately 200 other small projects (Banaga 1978:174). One of the former was located at Wakumare High School, and consisted of a breeding and distribution program involving 25–30 head a year.

Western Highlands Province

Semicommercial piggeries were established throughout the province, concentrated in the Mount Hagen and Wahgi areas (Magei and Thatcher 1976:156). At two locations, Linden and Madan, an estimated 300 free-ranging pigs were being run in the Wahgi swamp. At Minj, there were 90 semi-intensive pig projects with 460 animals. It was not policy to establish intensive piggeries, the constraints being poor management and the high cost of protein food. During 1976–7, 20 low-cost piggeries, 10 each at Minj and Kindeng, were to be developed, without loan finance. Free-range husbandry was planned and local feedstuff such as corn, soya bean and lupin were used. The possibility of nearby piggeries supplying pork to meet urban meat demand was investigated but expansion was not expected. According to Strathern (1984:96) most small-scale piggeries in the province were sited on smallholdings established for tea production, and on settlement blocks at Kindeng and Kondapena in the Wahgi Valley (Freund 1977).

Simbu Province

The province had 65 projects (40 financed by Development Bank loans and others by the Chimbu Savings and Loan Society (Howlett et al. 1976:247–6)), holding 339 pigs, and a further 10 new Development Bank projects awaiting stock (Iorive 1978:77–78). These projects were mainly producing 20–30 pigs a year for customary use in festivals. Extension staff apparently had difficulty convincing project owners to sell their pigs. It was intended to stock new projects with one boar and three sows, and to establish some 24 fattening projects in the Kundiawa area. Department of Primary Industry (DPI) stud boars were being used to improve stock. Project pig farmers had apparently joined with cattle farmers to form a livestock producer's association.

8.2.2 Momase

Morobe Province

Morobe was clearly the leading province in terms of commercial pig husbandry, with some 3000 pigs on expatriate-owned farms, and two locally-owned commercial piggeries (Gauga 1978:233). In 1977, some 2522 pigs were slaughtered at the abattoir, but only 4% came from local projects. There were 300 pigs on an unknown number of village projects. It was intended to improve village pig-feeding methods, and establish trial weaner projects. In 1986, there were 291 pig projects, 200 of which were in the Lae district (Isaacson and King 1987: II-32). During 1984, the provincial Primary Services worked on establishing 11 pig fattening projects in the Situm area for the live pig market.

Madang Province

In Madang there was a form of partnership between smallholders and Dylup Plantation, which operated an intensive piggery, producing pork for sale (Benjamin, W 1978:93). Dylup supplied feed (and weaners?) to four pilot pig-fattening projects in periurban locations near Madang. Weaners were raised to 60 kg average liveweight, and the pork sold in Madang for K1.76/kg dressed weight. There were only five projects with Development Bank loans, but it was intended to establish another seven in 1978. It was intended to expand fattening projects along the coast to Bogia, and also set up semicommercial projects at Bogia and Saidor. A station boar at Bogia was used for village pig improvement. Caven and Gitai (1990a:22) describe a failed piggery project at Bundi in 1980.

East Sepik Province

There were no, or very few, pig projects in East Sepik Province in 1975 (Setae 1976:71). However, some were at the planning stage in 1977–78, using locally produced stockfeed based on peanuts.

West Sepik Province

The province had five projects supported by Development Bank loans, and 25 semicommercial projects (Daur 1977:37). The project owners were apparently reluctant to use their own coconut as pig feed. As in Simbu Province, a pig farmer's association had been formed at Vanimo. It was intended to start pig-fattening projects near Vanimo and Aitape in 1978–79.

8.2.3 Papua

Western Province

There were 13 semi-intensive piggeries, with 450 pigs, suggesting rather larger projects than in most other provinces (Miria 1978:219).

Gulf Province

In 1975, there was one pig project supported by a Development Bank loan, and three others without finance (Tauaole 1976:78–9). A further six were planned, as well as a pig breeding and distribution centre.

Central Province

Of 30 pig projects, 15 were said to be moderately successful (Kupe 1976:120). The Development Bank was, however, reluctant to advance loans for pig projects due to past failures. It was intended to investigate the feasibility of establishing intensive pig-breeding projects.

Milne Bay Province

As in Central Province, pig projects financed by the Development Bank had failed, largely due to management problems (Abaijah 1978:196–7). Intensive piggeries were run at Giligile, Hagita and Cameron High Schools. It was planned to start a pig breeding program.

Northern Province

In Northern Province, three projects with a total of 20 pigs had been started, using the Papuan Agricultural Training Institute pig project as a demonstration (Oata 1976:20).

8.2.4 Islands

Manus Province

As in New Ireland and Milne Bay provinces, successful intensive piggeries were run by the two provincial high schools, Manus and Papitalai (Darku 1978:156). It was intended to establish six more intensive or semi-intensive piggeries in 1979, and to increase the number of breeders at Tamat Agricultural Station to 10.

New Ireland Province

The provincial pig program discouraged intensive village projects because of poor husbandry, and aimed instead to upgrade village pigs by introducing improved stock (Simbak and Joines 1976:37–8). The program was based on Manggai, Utu and Mongop high schools, which had established projects to provide pigs for distribution to smallholders. The school projects had about 137 pigs. During 1975(?), 120 weaners were supplied to 15 farmers by the Department of Agriculture, Stock and Fisheries (DASF) and the high schools. The demand for weaners apparently exceeded supply. DASF also assisted with pest and disease control.

East New Britain Province

The emphasis was on pig-fattening projects with seven near Rabaul, but plans to expand to 15 were hindered by a lack of weaners (Embi 1976:139). The projects received veterinary services. A decade later, the situation was broadly similar. In 1987, there were only five smallholder projects each in Rabaul and Kokopo districts, and 10 and three pig-fattening projects respectively in the two districts (Levett 1992:16).

West New Britain Province

The province had two pig projects, with 10 pigs at Biala financed by Development Bank loans (Makara 1976:146). In addition, there were 120 pigs owned by plantations, 20 by vocational centres and 15 by societies, but the projects were not commercially successful. It was intended to supply weaners to smallholders in both villages and the oil palm settlements.

Bougainville Province

Bougainville farmers were reported as showing little interest in piggeries (Momoi 1978:103). Bougainville Copper was releasing about 300 pigs (of improved breed) to village farmers, and there were also distributions from vocational centres and high schools. Extension staff were encouraging farmers to rotationally graze pigs on sweet potato, and to use protein supplements.

8.2.5 Summary

The above summary of smallholder pig projects, largely during the 1970s, shows several features. First, there were major regional differences in the scale and form of pig projects during this period. In terms of numbers, the Highlands provinces clearly dominated. Despite the incompleteness of the figures, the five Highlands provinces had at least 582 pig projects, holding approximately 1730 pigs (no pig figures for Enga Province); Papua appears to have had less than 50 projects; Momase a similar figure or fewer, and the Islands even less. Second, feed costs and lack of management skills were seen then as the main constraints (Densley, no date:10), though a few years later Mandich (1992) considered the social context of village production had been underestimated. Third, there appears to have been a wide variety of semi-intensive systems attempted, with free range and tethering especially mentioned in the Highlands. However, as shown below, one assessment survey revealed little use of grazing.

The policy of distributing weaner pigs, mainly of crossbred exotic breeds, peaked in the late 1970s. A decade later, in 1987–89, loans by the Agricultural Bank of PNG for piggeries totalled only K15 720, equivalent to 0.5% of agricultural loans (Caven and Gitai 1990a:37). In 1979, over 1000 weaners were sold to village projects throughout the Highlands for fattening.

A survey in mid-1980 of such projects in the western half of the Highlands (Southern Highlands, Enga, Western Highlands and Simbu provinces) sought to collect information on growth rates, health, mortality, diet and management factors (Gibbs 1981). Only 120 pigs were located in 19 projects (the response rate was about 50% of the weaners distributed in the surveyed area in the previous 10 months). Across the projects, the most common diet was sweet potato supplemented with protein concentrate, although on individual projects dietary regimes ranged from the use of sweet potato only to the use of purchased feedstuff only. Overall, underfeeding was general. The best growth rate was 313 g/day (considerably below the 420–500 g/day normally achieved at the Goroka Research Station). Unfortunately, the average was not recorded. Mortality was very high. In larger projects with seven or more weaners, mortality was 75% or higher. In projects with six pigs or less, 56% had no deaths, and only 9% had over 75% mortality. Survival in the first two months appeared critical. The condition of pigs in projects was often poor, with few or no veterinary supplies available. Only two of the 19 projects put their pigs out to graze. In all the rest, pigs were housed fulltime. Management skills and extension support were both minimal.

8.3 Smallholder urban and periurban pig husbandry

Pig husbandry is not restricted to the rural sector. Some of the project piggeries described above were located in periurban situations. Perhaps surprisingly, in 1974–75, a few households surveyed in Port Moresby suburbs said they were raising pigs: three households (9% in Morata) and two (17%) in Kila Kila (Thaman 1977:156–7). In 1996, the 1996 PNG Household Survey (Gibson and Rozelle 1998) also recorded a few pig-raising households in the National Capital District (see Chapter 5, Table 5.4, footnote). Most recently, in urban (or periurban) Port Moresby, disadvantaged or informal migrant women from the Bereina area of Central Province were reported as ‘harvesting’ waste foods at the city dump at Baruni to feed pigs for sale to villagers from other parts of Central Province such as Mekeo (Aisa 1996). Jenkins (1996:14) also noted that pigs were being raised on dumps in Port Moresby by migrant settlers. Earlier, the urban rubbish dump near Mount Hagen was described by Strathern (1989a:145) as a place where herds of pigs foraged for food, though these animals presumably belonged to rural villagers.

From about 1976, attention turned from the failing smallholder rural piggeries toward establishing smallholder fattening units in periurban areas using exotic weaners (usually Large White-Landrace crosses) and purchased feeds. Trial work on these was described in unpublished papers by Rouse (1977a; 1977b), and summarised by Walters (1981). Growth rates well above 500 g/day were reportedly obtainable. Fifteen units were established in 1976–7 in coastal areas, most financed by loans. Proposals for a 150 sow unit linked to smallholder fattening units to supply Rabaul with fresh meat were studied by Rouse (1977c), but the economics were poor.

In several provinces, but particularly Milne Bay and those in the New Guinea Islands, piggeries were run by institutions such as high schools. However, one agronomist considered that pigs only had a minor role to play at lowland institutions, citing the need for large areas of cultivation to grow feedstuff, or for capital to purchase them (Bourke 1978:136). He suggested that a few pigs (about 10), especially those run on a fattening basis and fed on mess scraps and garden wastes could be useful, although they were unlikely to make much of a dietary contribution. While high schools receive most mention in provincial reports in the mid to late 1970s, other institutions were also raising pigs. In one case at least, the pupils at a community school serving the oil palm settlements in West New Britain Province ran a small piggery (Benjamin, C. 1978:254).

There is fragmentary evidence of possible wider ramifications for the demise of the pig project boom of the 1970s. In the Western Highlands Province, at the time of the coffee boom in 1976–7, there was an increase in the purchase of large commercially produced pigs, which, from 1977 on, cost between K500 and K1000 (Strathern 1982a:115–7; 1984:97). However, by mid-1979, with coffee prices again falling, Hagen people were no longer buying such pigs, and were recorded as saying that their own home-grown pigs were better than commercially-raised stock, especially for major exchange occasions and for sacrificing to ghosts or spirits. Whether such perceptions were shared more widely across the highlands, and to what extent they have been maintained since, is not known. Relevant also are questions relating to local preferences for different types or parts of pork, in particular the relative proportions of fat and lean meat (see Chapter 10, Section 10.4).

9 Pig research trials: a summary

9.1 Introduction

Most experimental work on pig production in Papua New Guinea (PNG)⁹ was carried out between the late 1960s and early 1980s at the Tropical Pig Breeding and Research Centre (TPBRC) at Goroka, with minor work done at Erap, Rabaul and in Central Province. Significant research was also done at Piwa Agricultural Station in the Tari area of the Southern Highlands Province during the mid-to-late 1970s. More recently, a few further on-station trials have been done at Lae. Most trials have been under controlled conditions on stations rather than under village conditions with cooperating farmers.

The research program undertaken from the late 1960s focused on the major factors of genotype, nutrition, housing, management and disease control (Malynicz 1971b; Malynicz 1975a). The main aim was 'the development of husbandry systems capable of making best use of village resources, and using the survival and performance characteristics of both village and improved pigs' (Anderson 1972:646; Densley with Purdy et al., no date). Problems associated with village husbandry practices included the costs (labour for local; cash for imported) of pig feedstuff, the low productivity of indigenous pigs (slow growth, small litter size) and parasitic loads (Malynicz 1971b). The strategies adopted to meet these problems were based on the use of exotic breeds to improve the potential productivity of indigenous pigs, and the suitability of local ingredients for pig feed. It was understood that imported management systems by themselves were not enough, instead, adaptation in most aspects of the system was required (Purdy 1971).

The main research program on pigs was terminated in the early 1980s. This was apparently due to the failure of village-level commercial pig production and the fact that large commercial piggeries based on imported feedstuff and exotic breeds were producing meat for the PNG market (Bakau and Galgal 1994).

9.2 Use of pig wastes

Some limited work has been done on the use of pig wastes, either for energy generation using digester units, or as manure for soil fertility management.

9.2.1 Manure

Kimber (1982) investigated the effect of pig manure on sweet potato yields, reporting a significant yield increase (17 t/ha compared to 13.4 t/ha for no manure) at an application rate of manure of 22 t/ha. The yield at an application of manure of 44 t/ha, however, was only 15.9 t/ha, perhaps due to the heat and moisture of the dung. Kimber noted that other unpublished research at Aiyura confirmed that pig manure increased sweet potato yields.

Pig manure was also included in trials comparing four sources of organic fertilizer as part of a research program to find means of intensifying subsistence agriculture on the Nembi Plateau in the Southern Highlands Province (D'Souza and Bourke 1984, 1986). In one trial, manure was compared to *Azolla pinnata* and coffee pulp. Pig manure gave a significant yield response when applied to sweet potato and had a positive residual effect on sweet potato yield in a demonstration plot. The authors concluded that pig manure

⁹ See 'Definitions' section for explanation of names used in this report

would have an important role in improved farming systems, but further research was needed.

9.2.2 Digester studies

In the early 1970s there was considerable interest, following suggestions from George Chan, in the possibility of generating energy from recycled animal and other wastes, as well as using the dissolved nutrients as agricultural fertiliser (Watt 1972; Chan 1973; Thomas and Parfitt 1974). A workshop on waste recycling systems was held in 1973. Some studies were undertaken at the TPBRC to investigate the potential of pig wastes. Barton discussed problems requiring further consideration before detailed studies could be conducted (Barton, no date (b)), and reported work on one anaerobic digester unit trial (Barton, no date (a)). Malynicz (no date (d)) compared the costs of energy from digesters with that from conventional sources. He concluded that energy from digesters was cheaper than that from industrial fuels, but more expensive than that from firewood. He therefore saw little justification for further development of digesters, given the widespread availability of firewood in PNG. Interest in biogas production from pig wastes in PNG resurfaced 20 years later (Lea and Day 1993).

9.3 Nutrition and pig feed

A major constraint for the development of pig production under semi-intensive or village conditions was the cost of imported feedstuff. Thus, the suitability, effectiveness and relative costs of a range of feeds, especially local ones, has been a major focus of trials carried out in PNG.

9.3.1 Stockfeeds

A basic source of policy-relevant information and projections is the important 1974 conference on stockfeed (Watt 1974a). This included a number of papers dealing with pig-related material (Blackburn 1974; Bourke 1974; Jeffcoat 1974; Korte 1974; Kimber 1974a; Purdy 1974a; Watt 1974a; Kimber 1974b; Purdy 1974b; Malynicz 1974c).

Several other publications deal directly with stockfeed, either in terms of policy issues such as import replacement (Naidu 1989), or concerning the general role of a single crop as feed. Reflecting the importance of sweet potato in the PNG economy, there are a number of papers that, besides other things, discuss the role of sweet potato as stockfeed for pigs (Kimber 1972; Kimber 1974a; Kimber 1974b; Kesavan 1982; Sowe 1993; Bang and Kanua 2001; Kanua and Liripu, no date). Tubun and Karafir (1990) provide information for Irian Jaya. As regards cassava, Taru (1981) studied the effect of feeding fresh roots and leaves to growing pigs. According to Kohun and Grant (2000:49), Taru fed pigs 'varying amounts of roots and leaves with 0.5 kg of commercial pig grower ... The results showed that including cassava leaves with roots improved pig performance.' The potential role of cassava as stockfeed was reviewed by Kohun and Grant (2000), and its current role touched on by Grant and Allen (2001:790–1). Other work using cassava feed is described below (Section 9.6.2). Quartermain (1999) recently reviewed the use of sago products as pig feed under customary conditions, described Springhall's (1969a) trial results, and summarised some non-New Guinea information on the nutrient values of sago. The citation by Sillitoe (2003:331) (to, ultimately, Springhall's work) that sago is 'a rich source of ... protein' for pigs is a careless error. Trukai Industries Limited (2002) retail a locally produced range of stockfeed for pigs tailored to size and reproductive status.

9.3.2 Chemical composition of local ingredients for stockfeed

The composition of many tropical feedstuff, most of which are available in New Guinea, were analysed and listed in detail in Springhall (1969b). The list was also given in the now scarce publication, Springhall and Burgess (1969), and also in Springhall (1976). An abbreviated list was given in Watt et al. (1975:35). Turner and Malynicz (no date) also described the composition of some locally available stock feeding ingredients, including Tilapia fish meal, tuna offal, anchovy fish meal, soya bean seeds, dried algae, peanut kernels, mung bean seeds, rice bran, sorghum and other more common items such as corn and dried sweet potato.

9.3.3 Sweet potato

In many parts of PNG, sweet potato is the only food readily available as pig feed. Following the first comprehensive experiment feeding sweet potato to pigs in PNG by Springhall (1969a), seven research projects involving sweet potato were conducted by Malynicz at Goroka. Trials under intensive management included supplementing sweet potato with a variety of high-protein plant foods, such as peanuts, soya beans and commercial concentrate. Sweet potato and peanuts were evaluated as pig rations for exotic pigs (Malynicz 1971a). In a second trial, the effect of level of feeding and supplementation with sweet potato vines, on the growth performance of exotic pigs was evaluated (Malynicz and Nad 1973).

Cooked sweet potato increased average daily liveweight gains as compared to raw sweet potato, but the costs of cooking are significant (Watt 1973).

Clark and Malynicz (no date), responding to information that pig growers were reducing the levels of protein supplement below recommendations (1 lb protein concentrate supplement/day plus ad libitum sweet potato), examined both the physical and economic effects of feeding pigs at different levels of supplement. In an experiment of three treatments, each with six exotic pigs (14 weeks old), the pigs were fed with daily supplements of 1 lb (0.45 kg), 0.5 lb (0.23 kg) and 0.25 lb (0.11 kg). The trials stopped when the pigs in each treatment reached 120 lbs (54.4 kg). The performance results were unambiguous, with performance falling with declining protein. However, economic analysis of the costs showed more complexity. When sweet potato was cheap, it paid to substitute it for supplement, whereas when sweet potato was expensive, the least cost ration was that of 0.23 kg supplement per day (except when supplement price rose too high). Including all other fixed and variable costs (labour, loan depreciation etc) in the analysis, as well as the effect of throughput, showed that the highest level of supplementation gave the highest annual return.

Further research was done on less intensive management systems involving grazing on sweet potato. Rose (1979) at Piwa Agricultural Station compared single and progressive harvesting of sweet potato and showed that progressive harvesting significantly increased the yield of small pig tubers (weighing less than 100 g). In subsequent work, taking into consideration the possibility of differences in the ability of pig breeds to digest sweet potato, Rose and White (1980) evaluated the digestibility of chopped raw sweet potato at Goroka using indigenous village pigs on relatively low daily intakes (about 2.7 kg sweet potato/day for pigs of 93 kg liveweight, and about 1.3 kg sweet potato/day for pigs of 29 kg liveweight).

9.3.4 Protein supplement

Work at Goroka focused initially on using a modified Lehmann system of feeding, based on an energy ration of raw sweet potato and two types of supplement, either raw peanuts or protein concentrate (Malynicz 1971a). Pigs on the peanut supplement performed worst and those on the concentrate achieved only half the daily growth rate of the control

animals. Following up a growth problem in a commercial piggery, it was determined that too large a ration of protein concentrate (23% rather than 18%) was detrimental to pig growth (Malynicz 1971c).

Malynicz (no date (a)) compared three ways of feeding sweet potato with a protein supplement. In two treatments, the pigs were fed 454 g concentrate daily, with ad libitum sweet potato either raw or cooked. In the third treatment, pigs were fed a fixed ratio (1:10) of concentrate to sweet potato, adjusted daily to match intake. The pigs fed the fixed ratio gained most weight (650 g/day), compared to 551 and 404 g/day for the cooked and raw sweet potato Lehmann regimes treatments respectively. Concentrate consumption was highest for the fixed ratio, and approximately the same for the other two treatments. Sweet potato consumption differed markedly: from 7.03 kg/day for the cooked treatment, 5.29 kg/day for the fixed ratio and 3.45 for the raw sweet potato treatment. Costs were also analysed, including the cost of firewood for cooking sweet potato.

Four different protein supplements (fish meal, soya bean meal, cooked soya beans and protein concentrate) were evaluated with a diet of raw cassava using exotic hybrids (berkshire and tamworth crosses). As expected, the performance of pigs on the soya bean supplements was considerably poorer than the other two. Unexpectedly, however, the growth rate of the pigs on the fish meal ration was much greater than that of the pigs on the concentrate ration (Malynicz, no date).

Danbaro et al. (2001) recently investigated the use of sweet potato, with soybean meal as the protein source, for feeding exotic pigs at Lae. They confirmed higher growth rates using cooked rather than dried sweet potato, and higher growth rates using more than 400 g soybean/day.

Duks et al. (2001) studied the use of staples (sweet potato and corn) and protein concentrate in two trials following the Lehmann feeding system using both native and crossbred pigs. In the first trial using native pigs, there were no differences in either feed-conversion ratios or rates of weight gain between pigs on the control diet and those on either of the supplement rates. In the second trial, there were no significant differences in growth rates between crossbred pigs fed commercial grower, normal corn and quality protein corn.

9.3.5 Plantation and other byproducts

The results of research on plantation byproducts (coconut and copra meal, coffee pulp, cocoa pods, tuna offal meal, oil palm fruit, brewer's grains and pyrethrum marc) were summarized in Malynicz (1974c).

Coconut meal was evaluated in three experiments at levels up to 30% of the rations for growing pigs (Malynicz 1973f). There were no significant treatment effects in growth performance in any of the three experiments, though there was a trend for performance to decline with higher levels of coconut meal. In later work, Wenge and Nano (1988) found that copra meal concentrate at a high 60% of diet decreased feed intake.

Fresh coconut meat was evaluated as a pig feed in a trial using crossbred pigs (Malynicz and Nad, no date). There were only small differences between pigs fed coconut meat and a maximum of 450 g per day of protein concentrate, and pigs fed commercial rations. The growth rate of pigs fed ad libitum coconut meat and protein concentrate was significantly better than the growth of pigs on the other two diets.

Three further experiments evaluated pyrethrum marc, cocoa pod meal and dried coffee pulp as potential feedstuff, but all three proved to be detrimental to growth and efficiency of feed use (Malynicz 1974b).

A locally produced tuna-offal meal was evaluated with two preliminary experiments (Malynicz and Nad 1975). The first trial showed it to be inferior to two imported fish meals. In the second trial, the effect of protein level and supplementation with the vitamins and minerals in rations formulated from tuna offal meal and sorghum were studied. The vitamin supplement produced highly significant effects on performance, much greater than those due to the level of fish meal. It was suggested that while tuna offal meal is a reasonable source of protein (and probably calcium and phosphorus) it was deficient in minerals or trace elements.

Around Port Moresby, brewer's grains, a waste product from breweries, were used for feeding pigs. A trial to study their value as a protein ration showed that they make a useful inclusion in pig rations, at least at levels up to 15% (Malynicz 1976b).

A small trial was conducted at Kapogere (Central Province) to study the value of oil palm fruits in pig rations compared to a ration of crushed corn. The pigs fed oil palm grew more slowly than the pigs fed corn (Sewell and Malynicz, no date).

9.3.6 Feed restriction

Malynicz (1974a) studied the effects of feed restriction on a given increment of body weight in a trial using tamworth or berkshire pigs. Weight gain was reduced when allowances of less than 90% of ad libitum were fed, although the fall in weight gain with increasing restriction was not nearly as severe as predicted by other research. Three reasons were advanced for this: day temperatures at Goroka were over 15–20°C, the pig breeds used were more primitive and the growth of the less restricted pigs was low compared to experimental results in Europe. There was relatively little difference between the amount of food required to produce the increment from 20 to 200 pounds (9.1 to 90.7 kg) between treatments; allowances between 90% and 75% used least feed.

9.3.7 Legumes (peanuts, soya beans, *Leucaena*)

Malynicz (1974f) summarised research on the role of legumes as pig stockfeed up to 1974, concentrating on soya bean and *Leucaena*.

In a series of experiments, Springhall (1969a) investigated the use of supplementing imported pig feeds with some local materials, in particular soy bean and peanut hay. A soy bean/maize pig ration gave higher weight gains than a ration based on cooked sweet potato and added soy bean. The substitution of peanut hay for part of the sorghum ration resulted in no significant difference when compared with a control soy bean/sorghum ration.

Soya beans grow well in PNG but because there is no commercial oil meal plant, their use as pig feed is restricted to whole beans. Barton and Malynicz (no date) studied the effect of three rations containing raw or cooked soya bean with sorghum and sweet potato. The pigs fed the soya bean rations grew more slowly than those on the control rations. Cooking of the soya bean made no significant difference. They suggested that further work was necessary using different methods of heat treatment of soya beans (Barton and Malynicz, no date). A further two trials using whole soya beans were conducted (Malynicz 1974d). The second trial studied the effects of supplementing a ration of cooked soya bean and cooked sweet potato with two mineral supplements (plain salt or a mixture of salt and bone ash). Supplementation of soya bean–sweet potato rations with salt significantly improved live weight gain. These results confirmed that cooking soya bean improved its use, and that the addition of salt resulted in performance not greatly below that of pigs on a fully balanced ration.

Leucaena meal was added to the commercial grower ration at different levels in an experiment with crossbred pigs. Inclusion of between 10% and 20% *Leucaena* leaf meal significantly improved growth rate over the control ration (Malynicz 1974g).

Wenge (1981), in an unpublished study, studied the use of green legume leaves in feeding growing pigs.

9.4 Tethering and grazing trials on sweet potato

There is a considerable difference between the extensive forms of pig management used under village conditions and the intensive systems of modern commercial pig raising. Starting in the early 1970s, a series of trials investigated forms between these two extremes.

Malynicz (no date (f)) investigated the use of controlled grazing of pigs on sweet potato, with appropriate protein supplementation, in three experiments. In the first two experiments, six-month-old sweet potato fields of one square chain (0.0405 ha) were used, while in the third, the fields were 0.15 acre (0.06 ha). Sweet potato management had been poor and yields were low (2–5 t/hectare). The treatments in all three experiments compared the growth of pigs on grazing only, with a range of grazing and additional supplements. In all cases, the pigs that were grazed only either lost weight or grew very slowly, suggesting that some form of protein supplementation was required at this level of grazing. The trials also suggested that, under conditions of rotational grazing, faecal egg counts stabilise irrespective of nutrition.

Observations of the rooting behaviour of the pigs in the previous experiments showed that initially the pigs rooted for earthworms, which they ate with relish, leaving sweet potato tubers exposed (Malynicz, no date f). They then ate the sweet potato leaves, leaving the vines to wither and dry. Next they ate the sweet potato tubers. Finally, the pigs chewed the dried vines, spitting out the remains. All other vegetable matter was eaten, with the exception of flea bane (*Erigeron sumatrensis*).

Preliminary feasibility studies with rotationally grazed pigs on sweet potato were carried out at Banz in the Western Highlands Province by Shepherd and Malynicz (no date) in the early 1970s. The grazing was combined with a protein concentrate supplement daily. The trial indicated satisfactory growth rate and pig health (faecal egg counts were low), and the authors suggested that the advantages of such a grazing system included low capital cost, maintenance of soil fertility by pig manure and low labour requirements.

Further work on grazing and tethering pigs on sweet potato was carried out by Rose in the Southern Highlands Province. The first study (Rose 1976) was designed to follow closely local pig husbandry practice in the Tari area, though using exotic pigs (berkshire and landrace cross). The experiment compared the performance of three pigs, each on 4-month and 6-month systems of pigs grazing on planted sweet potato. The growth rate compared favourably with that found in semi-intensive systems elsewhere in PNG.

In a subsequent study, Rose (1981a) reported on a trial where 3-month-old village pigs were kept under an intensive system of outdoor management. The trial compared tethered pigs foraging on grassland without access to sweet potato with those in two treatments foraging on harvested sweet potato mounds. The liveweight gains of the pigs on grassland fallow were considerably less (140 g/day) than those of pigs foraging on the sweet potato treatments (191–205 g/day). In treatment 1, in which sweet potato tubers and leaves were fed ad libitum, Rose found that the amount of sweet potato consumed daily by pigs grazed on completely harvested sweet potato mounds (and thus with access to earthworms), ranged from approximately 1.05 kg/day for piglets of 10 kg liveweight to 2.40 kg/day for pigs of 30 kg (tuber weights converted from dry matter figures). Further details of this and related trials by Rose and others (see Rose and White 1980; Rose and Wood 1980; Rose 1981a, 1981b; Rose and Williams 1983/84) are summarised in the discussion on forage foods in Chapter 6, Section 6.2.6.

Kohun and Waramboi (2001) discuss the integration of crops and livestock generally in PNG smallholder farming systems, but do not focus on pigs. They note that at least two

projects involve the use of pigs in integrated farming in PNG: the Lutheran Training Centre in Morobe, and a Japanese project at Warangoi in East New Britain Province.

9.5 Housing

In the early 1970s, experimental work was done at Goroka on several aspects of pig housing. One trial of four types of floor (concrete, bare earth, wooden slats and elephant grass deep litter) found no significant differences in weight gain, food consumption or efficiency between any of the treatments (Malynicz 1973a). Another trial, which compared the performance of both indigenous and exotic pigs in two kinds of individual housing lots (open dirt lots and small concrete floored pens), found that the housing system affected weight gain, food conversion ratio, dressing percentage and back fat (Malynicz 1973e). A small experiment in 1972 examined the effect of different-sized rooms (from 2.5 to 11.5 m²) in deep litter, local materials, and housing on the growth rate and food eaten by young pigs, and found little difference in performance (Malynicz 1976c; Malynicz, no date e).

9.6 Growth

9.6.1 Exotic pigs under village smallholder conditions

From the late 1940s to the 1960s, it was government policy in PNG to make 'improved' exotic breeds of pigs available to villagers by distribution from government stations (Erap, Rabaul and Goroka). This continued, and greatly expanded, earlier distributions from centres of expatriate settlement (see Chapter 3, Section 3.4). Unpublished reports in the 1960s indicated that the survival and growth of these exotic animals was poor. This finding was confirmed by two trials. A preliminary assessment involved the distribution of 16 young pigs of three breed groups to villagers near Goroka and found little or no weight gain and very high mortality (Malynicz 1973b). It also found that the growth potential of indigenous pigs seemed low: reporting weight gains of only about 0.07 g/day for indigenous pigs kept under good improved conditions at the Goroka Research Centre. The second trial involved a larger survey, with the distribution of 129 exotic breed pigs to seven village locations in the highlands (Malynicz 1973c). Six months after distribution, weight gains averaged less than 100 g daily, though there was considerable variation between locations (from 16 g/day at Kundiawa to 140 g/day at Minj).

In 1980, Gibbs (1981) summarily reported the results of a follow-up survey of crossbred weaner piglets distributed to 19 smallholder pig projects in Enga, Southern Highlands, Western Highlands and Simbu provinces. No average growth rate was given, but the best project average was apparently 313 g/day (2.19 kg/week). No details of feeding and management regimes were given, but the feed was apparently sweet potato and concentrate. The normal rates for growers (presumably crossbred pigs?) kept at the TPBRC at Goroka were 420–500 g/day (2.94–3.5 kg/week).

9.6.2 Exotic pigs under experimental conditions

Malynicz and Nad (1973) evaluated the effect of level of feeding and supplementation with sweet potato vines on the growth performance of exotic pigs. The trial used three groups of six weaner (initial weights 15–16 kg) pigs each, over an 85 day period. The first treatment used an unrestricted crude protein ration; the second a restricted ration and the third a restricted ration with free access to sweet potato foliage. The mean daily gains were respectively 507, 447 and 410 g; the mean food conversion ratios were 4.88, 3.76, and 4.07. The unrestricted protein ration therefore increased the rate of gain by 13%, at a cost of 47% increased consumption. Restricted feeding resulted in feed savings of about 30%. The use of ad libitum grain feeding was therefore not recommended. The feeding of

sweet potato vines reduced the daily gain, but, because the digestibility of fibre in sweet potato vines had been shown to vary by breed, it was considered possible that the exotic pigs used in the trial were unable to successfully digest such rations.

Malynicz (1973e) compared the growth and carcass measurements of indigenous and exotic (berkshire or tamworth) weaner pigs (initial weights of 7.7–8.6 kg and 13.2–13.9 kg respectively) raised under two housing regimes (concrete or dirt floor) for a period of 100 days. The dirt floor regime consisted of the use of muddy fenced lots that had previously been stocked with village pigs and were known to be heavily parasitised. Both groups received the same *ad libitum* feed and water. On concrete, the exotic pigs gained 495 g/daily, the indigenous pigs 236 g/daily. On dirt, the respective gains were 404 and 185 g/day. The indigenous pigs ate less food: 0.95 kg/day on concrete and 1.06 kg/day on dirt compared to 1.63 kg/day and 1.60 kg/day, respectively, for the exotic pigs. However, their food conversion ratio was poorer, due to their slower growth rate.

In a subsequent experiment at Goroka in 1974–75, Malynicz (1992) compared the growth performance of indigenous and exotic (berkshire) pigs under relatively modern intensive husbandry, allowing both breeds to reach the same slaughter weight. The indigenous pigs grew at a much slower rate (281 days as against 178 days to reach a slaughter weight of 65 kg), ate much more feed (279 kg as against 197 kg), and had much more back-fat (3.8 cm compared to 1.7 cm).

Wenge and Nano (1988), in a trial of cassava feed, reported that large white pigs fed from weaning for 116 days on a cassava-based diet containing 0%, 50% and 60% copra meal-based concentrate, gained on average 570, 370 and 310 g daily, respectively, and took 3.1, 3.6 and 3.5 kg feed per kg gain. Copra meal concentrate at 60% diet decreased feed intake. The author has not seen an unpublished report on the use of copra meal by Nano et al. (no date), nor the Vudal student research reports (Bourke 1999a:60) of Kupe (1970) and Maino (1971) on the effects of three systems of feeding on growth rate, feed conversion and carcass quality, or that of Arek (1971) on the effect of coconut oil meal in growing pig rations on performance carcass measurements.

9.6.3 Trials under village conditions

Very few formal trials of pig production have been carried out off-station under village conditions of pig husbandry, though there are a few studies of performance under village conditions (see Chapter 6, Sections 6.2 and 6.3, above). There have also been assessments of programs that have yielded interesting results. For instance, high mortality was reported for exotic weaners distributed to village projects in the late 1960s. One of the first distributions of pigs to seven highlands' areas showed a mortality of 44% from weaning to 10 months (Purdy 1971:482). A decade or so later in 1979–80, pig-fattening projects in the highlands continued to show high mortality. A survey of 19 such projects found that over 75% of pigs died in large projects (those with 7 or more pigs), while mortality was lower in those with fewer animals (with no deaths in 56% of those with 6 or less pigs) (Gibbs 1981:104).

One major study in PNG under village conditions consisted of two experiments. The first was a preliminary assessment of the productivity of different breeds (exotic, crossbred and indigenous pigs) at a village near Goroka (Malynicz 1973b; Malynicz 1973c). The trial lasted five months, with weekly weighings. Mortality was high and weight gains were minimal. In the second, much larger study, the performance of 129 exotic pigs that were distributed to villagers throughout the highlands was studied. Results showed very wide variation in growth rates and mortality. It was concluded that village husbandry conditions were unsuitable for exotic pigs and that major changes in village management would be necessary before exotic pigs could achieve their potential productivity.

In a small, unpublished study in 1974, additional supplements of coconut, soybean and coral were fed to eight village pigs in the Papuan coastal village of Pinu for comparison

with pigs on normal village diets (Potter, no date b). Those on the supplement grew three times faster (averaging 1.22 kg/week) than the others.

In a study of the production performance of indigenous pigs in Irian Jaya, Randa (1994) measured the food consumed by 20 pigs at two coastal village and 20 pigs at an upland village (upland however only in a relative sense: probably no more than 200 m altitude) in Manokwari district for five months. In both locations, 10 farmers with two pigs each were involved: apparently the pigs were distributed to the farmers for the purpose of the research. All pigs were confined to pens. At the upland site, feeds included cassava, taro, sweet potato, sago, grated coconut, kangkong, salted fish, cabbage, amaranth and pawpaw (fruit and leaves). Most farmers fed their animals twice a day. At the lowland site, foods included cassava, taro (tubers, leaves, stem), rice, kangkong, grated coconut and salted fish. Much of the food seems to have been leftover and waste from kitchens, markets and institutions. The animals weighed an average 6.8 kg when the study began, and 19.9 kg and 21.7 kg, respectively, at the upland and lowland sites after 5 months. At the upland site, the average daily food consumption ranged from 2.3 kg/day/pig in the first month to 3.4 kg in the fifth month, while at the lowland site the figures were 2.2 to 3.3 kg/day/pig. The feed conversion ratio of the upland pigs was 37.01; that of the lowland pigs, 29.74.



Small pig killed by clubbing, Koge, Sinasina, Simbu Province, 1971.
Photographer: R. Hide

10 Nutritional role of pork in New Guinea human diets

10.1 National, regional and urban pork consumption

Until recently, national level information on pork consumption in Papua New Guinea (PNG)¹⁰ was scarce. Some writers have considered that estimation of consumption (and production) is too difficult, due to the complexities of the role of pigs in the country (Ihekoronye 1994:42). Although the 1982–83 National Nutrition Survey asked about food consumption with a 24-hour food-recall question, pork was unfortunately not distinguished as a separate category. Instead, it was subsumed within two possible classes ('tinned/freezer fish/meat' and 'bush meat'). Statistics on numbers of pigs slaughtered at abattoirs are kept by the Livestock Development Corporation (see Chapter 8, Section 8.1, above), but these account for only a small fraction of the national total. However, a range of widely varying estimates of pork consumption in PNG have become available over the last decade.

The Renewable Resources Sector Study Team (1993:22, citing Mandich 1992) estimated national level pork consumption based on commercial pig production within PNG at 1150 t for 1991. This represented only 2% of the estimated total meat consumption, compared to lamb/mutton at 56%, beef at 22% and chicken at 20% (Renewable Resources Sector Study Team 1993:23). At the other extreme, the Food and Agriculture Organization of the United Nations (FAO) Production Yearbook estimated national pork consumption (ie including village production) at 42,000 t in 1999 (FAO 1999). Quartermain (2001:626) presents two widely varying estimates of village production: 24,000 t for 1993 (on the basis of a national herd of 1.6 million head, 50% off-take, and 30 kg per carcass), and 5000 t for 1998 (on the basis of a national herd of 1.5–2.0 million head, 10% off-take, and 30 kg per carcass). The latter figure is similar to that given by Maika (2001:633, citing Vincent and Low 2000). More recently, Quartermain and Kohun (2002:40, see also Quartermain, 2002b:11) have updated village pork production to an estimated 27,000 t, and commercial production to a little over 1000 t.

Important new data recently became available from the 1996 PNG Household Survey (Gibson and Rozelle 1998; Gibson 2001a). This survey showed that pork remained the most consumed meat in PNG, with an estimated 11 kg per person annually in 1996 (Table 10.1). The household survey also underlined the major differences between the place of pork in rural and urban diets. It confirmed that pork is not a common urban food, and showed that pork consumption has a very regional pattern. Tables 10.1 and 10.2, below, show the average annual weight and value of pork consumption, relative to other meats and fish in PNG in 1996, by sector and by region.

People in the Papuan and Highlands regions consumed four to five times as much pork as those in the Momase and New Guinea Island regions in 1996 (Table 10.1). In terms of value (Table 10.2), the Papuan and Highlands regions consumed 145 million kina (K) of pork compared to K14 million in the Momase and New Guinea Island regions.

¹⁰ See 'Definitions' section for explanation of names used in this report

Table 10.1 Average annual consumption (kg per person) of pork and other meat and fish in PNG, 1996, by region¹

Foods	PNG	NCD	Papua	Highland	Momase	NGI
Pork	11	4	19	15	4	5
Fish ²	10	16	20	1	14	20
Chicken	6	20	8	7	3	3
Bushmeat	5	5	7	3	8	1
Lamb/mutton	5	16	3	7	2	1
Tinned fish	3	8	3	3	2	3
Tinned meat	2	9	3	1	2	3

NGI = New Guinea Islands

¹ The regions are the four major ones (for definitions in terms of provinces, see Definitions' section) as well as the National Capital District (NCD).

²Includes fresh, frozen, dried and shell fish.

Source: 1996 PNG Household Survey (Gibson and Rozelle 1998) and J Gibson (University of Waikato, pers comm, June 2001).

Table 10.2. Estimated total value (millions of kina) of pork and other meat and fish foods consumed by households in PNG, 1996, by region¹

Foods	PNG	Rural	Urban	NCD	Papua	Highlands	Momase	NGI
Pork	162	158	5	3	40	105	10	4
Chicken	113	72	42	23	22	45	17	6
Tinned meat	68	37	31	15	14	12	18	10
Tinned fish	63	44	20	9	11	21	15	8
Fish ²	60	34	26	9	11	5	24	12
Lamb/mutton	59	36	24	12	6	31	8	2
Bush meat	33	27	6	4	10	8	11	0

NGI = New Guinea Islands

¹ The regions are the four major ones (for definitions in terms of provinces, see Definitions p.) as well as the National Capital District (NCD).

²Includes fresh, frozen, dried and shell fish.

Source: 1996 PNG Household Survey (Gibson and Rozelle 1998) and J Gibson (University of Waikato, pers comm, June 2001).

Urban (National Capital District, NCD) consumption of pork was only 4 kg per person per year, compared to 15–19 kg in the Papuan and Highlands regions. In terms of value, rural consumption was estimated at K158 million and urban consumption at only K5 million. This valuation is much higher than the estimated values of pork production for 2000 made by the Australian Contribution to the (PNG) National Agricultural Research System (ACNARS) project: K36 million for village pork, and K3.4 million for commercial production (Maika 2001:632).

Low pork consumption in urban PNG was also indicated in earlier community-level surveys of Port Moresby and Koki (Hodge et al. 1996; Spinks 1963). Analysis of food consumption patterns in Port Moresby and Goroka between 1975–6 and 1985–86 showed pork consumption was minor and declining (Gibson 1997:8).

10.2 Rural pork consumption

As the largest indigenous domesticated animal and the largest wild game animal in New Guinea, the pig is a major potential source of meat in local diets. However, for many

years there has been debate about the extent to which pork contributes to human nutrition. Thirty to 40 years ago, it was commonly accepted by agriculturalists that pigs contributed little or nothing to New Guinea diets (Egerton and Rothwell 1964; Purdy 1971). Some nutritionists held similar views. For instance, Oomen (1961:325) noted that pigs in New Guinea were killed only on ceremonial occasions and thus pork was eaten 'once a year' in excessive quantities. Within anthropology, there was considerable discussion about the rationality of cultural rules clustering or channelling pork consumption in time and place (Vayda et al. 1961; Strathern 1971b; McArthur 1972; Vayda 1972; McArthur 1974; Rappaport 1984). Oddly, of the eight New Guinea societies included in Murdock's cross-cultural ethnographic files, two (Siuai in Bougainville Province and Ekagi-Me in West Irian Jaya) were coded as places where pork comprised more than 10% of all subsistence food consumed (Murdock and Morrow 1980:53), which is a considerable exaggeration. The ambiguous status of the pig as both a major social and symbolic valuable, as well as a source of meat, was described by Densley with Purdy et al. (no date:49–51): early estimates of Highlands pork consumption were shown to vary between 0.1 and 7 kg/person/year, and new national-level estimates were presented of 6–10 kg/person/year. The latter are similar to the recent figures from the 1996 PNG Household Survey discussed above.



Preparing pig blood sausages at Dom pig festival, Kagul, Sinasina, Simbu Province, 1972. Photographer: R. Hide.

The only information on the contribution of pork to human nutrition for lower-level areas is indirect evidence on pig numbers (see Chapter 5), and the direct, but very local and patchy, evidence provided by community-level diet-intake studies and estimates. These latter sources are useful indicators of some of the major variation occurring within broad regions. Table 10.3 lists summary data from more than 45 studies providing some information on the significance of pork (from both domestic and wild pigs) in New Guinea diets.

It must be emphasised that these studies vary greatly in terms of duration, sample size and method. There is no standardisation of edible portion, fat proportion or protein values;

therefore, the results cannot be compared closely. Rather than attempt to convert all results to a single index (such as grams of protein/person/day), the table instead lists summary information on pork consumption generally as it was presented in the original study, with some minor modifications. For instance, where the only data is the number of pigs killed, but an estimate of the average pig weight is given, a rough consumption estimate has been calculated. In short, the table's purpose is mainly to document sources, rather than to present comparative data.

Reflecting the relative significance of pig husbandry across the country, there appears to be significant variation in the importance of pork in local diets. Within the Papuan region, pork consumption ranges from nil to minimal in a range of island and coastal areas (eg the Trobriand Islands, and part of the Purari Delta in Gulf Province), rising to modest levels in many inland areas.

In the Momase region, the very limited scatter of studies suggests major variation, particularly in the availability of pork from wild pig. There is virtually no information from the New Guinea Islands. In areas of low population density on New Britain and in East and West Sepik provinces, there are some very high figures for wild pork consumption.

Within the highlands, a useful distinction can be drawn between the core central area of medium to high human population densities, and the outer fringe area, characterized by much lower population densities and considerable access to forest. Throughout the core highlands, the evidence of nutrition surveys suggest that domestic pig production provides (and has provided in the past) modest levels of pork for consumption.

Unfortunately, there are no good time-series data from any region or locality to identify long-term trends. The problems of measuring all foods eaten by people in short surveys in New Guinea are not discussed here. However, the main points are covered by others, such as McArthur 1974, Dwyer 1985b, Ulijaszek 1992 and Kuchikura 1994b.

10.3 Nutrient composition of pig meat

Hongo and Ohtsuka (1993) have noted that information on the composition of pig meat in PNG is limited. One consequence has been the use of data from modern pigs in other countries for the analysis of New Guinea diets (eg the early 1947 Nutrition Survey (Langley 1950), and see also the recent Pacific Food Composition Tables (Dignan et al. 1994)). Some other studies, such as those of Norgan et al. (1979) and Brand et al. (1991), also give values from New Guinea pigs. Table 10.4 lists all available published values for the nutrient composition of samples from pigs originating in PNG.

Other papers have presented further results from the Gidra samples. Suzuki et al. (1988) described mercury levels, Yoshinaga et al. (1991) described selenium contents, Yoshinaga et al. (1996) the carbon and nitrogen isotopic ratios, and Hongo et al. (1989:42) gave values of major nutrients and trace elements.

10.4 Meat and fat composition, edible proportions, dressing percentages and live weights

Malynicz (1992) has shown in a comparison of indigenous pigs and exotic berkshires, with both raised under modern intensive husbandry, that, compared to the berkshire, the indigenous pig differed considerably in terms of its meat product, with a shorter carcass, much thicker back fat, heavier skin and less muscle. Rose (1981b:160–162) described the carcass characteristics of indigenous pigs raised in a trial under intensive outdoor management. The ratio of muscle to fat was low, indicating that the pigs were fatter than exotic breeds. Other data also suggested a trend for indigenous pigs to be proportionately

higher in fat and lower in bone content than exotic animals. The edible portion of local pigs was also higher.

Table 10.3 Summary information on the significance of pork in diets at various locations in New Guinea, by region

Region/place	Survey type/ duration	Year	Sample size	Pork consumption	Reference
Papua					
Milne Bay Province					
Kiriwina	Weighed, 1–2 days	1947	124 persons	Nil	Langley 1950:94–95, 133
Kiriwina	Recall and weighed	1990	5 families	eaten < once/week	Lindeberg 1994:19, 49, 227
Wamira		1976		Nil	Kahn 1986:173
Gulf Province					
Purari Delta	14 days observed	1976	800 persons	21 wild pigs c.18.8 kg pork per person/year	Liem and Haines 1977:9–10
Kukipi	Daily diary survey, 14 days	1979	16 households	Nil	Morauta 1984:39, 48
Wabo	24 hr recall, 1 day only	1976		18–27% ate pork	Lambert 1983:571
Western Province					
Ume	111 days observed	1980	260 persons	36 wild pigs	Akimichi 1998:175–6
Mawata	Weighed, 6 days	1990	20 persons	13 g protein/ day (27% wild pig)	Suda 1996:98
Kubo, Gwaimasi	1 year survey	1986–87	25 persons	70 wild pigs 17.3 g protein/ person/day	Dwyer and Minnegal 1991a; Dwyer and Minnegal 1991b
Kubo	Weighed, 8 days	1988	20 persons	5.5 g protein/ day, (18% wild pig)	Suda 1997:88–92
Kubo	Weighed, 6 days	1994	26 persons	Nil	Suda 1997:88–92
Bedamuni	21 days	1978	na	4 wild pigs (101 kg)	van Beek 1987: Appendix B
Ningerum	Weighed, 5 days	1984	37 adult women	4–8% of energy intake	Ulijaszek 1992:342
Wopkaimin	3 months	1975	na	Domestic pigs, 190 kg; wild pigs, 36.2 kg	Hyndman 1986:41–43

Table 10.3 Summary information on the significance of pork in diets (continued)

Region/place	Survey type/ duration	Year	Sample size	Pork consumption	Reference
Western Province					
Seltaman	1 year	1989	200 persons	60 domestic pigs, 1290 kg, (61% all meat); 9 wild pigs, 198 kg, (9%)	Whitehead 2000: Appendix. C
Kasanmin	Weighed 25 days	1986	17 persons	2.8 g meat/ person/day	Kuchikura 1990:124
Seltaman	Weighed 5–7 days	1986	22 adults	0.5 g meat/ person/day	Kuchikura 1990:124
Highlands					
Enga Province					
Sari, Mae Enga	Estimated	1955–57	Average adult man	30–50 g meat/ adult man/day	Meggitt 1958a:297
Simbu Province					
Jobakogl	Weighed 6 days	1956	52 persons	13–29 g meat/person/day	Venkatachalam 1962:9
Jobakogl	Weighed 6 days	1975	78 persons	Nil	Lambert 1975:13
Yobakogl	Weighed 5–6 days	1981	67 persons	12–15 g meat/ person/day	Harvey and Heywood 1983a:102
Gumine, Wandi	Weighed 5 days	1961	5 families	0–3 g meat/ person/day	Bailey and Whiteman 1963:378
Nimai	Estimated	1972–73	67 households	11.6 g meat/ person/day	Hide 1981:507–8
Southern Highlands Province					
Wola	Weighed 3 months	c. 1975	12 households	20 g meat/ person/day	Sillitoe 1983:241
Huli	Weighed 6 days	1993	28 households	1.6 g protein/ person/day	Kuchikura 1999:80
Bosavi	Weighed 7 days	1999	8 households	3.7 g protein/ person/day (c.70% domestic pig)	Odani 2002:55–56
Swebesi, Kasua	Weighed 9 days	1974	36 persons	19.2 g meat/ person/day (?wild)	Freund 1977:324–326
Fagamaiu, Kasua	Weighed 9 days	1974	54 persons	36.7 g meat/ person/day (?wild)	Freund 1977:324–326
Etoro	Observation + estimation 1 year	1979–80	109 persons	3 g protein/ person/day	Dwyer 1985b:105–107

Table 10.3 Summary information on the significance of pork in diets (continued)

Region/place	Survey type/ duration	Year	Sample size	Pork consumption	Reference
Enga Province					
Raiapu Enga	Weighed 14 days	1966	36 persons	0.9 g protein/ person/day	Waddell 1972b:125
Murapin	Weighed 7 days	1966–67	90 persons	11 g (0–32 g) meat/person/ day	Sinnott 1975:30–31
Yumbisa	Weighed 12 days	1973	40 persons	218 cal/ person/day	Wohlt 1978:161
Western Highlands Province					
Kumbagl	Weighed 5 days	1976	15 persons	17–20 g meat/ person/day	Claydon 1978/79:148
Eastern Highlands Province					
Siane	Estimate	1953	village	77 g meat/ adult/day (?doubtful?)	Salisbury 1962:80
Kapanara	Food Frequency Survey 69 days	1977	13 households	c. once per week	Grossman 1991:242–4
Moke, Okapa	Weighed 5–7 days	1957	38 persons	Nil, but pork said to be eaten several times/month; often more frequently	Reid and Gajdusek 1969:332, 335, 339
Auyana	Estimated 240 days	1962	5 H'holds 18 persons	Approx. 28 g/ person/day (once per 2.1 weeks)	Robbins 1982:47–9
Lufa	Weighed 5–7 days	1969	82 adults	13.1% of daily protein	Norgan et al. 1974:325
Lufa	Weighed 2 to 3 days	1978, 1980	18 men, 8 men	45 g meat/ person/day in 1978; Nil in 1980	Kajiwara et al. 1984:57–8
Momase					
Morobe Province					
Busama	Weighed 1–2 days	1947	340 persons	Nil	Langley 1950:94- 95,133
Kaiapit	Weighed 1–2 days	1947	137 persons	17 g meat/ person/day	Langley 1950:94- 95, 133
Patep	Weighed 1–2 days	1947	211 persons	2.8 g meat/ person/day	Langley 1950:94- 95, 133
Western Province					
Miyanmin	Weighed NA	1969	159 persons	23 g protein/ person/week mostly wild	Morren 1986:55

Table 10.3

Summary information on the significance of pork in diets (continued)

Region/place	Survey type/ duration	Year	Sample size	Pork consumption	Reference
Madang Province					
Hagahai	Estimated	1989–90	273 persons	10–17 wild pigs/adult man/year	Jenkins and Milton 1993:287
Bomagai, Maring	Estimated	1965		28 g/day/ adult man meat (wild pig + other animals)	Clarke 1971:179
Bomagai Maring	Estimated	1965	154 persons	3–4 wild pigs/month (c. 0.02 g pork/person/day)	Clarke 1971:19, 90
Kaul, Karkar Island	Weighed 5–7 days	1969	120 adults	Pork 1.8% of daily protein	Norgan et al. 1974:325
East Sepik Province					
Central Wosera	Weighed, 6 days	1983	40 persons	Nil	Ross 1984:20, 59, 77
Saniyo-Hiyowe	Weighed 19 days	1967	32 persons	51 g meat/person/day; 7.2 g protein/person/day (50% domestic pig)	Townsend et al. 1973:93
Gadio Enga	Weighed 336 days	1967–68	c. 25 persons	6.4 g protein/person/day/ wild pig 2.1 g protein/person/day/ domestic pig	Dornstreich 1973:282, 322
Amongabi	Weighed	1965	57 persons	5 g meat/person/day ?wild pig	WHO 1975:36
West Sepik Province					
Wulukum	Weighed/ Estimated 4 weeks	1964	6 persons	0.02 g meat/person/day	Fountain 1966:56
Gnau	9 months	1968–69	370 persons	52 wild pigs (not including piglets)	Lewis 1975:50
Abrau	3–4 mths, observed	1969–70	181 persons	54 wild pigs	Kelm and Kelm 1980:88
Wamu	12 mths, observed	1970–71	95 persons	18 wild pigs	Huber 1974:251–2, 272

Table 10.3 Summary information on the significance of pork in diets (continued)

Region/place	Survey type/ duration	Year	Sample size	Pork consumption	Reference
New Guinea Islands					
Bougainville					
Nukutapu Island	24 hr recall, 1 day	1979	42 children	Nil	Lefroy 1981
West New Britain Province					
Garu	1 year survey	1973–74	village (166 persons)	130 wild pigs (total 5290 kg liveweight)	Liem 1977:286, 289–290
Irian Jaya					
Rural Irian Jaya					
Biak	Weighed 7 days	1957	44 adults	3 g meat/ person/day	Malcolm 1958:16
Urban Irian Jaya					
Sorong	Weighed 7 days	1957	33 adults	5 g meat/ person/day	Malcolm 1958:16

Table 10.4 Published analyses of the nutrient composition of pig meat, skin and fat originating from PNG (all values, except those for energy, expressed as g per 100 g edible portion)

Location or group	Description	Water (g)	Protein (g)	Fat (g)	Carbo- hydrate (g)	Energy		Gross energy kcal	Fibre (g)	Ash (g)
						kJ	kcal			
Lufa	Domestic pig meat, roasted	64.1	30.1	4.1	0.1	694	166	208	0.1	1.4
Kaul	Domestic pig meat, boiled	68.5	19.5	6.5	4.8	673	161	195	-	-
Kaul	Domestic pig meat and skin, boiled	64.5	27.0	5.4	2.1	719	172	201	-	-
Kaul	Domestic pig fat, boiled	26.5	4.0	68.3	0.0	2700	676	635	0.1	1.2
Wopkaimin	Domestic pig meat, fat and skin	39.7	14.9	35.6	0.0	1603				0.6
Gidra	Wild pig meat	77.0	20.5	0.7	0.5	376.6	90			1.3
Gidra	Wild pig meat	76.5	19.6	0.7	1.8	384.9	92			1.5
Gidra	Wild pig liver	68.5	22.0	3.8	3.9	577.4	138			1.8

Sources: Lufa, Eastern Highlands Province, and Kaul, Karkar Island in Madang Province (Norgan et al. 1979:31, 33); Wopkaimin, Western Province (Brand et al. 1991:43); Gidra, Western Province (Ohtsuka et al. 1984:163). The Gidra sample is the same as that shown in Hongo (1993:123), though the latter averages the two meat samples (R Ohtsuka, University of Tokyo, pers comm, June 2001).

It is noteworthy that in much of New Guinea pork fat is customarily more highly valued than pork meat (O'Hanlon 1989:120; Lemonnier 1990:108–9; Shaw 1990:147; Sillitoe 2003:266). The extent to which this preference has been maintained over the past half century, and whether taste now differentiates between urban and rural residents, is not known, though by the early 1980s, Reay (1984:73) reported that people in the Wahgi Valley were already preferring less fat on their pork. The European and North American experience in the 20th century, demonstrates that consumer preference can very rapidly shift from fat to leaner pork (Bennett 1970; Ufkes 1995).

In a comparison of 26 local Solomon Island pigs with 19 exotic ones, de Fredrick (1971b:57) found a significant difference in the dressing-out percentage of the two breeds. Over 62% of the local animals had a dressing-out percentage of over 75%, compared to only 37% of the exotics. Overall, the village pigs had a mean dressing-out percentage of 78% (de Fredrick 1977a:115). For New Guinea pigs weighing 20–24 kg, Malynicz (1973e:25) reported a dressing-out percentage of 73–75%.

The New Guinea nutritional literature contains a wide range of figures used for estimating the edible portion of pork: Rappaport (1967:62) used 50%, Dornstreich (1973:422) 60%, Buchbinder (1977) and Dwyer (1983:164; 1990:227) both 65%, Gibson (2001a:39) 84%, and Hyndman (1986:34) an impossibly high 96%. All were based on figures from elsewhere, though Dwyer (1983:164) used figures from a tropical source, and noted that offal would constitute some 10% of the edible weight. Unfortunately, neither the technical studies of the composition of New Guinea foods, nor the recent Pacific Island food tables, give edible portion or dressing-out figures for pork or pigs (Norgan et al. 1979; Ohtsuka et al. 1984; Brand et al. 1991:39; Dignan et al. 1994).

Actual data on the live or dressed weight of mature animals at slaughter in New Guinea is scarce, and some published figures need to be treated with caution. For instance, working among the Mae Enga in 1955–57, Meggitt (1958a:289) described pigs as carrying little flesh, with mature barrows dressing-out at only about 18–23 kg (40–50 pounds in original). This seems small, at least by comparison with the liveweight size of pigs slaughtered for significant social and ceremonial events in Sinasina 20 years later in 1972–73 (eg averaging 60 kg at marriages (Hide 1981:487–8)). For the Wopkaimin (Western Province), six domestic pigs consumed in 1975 averaged 66.6 kg each according to Hyndman (1986:34), considerably larger than the figures given by Whitehead (2000) for the Seltaman (see below). In 1934, Hogbin (1970:324) estimated the dressed weight of slaughtered pigs on Wogeo at about 45 kg each. Shaw (1990:44) estimated the weight of mature pigs amongst the Samo of Western Province at a large 113 kg. Blinkoff (2000:208) gave a figure of 91 kg for one animal among the Sokamin in West Sepik Province.

As regards the size of wild pigs killed by hunters, Dwyer (1983:164) notes that they are lean, often young and hence small animals, and he cited the average of 29.5 kg recorded for 10 kills by Gadio Enga hunters in 1968 (Dornstreich 1973:75–77). For the Miyanmin, Morren (1986:89) gave (for small samples) butchered weights of 46 kg for wild pigs and 43 kg for domestic pigs, with the largest domestic pig weighing 132 kg. Townsend (1974:230; 1969:50, 52) reported no pig weighing more than 45 kg (100 lbs in original) in the Sepik lowlands, with information on the kills of six domestic and nine wild pigs. However, larger pigs do occur in the Sepik lowlands, as evidenced by Whiting's statement that some may require as many as three men to carry them (Whiting 1941:112), and the photograph of a very large animal carried by a Yafar hunter in the West Sepik Province (Juillerat 1996). There is a good data set from the Seltaman area of Western Province, in which Whitehead (2000: Appendix C) reports killed domestic pigs averaging 36 kg for mature animals, 15 kg for medium size and 6 kg for piglets and shoats (with, respectively, 15, 20 and 75 consumed in one year), and wild pigs averaging 22 kg (9 eaten). In the lowlands of West New Britain Province, Liem (1977:289–290) estimated the average wild pig to weigh 40.7 kg (130 killed by Garu villagers over 12 months in 1973–74). For the Bedamuni in Western Province, van Beek (1987: Appendix B, Table 1) gave an average of 25.2 kg for four wild pigs killed over 21 days in 1978.

10.5 Pork consumption: gender and age variation

Paralleling concerns in the recent literature on gender differences in labour related to pig production (see Chapter 6, Section 6.6), there has been some concern with variation in the consumption of pork by age and gender. Although Modjeska (1982:85) considered that the New Guinea literature showed little evidence of differential pork consumption by gender, several authors have described situations where women or children, appear to have received smaller shares than men (Meggitt 1958a:297; Steadman 1971:92–3; Dornstreich 1973; Lindenbaum 1979:20, 133–4; Powell et al. 1982:103; Hyndman 1986; Gillison 1993:324–5; Jenkins and Milton 1993:286). However, evaluation is difficult without more detailed information, as discussed by Ferro-Luzzi et al. (1981) and Hide et al. (1992). Careful accounts of the outcomes of gender-specific cultural rules about food, including pork, are given by Kelly (1993) and Whitehead (2000).

Cultural restrictions on consumption may favour women. According to Parkinson (1979:83), over 100 years ago men were prohibited from eating pork on Tumbleo Island, as too were initiates of the Ingiet secret society on New Britain (Rivers 1968: Vol.2, 518, 534). Writing of the Gnau of West Sepik Province, Lewis (1975:92) considered that much of the best meat was mainly channelled to women and children by the operation of taboos on wild pig and cassowary imposed on men. In the 1960s and 1970s, Marilyn Strathern (1981:189, fn. 18) considered that Melpa women in the Western Highlands Province consumed more pork than men. Barth (1975:165–6) described Baktaman men as subject to more dietary restrictions affecting meat consumption (with the exception of wild pig) than women.

In other cases, whole groups have been prohibited from eating pork (or kinds of pork). Some of the earlier literature is summarised by Simoons (1994:60–61). In a more recent instance, Healey (1990:45) describes how a Maring group (Western Highlands Province) was prevented from eating wild pig. In another example described by Godschalk (1993:33), the Eipo population in the Weip Valley, eastern Irian Jaya, cannot eat pork due to a clan specific taboo linked to an origin myth: according to Schiefenhövel (1982:831) this includes one-third of the population of the southern Eipomek valley. Elsewhere, restrictions on eating pork were at times adopted by either men or women, as among the Sulka of East New Britain Province (Rivers 1968: Vol. 2, 538). More recently (as described in Chapter 4, Section 4.2.4, above), conversion to the Seventh Day Adventist Church in PNG has resulted in the abandonment of pork consumption by some groups and individuals. It would be interesting to know whether the expansion of Islam in Irian Jaya since incorporation in Indonesia has affected the valuation of pork by indigenous Papuans (Ryan 1969:355–356; Aditjondro 1982:66).

Throughout New Guinea there were customary ways of butchering (and killing) pigs (Haberland and Seyfarth 1974:249; Laycock 1975; Kahn 1986:84), and, in many places, conventions allocating particular cuts of pork to people of different gender, age or initiation status (Barth 1975:35–37; Stürzenhofecker 1998:136–139).

10.6 Relationships between pig ownership and health or nutritional status

A few PNG studies have used pig ownership as a variable in investigations of relationships between socioeconomic status and health or nutritional outcomes. In a Wosera Abelam (East Sepik Province) village in 1969, Gorlin (1977:42, 44) found that pig ownership was positively related to an index of nutritional status (Quetelet's index). He also found that the skin disease tinea was less frequent among children whose fathers owned more pigs, and that villagers with stronger patrilineal rights in the village owned more pigs than those lacking such links. A study in Oksapmin in 1967–68 linked the nutritional status of children partly to the relative wealth of their fathers in terms of pig ownership (Perey 1973:200–224). A comparative study of relationships between socioeconomic status (partly based on pig ownership) and health in one community

(Kaul) on Karkar Island, and one in Lufa (Eastern Highlands Province) in 1969, found little physical differentiation in Lufa, but considerable differences in Kaul (Hornabrook et al. 1977:372–4, 378, 380). In Lufa, women owning pigs had higher fertility (on average 0.5 more children) than those owning none. On Kaul, nearly 55% of men owned no pigs, but men of both higher than average, and average, socioeconomic status owned several pigs, and they enjoyed significant physical advantages in terms of health and nutritional status. In the recent study (1997) of nutritional status among 185 households in the very isolated Kamea area of Gulf Province, 58% of households owned no pigs but nutritional status was not generally related to pig ownership (King 1999:92).

10.7 Food security issues

In times of severe food shortages, the significance of pigs to their owners, both in terms of their fodder requirements and their role as wealth on the hoof, available for conversion into currency, food or goodwill (Kiza and Kin 2001:215), is well recognised in PNG. This is explicit in literature describing methods of assessing need in times of food shortage (Wohlt et al. 1982; Levett 1987), and also in descriptions of high-altitude adaptations to frost (Clarke 1989; Wohlt 1989:229–230). Under conditions of major food shortage, the fate of pigs is likely to depend not only on the food (and fodder) supplies available to their keepers, but also on their own supply of forage. The feeding and survival of pigs under emergency conditions is discussed in greater detail in Chapter 6, Section 6.2.7.

11.1 Chronological overview of veterinary work with pigs in New Guinea

Before World War II, there were no comprehensive records of animal diseases in New Guinea¹¹ (Egerton and Rothwell 1964). A 1938 list (compiled primarily for expatriate pig breeders) of the more important pig diseases in New Guinea included contagious pneumonia, tuberculosis, anthrax, suppurative otitis, heat apoplexy, abortion, catarrh, scours in young pigs, gastritis, mammitis and sow eating young (Gee 1938). In 1945–6, the first major survey of animal disease was conducted by an Army Veterinary Team (Australian Mobile Veterinary Survey Unit 1946).

Anderson (1960a) reviewed the status of animal disease in 1960. The 1946 survey data were brought up to date by Egerton and Rothwell (1964), with a comprehensive review of the animal disease picture in Papua New Guinea (PNG). During the late 1950s and 1960s, work was done on various aspects of pig diseases, including infection with leptospira (Forbes and Wannan 1955; 1958; Emanuel 1959), anthrax (Egerton 1965a), salmonella (Rampling and Egerton 1965), salmonella, shigella and enteropathogenic *Escherichia coli* (Morahan 1968) and intestinal emphysema (Egerton 1965c). Talbot (1969) reviewed new recordings on animal parasites (see also Miyazaki (1968)). In a wide-scale survey of pig disease (infectious disease, arthropod parasites and helminth parasites) in the Solomon Islands in 1967–69, de Fredrick (1977b) compared his results with those from work in New Guinea. The Entomology Section of the Department of Agriculture reported occasional pig pest observations (Entomology Section 1969:69).

In the 1970s, Norris and Anderson (1972) reviewed pests of livestock, and Caley (1972) described salmonella in pigs. Talbot (1972b) reported on the incidence and distribution of helminth and arthropod parasites of indigenous owned pigs, and published a bibliography of the infectious diseases and parasites of pigs in New Guinea (Talbot 1972a). Davis (1973a; 1973b) investigated disease among village pigs in the Eastern Highlands Province. Although not published, some of his results were cited by Malynicz (1977) and Densley with Purdy et al. (no date). Further work on parasites was reported by Ewers (1973). Copland (1974a) reported an outbreak of swine pox, and published a series of papers on various disease parasites (Copland 1974b), pneumonia (Copland 1976c) and capillaria (Copland 1975). Copland also published baseline haematological (Copland 1976a) and biochemical (Copland 1976b) information on both local and exotic pigs. Anthrax was the subject of a thesis by Chapman (1974). There was veterinary input, particularly concerned with *Clostridium perfringens*, to the research on the human disease known as pigbel (enteritis necroticans) (Murrell and Walker 1978; Walker et al. 1979; Walker et al. 1980). The 1970s concluded with a seminar on livestock disease in Port Moresby (Department of Primary Industry 1979).

In Irian Jaya, *Taenia solium*, believed to be newly introduced, was identified in the Paniai Lakes area (Gajdusek 1977).

During the 1980s, Nunn kept agricultural field staff in touch with the work of the Central Veterinary Laboratory (Nunn 1980a; 1980b; 1980c; 1981; 1982d). Nunn (1982a) also edited the proceedings of a 1981 conference of veterinary officers, which included papers on anthrax (Nelson 1982a), brucellosis (Nunn 1982e), cysticercosis (Owen 1982) and other diseases of pigs (Nunn 1982c). Sims and Malik (1989) later discussed veterinary services available to smallholders. Rose (1981b) reported on parasite levels in village pigs used in a trial in the Southern Highlands Province. There was continuing work on

¹¹ See 'Definitions' section for explanation of names used in this report

Clostridium perfringens in relation to pigbel (Lawrence et al. 1984; Davis 1984a). Wernery (1984) reported on antibiotic resistance to Salmonellae. In Irian Jaya, anthrax was reported in the Paniai area (Ronohardjo et al. 1984), and *Clostridium* was identified in pigs thought to have died of anthrax (Moekti et al. 1985). Nunn (1985) reviewed the viral disease situation of pigs in New Guinea. Nunn (1988b) also summarised the role of veterinary services in PNG. Varghese (1986) surveyed coccidia in pigs raised under both intensive and village husbandry conditions in Central Province. Concern with *Taenia solium* continued in Irian Jaya (Tucker 1986–87:228; Hyndman 1987), and there was concern with its possible spread to PNG (Owen 1982; Banks 1988).

During the 1990s, there was work on the strongyloides parasite (Viney and Ashford 1990). There was a major study of rotavirus in pigs in the Eastern Highlands Province (Alpers et al. 1991), and another mainly on rotavirus in humans which also looked at pigs (Pratt et al. 1992). Wilks and Madie (1991) reviewed veterinary public health services in the Western Pacific region. Paterson et al. (1993) investigated *Streptococcus suis* type 2 in pigs under both village and intensive piggery conditions. An outbreak of sweet potato poisoning, which killed pigs in Lae, was reported (Low et al. 1993). *Serpulina pilosicoli* was surveyed in humans and pigs in the Eastern Highlands Province by Trott et al. (1997) and by Mikosza (1998). The work of the quarantine service with border surveys was described (Puana and Owen 1994; McManus 1995), and Levett and Bala (1995) reviewed future disease problems. Work on *Taenia solium* and cysticercosis increased in Irian Jaya (Ito et al. 1999; Wandra et al. 2000; Margono, Subahar et al. 2001; Margono, Ito et al. 2001; Subahar, Hamid et al. 2001; Subahar, Putra et al. 2001; Ito, Putra et al. 2002; Ito, Wandra et al. 2002; Widarso et al. 2002; Wandra et al. 2003), and concern with the possible spread of *T. solium* to PNG continued (Owen 1999; Wandra et al. 2003). A new species of trichinella (Pozio et al. 1999; Murrell et al. 2000; Owen et al. 2000; Pozio 2000; Pozio 2001a; Pozio 2001b) was reported from survey work on the border in Western Province, and serosurveys of anti-trichinella antibodies were conducted in 1999 and 2001 in the Bensbach area, and in 2000 in Port Moresby (Owen et al. 2001; Pozio et al. 2001). Considerable work was done on methods to detect the transmission of *Trypanosoma evansi*, by wild pigs and other animal species, across the Irian Jaya border with PNG and from there to Australia (Reid et al. 1999; Reid 2000; Reid and Copeman 2000; Reid et al. 2001; Reid 2002). Survey work in 1998, useful for comparative purposes, was reported for the Solomon Islands (Veterinary and Livestock Division 1998).

The border work has clearly grown in importance during the last two decades. As of the 1980s at least, PNG was fortunate in being relatively free of major diseases of pigs (Nunn 1985:223; Nunn 1988a:96). Nevertheless, starting in 1980, health officials from Indonesia, Australia and PNG met to discuss animal health in New Guinea and adjacent islands (Ningiga and Nunn 1985:573–4). This led to the establishment of the Tripartite Committee on Animal Health and Quarantine. The Australian Quarantine and Inspection Service (AQIS) prohibits the movement of live animals, including pigs, from the southern PNG border into the Torres Strait Protection Zone (Lawrence 1994:378–381, cited by McNiven and Hitchcock, in press). The lack of reliable epidemiological data resulted in a joint feasibility study in 1981 to determine if a survey of major diseases could be conducted. In 1989 the Northern Australia Quarantine Strategy (NAQS), which recognised the special quarantine problems posed by the proximity of northern Australia to PNG, was set up within AQIS (Wright et al. 1998). After a funding increase that followed a review in 1995, NAQS underwent major structural changes. Surveys in the late 1990s included an extension and scientific survey of the southwest coastal region of PNG in February 1997, animal and plant health surveys of the region of PNG bordering Irian Jaya in August 1997 and May 1998, and a combined animal and plant health survey in Irian Jaya in August 1997 (Wright et al. 1998:13; Purdy 1999). As regards links with PNG, the 1998 review (Wright et al. 1998; Quarantine and Exports Advisory Council 2000), endorsed the current arrangements but recommended that Western Province receive more intense surveillance, and the use of helicopter-supported boat surveys of the PNG coastline. It also recommended that priority be given to the encouragement of PNG and Indonesian collaboration, and that strategic planning, particularly for the scientific program, should take account of the risk of political instability. In 2001, the Australian

Centre for International Agricultural Research (ACIAR) was supporting work on surveillance for trypanosomiasis (surra) in PNG and Irian Jaya (ACIAR 2001).

Throughout the 1990s, the border surveys were carried out jointly by the PNG Agricultural Protection Division and AQIS through the NAQS program (Puana and Owen 1994; Purdy 1999; Kola et al. 2001). In 1999, NAQS funded a 5-day training course, held in Bahasa Indonesian, for nine Indonesian veterinarians in Australia, in order to improve animal quarantine in the province of Irian Jaya and hence reduce the threat of exotic animal diseases to Australia (Schmedding 1999). The main pig diseases covered were classical swine fever and vesicular diseases. NAQS assesses quarantine risks in Northern Australia and provides an early warning system of exotic pests and diseases (Animal Health Australia 2001). In Australia, sentinel herds of pigs are monitored for Japanese encephalitis (JE) and surra (see below under trypanosoma). For JE surveillance, in recent years seronegative pigs are flown at the start of each wet season to strategic sites on Cape York and central Torres Strait Islands. These pigs are bled fortnightly to monitor for JE, and tested for Aujeszky's disease, classical swine fever, and porcine reproductive and respiratory syndrome. In PNG, there is regular sentinel animal monitoring at Vanimo, Kiunga, Morehead, Port Moresby and Lae. In May 2000, there was a general survey of diseases of quarantine concern along the PNG and Irian Jaya border, and at Lae. The current Australian quarantine strategy of NAQS, and the biosecurity issues shared with Papua New Guinea and the Indonesian province of Papua are reviewed by Thompson et al. (2003).

11.2 Bacterial diseases in pigs

11.2.1 Pneumonia

In pre-World War II New Guinea, pneumonia was described as causing heavy losses among pig breeders (Gee 1938). There was apparently a major epidemic in the Enga area in 1943–45, killing some 20–30% of pigs (Meggett 1974b:19). The disease was investigated in village studies in the Eastern Highlands Province in the early 1970s. Davis (1973b), cited by Densley with Purdy et al. (no date:49), described a lung worm (*Metastrongylus* spp.) — pneumonia complex which caused the death of 14% of the total pig population in one year. Copland (1976c) studied acute 'short-wind' (pneumonia) in pigs in two villages near Goroka over 12 months. He suggested that there were two types of 'short-wind', an acute form with high mortality and a chronic form with low mortality. He concluded that enzootic pneumonia was not a significant limiting factor in traditional pig husbandry, but that low nutritional status and heavy nematode infections resulted in increased susceptibility to bacterial pneumonia. See also Watt et al. (1975:80).

To establish baseline data for studies of pneumonia and anthrax in pigs, Copland studied normal haematological (Copland 1976a) and biochemical (Copland 1976b) parameters of indigenous and crossbred pigs under modern husbandry, and indigenous pigs under village husbandry. There were few differences between the breeds under intensive management, but the village pigs had significantly lower levels of many parameters, most of which were considered to be due to the low level of nutrition and heavy parasite loads typical of this regime.

11.2.2 Anthrax

Following earlier reports of anthrax in New Guinea (Gee 1938; Australian Mobile Veterinary Survey Unit 1946), it was described in 1964 as widespread in the highlands, with a further enzootic area of about 100 square miles in the Lumi area of West Sepik Province, and unconfirmed reports from the Ramu River mouth in Madang Province (Egerton and Rothwell 1964; Egerton 1965a). Egerton described anthrax as probably the most important bacterial disease of animals in New Guinea. He noted that in enzootic

areas there can be either an epizootic form, in which large numbers of pigs die, or individual cases. The epizootic form recurs at 3–5 year intervals, due to the development of herd immunity in a geographical area which lasts for approximately the life of a pig (ie 3–5 years). Egerton reported that highlanders usually ate pigs which died of anthrax, but that throughout the area, ‘the infective nature of the disease is recognized and the affected head region is discarded’. Skin infection in humans has been diagnosed once in New Guinea, in a laboratory worker. This was presumably Egerton himself (Egerton 2003). ‘In 1962–63, four cases of cutaneous anthrax were reported in native people in New Guinea’ (Egerton 1965b:143), but not confirmed bacteriologically. See also Watt et al. (1975:68) and Nelson (1982a).

During the 1960s there was a campaign to vaccinate pigs (in the highlands at least) against anthrax. In 1963–64 some 1531 pigs were vaccinated; in 1964–65 this rose to over 27,000, and in 1966 the target was 50,000 (Harvey 1966:67).

Outbreaks or epidemics of anthrax and their effects on local pig herds have been widely reported by anthropologists and others in PNG:

- in the Enga Province in 1943–44 (Meggitt 1958a:288; 1974b:19)
- in the Southern Highlands around Tari in the early 1940s (Frankel 1986:26)
- later both on the Nembi Plateau in 1980 (Crittenden 1982:275) and in the Lake Kutubu area (Weiner 1988:32–4)
- in the Karimui area of south Simbu Province in 1982 (Hide et al. 1984:226)
- elsewhere in Simbu at various times (Hide 1981:163, 483; Schaefer 1991:120)
- at Oksapmin in West Sepik Province between 1974 and 1979 (Cape 1981)
- at Bundi in the Madang Province in 1988 (Caven and Gitai 1990a:22)
- in the Eastern Highlands Province, in the Arona Valley in 1948 (Du Toit 1975:97), around Lufa between 1948 and 1960 (Glick 1963:14), and in the Fore area in 1962 (Lindenbaum 1979:130).

The only account from the lowlands is that from the Lumi area in West Sepik Province in 1968 (Lewis 1975:81–82).

In Irian Jaya there were several outbreaks of suspected anthrax after 1956 in local pig populations but, despite the pigs displaying the clinical signs of anthrax, there was no confirmatory laboratory data. The disease reappeared between April 1983 and mid-1984 in the Paniai area, and 3484 pigs, as well as 49 people who had consumed the affected animals, died (Ronohardjo et al. 1984:238). Laboratory studies showed that anthrax was responsible. However, it has also been suggested that the human mortality may have been due to *Clostridium perfringens* (Moekti et al. 1985).

11.2.3 Brucellosis

Brucellosis in pigs is caused by the bacterium *Brucella suis*. It causes sterility and abortions in sows, high piglet mortality and mortality and swelling of the testicles in boars (Watt et al. 1975:71). Although not listed by Egerton and Rothwell (1964) as affecting pigs in New Guinea in 1964, in 1973 Davis (1973a; 1973b), cited in Densley with Purdy et al. (no date:49), considered it was an important disease in village pigs in the Eastern Highlands Province. Nunn (1982e) reviewed the PNG situation in 1981. The disease is present in Indonesia (van der Giessen and Priadi 1988).

11.2.4 *Streptococcus suis*

The presence of *Streptococcus suis* type 2 was investigated in pigs raised under both village husbandry conditions and in intensive piggeries in PNG using two types of test (Paterson et al. 1993). Far higher proportions of the intensively raised pigs tested positive by both tests. It was suggested that, in intensive piggeries, *S. suis* type 2 is continually cycled between pigs. In village pigs, the low population density and harsh environmental conditions may prevent this cycle of infection.

11.2.5 Enteric bacterial infections

Although enteric bacterial infections are diseases that can have significant effects on pig production (and several are also important causes of food-borne diseases in humans), the results of surveys during the 1960s suggested that salmonellosis was not of great importance in PNG. Rampling and Egerton (1965) conducted a limited survey into the incidence of carriers of salmonella serotypes in pigs and cattle in New Guinea. Faeces and mesenteric lymph nodes of pigs were sampled in New Britain (309 faeces samples and 109 lymph node samples), and the highlands (320 faeces samples). They found two carriers in New Britain and one carrier in the highlands. There had been one outbreak of *S. cholerae-suis* in pigs in Port Moresby between July 1962 and August 1964. *S. london* was isolated at Erap in Morobe Province. No carriers among the pigs were found, but four different salmonella serotypes, *S. cholerae-suis*, *S. anatum*, *S. bareilly*, *S. infantis* and *S. vejle*, were isolated from the food mix and the meat meal. The incidence of salmonella infections in animals in PNG is very low. *S. cholerae-suis* was only isolated once by the authors despite PNG's large pig population. For PNG there is additional information in Morahan (1968), Wernery (1984, 1986); and for *E. coli* in Indonesia, see Supar et al. (1991).

Recent work on *Serpulina pilosicoli* in both pigs and human in villages in the Eastern Highlands Province found no infection in village pigs, but its presence was confirmed in 17 of 50 commercial pigs at a local piggery (Trott et al. 1997). Rectal swabs of villagers showed 23% infected. See also (Mikosza 1998; Moxley and Duhamel 1999).

11.2.6 Swine fever (hog cholera, pig typhoid, classical swine fever)

In 1938, Gee noted that this highly infectious and contagious disease was not present in the Territory of New Guinea but that, if introduced, it could wipe out large numbers of pigs in a very short time (Gee 1938). It is not yet present in the island of New Guinea. However, this disease is present in Southeast Asia (Blacksell 2000), and has recently been introduced to Western Indonesia. There is concern that it will spread to New Guinea. Classical swine fever was one of the infections proposed for survey in 1981 by the Tripartite Committee on Animal Health and Quarantine (Ningiga and Nunn 1985). The Commonwealth Scientific Industrial and Research Organisation (CSIRO) has recently trained a group of Indonesian veterinarians to help strengthen animal quarantine in Irian Jaya, and classical swine fever was one of the diseases covered (CSIRO International 1999).

11.3 Viral diseases

Nunn (1985) noted that few pig viruses have been demonstrated in PNG, apart from pig pox and porcine parvovirus. Nonsuppurative encephalomyelitis is occasionally diagnosed, and influenza and parainfluenza are likely to be present.

11.3.1 Swine pox

Swine pox was not listed for PNG in 1964 by Egerton and Rothwell (1964). Copland (1974a) described the first confirmed outbreak of swine pox in New Guinea, in young pigs in a piggery. Berkshire, tamworth and native cross pigs were affected but the native cross pigs had fewer lesions than the other breeds. It is not known how the disease entered the piggery as no pigs had been introduced in the previous 12 months. A piggery worker could have acted as a mechanical agent, carrying the virus from infected pigs in the village, but swine pox was not located in nearby villages. Imported pig feed and stable flies were also considered. From the distribution of lesions, Copland suggested that the stable fly was the most likely mechanical vector.

Although Davis (1973b), cited in Densley with Purdy et al. (no date:49), described swine pox as an important disease, Nunn (1985) did not consider it a significant cause of production loss in PNG.

11.3.2 Rabies

The island of New Guinea is currently free of rabies, although rabies is endemic to animal populations in much of Indonesia (Akoso 1985; Ningiga and Nunn 1985:573).

11.3.3 Rotavirus

Alpers et al. (1991) studied 29 pigs (aged 9 days to 3 months) from three villages in the Eastern Highlands Province. Group A rotavirus was found in the faeces of 16 pigs with infected individuals coming from all villages. Nongroup A rotavirus resembling group C was found in faeces from pigs from two villages. All of the group A rotaviruses examined had the same electrophoretype and this was distinct from that of the common type infecting humans in the area at the time of the study. None of the group A positive samples reacted with monoclonal antisera specific for human group A rotaviruses of serotypes 1, 2, 3, 4 or 8. The nongroup A rotaviruses also all had identical electrophoretotypes. Rotavirus infection did not occur in all young pigs and was not limited to young animals under two months of age. Infected pigs varied in age from 12 days to 20 weeks. This pattern of infection was attributed to the nonintensive husbandry methods in the villages, with less opportunity for transmission to occur than in intensive piggeries.

11.4 Parasitic diseases

Village pigs in New Guinea are often heavily infested with internal parasites, the most important being *Metastrongylus* spp., *Stephanurus dentatus*, *Macrocanthorhynchus hirudinaceus*, *Ascaris lumbricoides* and *Oesophagostomum* spp. (Egerton and Rothwell 1964:11–12). *Gnathostoma hispidum* is common in some areas. Further parasites of pigs were listed by Talbot (1969:89) including:

- Protozoa:
 - *Balantidium coli*
- Nematoda:
 - *Globocephalus longemucronatus*
 - *Gnathostoma doloresi*
 - *Strongyloides ransomi*
- Acarina:

- *Amblyomma cyprium cyprium*
- *Demodex* spp.
- *Haemaphysalis papuana papuana*.

Talbot (1972b) described the incidence and distribution of helminth and arthropod parasites of indigenous owned pigs. Internal parasites in pigs cause serious economic loss (Norris and Anderson 1972; Watt et al. 1975).

In Irian Jaya, surveys between 1957 and 1960 in the area of the Paniai Lakes (Couvée and Rijpstra 1961) suggested that the prevalence of *Balantidium coli* amongst different groups and their pigs increased with altitude and the relative density of pigs: the incidence at Paniai at over 1750 m was greater than at Mapi below 1500 m.

11.4.1 Kidney worm

Davis (1973b), cited in Densley with Purdy et al. (no date:49), described Kidney worm (*Stephanurus dentatus*) and gastrointestinal parasites such as *Gnathostoma hispidum* and *Hyostromylus rubidus* as prevalent in young animals in the Eastern Highlands Province. Adult pigs were said to be generally free of problems from internal parasites.

Rose (1981b) described the total counts of gastrointestinal worms in six village pigs (in the stomach, and in the small and large intestines) at slaughter after a foraging trial in the Southern Highlands Province, during which they were regularly drenched. He also gave the average nematode egg counts in faecal samples over the whole trial period. The large thorny-headed worm *Macroacanthorhynchus* was present in all pigs, and was the only species found as adult worms in the small intestine. He noted that piglet mortalities had been reported in the Tari area where this species had completely blocked the small intestine. The drench was apparently effective against lung worms.

11.4.2 *Metastrongylus* spp. and capillaria infections

Copland (1974b) described infections of village pigs by the lung worm, and infections with capillaria worms (Copland 1975).

11.4.3 Porcine spirurids (*Spiruroidae ascaropidae*)

Porcine spirurids are roundworms that are parasitic in the intestines of pigs and are commonly present in PNG. Before 1973, the known spirurid parasites of pigs in New Guinea were *Ascarops dentata*, *A. strongylina*, *Physocephalus sexalatus*, *Gnathostoma doloresi* and *Simondsia paradoxa*. Dung beetles were collected from under the dung of village pigs at Mount Hagen and Madang (Watkins et al. 1973). The dung beetles were the first demonstrated beetle host for porcine spirurids (*Ascaropidae* nematodes, *Physocephalus* sp. and *Ascarops* sp.) in PNG. Beetles from Madang showed a higher infection rate than those from the highlands.

11.4.4 *Trichinella papuae*

Trichinella is a nematode or roundworm that can be found in pigs. Until recently, trichinella had not been reported in PNG (or Irian Jaya) although border surveys during the 1990s had been looking for it (Puana and Owen 1994:7). Owen et al. (2000) described the discovery (in 1988) in a domestic pig, at the Balamuk Station in Western Province, of the first case of trichinellosis (caused by a new taxon within the genus *Trichinella* (Pozio et al. 1999)) in PNG. They found that about 9% of the local wild pig population in the focal area were also infected. However, neither local feral animals, nor domestic pigs

from elsewhere in the country (as evidenced by analysis of muscle tissue samples from 359 pigs between 1988 and 1998 from 15 provinces) were infected. They concluded that trichinellosis is confined to one remote locality in PNG, and they assumed that domestic pigs in the initial case may have become infected by eating infected wild pig meat. (For further details, see also Murrell et al. 2000; Pozio 2000; Pozio et al. 2001; Pozio 2001a; Pozio 2001b). The source of the new species *Trichinella papuae* found in the Bensbach area is not known, but may be Southeast Asia. A serosurvey of people and dogs living in six villages in the Balamuk area in 1999 found that 29% of the people showed anti-*Trichinella* antibodies, whereas all dog samples were negative (Owen et al. 2001). A further survey of the same area in April 2001 found 21% positive, whereas all samples from a survey in Port Moresby in 2000 were negative (Pozio et al. 2001). Some implications for human health are discussed further in Chapter 12, Section 12.3.2. In 2002, ACIAR began to support work by Murdoch University in collaboration with the PNG NAQS and the Secretariat of the Pacific Community on the surveillance of trichinella (ACIAR 2002b).

Strathern's (1989a:145) charge that pigs rooting on an urban rubbish dump at Mount Hagen in Western Highlands Province were eating infected food which resulted in them getting '... *Trichinella* worm in their flesh which is then passed on to humans and causes sickness', was undocumented and presumably incorrect.

11.4.5 *Trypanosoma evansi*

The *Trypanosoma evansi* parasite causes a disease called surra that is widespread in Southeast Asia. It affects a wide range of domestic and wild animals and is spread by March or other biting flies or by eating infected tissue. During World War II, the Japanese diagnosed four cases of surra in horses (believed to be imported) on Bougainville and promptly slaughtered them (Egerton and Rothwell 1964:10–11). No further evidence of the disease was detected.

In 1997–98, three surveys were undertaken by Reid and Copeman (Reid and Copeman 2000; Reid et al. 1999) to determine whether animals in PNG near the border with Irian Jaya were infected. Although a total of 545 animals were sampled, with 39 cattle, 2 pigs and 3 wallabies testing positive with one test, *T. evansi* was not isolated from any of these animals. There was strong evidence that *T. evansi* was not present in New Guinea or was only recently introduced, and that it is not endemic in the southwestern border area. Subsequent work has showed that two species of wallaby present in the area (the agile wallaby and the dusky pademelon) are highly susceptible to infection by *T. evansi*, and therefore have the potential to spread the disease should it be introduced (Reid et al. 2001). Surveillance measures are discussed further by Reid (2000; 2002). Work on improving surveillance for surra in PNG and Irian Jaya was supported by ACIAR in 2001 (ACIAR 2001).

11.4.6 Screw-worm fly

Screw-worm fly infestations have been found in pigs, besides many other animals, in PNG (Egerton and Rothwell 1964:12). See also Anderson (1960a) and Norris and Anderson (1972).

11.4.7 Porcine coccidia

According to Varghese (1977:345), coccidia, an intracellular parasite, 'renders the host susceptible to secondary infections by bacteria, flatworms, nematodes etc., reducing its resistance; and producing a state of continual poor health'. Varghese (1986:17) tested 232 domestic pigs raised on concrete, 98 free ranging village pigs and 5 wild boars, in the Port Moresby area for the prevalence of coccidian oocysts, and confirmed that coccidia

are common parasites of pigs in PNG. There was very little variation of infection between the corresponding age groups of village pigs and commercial pigs. This was unexpected, given that the intensively managed pigs were raised under a regime using sanitary controls and hygiene practices. Varghese considered that the 'absence of confinement, and the free-ranging and ad libitum foraging habits of these pigs in an area of about 3–4 km of open bush boosted their resistance to coccidiasis and/or minimized the rate of re-infection. No other viable explanation to this rather intriguing finding can be offered until further detailed comparative studies are completed'.

11.4.8 Ticks

Wassef and Hoogstraal (1988) reported on ticks, *Dermacentor (Indocentor) steini*, collected from mainly wild pigs in the Malay Peninsula, Thailand, Indonesia, Borneo, the Philippines and Irian Jaya. In Irian Jaya, ticks were recovered from four wild pigs, one domestic pig and one human. The authors recommended that the role of *D. (I) steini* in the transmission of infectious agents needs to be examined, because it also feeds on humans and is known to harbour agents that infect humans and other wildlife.

Pig carers frequently delouse their domestic pigs, as reported for the Maring of the Western Highlands Province (Lowman 1980:81), and the Saniyo-Hiyowe of East Sepik Province (Townsend 1969:50), and photographed by Lütkes (1999:362) at Tararan village (Wampar cultural area) in Morobe Province.

11.5 Poisoning, injury and predation

11.5.1 Sweet potato poisoning

An interesting case of pigs dying from sweet potato poisoning has been reported from Lae (Low et al. 1993). Five pigs were allowed access to a 2-hectare sweet potato garden at the University of Technology. The first sow died within four hours of entering the garden and two others died within 15 hours. Samples of sweet potato tubers taken from the garden had the same smell as the stomach contents from the dead pigs, and found to be contaminated with *Fusarium solani*, a fungus found on plants and soils that can produce trichothecene toxins (Department of Environmental Health and Safety 2001). These toxins may be associated with disease in humans and animals.

11.5.2 Rodent injury

Pigs in the Dugum Dani area of the Irian Jaya highlands during the early 1960s were said to suffer attacks by rodents in their stalls at night that left minor skin wounds (Heider 1970:50, 56).

11.5.3 Snake bite and attack

Snake bite as a cause of pig mortality is reported from the southern fringe areas of the Eastern Highlands Province (Boyd 1984; Hayano 1990:99), and the Goilala area in the Papuan highlands (Hallpike 1977:74). In the Sepik lowlands, Townsend (1969:51) reported a piglet eaten by a python (which, in its turn, was eaten, plus piglet, by people). In the highland Kaironk Valley (Madang Province), Kalam people report that a large snake (probably *Python amethystinus*) preys on pigs, and that a venomous snake (perhaps the death adder, *Acanthophis antarcticus*) may kill pigs (Bulmer et al. 1975:286–8). Interestingly, there are only a few instances on record of pigs eating snakes (Dornstreich 1973:245; Harrison 1976:35; Baldwin 1982:38; Akimichi 1998:173), but it is presumably common during free foraging.

11.5.4 Other predators: dogs, eagles, quolls and crocodiles

Domestic pigs, especially piglets, are reported as vulnerable to the (uncontrolled) attacks of hunting dogs (Bulmer 1967:19; Brumbaugh 1980:67; Baldwin 1982:36; van Beek 1987:25; Kocher Schmid 1992:196; Obrist van Eeuwijk 1992:111), and (presumably rarely) to attacks by eagles (Franklin et al. 1978:227; Brumbaugh 1980:221–4). Majnep and Bulmer (no date) also report that in the Kaironk area (Madang Province) the spotted quoll (*Dasyurus albopunctatus*) can kill young pigs. In some lowland areas, crocodiles must be a threat to pigs (Cheesman 1960:39–40; Hughes 1970:273), though the only attack I have found in the literature is one in 1972 on Teop Island on the northeastern Bougainville coast (Shoffner 1976:167).

11.6 Ethnoveterinary knowledge

Statements by veterinarians such as Purdy (1971:482) to the effect that there is little evidence of customary knowledge of the concept of infectious disease, undoubtedly have some validity, though there are significant exceptions (Egerton 1965a:143; Lewis 1975:81–2). In the case of the Kuma of the Western Highlands Province, for instance, Reay (1959:13) reported that infection was recognised in relation to anthrax, and pigs were dispersed in response to an outbreak. The Wola of the Southern Highlands Province also believe that most pig illness is contagious, and thus they kill animals to prevent illness spreading (Sillitoe 1979:269).

Recognition needs to be given to the existence of an extensive body of ethnoveterinary knowledge. In general, this has not been widely documented, but examples include Meggitt (1958a:292–3), Glasse (1963:33–34), Sterly (1978/79; 1997: Vol III, pp. 91–92), Powell (1982:119), Kocher Schmid (1991:226, 296–8), Cook (1995:289–290), Petir et al. (no date), Pawley and Bulmer (no date: 160, 171, 201, 277, 289), and Sillitoe (2003:277–281). Frankel (1986:81) has commented on the extensive anatomical knowledge of pigs displayed by the Huli people at Tari in the Southern Highlands Province. Everywhere that pigs are kept, castration of male animals is practised. Reported only from the Dugum Dani of Irian Jaya, is a minor operation performed on female pigs involving (precise details are not given) the cutting of a tube in their stomachs that is said to assist growth (Heider 1970:51; 1979:37).

12 The part played by pigs in human disease

Both the number of pigs and the intimacy of the relationships between domestic animals and their human keepers mean that a number of diseases affecting the human population can be related to pigs as hosts and carriers. Some diseases, such as pigbel (enteritis necroticans), have an established history in parts of New Guinea¹², others have only recently been reported on the island. As well as direct links between the animals and disease, the role of pigs as the major domestic or household animal means that they are also of significance to a range of health projects (Lynch 1967).

12.1 Bacterial diseases

12.1.1 Pigbel (enteritis necroticans)

Pigbel or enteritis necroticans is caused by the bacterium *Clostridium perfringens* (Davis 1984a). Pigbel was a very significant disease, especially in the central highlands of PNG up to the 1980s (but not exclusively, see Radford and Bassett (1968) and Lewis (1975:92)). The disease is related to the nature of customary diets and the sporadic consumption of pork (particularly at large ceremonies or pig feasts), other meat or even high-protein vegetables (Murrell 1966). In the period 1963–67, for instance, it was reported as responsible for 47% of the hospital deaths of children at Mambisanda Hospital in Enga Province (Waddell 1972b:195), and even in the mid-to-late 1970s was the commonest cause of death in children over 12 months of age at Goroka Hospital (Shann and Lawrence 1979). In the 1970s, at Wabag Hospital in Enga Province, it was the commonest surgical condition requiring laparotomy (37.5%), and 64% of patients with this diagnosis were adult (Lennox and Kia 1982). As early as 1966, it was predicted that the disease would disappear as modernisation lowered the status of pigs and changed the conditions under which pork was consumed (Editorial 1966:38).

Since 1980, the immunization of babies and children has reduced the number of pigbel cases to a fifth of the previous level, and the disease has diminished in significance. Lawrence (1992) provides a concise up-to-date summary. For the large literature before 1977, see Hornabrook and Skeldon (1977). For the period between 1976 and the mid-1980s, see Lawrence and Walker (1976); Lawrence (1978; 1979; 1983); Lawrence, Shann, Freestone and Walker (1979); Lawrence, Walker, Freestone and Shann (1979); Lawrence, Walker, Garap and Avusi (1979); Lawrence, Watt and Basten (1979) and Lawrence et al. (1984). For the veterinary background, see Walker et al. (1979), Walker et al. (1980) and Walker (1992).

By the late 1970s, Frankel (1986:16) records that the Huli people at Tari recognised pigbel as an illness, and had accepted the medical theory relating it to pork consumption.

12.1.2 *Serpulina pilosicoli*

Five villages in the Eastern Highlands Province were surveyed and *Serpulina pilosicoli* found in rectal swabs of 22.8% of individuals (Trott et al. 1997). The annual incidence of infection in the village was calculated at 93.6%, with an average duration of infection of 117 days. The organism was not isolated from any village pigs but its presence was confirmed in 17 of 50 commercial pigs sampled at a local piggery. There is a possibility

¹² See 'Definitions' section for explanation of names used in this report

of cross transmission between humans and animals. See also Mikosza (1998) and Moxley and Duhamel (1999).

12.1.3 *Salmonella choleraesuis*

Salmonella choleraesuis has been demonstrated as the cause of pneumonia in infants (Gratten et al. 1983; Gratten and Montgomery 1991).

12.1.4 Porcine brucellosis

Porcine brucellosis is present in Papua New Guinea (PNG), but is reported to have only a low prevalence amongst village pigs, with occasional outbreaks in commercial piggeries (Levett and Bala 1995:149). It is present in Java, where the high infection rate is considered a potential health danger for abattoir workers (van der Giessen and Priadi 1988). For humans, brucellosis is a serious public health concern. It can make people feel unwell for months, with symptoms including fever, headaches, joint pain and weight loss, and, if untreated, can be fatal.

12.2 Viral diseases

12.2.1 Japanese encephalitis

Japanese encephalitis (JE) virus in Southeast Asia is an important cause of viral encephalitis in people, with approximately 50,000 cases annually and about 15,000 deaths, mostly of children. JE is a vectorborne viral disease, transmissible from pigs to humans by mosquitoes. Significantly, the pig is an amplifying host (wading birds are also hosts) but does not usually become ill. In Indonesia, JE virus was isolated in mosquitoes on Java as early as 1974 (van Peenen et al. 1974; van Peenen et al. 1975). It had been found a few years earlier on Sarawak (Simpson et al. 1974). Subsequent surveys described antibodies to JE as prevalent in human and pig populations (though seropositivity declined from west to east in the Indonesian archipelago), and JE vector mosquitoes as abundant (Wuryadi and Suroso 1989). Although recognising that JE was not yet a public health problem in Indonesia, Wuryadi and Suroso (1989) warned that it was only a matter of time before it became so. It was not until 1999 that two possible human JE cases were found (Yoshida et al. 1999). Recent cases have been reported from the Timika area of Irian Jaya (Spicer 1997; Spicer et al. 1999; Rodhain 2001).

JE virus activity occurred for the first time in Australia in March–April 1995, with the diagnosis of three cases on Badu Island in the Torres Strait. A survey of the distribution of the virus was conducted using human and porcine serological tests, and the virus appeared to be widespread on the outer islands (Hanna et al. 1996). Hanna et al. ascribed the outbreak to a combination of environmental factors, with large numbers of domestic pigs kept in pens in close proximity to human dwellings and to standing water where *Culex annulirostris* was breeding. They suggested that the virus from PNG could have been brought from PNG by migratory birds or windblown mosquitoes. Residents in most Torres Strait islands were then vaccinated, and a sentinel pig surveillance program was established. In 1996–97, JE virus activity was restricted to the northern island of Saibai near PNG. In 1997–98, sentinel pigs in the Torres Strait began to seroconvert to JE virus just before the onset of JE infection in a young unvaccinated child on Badu Island (Hanna et al. 1999). Pigs on the mainland on Cape York then seroconverted. Hanna et al. concluded that cyclonic winds carried infected mosquitoes from PNG, but, although JE virus activity was more widespread in North Queensland in 1998 than in the previous three wet seasons, its transmission there was limited by ecological factors, such as less intensive pig husbandry and fewer mosquitoes.

It appeared that the 1995 and 1998 JE viruses had a common source. Following further work, Johansen et al. (2001; 2000) concluded that PNG (26 Western Province locations surveyed entomologically in 1997 and 1998) was the source of the JE incursion into Australia. They isolated JE virus from mosquitoes collected at Lake Murray in 1997, and from Abam (mainland opposite Daru) in 1998. There was no JE outbreak in 1999 in the Torres Straits Islands. However another occurrence in 2000 provided an important insight into the possible role of pigs in transmission to people.

Before 1998, between 180 and 220 domestic pigs were kept on Badu Island (population 800–1000 people), primarily in small backyard pens with less than 10 pigs each (van den Hurk et al. 2001). After the 1998 outbreak, all pigs were relocated to a communal piggery located some 3 km from the community. An unknown number of feral pigs remained but were not generally close to people. In early 2000, the communal piggery housed some 66 domestic pigs. In early January 2000, there was an outbreak of JE, with initially three, and by mid-January all sentinel pigs on Badu, seroconverting to JE virus. Some domestic pigs on Moa Island also seroconverted; however, no human cases of JE occurred during 2000. In previous years all JE virus isolates from Badu came from one particular mosquito species (*C. annulirostris*), but in 2000, no virus was isolated from this species. Instead, a new genotype of JE virus was found for the first time in Australia (Pyke et al. 2001), and this was isolated from a different mosquito *C. gelidus*, which in Southeast Asia is an important JE vector. While winds had been linked to the 1995 and 1998 occurrences, in 2000 it appears that on only 2% of days had winds been suitable for mosquito transport to Badu before the transmission of the virus. Thus, bird transport may have been significant in this case. However, further work on windborne insects in 2000 did not provide conclusive evidence that windblown mosquitoes introduced JE from New Guinea to Australia (Johansen et al. 2003). A study of the genetics of mosquitoes has shown that *C. annulirostris* is represented by a mixed population in the Western Province, Torres Strait and Cape York region, indicating frequent widespread dispersal of this species (Chapman et al. 2003).

It appears that the relocation of the Badu pigs from household pens to the communal piggery resulted in a significant decrease in the proportion of *C. annulirostris* mosquitoes feeding on pigs within the community (van den Hurk et al. 2001). Comparison of the source of blood meals from *C. annulirostris* mosquitoes collected within the community in 1995–7 and in 2000, showed that pigs declined as the source from 31% to 2% (associated with large increases in humans and dogs as sources). In contrast, of the mosquitoes collected within 2 km of the piggery in 2000, 96% had pig blood meals and very few had fed from other mammals. This implies that the risk of people being bitten by mosquitoes that had previously fed on pigs infected with the virus is likely to have declined. Mosquitoes engorged on pig blood meals from the piggery did not seem to be flying as far as the community. Van den Hurk et al. (2001) note that similar changing patterns of JE virus transmission have been reported from both Japan and Taiwan following the relocation of pigs away from human settlements to specialised farms.

JE is now believed to have originated from an ancestral virus in the Indonesia–Malaysia region of Southeast Asia (Solomon et al. 2003). It is not known how long JE has been in PNG and Irian Jaya, nor how widely it is distributed. According to Johansen et al. (2000) serologic evidence suggests it has occurred in some parts of Western Province in PNG since at least 1989. Human infection is reported from the Upper Fly, and there has been also a suspected outbreak in Milne Bay Province. Antibodies to JE virus have been reported from pigs in West Sepik Province. The disease is emerging as a significant threat to human health in PNG, but at present the incidence is unknown and is probably underestimated due to the lack of diagnostic services and surveillance (Department of Health 2000:32). Spicer et al. (1999) report that 5 sera, positive for JE, were collected from indigenous residents of the Timika region of Irian Jaya who had not travelled elsewhere, and were thus presumed to have been infected locally. The Badu results described above suggest that where JE is a significant risk in PNG, consideration may need to be given to altering pig husbandry patterns.

12.2.2 Zoonotic paramyxoviruses (Menangle, Hendra and Nipah)

Recent years have seen the appearance in the wider region of three zoonotic paramyxoviruses causing diseases in humans (Hoffmann 1999). The Menangle virus is closely related to Hendra virus (previously called equine morbillivirus) affecting horses and humans (Halpin et al. 1999). Flying foxes form the reservoir host for these viruses, and six species of flying foxes in PNG have tested positive to Hendra virus. In 1997 the Menangle virus led to an outbreak of zoonotic disease in pigs and humans in New South Wales (Halpin et al. 1999). An outbreak of the Nipah virus, another bat virus for which the pig is the amplifying host, occurred in Malaysia and Singapore in 1997–1999; all the human deaths were in adults who had worked with pigs in intensive pig farms, and many patients reported illness in their pigs in the preceding weeks (Chua et al. 1999; Farrar 1999; Paton et al. 1999; Saharee et al. 1999).

12.2.3 Rabies

PNG is rabies free. Akoso (1985) reported that rabies was endemic in most of Indonesia in 1984, but that the eastern islands of Bali, East Nusatenggara, East Timor and Irian Jaya were free of the disease. Between 1979 and June 1983 there were five cases of pig rabies reported in Indonesia. There are still no cases of rabies reported from Irian Jaya, though monkeys (kept as pets, and with a feral flock reported to be outside Jayapura) and dogs are considered likely carriers (Levett and Bala 1995:149).

12.2.4 Diarrhoea and rotaviruses

The close association between pigs and people in both rural and periurban environments is a risk factor for diarrhoea in humans (Jenkins and Howard 1992; Wyrsh et al. 1998; Moxley and Duhamel 1999). Sleeping with pigs is particularly associated with diarrhoea (Jenkins and Howard 1992). In an urban settlement in Port Moresby, the presence of pigs in compounds was associated with diarrhoea in children below five years of age (Bukonya and Nwokolo 1991). A recent survey in the highlands found rotavirus in faecal samples in children with severe diarrhoea. A rotavirus strain infecting piglets was also demonstrated (Pratt et al. 1992). Subsequent detailed work on pigs in Eastern Highlands Province villages found that all of the group A rotaviruses examined in pig faecal samples were distinct from the common type infecting humans in the area at the time of the study (Alpers et al. 1991).

12.3 Parasites

A number of different parasites infect pigs. Probably the most important for humans are the tapeworm (*Taenia solium*), trichinella, hydatid disease, malaria and ticks, all of which are described below.

Foraging pigs commonly eat human faeces in New Guinea. Jones (1976) showed that if these faeces contain the eggs of *Ascaris* or hookworm the former are unharmed while the latter are mostly destroyed. He suggested that pigs may play a significant role in spreading ascariasis amongst people while reducing exposure to hookworm.

Other work on parasites and possible inter-relations between humans and pigs in New Guinea includes Barnish and Ashford (1989), Clements (1936), Couvée and Rijpstra (1961), Desowitz and Barnish (1986), Ewers and Jeffery (1971), Ewers (1972; 1973), Jones (1976), Kelly (1975), Radford (1973), and Viney and Ashford (1990).

12.3.1 *Taenia solium* (tapeworm) cysticercosis

The major intermediate host of the human tapeworm *T. solium* is the pig, but humans can also act as intermediate hosts. Infection occurs from eating contaminated feed or, in the case of pigs, directly eating human faeces. When infected, cysticerci may develop in brain tissue, eyes and other organs resulting in severe and fatal disease (Banks 1988). Sciutto et al. (2000) see infection with *T. solium* emerging as a major health problem of global dimensions in developing countries, and Román et al. (2000) have recently called for neurocysticercosis to be declared an international reportable disease. Its significance in parts of Asia has been emphasised by Rajshekhar et al. (2003). Recent work suggests that the occurrence of taenia tapeworms in humans in Africa took place earlier than the development of agriculture and animal husbandry including pig domestication (Hoberg et al. 2001). Nakao et al. (2002) report that the type of taenia found in Irian Jaya is similar to the Asian type which differs from that found elsewhere in the world. Earlier work on taenia further west in Indonesia is reported by Fan et al. (1992; 1989).

New Guinea was believed to be free of *T. solium* until 1966 (Fritzsche et al. 1990). In western Irian Jaya, however, it was recognised in the early 1970s that the larval stage of the tapeworm was causing neurocysticercosis in the Paniai (Wissel) Lakes area occupied by the Ekari (Ekagi) or Me (also known earlier as the Kapauku) people (Tumada and Margono 1973; Gunawan et al. 1976; Desowitz et al. 1977; Gajdusek 1977; Gajdusek 1978; Subianto et al. 1978; Tjahjadi et al. 1978a; Tjahjadi et al. 1978b; Diwan et al. 1982). The disease is believed to have been introduced in about 1971 by the importation of infected pigs from Bali and its spread was initially confined to the Paniai area in Irian Jaya (Coker-Vann et al. 1981; Hyndman 1987). In the 1980s, a survey amongst the Ekari people found 19% infected (Muller et al. 1987; Banks 1988). By 1982, it had spread widely within Irian Jaya, but had not been recorded in PNG (Anon 1980:80, 84; Aditjondro 1982). Improved husbandry methods such as permanent pig enclosures, and the use of pit latrines by people, were recommended as counteractive measures in Irian Jaya (Tucker 1986–87:228). During the 1980s, methods for the serodiagnosis of human cysticercus infection improved (Diwan et al. 1982; Coker-Vann et al. 1984). By 1991, taeniasis was described as endemic on Bali, Sumatra and in Irian Jaya (Depary and Kosman 1991). In 1997 it was described as pandemic in Irian Jaya (Simanjuntak et al. 1997:321).

In 1993, Handali et al. (1997) conducted a community survey in three subdistricts in the Baliem Valley (Jayawijaya district) of the highlands of Irian Jaya and reported cysticercosis amongst the Dani people, with a high incidence of epileptic seizures and subcutaneous cysts. Seizures and cysts occurred 2.5 and 4.6 times more frequently, respectively, in men than in women, and it was suggested this was related to gender differences in handling and eating pork at ceremonies. Examination of records from Assologaima subdistrict (located just to the north of Wamena in the Baliem in Jayawijaya district) for the period 1991–95 showed the numbers of epileptic seizures rising from 4 in 1991 to 145 in 1995 (with 13 fatal overall), and the cases of burns fluctuating between 120 and 217 between 1991–1994 and then jumping to 452 in 1995 (Wandra et al. 2000). Histopathology confirmed that cysts resected from 14 men and one pig were cysticerci of *T. solium*. Deoxyribonucleic acid (DNA) analysis showed no difference in the cysts between people and pigs (Wandra et al. 2000). It was suggested that most cases of burns or epileptic seizures at Assologaima were caused by *T. solium* cysticercosis (Margono, Subahar et al. 2001; see also Hamid et al. 1999). By 1997, 54 persons tested seropositive to *T. solium* in the Manokwari area to the west of the highlands region (Wandra et al. 2003:885).

In 1999–2000, Subahar, Hamid et al. (2001) and Subahar, Putra et al. (2001) serosurveyed 18 villages in Jayawijaya district collecting 160 human serum samples and 71 pig samples from five villages. Overall, there were 51% positive results for the human survey, ranging from 43% to 67% between villages, results suggesting that human cysticercosis and taeniasis remain highly endemic in this area. Of the pigs, 70% were seropositive, and in only one of the five villages (but one in which only one pig was surveyed) were no positive results found. Dogs may be an alternative intermediate host in

this region. Recent analysis of dog sera from Jaywijaya showed that 7 of 64 dogs were highly positive, and DNA analysis of cysticerci of *T. solium* found in the brains and hearts of two dogs confirmed that they were the same as *T. solium* previously confirmed from both people and pigs in the area (Ito, Putra et al. 2002). A recent preliminary survey of a community in the neighbourhood of Wamena in the Baliem Valley found that 8.6% of the population carried *T. solium* (Margono et al. 2003).

In the case of PNG, the possible spread of the parasite has been seen as a potential problem for some time (Anon 1980:80, 84; Wernery 1986; Banks 1988; Barnish and Ashford 1989). This is due both to the traditional movements of peoples and pigs in the border area, and to the flow of refugees — an estimated 10,000 refugees left Irian Jaya for PNG in 1984 (Fritzsche et al. 1990; McManus 1995). The first and only reported case, in 1984, of a probable PNG resident patient suffering from cysticercosis was an Irian Jayan refugee who had immigrated in 1980 (Fritzsche et al. 1990) (though see below for asymptomatic cases). A close watch is reportedly kept in the border area, though the practical constraints are great. McManus (1995) called for a rigorous survey to determine the current status amongst humans and pigs in the region. Surveys in 1997 of both Irian Jayan refugees resident in Western Province and PNG villagers in the border region found 16 (3%) of 541 persons tested seropositive for *T. solium*, but none had any signs or symptoms of clinical cysticercosis (Wandra et al. 2003:885; Flew 1999:57).

Throughout the 1990s, border surveys were carried out jointly by the PNG Agricultural Protection Division and Australia's Quarantine and Inspection Service (AQIS) through the Northern Australia Quarantine Strategic (NAQS) program (Puana and Owen 1994; Kola et al. 2001). In November 1999, a serosurvey for antibodies to taenia (and trichinella, see below) of 97 people living in six villages in the Bensbach (Balamuk) area of Western Province found that all samples were negative (Owen et al. 2001). The authors suggested that factors preventing (or hindering) the spread of cysticercosis from the Irian Jaya highlands to the southern lowlands of Western Province would include the low population density, and the small numbers of domestic pigs, that are normally kept penned and thus are unlikely to have access to human faeces, in the Bensbach area (Williams 1937:18–19). Samples from further survey work at Bensbach in 2001 and in Port Moresby in 2000 have also been negative for taenia (Pozio et al. 2001), confirming that *Taenia solium* continues to be restricted to the western half of New Guinea.

12.3.2 Trichinella

Trichinella is a nematode or roundworm that can be found in pigs (see Chapter 11, Section 11.4.4). The young worms or larvae that live in pig meat can infect humans after eating if cooking is insufficient, resulting in human trichinellosis. Infection can result in muscle pain, headache, eye pain and difficulties breathing and chewing (Puana and Owen 1994:7). See also Alicata (1970), and Takahashi et al. (2000). The first cases of trichinellosis (caused by a new species *Trichinella papuae*) in both domestic and wild pigs in New Guinea were reported in 1999 from the Balamuk area near Morehead in the Western Province (Pozio et al. 1999), although the first case of an infected pig died of unknown causes in 1988. A subsequent survey found that about 9% of the wild pig population in the focal area adjacent to Irian Jaya was infected, but no infection was found in feral pigs from other parts of Western Province, nor in 359 sampled domestic pigs from 15 other provinces (Owen et al. 2000).

In November 1999, a serosurvey of 97 people and 13 dogs living in six villages in the Balamuk area found that 29% of the people showed antitrichinella antibodies, while all dog samples were negative (Owen et al. 2001). No clinical signs or symptoms related to trichinella infection were observed for those showing positive serology. There was a higher rate of infection among men (68%) than women (32%), which the authors related to hunting practices associated with wild pig captures, with male hunters consuming often hastily cooked meat before returning to their villages. It was suggested that the puzzling lack of positives among the dogs tested might be due to them not being used for hunting and thus not having access to wild pig carcasses. Subsequent surveys of 89 people in Port

Moresby in 2000, and 115 persons in the Bensbach area in 2001, found 21% positive for trichinella at Bensbach, but none in Port Moresby (Pozio et al. 2001).

12.3.3 Hydatid disease

Hydatid disease is a potentially serious threat to human health in countries where people, sheep and dogs live in close association. It is uncertain whether pigs, along with humans and wallabies, are potential intermediate hosts. At present there is no evidence of the disease cycling in PNG, and only sterile cysts have been found in cattle in the Markham Valley (Alto and Nettleton 1989).

12.3.4 Malaria

The degree to which mosquitoes of the *Anopheles punctulatus* complex bite humans in different New Guinea villages has a significant effect on sporozoite rates. As early as 1927, it was considered that the presence of domestic animals such as pigs, goats and cattle near villages deflected mosquitoes from human hosts, and in a report on health in the Western Islands of Manus Province Cilento (1928:41, 43, 48–9) supported their role in malaria prophylaxis. In the 1950s, observation of variation in the blood preferences of mosquitoes in the Trobriands and on Fergusson Island in Milne Bay Province led Spencer (1964:22) to suggest that ‘It seems likely, therefore, that where pigs are numerous, and live closely associated with their owners, the pig blood ratio may rise at the expense of the human blood ratio’. Thirty years later, Cattani (1992:305) wrote that ‘While all species bite humans, they prefer other mammals such as dogs and pigs, and the local availability of alternative host species has a profound impact on the man-biting rate’. Considerable work on the extent to which pigs and other domestic animals are bitten in New Guinea has been reported: see, for instance, Black (1955), Spencer (1964), Burkot et al. (1989), Burkot et al. (1990), Burkot et al. (1988), Foley et al. (1991), Hii et al. (2001) and Hii et al. (1995).

Following a major malaria epidemic in the Mount Hagen area in 1955, it was suggested that deep ditches dug around gardens to protect them from pigs were probably significant breeding places for anopheline mosquitoes in the rainy season (Spencer et al. 1956:111).

12.3.5 Ticks

Dermacentor steini has been recorded from forests in the Malay Peninsula, Thailand, Borneo, Indonesia, the Philippines and Irian Jaya. The major hosts of *Dermacentor steini* are wild pigs but collections have also been made from man, goats, dogs and rodents, and also from forest vegetation (Wassef and Hoogstraal 1988).

In the PNG highlands, the commonest tick on village pigs is *Amblyomma cyprium cyprium*, but it is not known to be a problem (I Owen, National Agriculture Quarantine and Inspection Authority, pers comm, June 2001). Owen notes that other common ectoparasites are the louse *Haematopinus suis*, and the mites *Sarcoptes* and *Demodex*, with the mites producing mange that can be problematic at times.

12.4 General

12.4.1 Water pollution from (mainly pig) faeces

Village water supplies in New Guinea consist almost entirely of local streams and springs. Lane (1967) surveyed water sources in lowland East and West Sepik provinces and found that customary water supplies were considerably more polluted than modern

wells. Though the sources of the faecal pollution were not identified, pigs would have been involved (Morahan 1968). Studies in Enga Province (Feachem 1973b; Feachem 1974a; Feachem 1975; Feachem et al. 1977; Feachem 1977) and Eastern Highlands Province (Bargh and Baru 1982) in the early 1970s and 1980s respectively, showed that water used by villagers for drinking and domestic use was badly polluted due to faecal (primarily pig) coliform content and faecal streptococci. Studies on the Purari River are reported by Petr (1980; 1983). In the Hagen area of the Western Highlands Province, attempts to keep pigs out of water supply areas (presumably in the 1970s-80s) were unsuccessful (Strathern 1989a:145). In the lowland Dreikikir area of East Sepik Province, waterholes were often unprotected from both domesticated and wild pigs (Allen 1989:38).

At the 1984 Workshop on Village Water Supplies, it was noted in discussion that the prevalence of children with pig amoeba in PNG was higher than reported anywhere else in the world (Smith and Alpers 1985:15). Lupiwa (1985:35) reported that the majority of village water supply sources tested in the Eastern Highlands Province had unsatisfactory levels of coliform bacteria. In the Asaro Valley and Waisa area, he saw pigs drinking from human water sources on two occasions. In contrast to these generally negative views, Jenkins (1985:61) pointed out that 'Efforts are made in many communities to prevent faecal contamination, especially from pigs'.

12.4.2 Injuries

Although Garner (1989), in a slightly tongue-in-cheek editorial in the *British Medical Journal* discussing a paper by Barss and Ennis (1988), stated that the topic of injuries caused by pigs in PNG was one that 'few authors have commented on', there is in fact considerable documentation.

With due care, domestic pig husbandry generally holds few risks of physical injury to humans. However, injuries do occur, and even fatalities — Cheesman (1949:102–3, 117) described an incident in which an irate tamed sow killed a woman on Waigeu Island in Irian Jaya in 1938. The Kubo of the Western Province in PNG consider the close presence of (adult) pigs to be inimical to the safety of human infants, on the grounds that their health would be compromised if their body wastes were eaten by pigs (Dwyer 1993:126). Gell (1975:17) described the few domestic pigs among the Umeda in West Sepik Province as frequently very dangerous, ill-natured pets. One of the reasons Enga people gave for castrating young male pigs was to avoid injury to, or the death of, young children (Meggitt 1958a:291). Bulmer (1960:92) commented on the risk of injury from large boars among the Kyaka Enga. In the early 1970s, injuries from attacks and bites to people among the Raiapu Enga by domestic pigs were fairly common, accounting for about 10% of trauma cases, or about one case per 1000 per week (Feachem 1973a:27). In a survey of 2099 potential working days by 27 persons in Sinasina (Simbu Province) in 1972–73, out of a total of 41 days lost directly to illness, four, or 3%, were due to a domestic pig goring an adult man (Hide 1981:630–1). There are also reports of the risks of pig husbandry from both the Southern (Wormsley 1978:44, 49) and the Eastern Highlands provinces (Robbins 1982:64–5). The ethnomedical literature contains at least two treatments (crushed *Psychotria* sp. leaves in Central Province, and leaves and bark of *Erythrina indica* on Tami in Morobe Province) for pig bites (Holdsworth and Farnworth 1974:158; Holdsworth 1977:52, 77).

By comparison with domesticated animals, many writers warn that wild or feral pigs in New Guinea can be extremely dangerous to people (Jenness and Ballantyne 1920:20; Blackwood 1935:318; Whiting 1941:114; Eyde 1966:61; van Baal 1966:408; Lindenbaum 1979:22; Dalton 1988:126–7; Goodale 1995:70; van Helden 1998:184). Bites and wounds by pigs (domestic/wild not distinguished) were a significant source of injury recorded in a national questionnaire survey concerned with dangerous fauna and flora in 1971–2 (Bell 1973:325, 331). Barss and Ennis (1988) reviewed all injuries caused by pigs that were referred from Milne Bay Province to the Provincial Hospital over a six year period. The 20 patients' injuries were deep, involved multiple critical structures and

were grossly contaminated. Most of the injuries occurred as a result of hunting feral pigs. Hunters using dogs and carrying only one spear were most at risk. Mikloucho-Maclay (1975:192) recorded a badly wounded Astrolabe Bay (Madang Province) hunter's account of his failure to despatch a fire-driven pig with his spear in 1872; Morren (1986:207) has described vividly the death of a young Miyanmin pig hunter in 1969, and Dwyer (1990:71) recorded major injuries to an Etoro hunter who blocked the path of an angry wild pig. For the Yafar of West Sepik Province, Juillerat (1996:171) recorded three deaths and several severe injuries over ten years. Amongst the Kasua of the Southern Highlands, Freund (1977:49) identified ten pig-related deaths in genealogies.

12.4.3 Use of pig bone in human surgery

Traditionally, Huli surgical experts in the Southern Highlands Province used to replace damaged areas in the human skull with parts of pig scapulae (Frankel 1986:91).

13 Impacts of pigs on environmental zones

With the domestic pig population in New Guinea¹³ estimated at over 2.2 million, and an unknown but large number of feral pigs, there is little doubt that pigs can significantly impact the different environments they occupy (Brookfield with Hart 1971:87). Although Fosberg (UNESCO 1960:168–9) considered that pigs had relatively little impact on pre-contact Pacific ecosystems, his main concern was smaller Pacific islands further to the east. While there is now a considerable literature from the wider Pacific region focused largely on the environmental impacts of feral pigs, with significant material in particular from Hawaii (Mueller-Dombois et al. 1981; Diong 1983; Stone and Loope 1987), and Australia (Hone 1987; Caley 1993; Caley 1994; Caley 1997; Choquenot 1998), there has been little research specifically directed to such questions in New Guinea. Nevertheless, there is a body of work that refers to, or gives some account of, pig impacts on a range of New Guinea vegetation zones. The following gives a brief overview of this literature.

13.1 Subalpine and Alpine

Despite the general understanding that wild pigs are rarely found over 1650 m in the highlands (Bulmer and Bulmer 1964:48), they are reported at very high altitudes over 3000 m (Flannery 1995:61). Wide-ranging domestic and or feral animals are also reported from high altitudes on Mount Wilhelm (Smith 1990), and on Mount Albert Edward (Hope 1975:5), where they root up large areas of vegetation affecting short grass bog and *Coprosma-Poa* tussock grassland most severely.

13.2 Montane Forest (over 1500 metres)

There are many reports of extensive pig (both domestic and feral) foraging and disturbance to the ground and shrub cover in montane forest areas, mainly but not exclusively in secondary growth (Howlett 1962:142–3; Healey 1973; Smith 1977:189; Simpson 1978:98–102; Gillison 1993). For further information, see also Aitchison (1960), Dwyer (1978a, 1978b) and Smith (1990). On Mount Wilhelm, according to Smith (1977:209–210), the foraging activity of domestic pigs

... results in considerable disturbance of soil and low vegetation, for example up to 2750 m above Keglsugl. The spread and increase of many adventive herbaceous plants is thereby favoured, and it is probable that regeneration of most forest trees is adversely affected. In addition, further forest damage is inflicted by man in order to construct the stout fences necessary to exclude roaming pigs from gardens ... Domestic pigs seldom stray above 2900 m except when led along paths from one area to another, when they may greatly affect local areas by rooting during halts on the journey, as at Kuraglumba and on Kombugli hill.

One consequence of such disturbance may be a reduction in the local diversity of small terrestrial rodents (Dwyer 1978b; May 1978). Where pig husbandry has been abandoned, as at Maimafu in the Eastern Highlands Province, visiting botanists are reported as commenting on the lack of disturbance in the forest understorey (West 2000:119).

¹³ See 'Definitions' section for explanation of names used in this report

13.3 Lower Montane Forest (less than 1500 metres)

Dwyer (1982b:175–6) noted that in areas of medium human density in the highlands (eg the Schraders in Madang Province, and Elimbari in Simbu Province), pigs commonly, in association with humans, have the effect of simplifying the remaining forests ‘both floristically and structurally’. In the case of Mount Elimbari, the effect on the forest understorey was particularly marked. Dwyer further considered it likely that pigs may have had a major impact upon terrestrial fauna in the highlands, ‘either directly through changes they have induced in vegetation, or indirectly through competition with other fauna for food’.

Plowman’s (1983) study of macrofauna in the litter of two montane forests in the Southern Highlands Province, one a mature forest above the gardening zone, the other a regenerating forest within the gardening zone, showed that both abundances and biomass of litter invertebrates were greater in the mature forest than in the regenerating forest. She suggested that the fauna of the litter is influenced by human activity particularly in relation to foraging by domestic pigs.

There is additional material in Dwyer (1984), Hyndman (1982), Kula et al. (1987), Morren (1979) and Thomas (1999).

13.4 Wetlands: swamps and lakes

Domestic pigs are reported from lake sides at over 2000 metres, for instance at Birip in Enga Province (Cromarty 1996). At Kayamanda Swamp at 2500 m in Enga Province, villagers live around the swamp, and their pigs ‘wander in as far as the water depth and the mud will allow’ (Walker 1972:481). According to Walker (1972:497–99), the distribution of vegetation types was most closely related to the ‘land:water relationship and to the degree of disturbance by pigs’. He saw the continuity and intensity of pig disturbance as the main determinants of the vegetation and microrelief of the swamp. The chief characteristics of pig disturbance were: ‘unselective destruction by rooting and trampling. They have a strong preference for areas where the greater part of the surface is slightly above and below (< 5 cm) water level. Coarse detritus mud is comminuted to a uniformly fine material which is readily transported by the streamlets formed in the drier parts and the general centripetal wash after rain elsewhere.’ Walker distinguished between preferential selection of plant species for food, and unselective destruction by rooting and trampling.

There is less information from wetlands at lower altitudes. Swamp wetlands are widely reported as favoured foraging grounds for domestic pigs, for instance near Tari (Southern Highlands Province) at c. 1600–1800 m (Wood 1984; Ballard 1995), and around Lake Kapiago at 1500 m (Robinson 1999; 2001). At even lower altitudes (< 700 m) in the Simbu and Southern Highlands provinces, domestic pigs are reported as managed in inland sago swamp areas (Hughes 1970).

According to Stronach (2000:91), feral pigs may play an important role in vegetation processes in the swamps and grassland, below 30 m altitude, in the Trans-Fly region of Western Province, where large numbers of pigs are found (Paijmans et al. 1971:16). Heavy pig-rooting in swamps and grassland away from human settlement results in less grass, and the formation of fire breaks and seed beds ‘for the regeneration of *Melaleuca* spp., promoting the spread of woodland and forest at the expense of grassland and open swamps’.

Given the widespread distribution of the aggressive weed, water hyacinth (*Eichhornia crassipes*), in waterways in both PNG (Osborne and Leach 1984) and Irian Jaya (Sukarwo 1991), its use as pig fodder (Pacific Island Ecosystems at Risk (PIER) 2000) may be worth exploring.

13.5 Mangroves

Although pigs are reported as foraging in mangrove areas, one early assessment considered that they inflicted insignificant damage to the vegetation (Gray 1960:352). Liem and Haines (1977:8–10) estimated that villagers in the Purari Delta were harvesting about one feral pig per year per 190 ha of mangrove forest in 1976.

13.6 Grasslands

On the basis of detailed study of the vegetation in the vicinity of Lake Ipea at 2200–2800 m in Enga Province, Walker (1966:524) concluded that it is ‘extremely likely that grassland is maintained more or less permanently under *Imperata* dominance where pig pressure is low and fire incidence high and under *Miscanthus* dominance where the relative importance of these factors is reversed’. In short, ‘pigs and fire maintain *Miscanthus* and *Imperata* dominance respectively in the grasslands’.

The impacts of pigs on grassland are discussed elsewhere by Bulmer and Allen (1987): see also Aitchison (1960), Dwyer (1978b), Henty (1982), Löffler (1977), Grossman (1984) and Healey (1990:24). In a detailed survey of *Rattus exulans* in grassland in the Eastern Highlands Province, Dwyer (1978a:246–7) concluded that gardening activities associated with the husbandry cycles of customary pig festivals affected population fluctuations of this rodent, and suggested that pigs may reduce this species’ impact on and around gardens and settlements. One possible consequence, he noted, was that any reduction in pig husbandry associated with modernisation might mean a relaxation of previous controls on the rodent population. Areas of recent conversion to the Seventh Day Adventist Church (see Chapter 4, Section 4.2.4) would offer a good opportunity to investigate this suggestion.

Havel (1960:311) and Robbins (1972:88) considered that pigs hindered the regrowth of trees, a point also made by Rappaport (1967) in relation to pigs rooting in recently abandoned gardens.

Foraging pigs may accelerate slope wash on grassland areas under *Miscanthus* since the pigs break down soil structure (Löffler 1977:9). In grasslands in the Eastern Highlands Province, Howlett (1962:171–172) described localised but severe over-grazing of fallow and uncultivated land in the Korofeigu area. People were keeping large numbers of pigs (more than three times the normal highland levels of approximately 1:1). In 1960, patches of ground were completely denuded of vegetation, despite attempts by agricultural staff to encourage the planting of such plants as pines and raspberries to control erosion. Soil disturbance from rooting by pigs may result in the formation of soil microrelief (Bleeker 1983:257).

Current understanding of the relative distribution of pigs in areas of adjoining forest and grassland is inadequate. In the Eastern Highlands Province in 1963, Watson (1983a:52–53, 88–9) reported considerably more domestic pigs in grassland areas than in those communities with forest access. Presumably his grassland category included some additional environmental factor (perhaps swamp?). Conversely, in the west of the Eastern Highlands Province, grasslands below 1680 m near the Tua River were said in 1969 to be rarely visited by pigs (and thus gardens located there could be left unfenced), in contrast to the mixed zone of secondary forest and fenced gardens above 1680 m where most pigs were husbanded and foraged freely (Bragginton 1975:40, 48, 67).

13.7 Gardens and other cultivated areas

In most ecological zones, cultivated cropland represents a major attraction to omnivorous pigs, whether domestic or wild, and hence is protected by a range of fencing and enclosure barriers. However, in many parts of the highlands of New Guinea, pigs are also

deliberately placed into gardens, at the end of a harvest sequence, to remove remaining sweet potato tubers and to assist in turning the soil before replanting (Westermann 1968:139; Paglau 1982:117; Wood and Humphreys 1982:106; Tucker 1986–87:101, 116, 136). The major environmental risk they pose, particularly where slopes are steep, is soil erosion due to their vigorous rooting activities (Kingston 1960:234–5; McIntosh 1960:123; Paglau 1982:117; Powell et al. 1982; Wood and Humphreys 1982:106; Humphreys 1984; Tucker 1986–87:229; Sillitoe 1993a:145, 1996).

In the Baliem Valley of Irian Jaya, where pigs are taken into old sweet potato gardens to dig for earthworms and the remaining tubers, Purwanto (1997:336–340, 524–5, 538, 542, 586) considered that the action of turning the soil benefits the soil texture. He noted (Purwanto 1997:399) that during the first few months after a garden is abandoned, there is tendency for the soil organic matter to decrease as the pigs dig for earthworms which concentrate the organic matter in the top humous layers. Conversely, however, their rooting slows the regrowth of vegetation by uprooting plants, and prevents or slows the growth of herbaceous cover during very short fallows between plantings. Similarly, they reduce the floristic diversity in second stage (5–8 years) secondary forest by digging out herb shoots in their rooting for worms (Purwanto 1997:524–5), as they also do in the transition zones between tracks and primary forest where their actions hinder the regrowth of pioneering species (Purwanto 1997:539–542). Much earlier, Brookfield with Hart (1971:113) had noted that in areas of intensive agriculture in the New Guinea highlands the nature of the fallow cover was controlled indirectly by the rooting, grazing and browsing of pigs, as well as by direct planting of preferred tree species.

In the Baliem Valley of Irian Jaya, Askin et al. (1990; also Askin 1996: 269) report that only young pigs on tether were admitted into terraced slope areas. Pigs were considered to be a major factor in soil erosion. They noted that the size and/or age of young *Casuarina* seedlings is crucial to their survival in areas entered by pigs. Seedlings over one metre tall were no longer vulnerable to pigs.

In flat swamp lands, uncontrolled pigs can inflict substantial damage to the elaborate system of ditching and drainage necessary for cultivation in such wetlands (Powell with Harrison 1982; Wood 1984; Wood 1985:44).

For further discussion of the impact of pigs in cultivated areas, see also (Thomas 1941; Aitchison 1960; UNESCO 1960; Hughes 1966; Grossman 1980; Dwyer 1984; Grossman 1984; Bulmer and Allen 1987).

It is not only food gardens that are subject to pig damage. Semipermanent coffee plots or plantations are also vulnerable to foraging pigs (Harvey-Jones 1988; Talopa 2000; West 2000:138).

Pigs may also play a positive role in agricultural areas by delivering manure to areas of cultivation or fallow. Thiagalingam and Bourke (1982:219) estimated the total amount of pig manure generated annually at 1.5 million tonnes in the early 1980s (on the basis of one t/manure/year/pig), yielding 1890 t nitrogen, 1890 t phosphorus and 1260 t potassium, with an estimated cash value of K2.9 million/year. What is not known, however, is how much of this is delivered by pigs to appropriate areas of fallow and second-growth. In the Baliem Valley of Irian Jaya, Purwanto (1997:339) considered that there was little use of manure in old gardens because pigs mainly defecate at night, a point also made by Bowers (1968) for the Western Highlands Province. However, Meggitt, writing of the Mae Enga in the period 1955–57, considered that people recognised the value of pig dung and specifically applied it with mulch material in mounds to enhance soil fertility (Meggitt 1958a:291, 306). Sillitoe (1996:392) has a similar report for the Wola as regards the use of swept up manure on gardens near houses. Salisbury (1962:48) considered pig manure contributed to the fertility of fallow land in the Siane area of the Eastern Highlands Province.

There is nevertheless little documentation of the direct use of pig manure for agricultural purposes, at least under customary conditions. For minor cases in lowland locations in

Western Province and Bougainville Province, see Lyons (1926:336), Baldwin (1982:38) and Nachman (1978:31). Writing of PNG generally, Kohun (1996:168) considered that the main reason for letting pigs into land prior to gardening is to break up and aerate the soil rather than to provide nutrients from manure and urine (see also (Kohun and Waramboi 2001:659)). However, this contradicts at least one Simbu farmer's view (Paglau 1982). In the Marind-anim area of Irian Jaya, an aversion to pig manure has been reported (van Baal 1966:141).

13.8 Water catchments

High densities of pigs in water catchments are liable to have significant effects on water quality downstream (Feachem 1973b; Feachem 1975; Feachem et al. 1977; Petr 1983). For further reports, see Chapter 12, Section 12.4.1 (under Water pollution from mainly pig faeces).

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Subject listings of references on pigs in New Guinea

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1. Research projects and issues

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