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FARMING IN BRUNEI:
CURRENT SYSTEMS AND PROSPECTS
FOR BEEF PRODUCTION

BY

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Abstract: (M.Phil.)

The paper analyses the environmental, demographic and socio-economic characters of a topographically discrete area of 321 square kilometres of the Lower and Mid-Tutong Plain within the State of Brunei, a Muslim Sultanate on the Northwest coast of Borneo. The majority of the data was obtained through face-to-face interviews with a random sample of six hundred and fifty nine householders, an estimated sixty per cent of those resident within the project area.

Detailed descriptions are given of agricultural production and farm sales. Also, information is provided on the levels of non-farm earnings and the degree to which these contribute to household incomes.

Production data on liveweight gains per animal and per hectare and management regimes are detailed for a model smallholder beef unit situated in the north of the project area. Using these data an estimate is made of the possible range of smallholder beef production systems and incomes calculated using current 1977 prices.

Beef consumption figures for the period 1973-1977 are detailed and a calculation made by income and ethnic group on the probable demand for beef within the State in 1984. These indicate that the State will not be able to achieve its aims of self-sufficiency and that because of location constraints on production significant advisory efforts will be necessary to increase production by any real amount.

Broad based extension recommendations are made as to the methods by which production increases can be achieved within the project area.

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DECLARATION

None of the material contained in this thesis has previously been submitted for a degree in the University of Durham or any other university.

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GLOSSARY

BEEF: Used to describe meat from both cattle and buffalo. The term carabeef used in the Philippines for buffalo meat has not been adopted.

BELUKAR: Regrowth of grasses, sedges, herbaceous and woody plants following the clearance of primary forest.

DISTRICT: The major administrative division of the State of Brunei. There are four, each under the jurisdiction of a District Officer.

DISTRICT AGRICULTURAL OFFICER: The senior representative of the Department of Agriculture in a District. Money and staff are voted to him at the discretion of the Director of Agriculture.

EDR: The abbreviation of the term "Extract from District Records" which describes the award of a lease on a plot of land by His Highness The Sultan of Brunei to citizens of the State. Leases may be sold between citizens and are normally granted in perpetuity.

JALAN KECHIL: Unmetalled roads connecting villages, built and maintained by the District Office.

KAJANG: A general term to describe house walls constructed of dried fronds of the nipah palm (Nipa fruticans) wovan with rattan vine (Rotan spp.)

KAMPONG: Theoretically, the malay word for village or hamlet but in practice the prefix (abbreviated as Kg.) for any collection of two or more houses.

KERANGAS: Lowland heath forest with a thin canopy of small trees found on excessively drained, acid sandy soils.

KETUA KAMPONG: A village headman, elected by all resident males over twenty one years of age from the specific village. He has certain administrative responsibilities, reports to the District Officer and is paid a retainer by Government.

MUKIM: A sub-division of a District.

PADDY: The unmilled grain of the rice plant (Oryza sativa) still contained within the lemma and palea.

PEKAN: Town or urban area.

PENGHULU: The administrator of a Mukim, nominated by the District Officer.

RAMBUTAN: A lowland Malecia tree (Nephelium lappaceum) bearing an annual crop of succulent fruits contained within distinctive soft-spined red or yellow epicarp. A relative of the litchi (Litchi chinensis).

SAGO PALM: Metroxylon palm producing a nutritive farinaceous substance from its pith.

SUNGAI: River or stream.

TOL: Technically a "Temporary Occupation Licence" used to describe the award of a lease on a plot of land by the Commissioner of Lands. The lease, which is renewable, is for twelve months and restricts the use to agricultural purposes only.

WOODBOARD: Clapboard, weather-board, or tongued and grooved wooden panelled walls.

FARMING IN BRUNEI
CURRENT SYSTEMS AND PROSPECTS FOR BEEF PRODUCTION

1. INTRODUCTION

1.1 Objectives

The initial objective of this study is to review contemporary patterns of land use and settlement in the agricultural sector in Brunei. This is achieved through the enumeration of an agricultural survey within a discrete rural area in central Brunei. From this it is possible to identify the productive farm units in terms of enterprises as well as land areas and those farm family households by size, income bracket and ethnic group which contribute to the productive process.

Emphasis is placed later on cattle production, and an analysis carried out of a model smallholder beef unit. In a comparison between this and the results achieved from the agricultural survey it is possible to indicate certain environmental and socio-economic constraints which need to be overcome if more productive systems of cattle rearing are to be achieved. Further, a model of a possible beef production programme is advanced that overcomes many of the resource constraints identified within the local environment and also complies with and supports the aims and objectives of the State National Development Plant, 1975-1979.

1.2 Agricultural Development Problems

The major problem of agricultural development at the small farmer level in Southeast Asia is perhaps the lack of diversification of the rural economy, limiting the pattern of employment, producing an inefficient marketing structure for farm produce (135 and 89) and creating extremely low living conditions (66).

Anker (1973) (3) in his analysis of international development problems categorised these problems under a number of headings which fit very closely the defined problem areas of the Southeast Asian situation (68, 89, 140). They are all of a fundamentally basic nature and in the following listing there is no priority or ranking inflicted upon the relative importance of the topics.

Low productivity is one of the basic problem areas. The average individual works at such a low level of productivity and often still within a wood economy (138) that his tools, attitudes and output have not changed for centuries. Also, with these rudimentary tools, and often poor materials, products are of poor quality. The whole technological scale is geared to the self-preservation of the household which at its highest productive level attains self-sufficiency. The market economy for the disposal of surpluses is by and large missing because of the uncertainty of the availability of any saleable produce, the small volumes and diverse nature of the products for sale and the low purchasing power of the rural sector.

From this poor resource base it is not difficult to appreciate that even working long hours is unlikely to yield an increased material return. Also, during the farming year either a dead season, for instance in a single rice crop culture, or even at certain times during the cropping season, for example during the tillering period of a rice crop, there is severe under-employment of the farmer as well as his family. Nevertheless, all this labour becomes required to its maximum and more at short peak labour periods of the rice season at transplanting and harvesting times (55). Within this situation of uncertainty there are strong human constraints due to the concentration of economic, social, political and even religious forces that solidify the agricultural pyramid such that hierarchical positions are unmovable. Any parallel to the industrialised countries' theoretical 'farming ladder' is not possible, and the situation becomes polarised into one of wealth and land ownership being synonymous with the urban environment and poverty and subsistence living being equated with the rural environment.

Because of this concentration of resources within the urban area, decision making on anything rural tends to be demoted in importance and physical facilities such as roads, water, electricity, sewage, health services and schools often get neglected in the rural areas.

In many parts of Southeast Asia such a rural malaise has become an accepted way of life with an associated rural exodus of

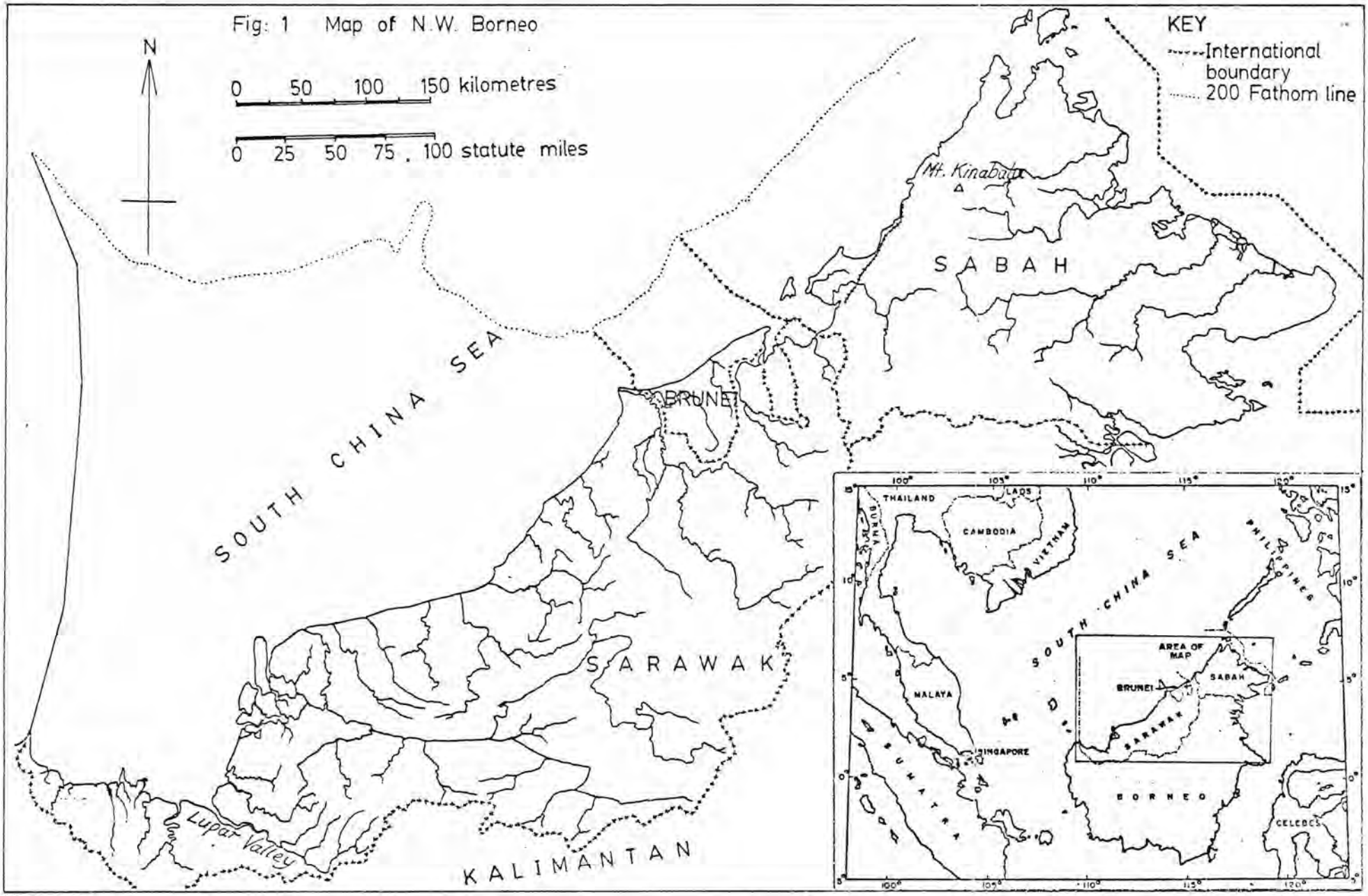


Fig: 1 Map of N.W. Borneo
N
0 50 100 150 kilometres
0 25 50 75 100 statute miles
KEY
International boundary
200 Fathom line
Mt. Kinabalu
SABAH
SOUTH CHINA SEA
BRUNEI
SARAWAK
Lupar Valley
KALIMANTAN
THAILAND
LAOS
BURMA
CAMBODIA
VIETNAM
PHILIPPINES
MALAYA
SINGAPORE
SUMATRA
BORNEO
CELEBES
AREA OF MAP
BRUNEI
SABAH
SARAWAK

all those unwilling to accept 'the system' or wanting to try their luck within the urban environment. However, these ideas conflict rather strongly with the standard conceptions of agricultural development problems as defined in retrospect by Chambers (1975) (26) and Bunting (1976) (23), where it has been conventional for the agriculturalist to blame the farmer for his non-acceptance of new ideas or the extension worker for his non-ability to communicate these ideas to the farmer.

Within this framework it is important to appreciate that this thesis is orientated to those development aspects which enhance and improve the agricultural process and which can be encompassed in the term agricultural development. It does not in any way attempt to define or to propose solutions for those problems separate from the agricultural process but pertinent to the rural environment per se which are often listed under the aegis of rural development. Nevertheless, it has become fashionable internationally to deal with all non-urban development in terms of rural development (3 and 40) even when the problems and possibly their solutions are directly related to the agricultural process. Mosher (1972) (81) has interpreted this by considering agricultural and rural development in a series of sub-systems, each an inter-reaction of different activities with some of the activities common to more than one sub-system. He considers that most agricultural projects only encompass technical agricultural sub-systems although requiring the simultaneous availability of sub-systems including agricultural services. These services are therefore an integral part of the agricultural development process and without them development is incomplete (129).

1.3 Bornean Agriculture

Historically, the land surface of Borneo, the Malay archipelago and many parts of Indonesia repelled both the indigenous inhabitant and expatriate alike with its natural vegetation of complex and dense, multi-storied tropical rain forest (91). The classic statement that "the land divides and the rivers join" (95) alongside a traditional agriculture of self-sufficiency through shifting cultivation built up at least a perceived wall of

opposition to the development of a cash agriculture (33). It was because of this that the immigrant Europeans took to farming themselves either in monoculture plantations as in the Malay peninsula or on mixed enterprise estates in parts of Indonesia.

It is basically in this structure, with the fringes of the plantation economy penetrating Brunei (67), that Northwest Borneo entered the second half of the twentieth century. Little industrial development, outside the expatriate-organised extraction of hydrocarbons had taken place (87) and even the plantation business, which provided few benefits to the rural sector, was largely in expatriate hands (76).

Osborn (1974) (82) considered that by this time within Peninsular Malaysia development policy had become urban or city orientated. The increasingly sophisticated private sector was successfully managing the estate system, the population was already highly urbanised and a general paternalism had developed towards the rural Malays with the philosophy of not altering their culture or living conditions. Thus, within smallholder rice development schemes in Malaysia objectives have been directed towards increasing levels of production and in so doing improve the standards of living (89). However, improvements in agricultural technology have done little to improve the underlying causes of rural poverty. On the contrary by trying to reproduce or retain the 'desirable' characters of a 'peasant' society, surveys of rice farmers' incomes in the peninsula have persistently revealed poverty (99).

However, the micro-level investigation and planning in existing communities has received less sympathy or systematic attention than macro-level modern sector planning. Thornton (1970) (121) considered this was because planning at the micro-level appears on a cost-benefit basis to be more expensive, agricultural economists (as surveyors and planners) are few and government departments responsible for village development are new.

There has also been a maintenance of the rural <u>status quo</u> within the structure of the estate system where, despite sophisticated agronomic research and organised hierarchical

management systems, the development of the infrastructure and amenities has by and large been neglected. Similar problems were encountered on land settlement schemes in Peninsular Malaysia by the Federal Land Development Agency during the 1960's, where social objectives did not go hand in hand with economic ones (2).

1.4 Brunei Agriculture

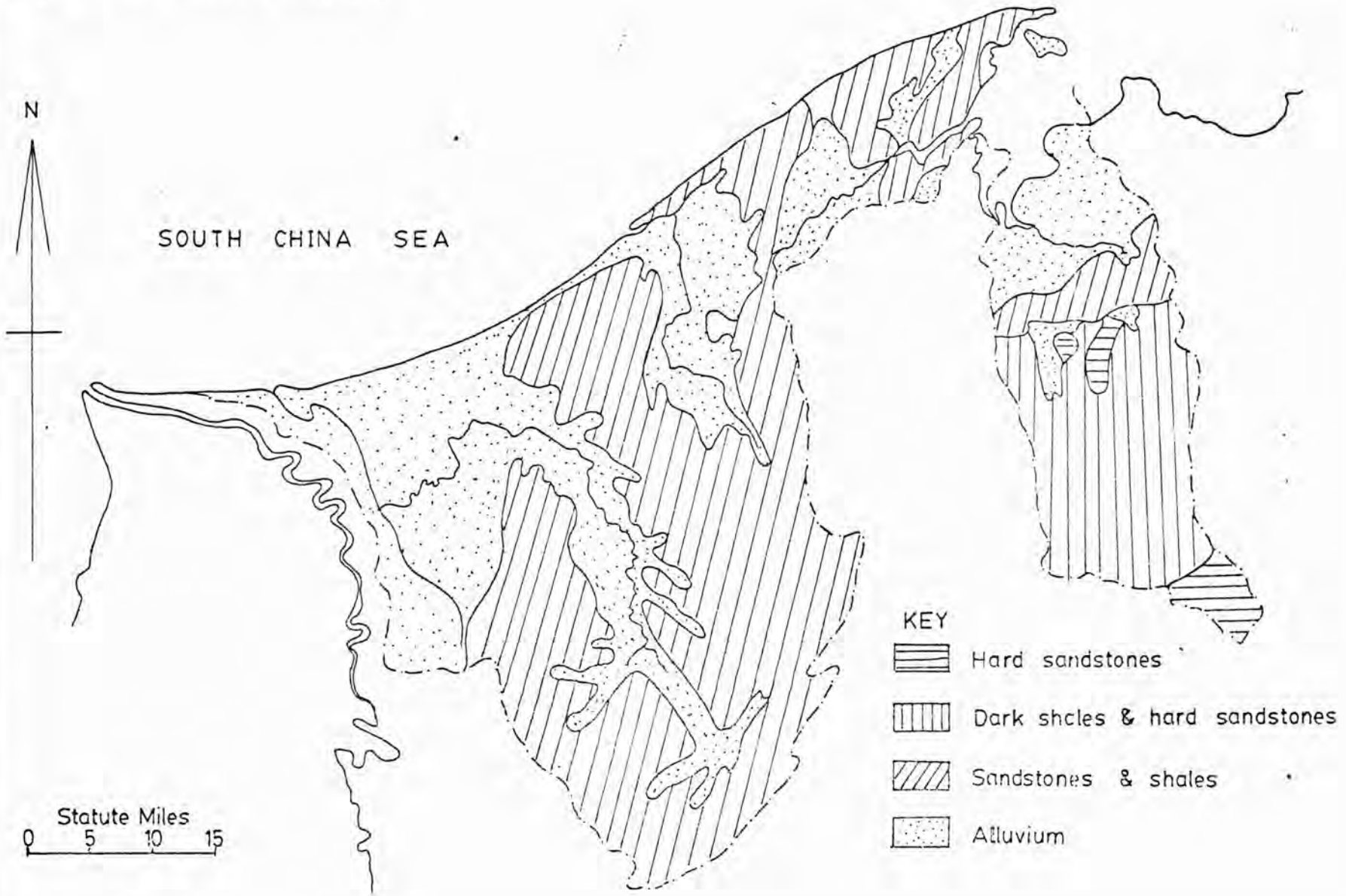
The total area classed as having agricultural potential (63) is about 130,600 hectares - no more than twenty two per cent of the total land area of Brunei - and much of this requires substantial investment to make it productive.

At the present time only about one third of this land of agricultural value is sufficiently accessible i.e. can be considered as practicable for early improvement. These lands lie principally in those areas already well served by the network of roads. The main reserves of potentially good but presently inaccessible land lie in the interior of the Tutong and the Belait Districts (Fig. 4).

Of the 40,800 hectares of land of agricultural value that is already reasonably accessible it is estimated that no more than fifteen per cent or 6,100 hectares is being cultivated at present, thirty per cent is too steep, whilst some twenty five per cent is probably lost for roads, housing and similar uses (Woodroofe, personal communication, 1974). This leaves some 12,250 hectares (30%) of undeveloped land with early development potential but, as already explained, much of this requires considerable investment before it can be used productively. Before such investment is made the producer/developer must have sufficient confidence in his rights of tenure and his chances of recovering his investment.

Land tenure in Brunei is governed by the Land Code. All land belongs to the State but may be allotted to an individual on a temporary or permanent basis by His Highness The Sultan on the advice of his Council of Ministers. At present only four per cent of the State's total land area has been so allotted as "long-term leases" or "leases in perpetuity" (so-called EDR or Extract for District Record leases). This amounts in total to some 23,000 hectares but it is most important to recognise that some 20,400 hectares of

Fig: 2 Generalised Stratigraphy



Source: After Hunting , 1969

this land lies within the compass of the 40,800 hectares of readily accessible potential agricultural land already referred to above.

In other words, although EDR leases constitute only four per cent of the total land area of Brunei they constitute fifty per cent of the potential agricultural land that is now accessible for use and development. State lands in Brunei not already allotted under EDR leases are frequently farmed with annual crops under annual Temporary Occupation Licences (TOL). Lands held under these latter leases are often found within the 40,800 hectares of good accessible land.

Although exact figures are not available a summary of an estimate of the land tenure position in 1976/77 is shown in Table 1.

TABLE 1. Estimate of Land held under Different Tenural Systems, 1976/77.

Total land area in Brunei	571,500 hectares
Suitable for agriculture	
Inaccessible	89,800 hectares
Accessible	40,800 hectares
Of land suitable and accessible	
Long leases - under cultivation	3,050 hectares
Long leases - not cultivated	6,100 hectares
Used for housing, etc.	6,000 hectares
Probably unusable	6,100 hectares
State land - under TOL cultivation	3,050 hectares
Not cultivated	6,100 hectares
Roads and other uses	4,300 hectares
Probably unusable area	6,100 hectares
Total	40,800 hectares

Source: After Woodroofe, personal communication, 1974.

2. THE BRUNEI ENVIRONMENT

2.1 Geology and Geomorphology

Borneo, together with the Malay peninsula, parts of Sumatra and the submerged Sunda Shelf, forms an extension of Continental Asia which is known as the Sunda Shield. The core of this Shield is characterised by igneous and metamorphic rocks with sediments added along the margins during the Upper Cretaceous. A geosynclinal downwarp termed by Liechti et al. (1960) (71) as the Northwest Borneo Geosyncline occurred on the northern slope of this continental core. This was characterised by large scale subsidence and the deposition of a huge thickness of sediments which extended from the Lupar Valley in the State of Sarawak to the area of Mount Kinabalu in the State of Sabah (Fig. 1). Continuing subsidence and deposition have given rise to broad, gently folded synclinal basins, plunging to the north in Brunei and separated by steep, narrow anticlines. Flat coastal plains have developed along the seaward margin.

Access on land through such terrain, especially under tropical forest conditions, is extremely difficult. Also, the poor soils developed on these sedimentary rocks have only been able to support a very low population. Bruneians have therefore looked towards the flatter coastal plains for their habitation and towards the sea for their food. Maritime expertise and convenience consequently led them to use the rivers rather than land to provide routes inland. In the same way it is the coastal alluvial flats and colluvial edge soils where farming has become possible under traditional patterns of single rice crop cultivation. This has given rise to small discrete patches of land coming under cultivation by individual households.

In the southeast of the state the peaks associated with these anticlines are made up of hard massive sandstone, with some hard shales. The rest of Temburong (Fig. 4) and the low hills running through the north central area of the country, are composed of the Temburong and Setap Shale Formations respectively, comprising dark shales with intervening horizons of hard sandstones. The hills of the rest of Brunei consist of alternating bands of shales and sandstones, siltstones, mud stones and even clays in places (Fig. 2).

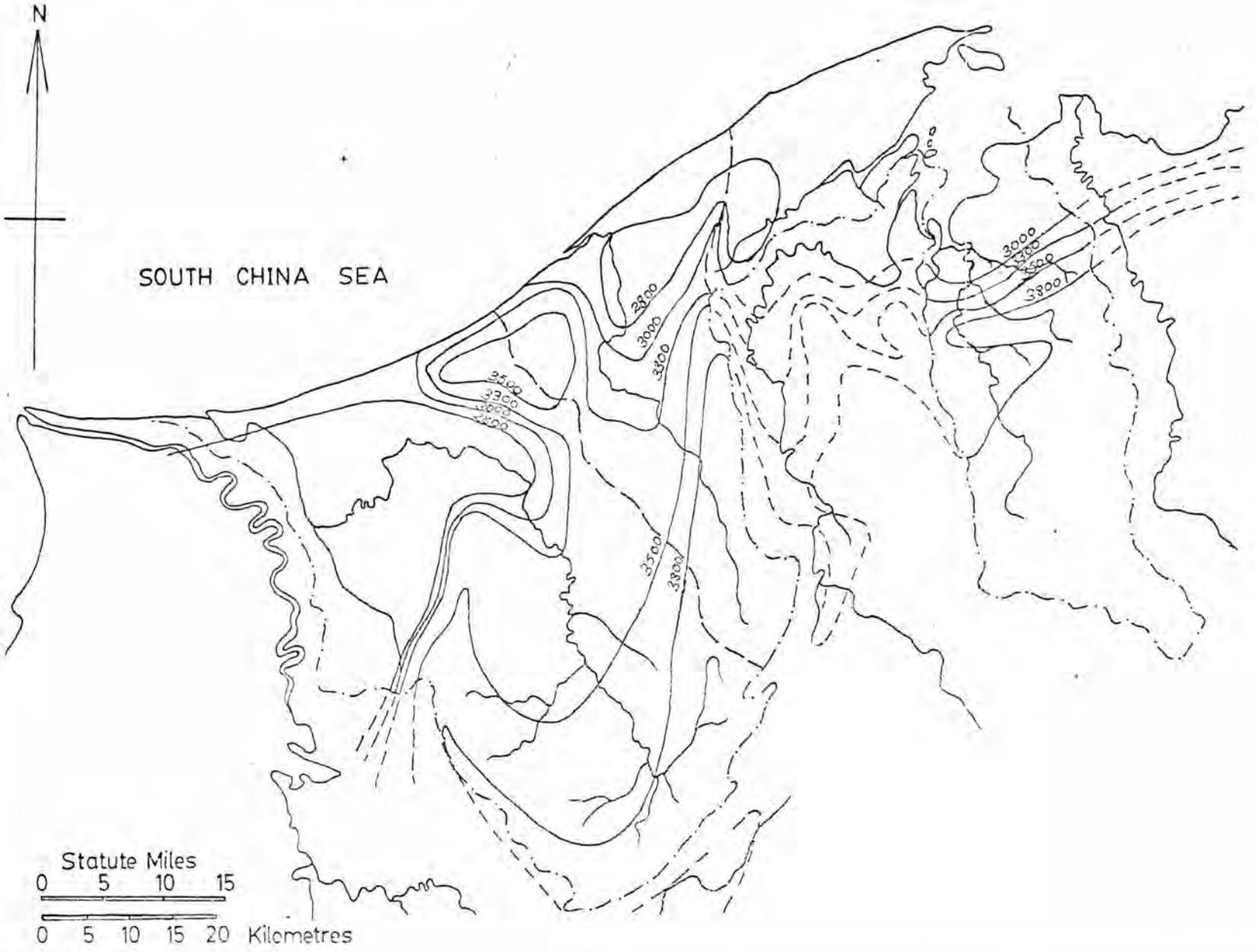
Recent geomorphological evolution has been controlled largely by heavy rainfall and changes in sea level, so that alluvial terraces and coastal raised beaches are common occurrences. Conditions of rising sea level produce a situation where drainage is very poor and much of the alluvial in-filling is in the form of peat. The peaks and ridge tops of the former land surface protrude abruptly through the alluvium to form a complex pattern of low, steep sided hills and flat valley floors. The present alluvial flats and deltas have been built up in post-glacial times, probably during the last 20,000 years, and the peat within the last 5,000 years.

The farming systems within this soil, topographical and habitation complex can be classified into three broad categories. The major and traditional system is a form of shifting cultivation. The main crop involved in the rotation is hill rice and this is generally the first crop extensively planted on newly cleared land. It is preceded by patches of maize (Zea mays) and followed by various sorts of vegetables and cassava (Manihot esculenta) lasting over a period of four or five years. Livestock do not play any large part in this farming pattern apart from the pigs and poultry maintained around the house.

The second category encompasses the lowland farmers who operate from a settled home and work the areas of high water table land. With rice providing the main portion of the diet, wet paddy (Oryza sativa) is the most important crop in the system. Vegetables, grown on small-scale bed systems with mixed populations of fruit trees grown around the homestead complete the crop cycle. Chickens for meat and eggs and goats and a cow may be kept around the house. The major livestock investment, however, is likely to be in the swamp buffalo (Bubalus bubalis) which run semi-feral as multi-owned herds over areas of deep swamp peat. As cash employment has increased these farm holdings have become a part-time interest for most family groups.

Thirdly are the small group of mostly commercial farmers, working areas of colluvium, not necessarily in easy reach of areas of population. Their main enterprises are poultry, pigs, vegetables and fruit trees.

Fig: 3 Mean Annual Rainfall in Milimetres.



Source: After Hunting, 1969

2.2 Soils and Drainage

With the youth of the residual rocks, all Tertiary in age, and the relative movement of sea level in relation to the land during the Quaternary, the zonal soils of Brunei are tropical red and yellow earths. In the three western Districts the dominant azonal soils are heavy, poorly drained sandy, fine sandy and silt loams (Allen, personal communication, 1974). Due to the effect over time of climate there has been a continuous downward leaching of the weathered material both in solution and suspension to form a soil in which the upper part is depleted, especially of clay minerals.

Other than this soil group there are the gley soils derived from riverine and recent marine alluvial deposits and the great majority exist under a situation where the water table is at or near the surface, which gives little differentiation within the profile. Nutrient levels are again low with limited leaching of bases and clay particles. Organic soils may be considered as the other major soil group which consist of almost raw woody tissue which has built up under water-logged, anaerobic conditions.

2.3 Climate

Brunei lies within the Tropical Convergence Zone between latitudes 4° and $5^{\circ}5'$N and longitudes $114^{\circ}4'$ and $115^{\circ}23'$E. Differences in day length therefore vary very little, ranging from 28 minutes at 4° N to 36 minutes at $5^{\circ}5'$ N between the longest and shortest day. The principal factor controlling the weather is this Tropical Convergence Zone where the heavily moisture laden South-east Trades and Northeast Trades converge and migrate seasonally. The net effect is that two dominant wind seasons occur - the North-east and Northwest monsoons with the former dominant between November and early April and the latter from July through to September. The types of rainfall associated with both these seasons are orographic whilst, during the intervening months, winds are variable and light causing instability rain. The mean annual rainfall within the State is presented in Fig. 3. These average figures, however, hide some large variations at the extremes. These are illustrated in Table 2 where maximum, mean and minimum monthly figures are presented for

the thirty one year period that records have been maintained at Seria in the west of the State (Fig. 6).

TABLE 2. Maximum, Mean and Minimum Monthly Rainfall Figures, Seria, 1947 - 1977

Month	Maximum	Mean mm.	Minimum
January	1,262	355	25
February	352	142	1
March	427	186	39
April	521	179	34
May	547	219	71
June	516	215	36
July	411	187	72
August	404	210	42
September	482	247	83
October	618	290	117
November	568	323	174
December	832	392	153
Total	3,605	2,945	2,302

Source: Brunei Shell Petroleum Company Limited, personal communication, 1978.

The Government station maintaining records of temperature and sunshine for the longest period of time is Brunei Airport where data have been collected since 1968 (Allen, personal communication, 1974). The average minimum diurnal range amounts to only 4.7°C in February, which also has the highest bright sunshine average of 6.87 hours per day, to a mean of 9.8°C in May. The corresponding lowest bright sunshine average is in December with 5.90 hours per day.

2.4 Natural Vegetation

Nearly all the vegetation in the State can be classed as tropical rain forest, the chief feature of which is the great variety of evergreen trees. The primary rain forest has a closed

canopy made up of three or four distinct storeys but the secondary forest, belukar, is less orderly, especially in the first ten to twenty years of regrowth and access through it is extremely difficult.

The natural forest has been divided by Browne (1955) (22) into three divisions: lowland heath forest (Kerangas); swamp forest; and, lowland dipterocarp forest. Kerangas is found on excessively drained, acid, sandy soils and is easily recognised by its poor growth with small trees, thin canopy and prominent undergrowth. Ru Gunong (Casuarina sumatrana) and Simpoh (Dillenia eximia) and the genus Agathis of the conifer family are all distinctive trees which grow in these podzols. The swamp forest proper covers areas such as the Tutong valley and Lower Belait Basin with trees up to thirty metres tall and different types of climax forest dependent upon the soil type. Kapur paya (Dryobalanops rappa), Terantang (Campnosperma spp.) and Jelutong (Dyera spp.) are three representative trees (19). There are also areas intermediate between true swamp forest and mangrove forest and even those virtually free of trees but with dense thickets of asam payah palm (Zalacca conferta). The coastal swamp vegetation is typified by the dense growth of mangrove and nipah palms, Nipa fruticans with a gradation to the latter with a reduction in salinity.

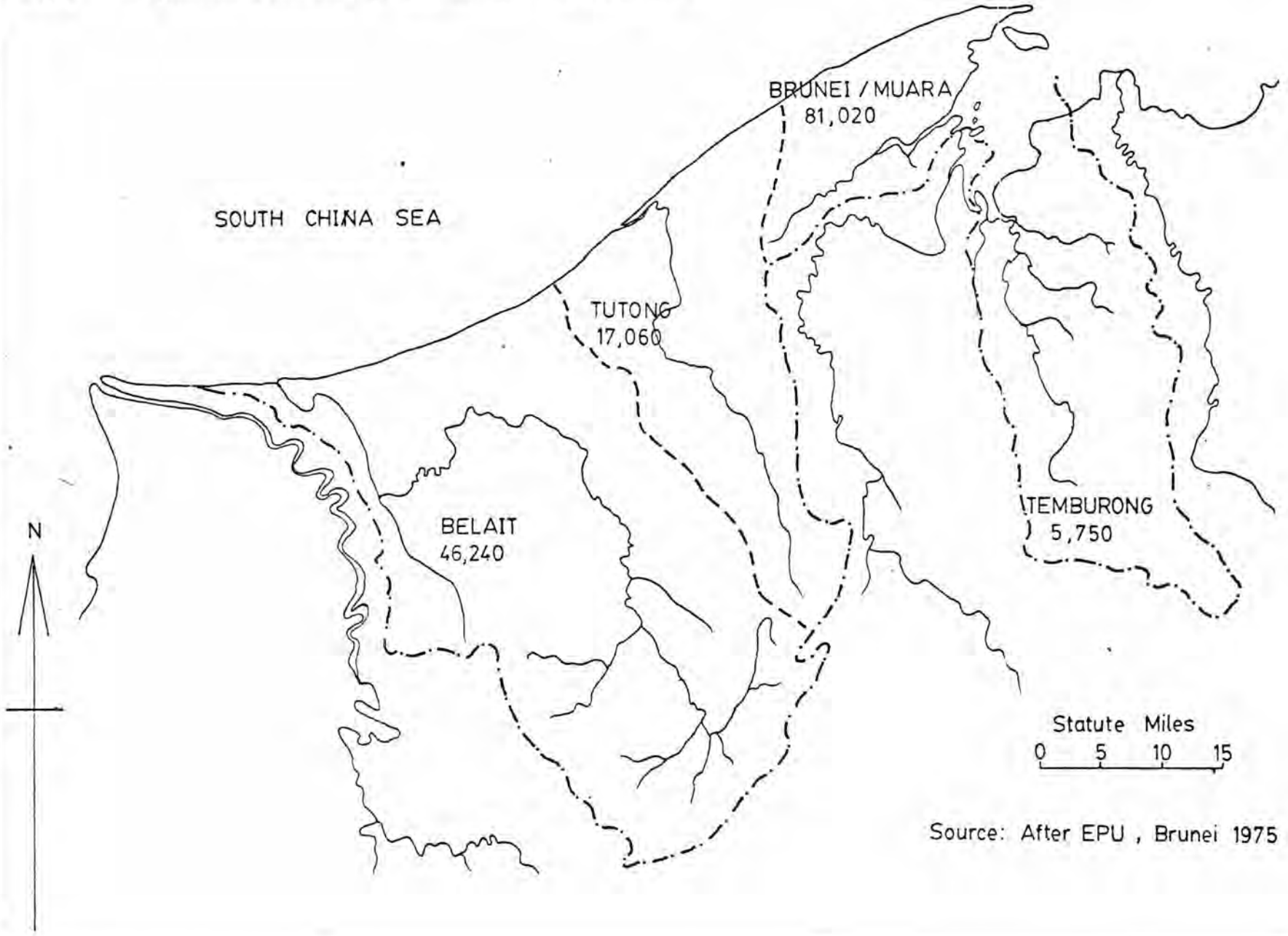
The lowland dipterocarp forest is the dominant vegetation type within the State although it is also the first to be cleared and settled.

2.5 People and Agriculture

The total indigenous and expatriate population of the State in mid 1974 was officially estimated at 150,070 (116), giving a mean density of 26 persons per square kilometre (Fig. 4). Although this concentration is low, it is not a good indication of the true situation as a large proportion of the population is concentrated along the coastal plain, especially around the capital and the oil-field area, leaving extensive areas of the interior sparsely populated.

The present day population shows a significant increase over that at the start of the century when enumerations were first

Fig: 4 Population Estimate by District for Mid-Year 1974.



initiated. Up until the 1930's the increase in the population in the region was in the order of one per cent per annum, which during the 1950's rose in North Borneo (now Sabah) to 2.9 per cent per annum (69). However, the rate of growth between 1947 and 1960 in the State was inflated as it included many returning Brunei citizens who left during the Japanese occupation of 1941-1945. The high growth rate between 1960-1971 on the other hand was due more to an expansion of commercial activities in the State. This can be seen by an analysis if the population figures by District, bearing in mind that the commercial centre is the capital, Bandar Seri Begawan in Brunei/Muara District, and the oil and gas operations are concentrated around Seria and Kuala Belait in Belait District (Fig. 6).

TABLE 3. Total Brunei Population from Official Census Data

Year	Total Population	Percentage Annual Increase
1911	21,718	-
1921	25,451	1.6
1931	30,135	1.7
1947	40,657	1.9
1960	83,877	5.7
1971	136,256	4.5

Source: 69 and 113.

TABLE 4. Population by District, 1931-1971

Year	District							
	Brunei/Muara		Tutong		Temburong		Belait	
	No.	% Increase	No.	% Increase	No.	% Increase	No.	% Increase
1931	18,281	-	5,651	-	2,306	-	3,897	-
1947	18,531	1.4	6,847	21.2	2,712	17.6	12,567	222.5
1960	37,511	102.4	10,710	56.4	3,948	45.6	31,708	152.3
1971	72,791	94.1	15,858	48.1	5,224	32.3	42,383	33.7

Source: 69 and 113.

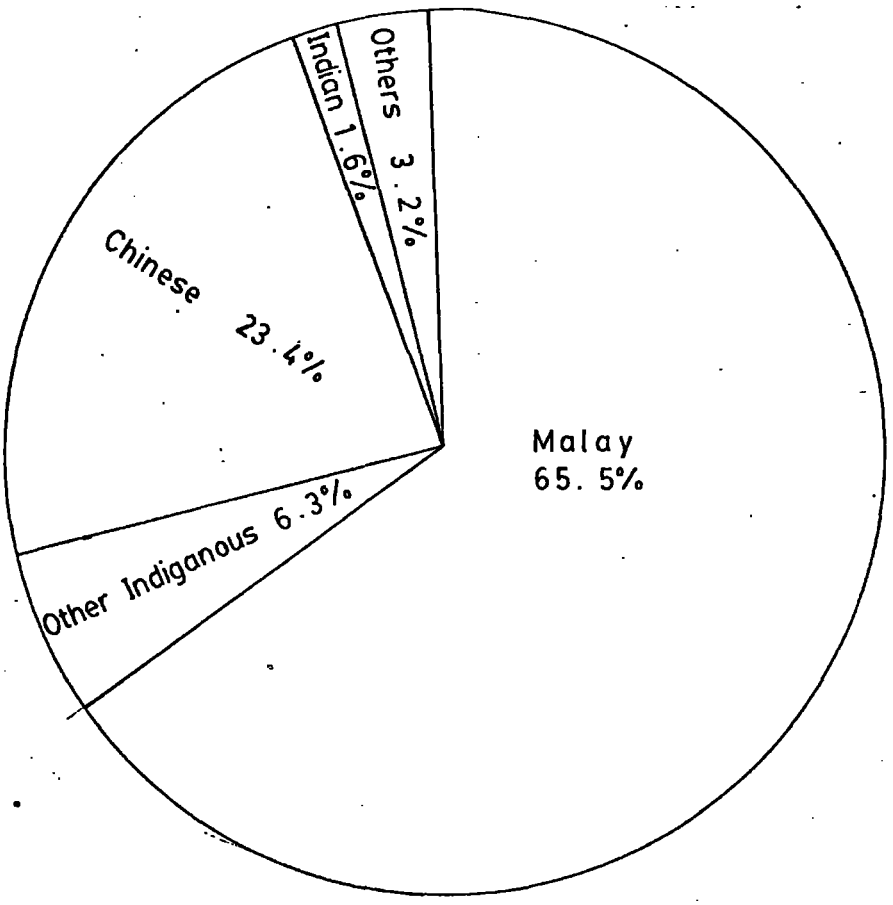


Fig: 5 Population by Ethnic Group in 1971

Source: After, State of Brunei (1973)

The largest immigrant group is the Chinese who only started to settle permanently in Brunei during the present century. They chose to live in and near the towns, and were involved either in trading or the more immediately commercial sides of agriculture, i.e. market gardening and poultry production. Their numbers have grown greatly over the last sixty years, from about 3 per cent of the population in 1911 to nearly 30 per cent at the presentime. The others category in the piechart shown as Fig. 5 includes small groups of expatriate workers, mostly employed in Government service or in the oilfield area.

Out of this total population, the 1960 census recorded 23 per cent dependent largely upon agriculture. Also, the population enumerated in the 1964 census of agriculture (107) as being involved in farming in some way was 38,587 persons or nearly 40 per cent of the estimated State population at that time, whilst the number dependent on agriculture as a main occupation was 18,000 persons or 18.4 per cent of the estimated total population. The average size of the holdings was calculated as 2.6 ha, with 50 per cent of the households in the range 0.6 ha to 4.0 ha. The main crops were paddy, rubber (Hevea braziliensis), sago (Metroxylon spp.), coconut (Cocos nucifera) and pepper (Piper nigrum) in order of importance by land use area.

However, agricultural productivity in the State is low whether it is measured on an area basis, per caput, or per head of farming population. The main reason for this is that currently there is the opportunity for more lucrative and more secure forms of employment and the structure of the agricultural industry is orientated away from the market and towards the needs of the individual household.

2.6 Economy of Brunei

The British Malayan Petroleum Company started searching for oil in Brunei in 1913 and in 1929 the Seria field was discovered in the western part of the Sultanate. Production gradually rose to 17,000 barrels per day by 1940 and, after the Japanese occupation between 1941-45, peaked at 114,700 barrels per day in 1956.

TABLE 5. Net Imports into Brunei 1965-1970 and 1970 to 1974

	Av. 1965/70	1970	1971	1972	1973	1974	1965-1970	1970-1974
			B$m.				Per cent change per year	
Food	27.49	31.78	33.84	39.21	47.59	57.59	+ 112.4	+ 20.3
Beverages and tobacco	6.19	7.71	7.28	7.96	9.21	9.88	+ 11.4	+ 7.0
Crude mats	3.25	7.14	5.81	6.85	2.90	2.94	+ 938.3	- 14.7
Animal/veg. oil and fats	0.99	1.25	1.33	1.31	1.44	3.01	+ 10.3	+ 35.2
Chemicals	8.19	10.87	16.85	17.16	22.08	35.45	+ 17.8	+ 56.5
Manufactured goods	40.77	68.36	134.19	71.12	79.44	174.30	+ 40.5	+ 38.7
Mach./transport equipment	61.38	88.73	207.22	95.75	104.43	93.50	+ 28.6	+ 1.3
Misc. manufactured goods	12.30	14.74	21.37	21.40	18.70	20.98	+ 12.7	+ 10.6
Misc. transactions	9.16	8.36	8.52	4.28	6.32	6.24	+ 2.9	- 6.3
Total	169.72	238.94	436.41	265.04	292.11	403.89		+ 17.3

Source: 44, 45, 46, 47, 48, 49, 50, 51 and 52.

From 1954 onwards, Brunei Shell Petroleum Company Limited, as the name of the local company had become, carried out offshore surveys and exploration drilling on the continental shelf. As a result of these activities offshore production was started in 1964. In 1968 the total production from both onshore and offshore wells surpassed the maximum production rate achieved in 1956 and during 1976, production of oil and natural gas liquid averaged 221,000 barrels per day. In addition to this, significant reserves of natural gas were discovered which are exported on a contract basis to Japan. It is expected that a total of over 65 million tons of gas will be supplied to Japan during the 20 year period of the contract.

Oil and gas are Brunei's major exports and earned the State nearly B$2,000 million from oil and B$425 million from gas in 1975. Such an income has allowed the Brunei economy to achieve a high degree of financial strength and stability. At the same time imports rose significantly and these are detailed in the Table 5. The highest increase in gross value was in manufactured goods and chemicals, the former because of infrastructure development and the latter is inputs for the oil industry. Apart from these the greatest rises were in imports of food and animal and vegetable oils and fats, indicating the negative impact of the oil industry upon the growth of agriculture in the State.

However, increases in gross monetary values of imports do little to indicate increases in quantities and thus a summary is shown in Table 6 of changes in weights of imported food stuffs by type. By and large volumes of imports remained static or increased in line with general trends in population. The notable exception to this was the import of meat and offals where there was an absolute reduction in imports.

TABLE 6. Tonnes of Foodstuffs imported into Brunei, 1970 and 1974

	1970	1974	Percentage increase/ (decrease) per year
Live/frozen processed meats and offals	1,002	571	(10.8)
Fresh/processed/ canned fish	759	1,068	10.2
Rice	10,906	11,640	1.7
Other cereals (whole/milled/ processed)	3,354	3,990	4.7
Citrus/bananas	633	869	9.3
Fresh vegetables	1,403	1,431	0.5
Frozen/dried/ canned vegetables	688	843	5.6
Animal feeds	10,808	12,311	3.5

Source: 48 and 52.

3. TUTONG AREA SURVEY

3.1 Introduction

During 1973, a house-to-house technical, agricultural and socio-economic survey of a sample of the rural households in the Lower and Mid-Tutong Plain of Tutong District, the most agricultural of the four Districts in the State (Fig. 6) was carried out with help from Brunei Government Department of Agriculture Staff. The initial approach to each family was carried out through the District Agricultural Officer and Kampong Ketua. The sample was drawn from those household heads who were available when the interviewers visited each village. However, several visits were made to each village at differing times of the day and on different days of the week such that the sample was considered to be drawn from a random selection of households.

The total number of heads of households interviewed was 659 and all the interview forms were subsequently coded and analysed. In the following sections these data are presented and analysed.

3.2 Project Area

The boundaries of the project area are the Tutong River and the eastern boundary of Tutong Town in the west, and the watershed of the sandstone and shale hills of the Seria Formation extending south from Jerudong in the east. The watershed of the Bintuaran Range forms the limit to the area in the north and the extent of the motorable road and its environs around Kampong Benutan in the south (Fig. 7). The whole covers an area of 321 square kilometres and forms a topographically, ethnically and community wise discrete region within the District.

Each District of Brunei is sub-divided into a number of Mukims (Fig. 8) and the distribution of households by Mukim in the area of Tutong District under discussion is given in Table 7.

Fig: 6 District and Project Area Boundaries

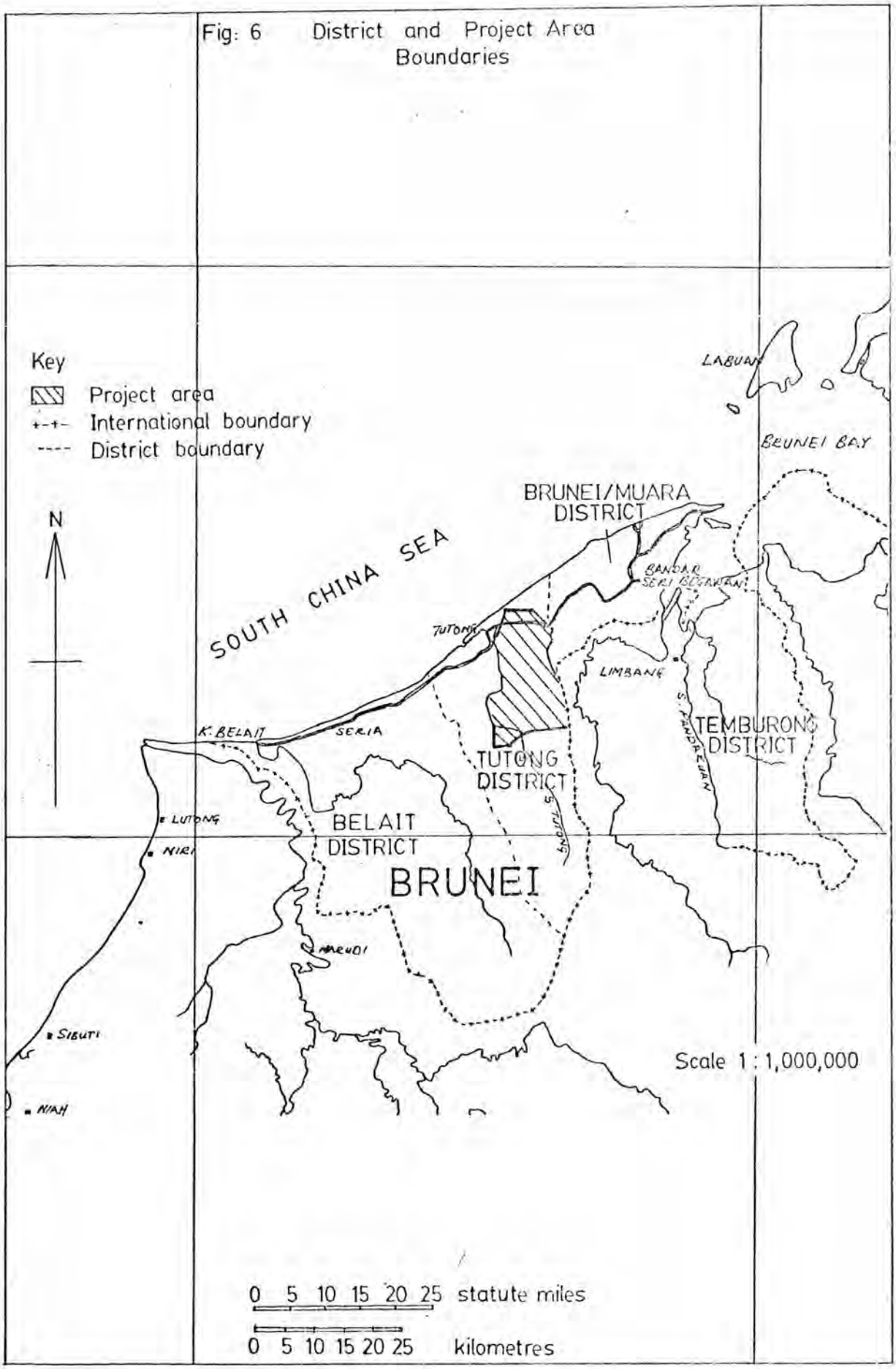


TABLE 7. Interview Household Sample Distribution by Mukim

Mukim	Households interviewed	Total no. of households in Mukim	Total no. of households in survey area	Percentage of Sample
Rambai	56	221	111	50
Keriam	154	432	257	60
Kiudang	208	355	355	59
Lamunin	177	278	278	64
Pekan Tutong(1)	64	623	97	66
Total	659	1,909	1,098	60

Source: 107 and 113.

(1) Pekan Tutong is the commercial centre for the District and the majority of households exist under a suburban or dormitory status. The survey therefore only extended as far as the outskirts of the town and included the rural area of Kampong Penanjong of 97 households which is situated just within the boundary of the Mukim.

There are three other Mukims in Tutong District, Mukim Telisai with 186 households, Mukim Ukong with 218 households and Mukim Tanjong Maya with 257 households. This gives a total of 2,570 households in the District. By excluding those households in the urban part of Pekan Tutong this figure is reduced to 2,044. Thus the project area covers some 54 per cent of the District rural households.

Through the northern part of the area the main Tutong to Bandar Seri Begawan paved highway runs in an East-West direction off which, in a south-westerly direction, runs the paved road to Kampong Lamunin. From these two surfaced highways, a network of minor roads (jalan kechil) run along the sides of the swamps, the colluvial ridges and river banks. Except at the height of the monsoon season these earth-topped roads provide pedestrian and light motor access to almost all parts of the project area. The main river,

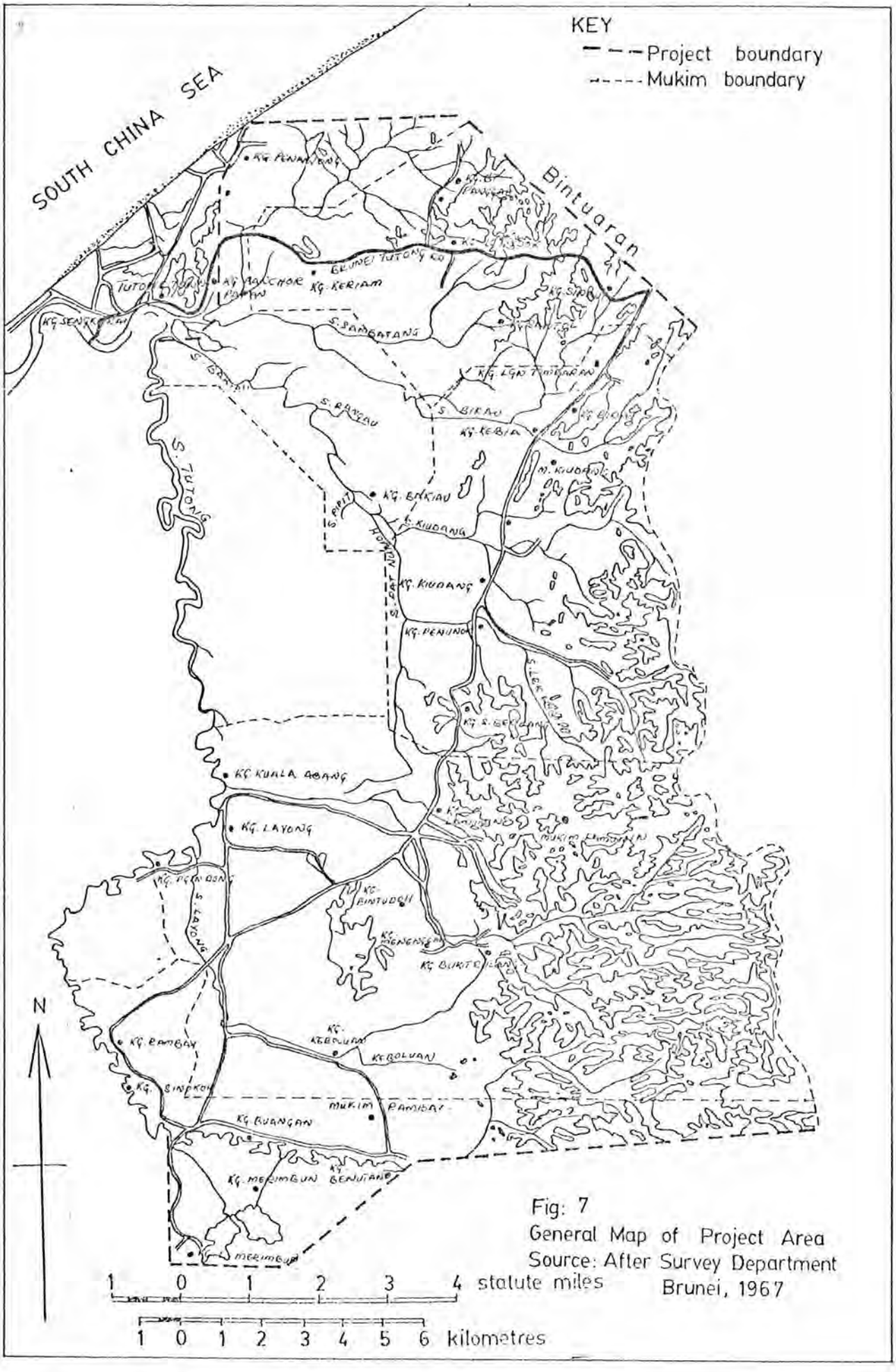


Fig: 7
General Map of Project Area
Source: After Survey Department Brunei, 1967

the Sungai Tutong in the west, forms a major means of communication North-South, the Sungai Birau is navigable by outboard for up to four kilometres and the Sungai Bakiau for approximately eight kilometres from their respective confluences with the Sungai Tutong (Fig. 9).

Topographically, the area can be divided into flat low-lying areas, areas with slopes not exceeding 25° and areas with slopes of more than 25° (Fig. 10). The low-lying areas cover almost half (46%) of the whole project area. Peat soils are most prominent and constitute about 70 per cent of this area (10,500 hectares out of a total of 14,900 hectares) while the remaining soils are made up mainly of alluvial organic and non-organic gleys with small areas of yellow-red podzolic residual soils.

The land with slopes up to 25° accounts for an estimated further 16 per cent or 5,200 hectares, mostly with residual soils. The higher land in the east of the project area with steep slopes exceeding 25° makes up the remaining 38 per cent (12,300 hectares) and consists of medium to light yellow-red podzolic residual soils. Figure 11 illustrates the distribution of the major soil series within the project area.

TABLE 8. Distribution of Land by Slope in the Project Area

Classification	Percentage Distribution	Area (hectares)
Flat	46	14,900
$\lhd$ 25° slope	16	5,200
$\rhd$ 25° slope	38	12,300
Total	100	32,400

The main areas of current agricultural production and areas suitable for development must be considered as the edge peats, other non-swamp flat areas and that land with a slope than 25° - in total this constitutes some 9,400 - 12,200 hectares.

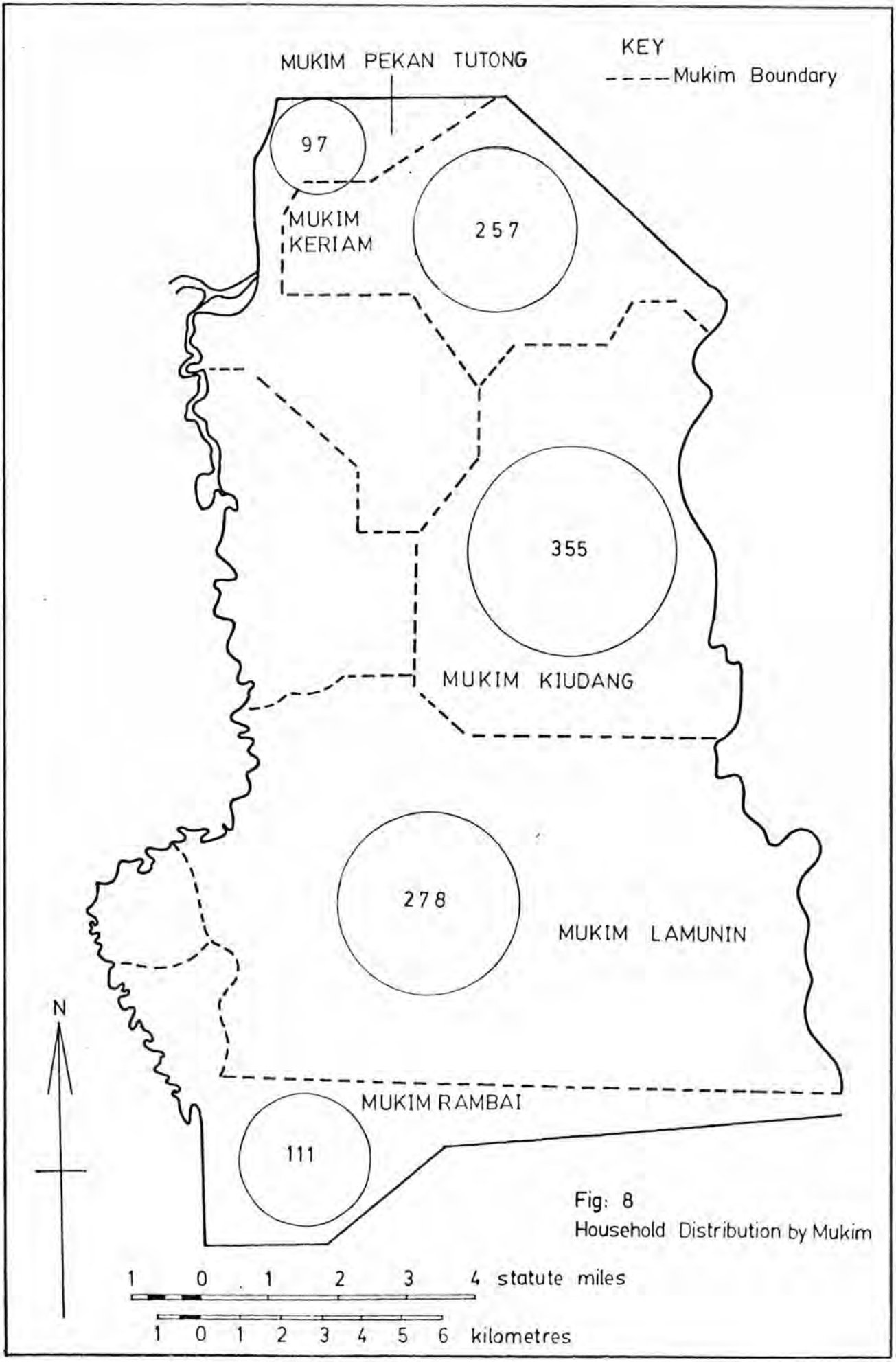


Fig: 8
Household Distribution by Mukim

The study area can be divided into three catchment zones (Fig. 12). These are the catchments of the:

(1) Sungai Kelakas;
(2) Sungai Birau and Sungai Bakiau; and,
(3) Sungai Abang, Sungai Benutan and Sungai Layong.

These occupy in total an area of 21,900 hectares or 68 per cent of the total i.e. the total excluding the swamp areas.

Catchment area 1 - Sungai Kelakas and its tributaries occupy some 1,800 hectares. The river is sluggish in its middle part where it flows through flat, low-lying peat land. The presence of logs, branches and living plants often block the passage of water. The area where the main road crosses the river is especially heavily vegetated, limiting the discharge and allowing a backflow of saline water. The main river divides north of Kampong Keriam and the tributaries rise in the higher land at Kampong Bukit Panggal where they appear as small drains containing standing water.

Behind the heavy saline soils at the mouth of the river the peat soils are up to 100 cm and more in depth and consist of raw wood tissues built up under water-logged, anaerobic conditions. Upstream there are mixtures of peat and alluvial soil and the tributaries rise in the residual shale and sandstone hills of the Bintuaran Range.

Catchment area 2 - Sungai Birau and Sungai Bakiau and their tributaries cover an area of approximately 10,700 hectares. Sungai Birau is navigable by outboard motor up as far as Kampong Bakiau. The tributaries of Sungai Birau and its branches lead to the higher land in the north eastern part of the catchment area. The tributaries of these rivers are often drains which although modified by man have become, in many cases, blocked by logs, branches and creepers.

Apart from the peats, the non-saline gleyed soils found in this catchment area consist of young alluvial clays which are non-organic and heavy textured. These soils are mostly found in the middle to upper reaches of the tributaries between the peats and the residual sandstones. Saline gleyed soils are found right at the

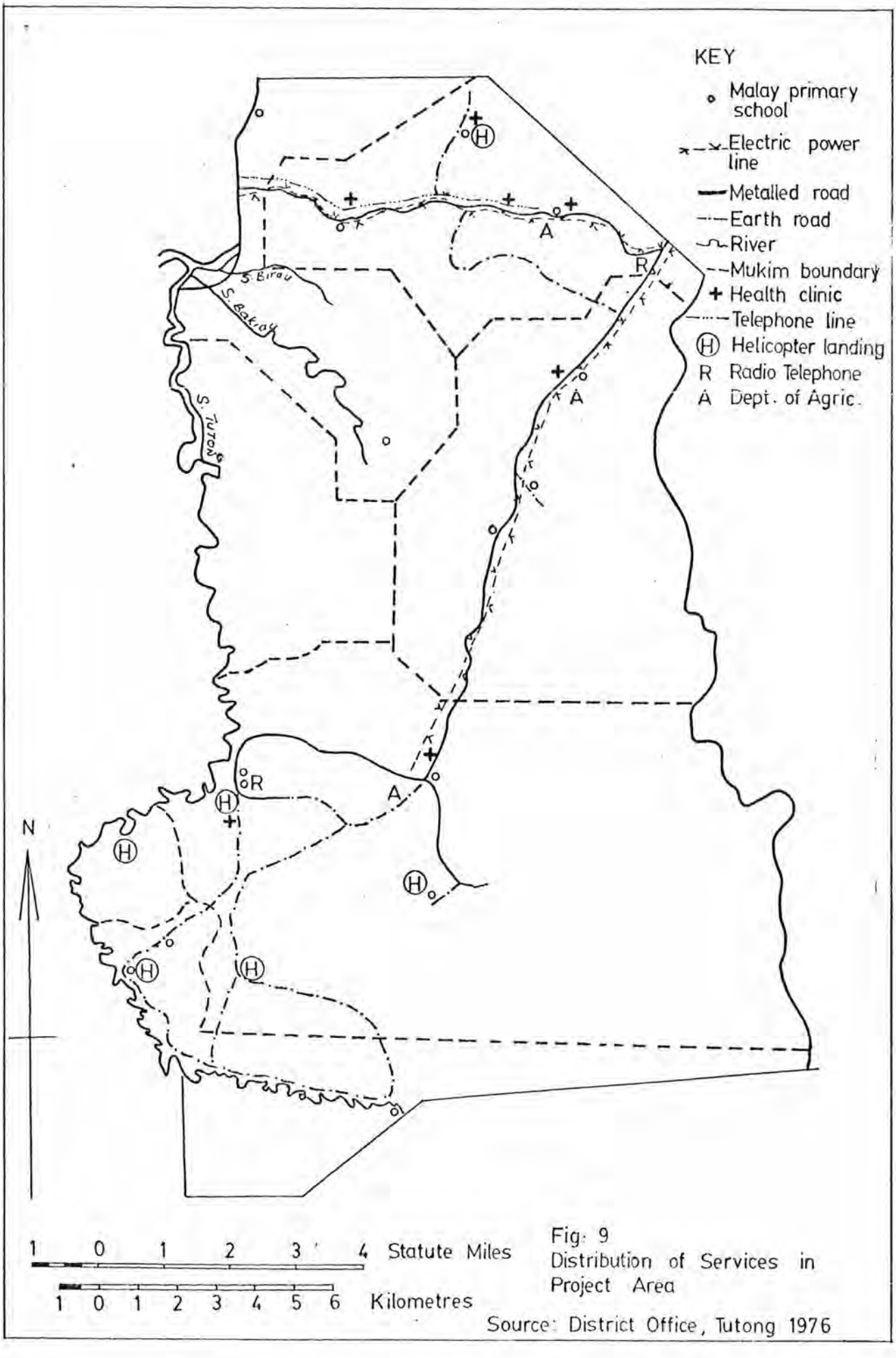


Fig: 9
Distribution of Services in Project Area

Source: District Office, Tutong 1976

mouth of both the Birau and Bakiau rivers.

Catchment area 3 - Sungai Abang, Sungai Benutan and Sungai Layong. This catchment area consists of Sungai Abang in the north, Sungai Benutan in the south and Sungai Layong in the middle. The three rivers jointly have a catchment of about 9,400 hectares. Sungai Abang rises in the higher land near the Limbang border, Sungai Layong rises around Kampong Panchong, runs westwards and then to the north where it joins the Sungai Tutong. Sungai Benutan runs westwards and its tributaries rise in the high land at the Limbang border.

The land in this catchment area is slightly undulating with flat areas alongside the Tutong river. Eastwards the land rises and is hilly towards the border with Limbang with small flattened valleys along the tributaries where much of the high land has slopes exceeding 25°.

3.3 Demographic Data

The 1971 official census showed that the average rural household size was between six and seven (113). These data are listed in Table 9 with the details of those from the household survey in Table 10. The size of the household appears to vary little in relation to ethnic group or situation within the project area with the exception of Mukim Tutong.

The difference between the seventh and eighth columns of figures in Table 10 requires explanation. Secondary school children in the more distant villages do not live at home but are only temporary residents for weekends at monthly intervals during term time and during the school holidays (the survey was carried out during term time). Thus there is a difference between household size and family size.

The split of the population between ethnic groups by household was 94 per cent Malay and other indigenous peoples, and six per cent Chinese. This was consistent with the population data from the 1971 census which for the same Mukims had a breakdown of 92 per cent Malay and other indigenous, and 8 per cent Chinese. The details of these two sources of data are set out in Table 11 and the

distribution of households by Mukim and ethnic groups are detailed in Table 12 and illustrated in Figures 13 and 14.

TABLE 9. Household Size by Mukim from 1971 Census

Mukim	Population per household
Rambai	5.6
Keriam	6.1
Lamunin	5.9
Kiudang	6.2
Tutong	7.0
Average	6.3

Source: 113.

TABLE 10. Average Family Size in the Project Area

Mukim	1. Household pop.	2. Male 17-60	3. Female 17-60	4. Dependent over 60	5. Children under 10	6. Children 10-16 at home	7. Total household	8. Total family
Rambai	343	1.6	1.4	0.2	0.9	2.0	6.1	6.8
Keriam	1,003	1.3	1.5	0.5	1.5	1.7	6.5	6.6
Lamunin	1,167	1.5	1.4	0.5	1.5	1.7	6.6	6.9
Kiudang	1,303	1.5	1.4	0.5	1.3	1.6	6.3	6.4
Tutong	493	1.5	1.8	0.5	1.9	2.1	7.8	7.8

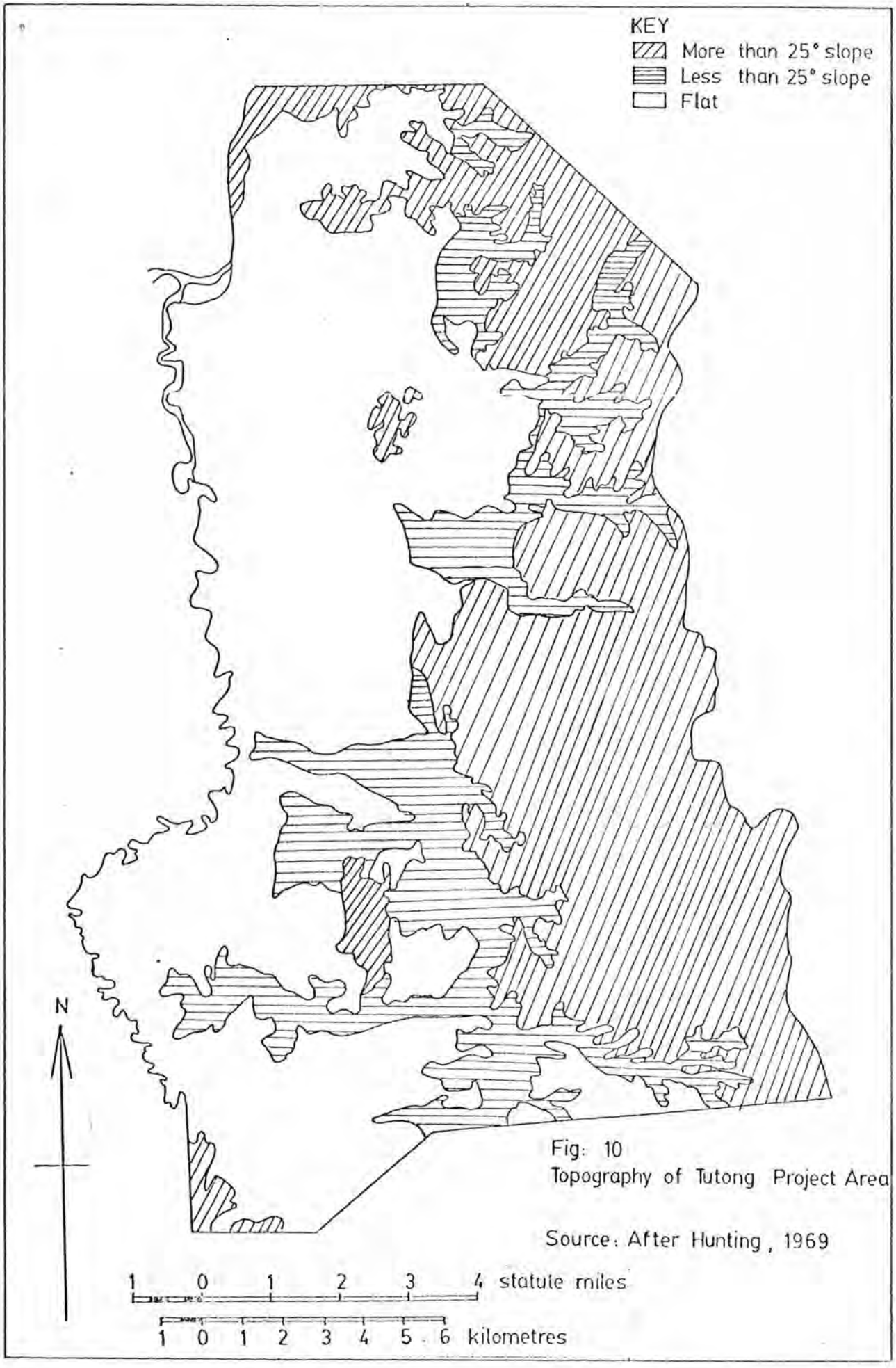


Fig: 10
Topography of Tutong Project Area

Source: After Hunting, 1969

TABLE 11. Census Based Project Area and Interview Based Sample Populations by Mukim and Ethnic Group

	1971 CENSUS				PROJECT AREA SAMPLE CENSUS			
Mukim	Malay and Other Indig.	Chinese	Other	Total	Malay and Other Indig.	Chinese	Other	Total
Rambai	1,218	27	1	1,246	329	14	0	343
Keriam	2,494	118	0	2,612	978	25	0	1,003
Kiudang	2,005	199	0	2,204	1,179	124	0	1,303
Lamunin	1,397	232	3	1,632	1,054	113	0	1,167
Tutong*	668	1	0	669	493	0	0	493
Total	7,782	577	4	8,363	4,033	276	0	4,309
Percentage	93	7	0	100	94	6	0	100

* Kampong Penanjong only.

Source: 113.

TABLE 12. Distribution of Households by Mukim and Ethnic Group in Sample

Mukim	Malay	Kedayan	Indigenous	Chinese	Total
Rambai	5	4	45	2	56
Keriam	98	41	12	3	154
Lamunin	50	46	66	15	177
Kiudang	80	31	77	20	208
Tutong	55	0	9	0	64
Total	288	122	209	40	659

Finally, details of these project area household and population figures are detailed in relation to comparative District and State figures in Table 13. They endorse and enlarge on those data mentioned in the introduction.

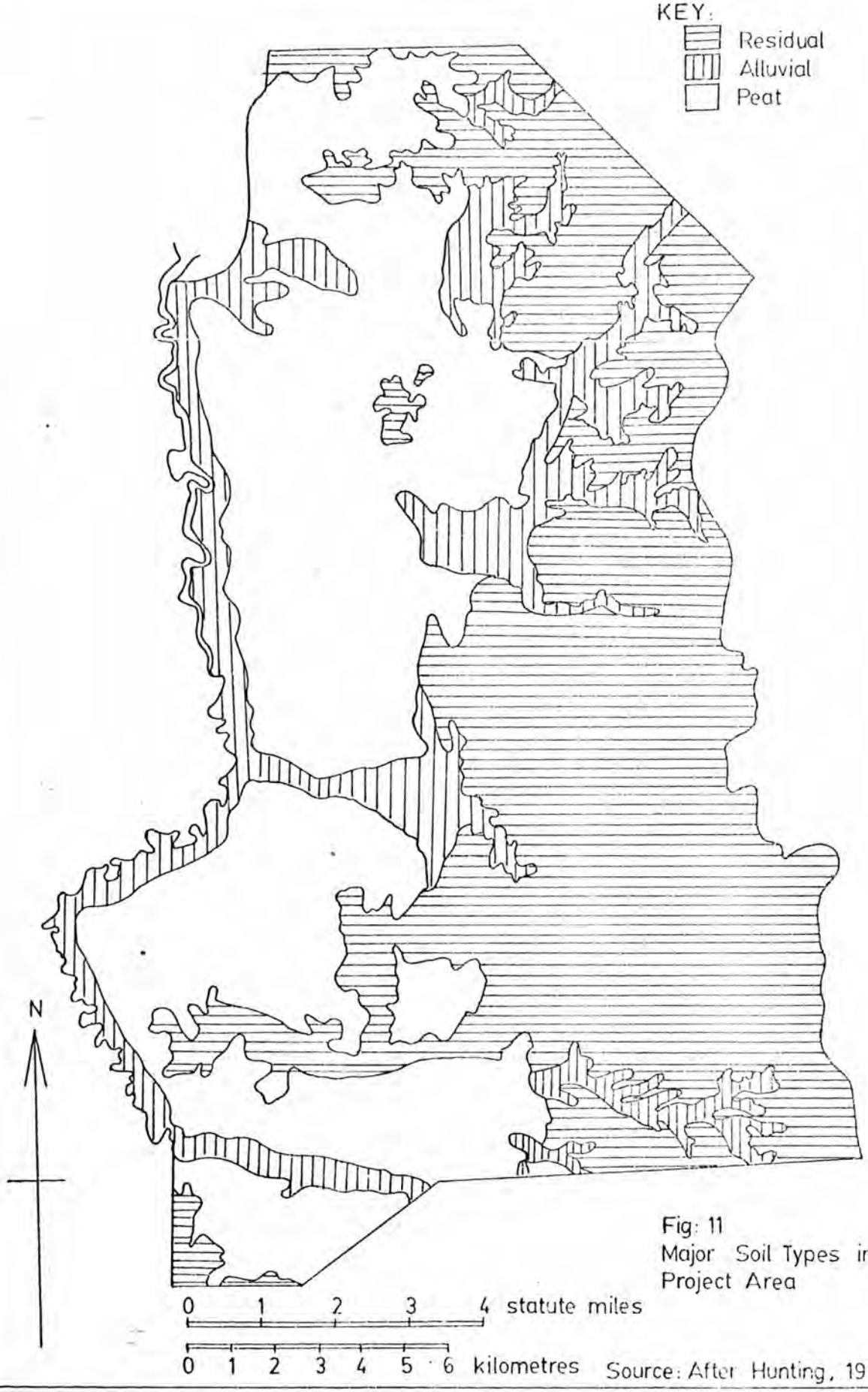


Fig: 11
Major Soil Types in the Project Area

Source: After Hunting, 1969

TABLE 13. Household and Population Data for Project Area, District and State

	Households	Population
Sample Survey	659	4,309
Project area	1,098	7,182
Mukims in project area	1,909	12,067
Tutong District	2,570	15,858
Tutong urban & town	526	3,704
Tutong rural	2,044	12,154
BSB[1] Census District	6,122	36,987
Brunei/Muara District	5,805	35,804
Belait District	7,974	42,383
Temburong District	885	5,224
State Total	23,356	136,256
State Urban		86,703
State Rural		49,553

(1) Bandar Seri Begawan Municipality

Source: 113.

3.4 Social Situation

A greater appreciation of the local situation may be gained if some details are given on the social conditions of the people within the project area. Table 14 details the distribution of households by distance from the paved highway and Table 15 indicates the quality of the houses and their distribution by ethnic group and location.

TABLE 14. Distribution of Households by Distance from Paved Highway

	Number	Percentage
Roadside	371	56
Trackside	148	23
Limited access	140	21
Total	659	100

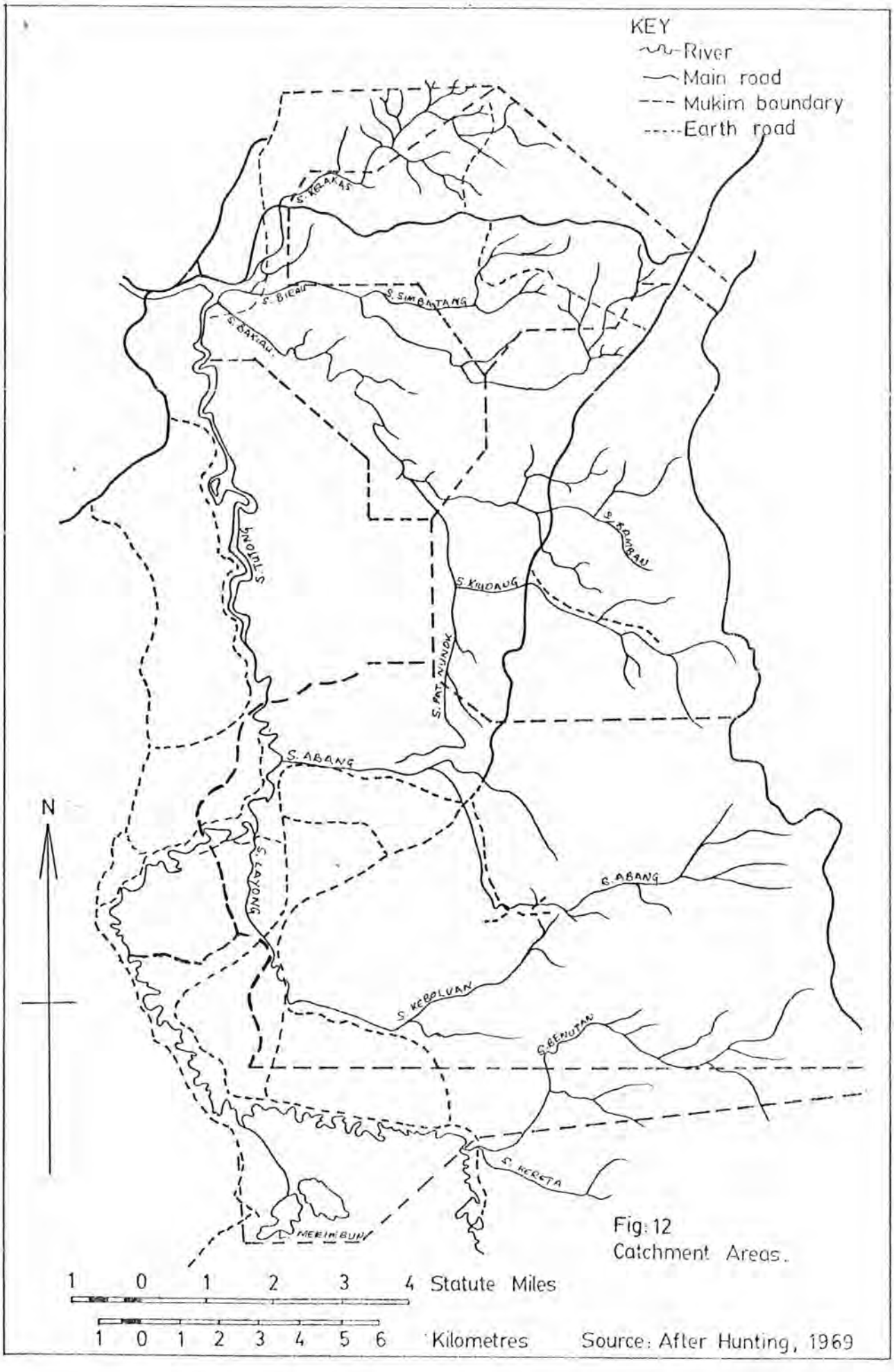


Fig: 12
Catchment Areas.

Source: After Hunting, 1969

TABLE 15. Quality of House Type be Ethnic Group and Location

Ethnic Group	Concrete	Wood Board	Kajang
		Percentage	
Malay	7	86	7
Kedayan	5	84	11
Other Indigenous	1	79	20
Chinese	3	90	7
Mukim			
Rambai	0	80	20
Keriam	15	82	3
Lamunin	5	83	12
Kiudang	0	82	18
Tutong	12	88	0
Total	4	84	12
Number	26	554	79

There is a transition from a high proportion of concrete block and concrete frame houses to more traditional wooden houses with plaited matting or kajang walls the further away from the paved road the house is situated. Concrete framed houses are only found in villages on or adjacent to the main highway. However, whether this more modern housing is related to the availability of materials and services, whether those individuals with local status and capital obtained road-side plots, or whether road-side occupation has given a greater opportunity of cash employment on a full-time basis is not known: a combination of all three is suspected.

The provision of services is also concentrated towards those living by the highway. In the case of electricity, only 24 per cent of the houses in the project area had a domestic electricity supply and only three households out of these 159 had their own generating sets; the rest tapped the central supply. There was also a gradation in the sophistication of water supply facilities. 97 per cent of families living near to Tutong town had a supply of piped water, either in or close to the house, 66 per cent of those along the highways had a well or spring nearby, whilst the majority of those living

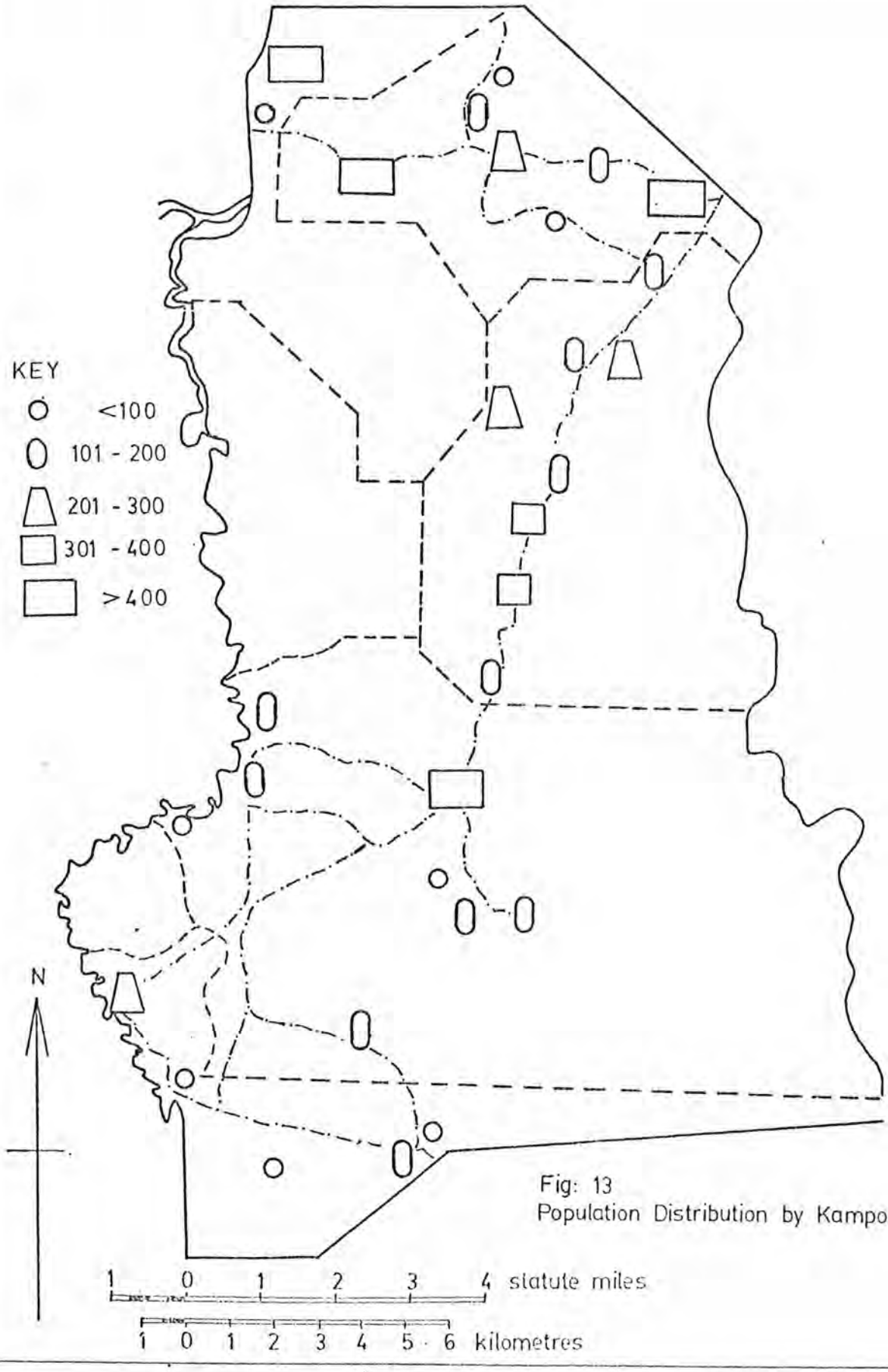


Fig: 13
Population Distribution by Kampong.

away from the roads only had access to a river or stream.

Domestic sanitation was again only found along the main road with 92 per cent of those living near the Tutong to Bandar Seri Begawan highway having some form of sanitation, 47 per cent of those living adjacent to the Lamunin road having some domestic sanitation and only three per cent of those households away from these two roads being similarly served. A summary of service distribution by nearness to the paved highways is shown in Table 16 and illustrated in Figure 9.

TABLE 16. Distribution of Services in Relation to Distance from Paved Highway

	Roadside	Trackside	Limited access
		Number	
Concrete housing	26	0	0
Wooden housing	340	122	92
Kajang housing	5	26	48
Electricity supply	148	8	3
Piped or well water supply in or near the house	307	9	2
Domestic sanitation	341	70	4

Ownership of vehicles is shown in Table 17.

TABLE 17. Ownership of Different Classes of Vehicles by Mukim

Mukim	Nil	Bicycle	Motorbicycle	Car	Truck	Marine Engine
			Number of Households			
Rambai	18	28	6	0	1	3
Keriam	32	44	12	65	1	0
Lamunin	42	90	10	33	0	2
Kiudang	58	109	10	31	0	0
Tutong	12	12	3	36	0	1
Total	162	283	41	165	2	6

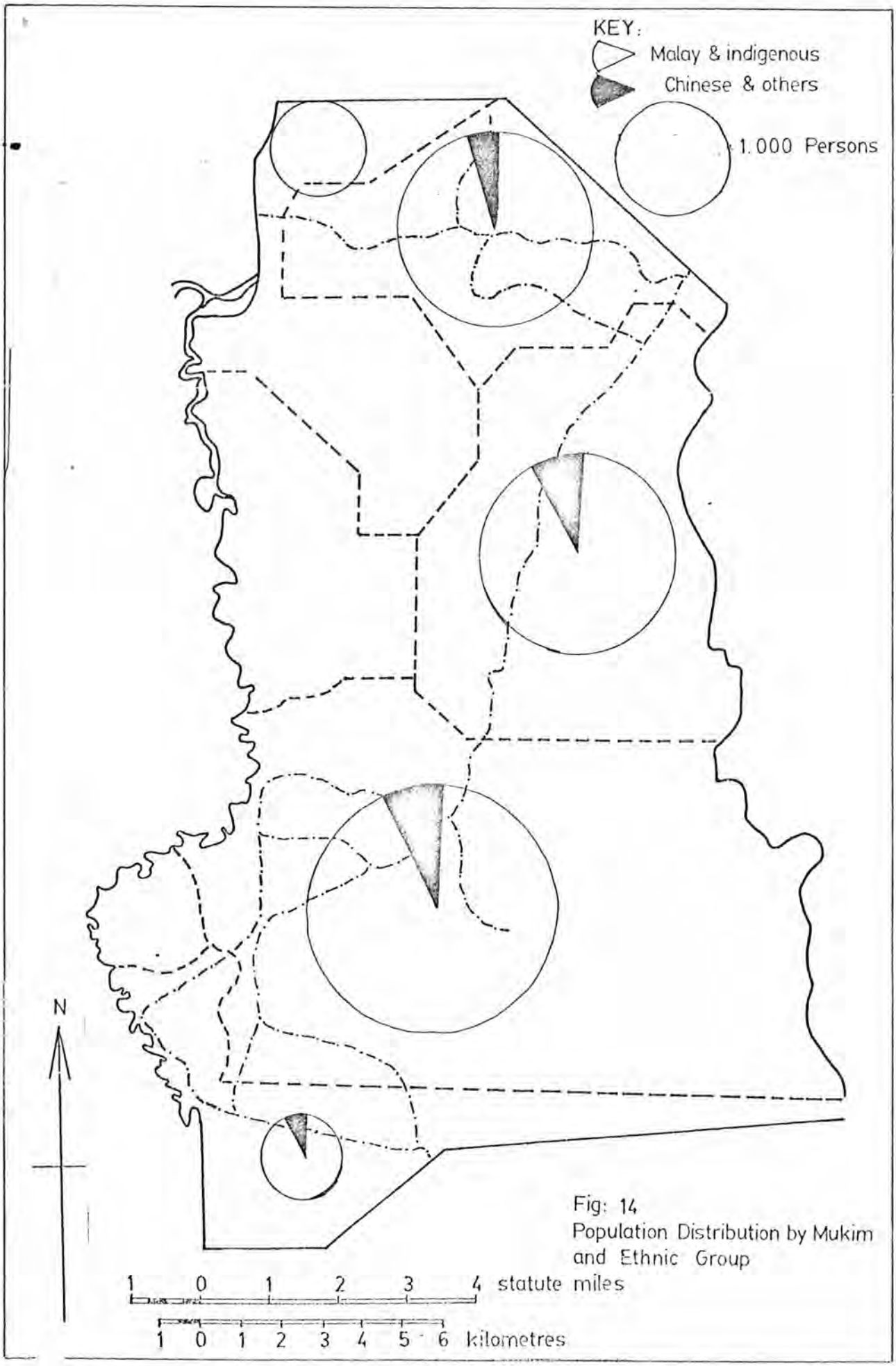


Fig: 14
Population Distribution by Mukim and Ethnic Group

3.5 Land Tenure Status

Extrapolated figures from the survey showed that nearly 1,300 hectares of land was held under EDR (Extract from District Records) leaseholds within the project area by resident householders. The average size of these boldings was 1.80 hectares although there was a considerable range in mean sizes between Mukims. The details are given in Table 18.

TABLE 18. Average Size of Holdings Held under EDR Lease by Mukim

Mukim	Households reporting EDR leaseholds	Percentage	Holding size (hectares)
Rambai	46	82	2.57
Keriam	99	64	1.06
Lamunin	133	75	2.20
Kiudang	141	68	1.71
Total	419	64	
Average	-	-	1.80

There are also considerable areas of land in the project area held under lease to individuals not resident in the area. These were estimated as adding approximately a further 400 hectares making a total of 1,700 hectares held under this form of tenancy. Further data from the survey showed that only 40 per cent or 680 hectares of this area was currently under cropping. Most of the remainder was under secondary forest, belukar, following hill rice or under moribund seedling rubber.

Information from the survey indicated that there was 1,071 holdings leasing land under TOL licences (Temporary Occupation Licences) within the project area. Each had an average of 0.72 hectares giving a total for the area of 770 hectares. However this conflicted severely with the District Office records for although the average holding size was comparable (0.77 hectares) the number of registered licences in the area was only 613, giving a total of 472 hectares.

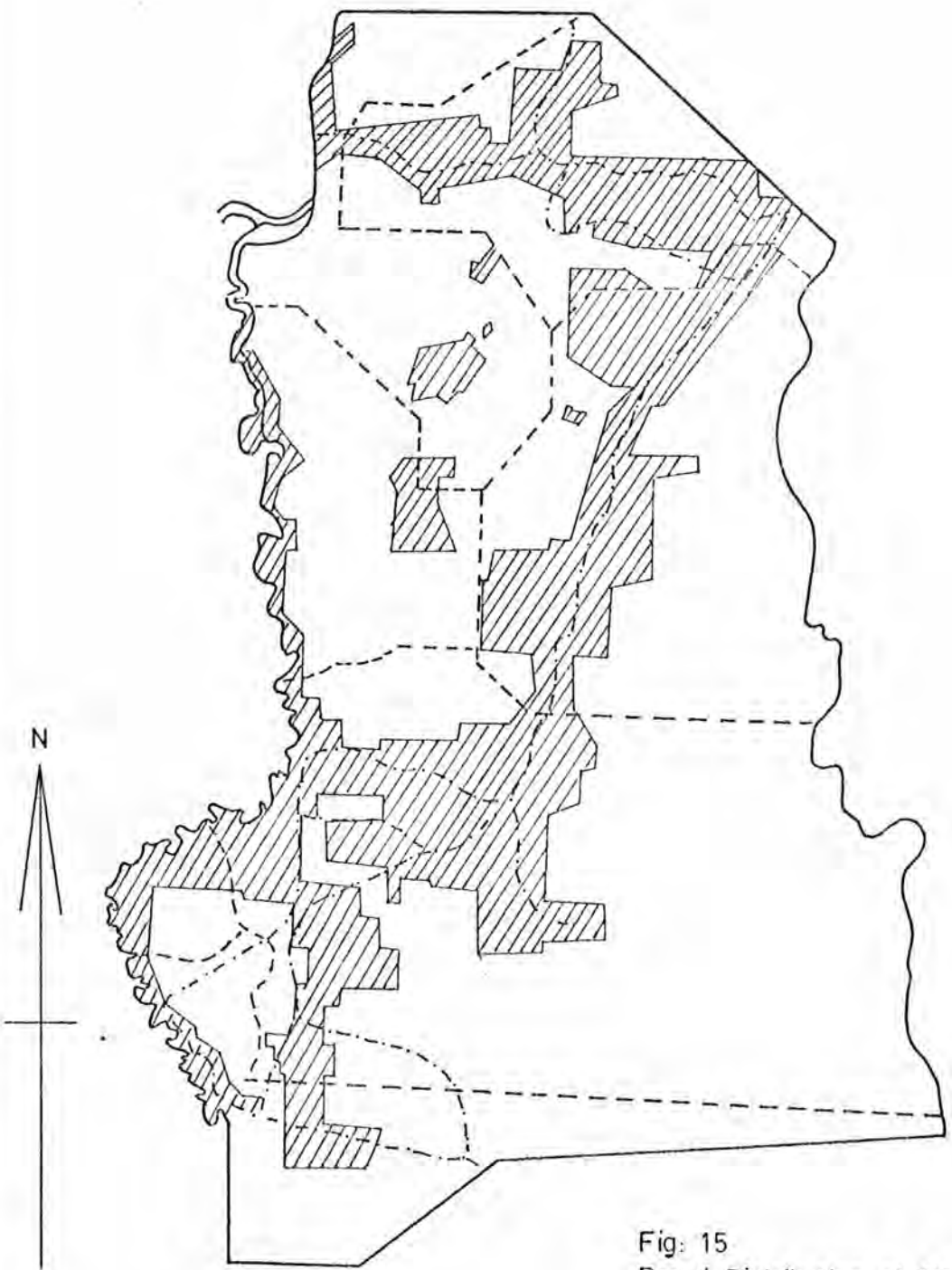


Fig: 15
Broad Distribution of EDR Land Throughout Project Area.

1 0 1 2 3 4 Statute Miles

1 0 1 2 3 4 5 6 Kilometres

Source: After Survey Department Brunei, 1967

TABLE 19. Number and Size of TOL Holdings by District Records

Mukim	Number of licences	Averages Size (hectares)
Rambai	27	1.13
Keriam	204	0.50
Lamunin	120	1.42
Kiudang	102	0.93
Tutong	160	0.50
Total	613	472.00
Average	-	0.77

Source: District Lands Officer, Tutong, personal communication, 1975.

This discrepancy appears to be due to misreporting by householders who are currently farming, without a licence, land which had previously been held under TOL. Details, by Mukim, from the District Register are given in Table 19 and illustrated in Figure 15. The three categories of land covered 2,470 hectares, 7.5 per cent of the total project area.

The distance of these holdings from the home and the split of holdings into differently situated, and tenurally held parcels was difficult to estimate. All that can confidently be said is that in about half the situations (52 per cent) the major area under cultivation was situated around the house, in 38 per cent of the cases it was up to one mile from the house and in the remaining 10 per cent of situations it was more than one mile away from the home.

The labour available to work on these holdings was restricted to that available in the household; nowhere within the project area was non-family labour employed. This gave a full-time family labour of one labour unit per farm with one or two part-time workers available during the agricultural labour bottlenecks of the rice season.

3.6 Traditional Agricultural Practices

Tutong District is currently considered as one of the major rice growing areas in the State. Total area in the District under

rice at the time of the survey was estimated by the Department of Agriculture at 806 hectares of swamp rice and 355 hectares of hill rice. On a project area basis this would mean that there was an estimated total of 627 hectares under rice.

Table 20 shows that for the Malay, Kedayan and other indigenous peoples the percentage of their holdings devoted to rice was only slightly more than that devoted to fruit trees, with the areas under vegetables a poor third. Only in the case of the Chinese population was rice production not dominant. They concentrated more on vegetables and fruit trees.

TABLE 20. Percentage of Farmed Land Devoted to Worked Crops by Different Ethnic Groups

Ethnic Groups	Rice	Rubber (tapped)	Vegetables(1)	Fruit Trees	Sago
	Percentage of cultivated area				
Malay	43	0	18	39	0
Kedayan	41	0	25	33	1
Other Indigenous	43	1	18	26	12
Chinese	7	0	65	23	5
Average(rounded)	40	0	20	35	5

(1) Including cash crops such as sweet corn.

The season for growing rice traditionally extends from September until March, after which the land is left fallow until the following season and small-holders grow vegetables and other cash crops on areas of land which have not been cultivated during the preceding seven months. Fruit trees (rambutans, mango and several cultivars of citrus) are grown under semi-wild conditions, often only being tended during the establishment phase and at annual harvest.

TABLE 21. Distribution of Productive Crop Areas by Mukim

Mukim	Rice	Vegetables	Fruit Trees	Sago
	Percentage of cultivated area			
Rambai	71	5	22	2
Keriam	40	34	26	0
Lamunin	31	30	32	7
Kiudang	35	29	31	5
Tutong	55	8	37	0

In the same way, when total production is considered using a financial measure (in order to compare the gross production values of different crops) the highest average gross household product in the case of the Malays, Kedayans, and other indigenous peoples is obtained from rice, with vegetables and fruit trees competing for second place. However, for the Chinese, a much larger proportion of the income is obtained from vegetables with fruit trees as a further important source of cash income. Details are given in Table 22.

TABLE 22. Household Gross Crop Production expressed in Brunei Dollars at 1973 Harvest Prices

	Rice	Vegetables	Fruit Trees	Sago	Other
	B$ per holding for those households reporting				
Malay	311	179	253	-	165
Kedayan	354	332	282	-	132
Indigenous	308	195	193	177	123
Chinese	306	2,349	471	-	183

The conformity in production income from rice growing masked some extremes at the margins. Thirteen per cent of the households interviewed did not grow rice at all and five per cent (30 households) had a gross production exceeding B$800 per annum. Of these highest level producers 12 came from Mukim Keriam, seven from Mukim Lamunin, six from Mukim Kiudang, five from Mukim Rambai. Not only were these producers found in discrete areas but also they were usually neighbours. Also, these highest level producers were farmers with mixed holdings, larger than average families, generally poor living conditions and some (but limited) off-farm earnings.

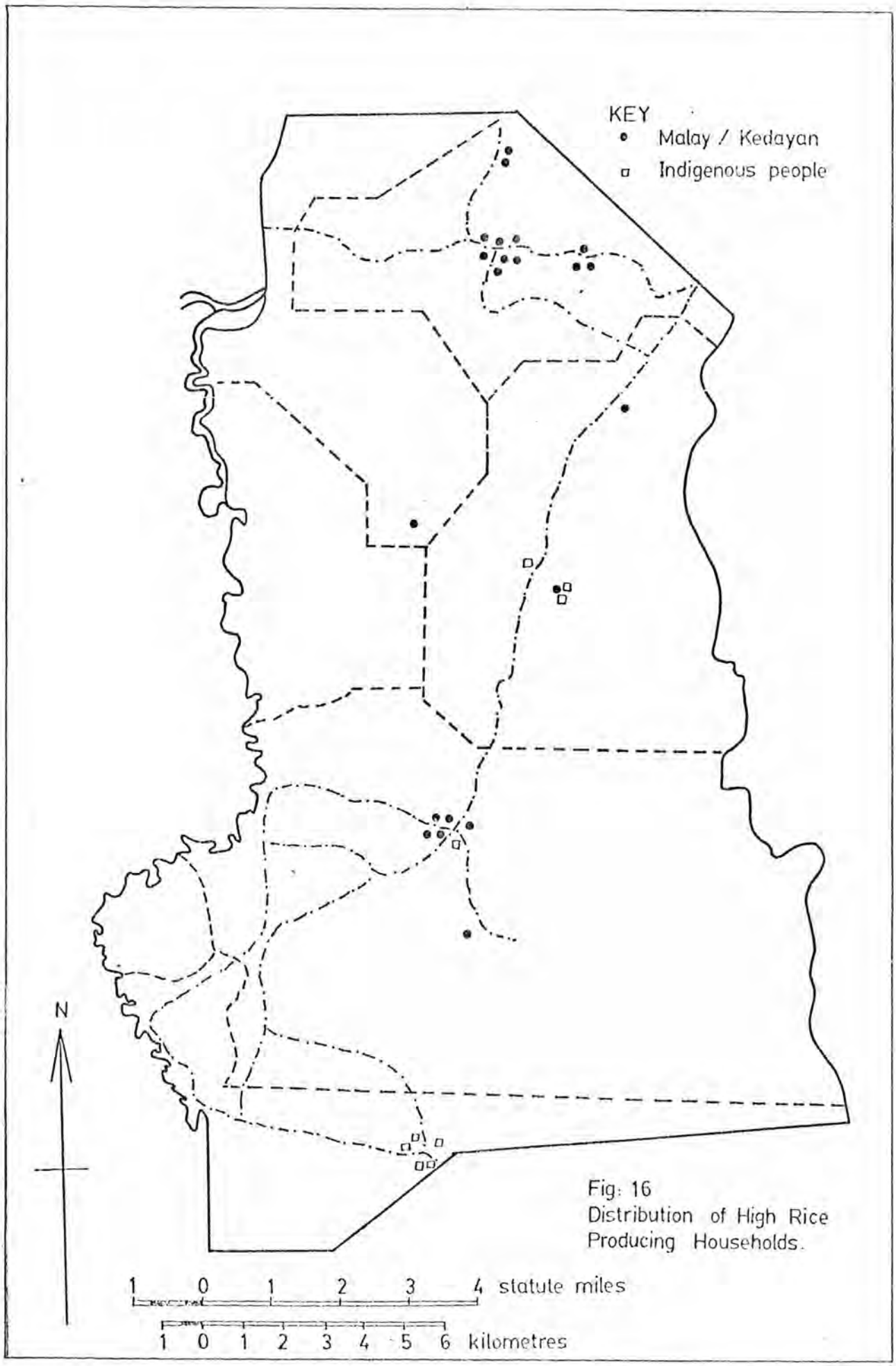


Fig: 16
Distribution of High Rice Producing Households.

The average total production income from rice of these 30 holdings at standard Government prices was B$977/year. The ethnic split of these producers was 50 per cent Malay, 30 per cent indigenous peoples and 20 per cent Kedayans with no particular orientation of ethnic group to location. For the distribution within the project area see Figure 16. The average production income from rice of the remaining 82 per cent of households growing rice was in the region of B$200 per year.

Of the 86 non rice-growing households, 64 were Malays and indigenous peoples and the remaining 22 were Chinese. Just less than half of the latter group (nine households) were major producers of vegetables and individual Chinese families were high producers of pigs and poultry. Table 23 lists the reasons given by households not growing rice.

TABLE 23. Reasons Expressed by Households not Growing Rice

Reasons	No. of households
1. High non-farm income	29
2. High farm income	26
3. No labour in family	8
4. Gifts/Capital	6
5. No land available	5
6. Reason unclear	12
Total	86

The selling of paddy was not a normal practice and did not contribute in any sizable way to the community income. Only 26 households (4%) from the whole sample sold any paddy during the year, 14 from the high producing group (two of whom sold paddy to a value of more than B$800 per year) and the remainder from the lower production group. Estimated family income for the whole selling group was B$290 or approximately B$200 when the major sellers were excluded. None of the sellers was Chinese and only six were indigenous peoples; by far the majority (19) were Malays or Kedayans living in Mukim Keriam and Mukim Lamunin. However, one of the two householders selling more than B$800 worth per year was an indigenous inhabitant living in Kampong Benutan, Mukim Rambai.

The fluctuation in the value of fruit tree and vegetable production per household per year was even greater than that in rice production. To take vegetable production first, 376 households (57 per cent of the sample) did not grow any vegetables and, of the remaining 283 households, 260 families had an average annual production valued at only B$115, leaving the other 23 families (4%) of the sample with an average production income of B$3,559 per household per year. Of these high producers, 10 were Chinese, eight Malays and Kedayans, and five indigenous. The main production area was Mukim Kiudang where just over half of the high producers lived.

Of the households growing vegetables, only 129 sold any of their produce with the 23 high producers all high sellers with an average sales value of B$3,390 per year each, excluding a per household vegetable consumption valued at B$170 per year. At current wholesale prices this must be considered as an under-estimate of the value of actual consumption by the average sized family.

The remaining 106 sellers were divided into those selling less than B$200 worth per annum and those selling between B$200-B$800 worth per annum. Details of the ethnic and location distribution of these two groups are shown in Table 24 and Figure 17. These commercially orientated vegetable growers cannot easily be distinguished from their neighbours. However, they have the availability of land and willingness to allocate labour to the enterprise even perhaps to the detriment of their off-farm income potential. However, they are not, bar one, mixing their vegetable growing with poultry or pig rearing on any scale and have lower than average capital and fixed assets.

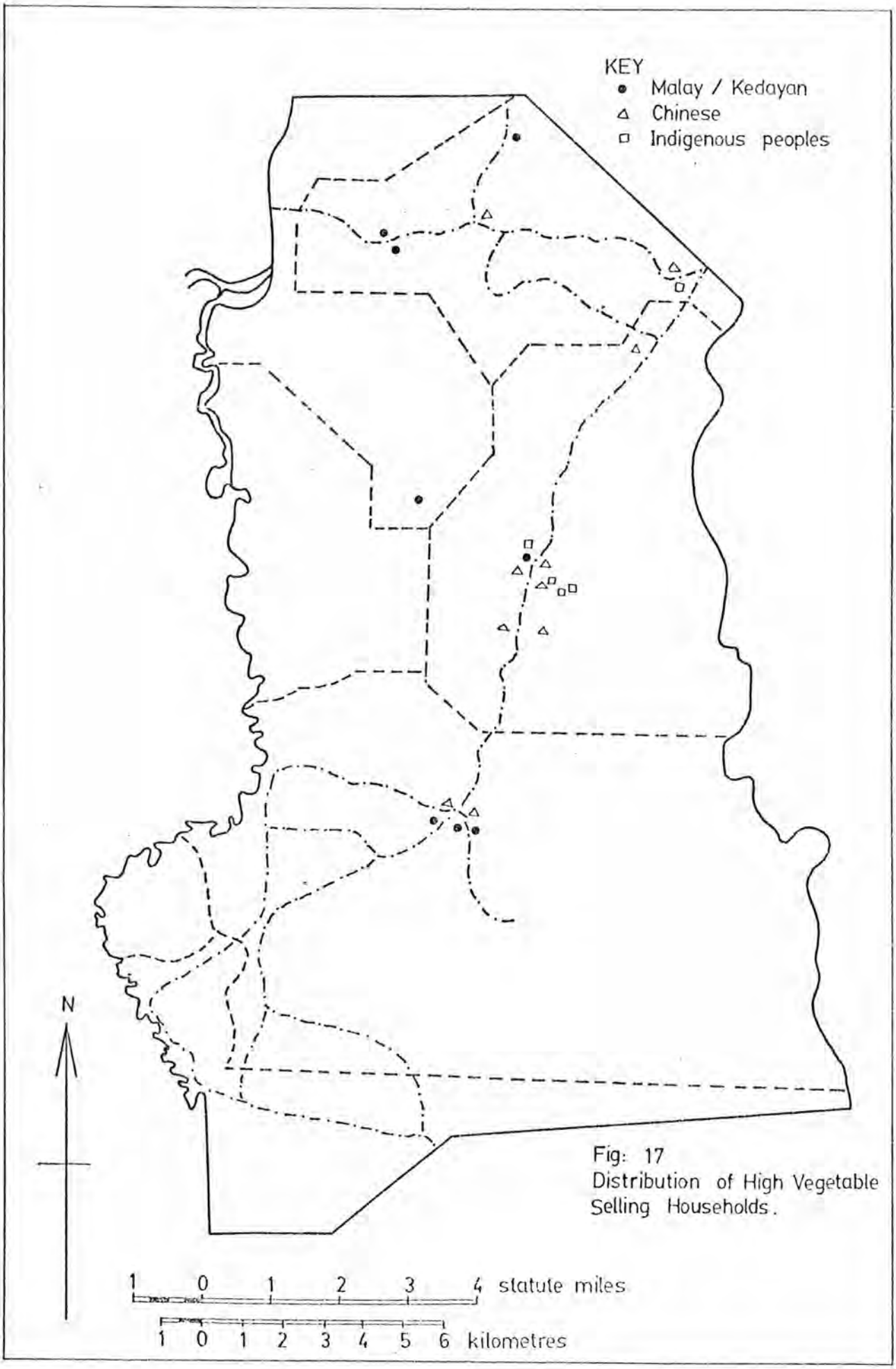


Fig: 17
Distribution of High Vegetable Selling Households.

TABLE 24. Distribution of Households Selling Vegetables by Mukim and Ethnic Group

Sale value	More B$800	B$200-800	Less B$200
Number of households selling	23	23	83
Average sale value (B$)	3,390	368	63
Distribution by Mukim (Number)			
Rambai	0	0	3
Keriam	6	1	22
Lamunin	5	11	31
Kiudang	12	11	25
Tutong	0	0	2
Distribution by ethnic group (Number)			
Malay	7	6	30
Kedayan	1	3	30
Indigenous	5	10	21
Chinese	10	4	2

Another contribution to the households' farm income was from fruit production. The smallholder pattern here differed from vegetables in that a large proportion (93%) of households grew some fruit and also more than twice the number of vegetable growers i.e. 7 per cent of the sample or 49 households, reported that the value of their production exceeded B$800 per annum. Their average production value was B$968 whilst that of the other producers was B$267.

When it came to sales, a much lower proportion of the producers sold their crop in the market. A proportion of the crop might have been given away to friends and relations but the majority of the household production appeared to be consumed by family members. Of those who did sell, 27 households had sales exceeding B$800, 61 had sales of B$200-B$800, and 152 households had sales of up to B$200. The distribution of these by Mukim and ethnic group is given in Table 25 and illustrated in Figure 18.

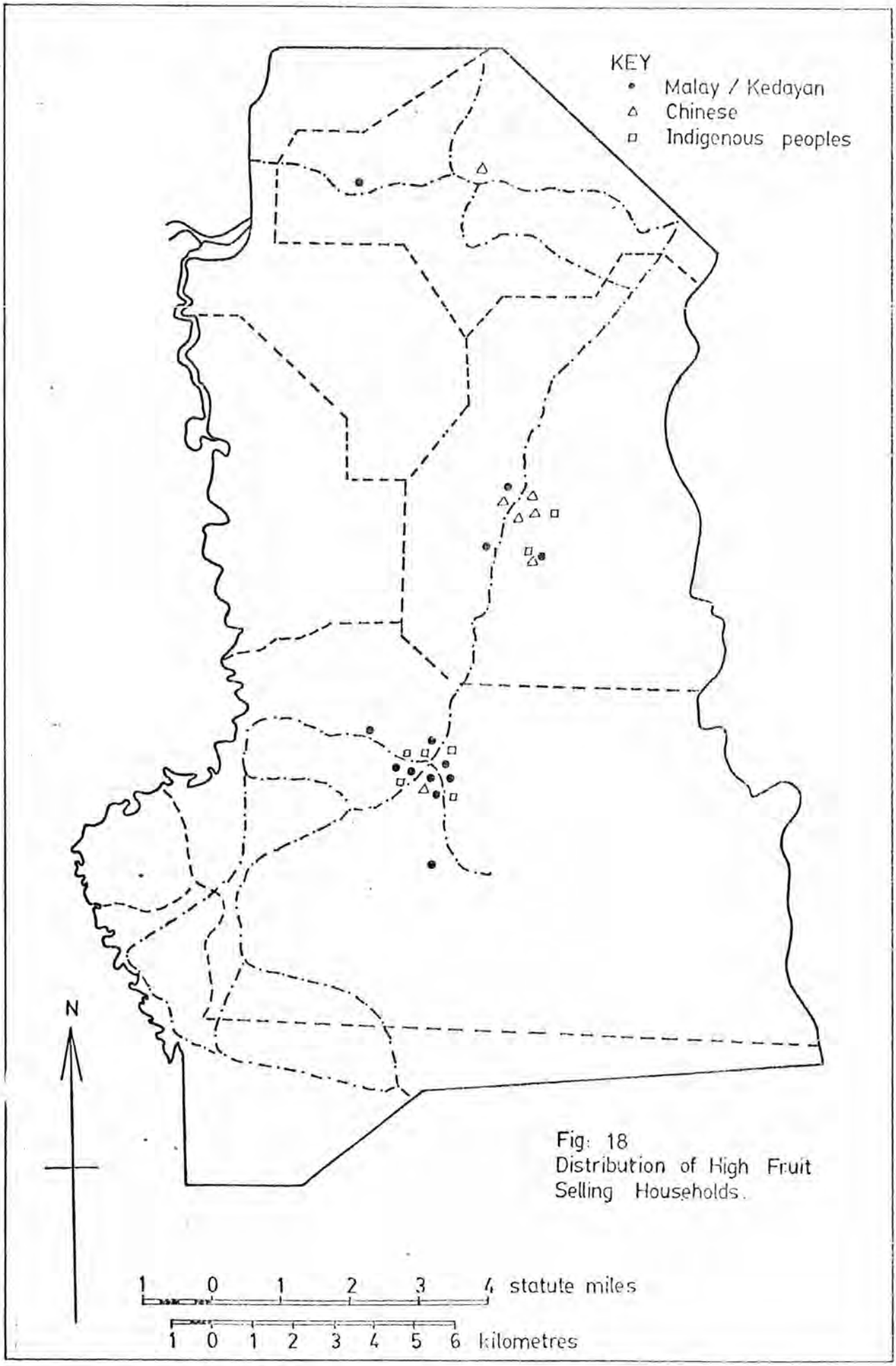


Fig: 18
Distribution of High Fruit Selling Households.

TABLE 25. Distribution of Households Selling Fruit by Mukim and Ethnic Group

Sale value	More B$800	B$200-800	Less B$200
Number of households selling	27	61	152
Average sale value (B$)	974	374	53
Distribution by Mukim (Number)			
Rambai	0	0	5
Keriam	2	11	32
Lamunin	17	26	44
Kiudang	8	22	62
Tutong	0	2	9
Distribution by ethnic group (Number)			
Malay	8	28	52
Kedayan	5	16	40
Indigenous	7	13	54
Chinese	7	4	6

Fruit sellers, bar the one farmer mentioned in the discussion on vegetable production, did not mix their production with livestock. There was even little complementarity between fruit trees and vegetable production as only 20 per cent of the households selling B$200 worth or more of fruit sold a similar value of vegetables.

Sago was the most important minor crop and was produced by 45 reporting households in the project area. All but three of these either felled the occasional palm to sell as logs to the local sago mill or used the fresh rasped material for feeding their own pigs. Their average production value was only B$123 per year. Of the remaining three households, two produced sago for starch and had an average production income of B$6,600 and a sales income marginally lower at B$6,500 whilst the third used 89 per cent of their production, valued at B$42,800 per year, as a source of pig food. Forty-three of the families producing sago lived in the Mukims of Lamunin, Kiudang or Rambai and those who sold any material lived in either Mukim Kiudang or Mukim Lamunin.

Just over 20 per cent of the households also grew "something else". Although covering a wide range of possibilities outside the previously defined rice, vegetables, fruit trees and sago this category of "Other Crops" within the project area constituted mainly maize. This was a local cultivar which, although sold as sweet corn, had almost certainly become crossed with feed-corn cultivars at some stage in recent history. The production income of these 133 households averaged B$173 per year, a figure which - as in the majority of these analyses - masked a small high production group from the majority of producers.

In this instance the fourteen top producers had a production income of B$821 and the rest, one of B$97. However, this did not mean that the high producers were the main sellers in the community; no grower sold maize to the value of more than B$800 and only four had sales of between B$200-B$800: their average being B$698. The remaining 49 sellers had an average sales income of only B$97.

3.7 Livestock Practices and Patterns

The number and distribution of large livestock recorded within the project area showed little relationship to data collected during previous livestock censuses carried out by the Department of Agriculture. The extrapolated numbers of buffalo and cattle reported by situation in the project area and from the 1973 census are shown in Table 26. The reason for this disparity is that the figures for the 1973 Government census were largely raised from annual reports and office discussions (Woodroofe, personal communication, 1977), whereas the project area data were obtained from interviews in the field.

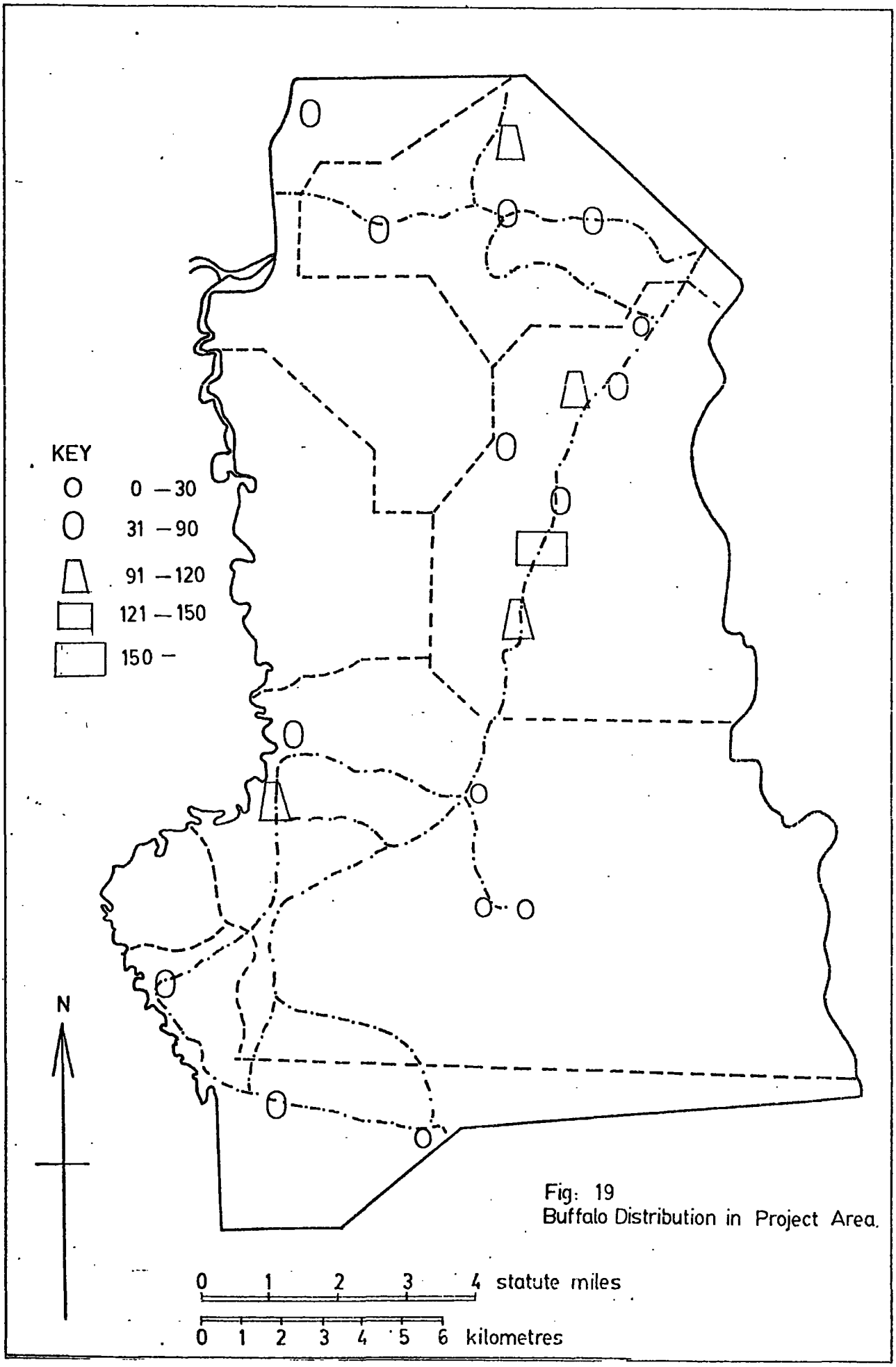


Fig: 19
Buffalo Distribution in Project Area.

TABLE 26. Comparison of Agricultural Census and Project Area Extrapolated Sample Large Livestock Population

Mukim	1973[1] Census		Extrapolated Sample		Census / Sample x 100	
	Buffalo	Cattle	Buffalo	Cattle	Buffalo	Cattle
Rambai	135	76	122	60	111	127
Keriam	412	84	431	119	96	71
Lamunin	214	50	349	49	61	102
Kiudang	754	72	997	67	76	107
Tutong	38	52	16	116	238	45
Total	1,533	334	1,915	411	-	-
Average					81	81

(1) Source: District Agricultural Officer, Tutong personal communication, 1975.

Only 46 per cent of the households reported owning buffaloes and nine per cent reported owning cattle giving a total project area livestock population of 1,915 buffalo and 411 cattle. There were, however, concentrations of buffaloes in Mukim Kiudang and cattle in Mukim Keriam, Mukim Pekan Tutong and Mukim Kiudang. (Figures 19 and 20)

TABLE 27. Project Survey Buffalo Census by Situation and Owner

Ethnic Group	More than 4		1 - 4	
	No.	%	No.	%
Malay	24	8	99	35
Kedayan	9	7	60	50
Indigenous	46	22	48	23
Chinese	4	10	12	30
Mukim				
Rambai	4	7	13	23
Keriam	18	12	49	32
Lamunin	14	8	72	40
Kiudang	47	23	79	38
Tutong	0	-	6	9
No. households	83	13	219	33
Average	9.2		1.8	
Total Population	764		394	

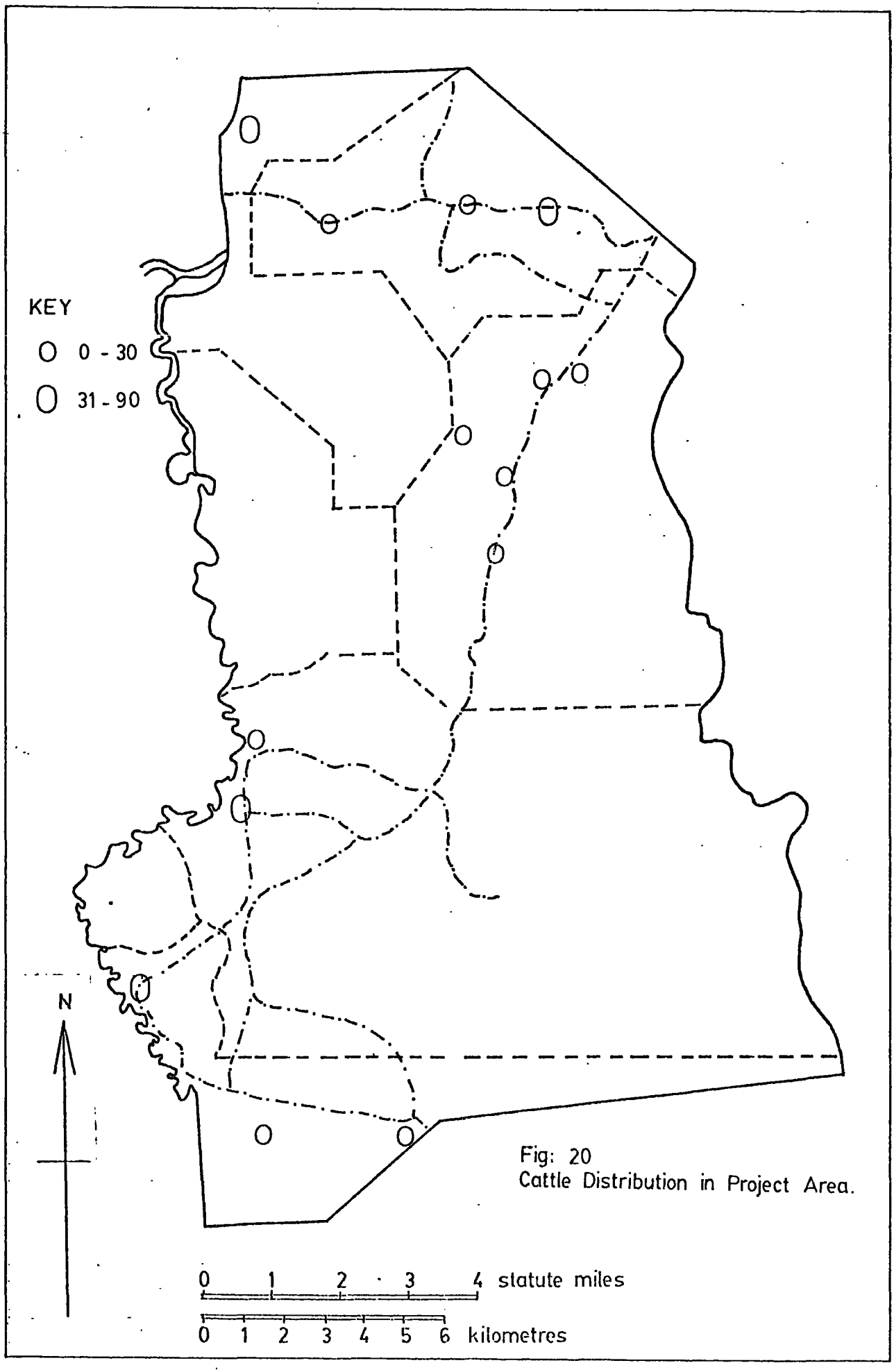


Fig: 20
Cattle Distribution in Project Area.

TABLE 28. Project Survey Cattle Census by Situation

Ethnic Group	More than 4		1 - 4	
	No.	%	No.	%
Malay	14	5	25	9
Kedayan	0	-	0	-
Indigenous	8	4	13	6
Chinese	0	-	1	2
Mukim				
Rambai	3	5	4	7
Keriam	4	3	15	10
Lamunin	4	2	4	2
Kiudang	4	2	5	2
Tutong	7	11	11	17
No. Households	22	3	39	6
Average	7.2		2.4	
Total Population	158		93	

These figures give a project area estimated population of 2,326 head of large livestock. Although no sex or age determination was enumerated in the survey, both the 1964 Agricultural Census and the 1973 Department of Agriculture Livestock Census show a preponderence of female stock in a ratio of 2:1 to males. This would mean a population of about 1,550 females in the project area.

Allowing for the long gestation period of the buffalo, probably a long calving interval in both cattle and buffalo verging in many cases to almost barren stock and a high calf mortality, there should be an estimated 270 calves weaned per year. However, neither do the livestock population levels appear to be rising nor did the survey bring to light sales which equated in any way with the postulated rearing figures. Details of sales obtained during the survey averaged less than a head per year from the fifty households in the project area reporting sales.

TABLE 29. Buffalo and Cattle Sellers by Situation and Ethnic Group

Mukim	Number	B$/yr./house
Rambai	3	550
Keriam	22	635
Lamunin	5	556
Kiudang	20	779
Tutong	0	-
Total	50	
Ethnic Group		
Malay	24	709
Kedayan	4	460
Indigenous	21	706
Chinese	1	400
Total	50	
Average		680

Although 93 per cent of the households interviewed kept some poultry around their houses, only 76 had any surplus to their household requirements. The average income for those reporting sales was B$390 per annum. However, there was a large discrepancy within the group between the four major producers and the rest. Details by category are given, followed by details of net product per bird from these major growers (Tables 30 and 31).

TABLE 30. Poultry Average Income by Seller Group

Annual Income Group (B$)	No. Households Reporting	Average Income B$/Year
> 800	4	5,700
200-800	11	318
< 200	61	115

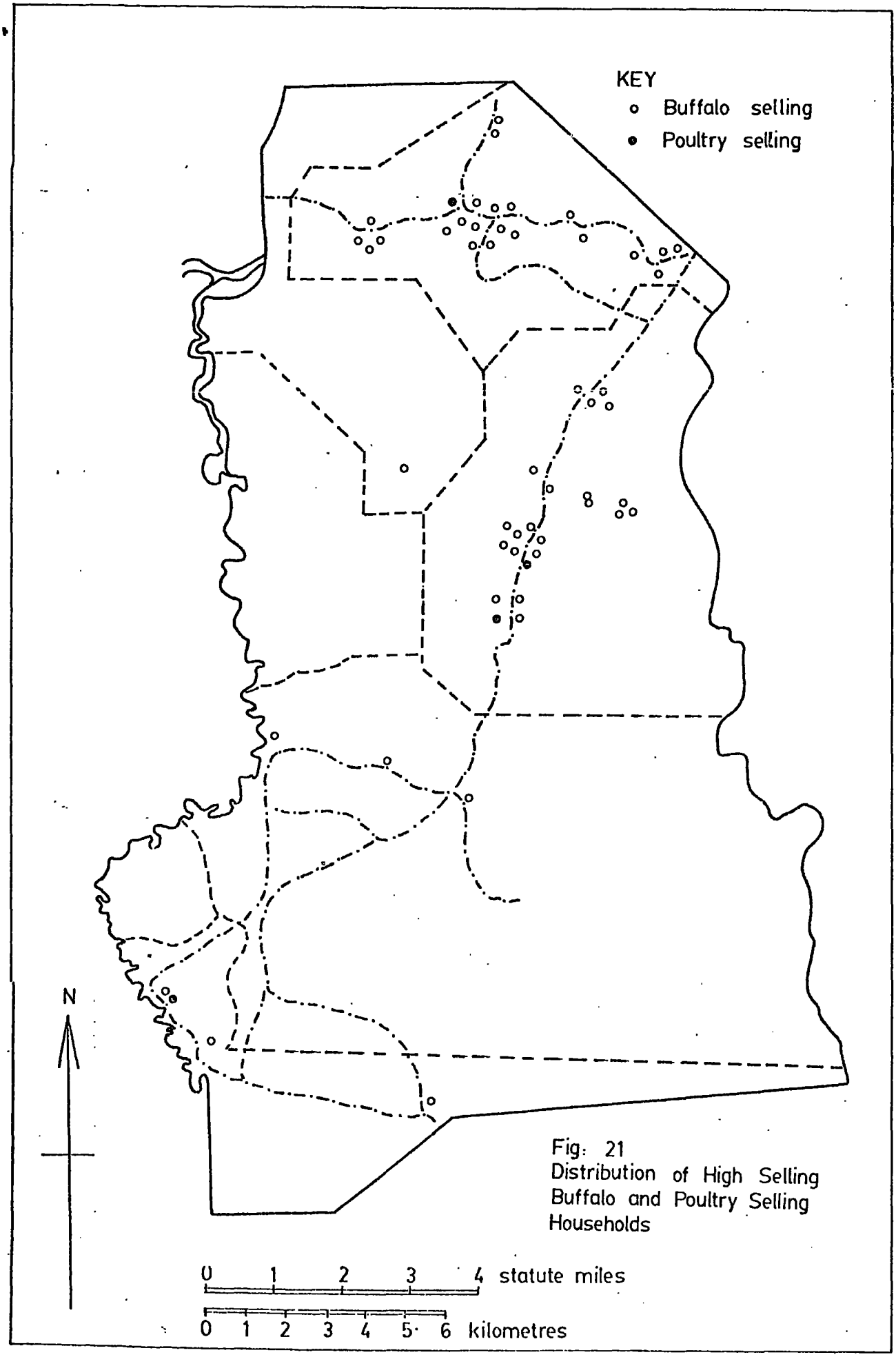


Fig: 21
Distribution of High Selling Buffalo and Poultry Selling Households

TABLE 31. Net Product of Main Chicken Farmers in Project Area

Mukim	Ethnic Group	No. birds	Net product (B$/yr)	
			per flock	Per bird
Rambai	Chinese	1,600	5,100	3.19
Keriam	Malay	2,000	No data available	
Kiudang	Chinese	4,000	14,700	3.68
Kiudang	Chinese	1,000	3,000	3.00

Other livestock enterprises represented within the area were pigs and goats. The production and income within the area from the latter was so small that it is not included in this report but there was a limited production of fat pigs by 143 households, 67 per cent of which were sellers. Their net product by income group is detailed in the table below. The distribution of the households selling livestock is shown in Figure 21.

TABLE 32. Pig Average Income by Seller Group

Annual Income Group (B$)	No. Households Reporting	Average Income B$/Year
▷ 800	15	No data
200-800	57	399
◁ 200	24	112

3.8 Summary of Pattern of Sales

The overall pattern of agricultural sales has shown itself as one where a limited number of farmers scattered throughout the project area are producing goods for the market whilst a far larger proportion are producing for home consumption and a small number although situated in the rural environment have no production at all. Table 33 shows the proportion of these farmers for each of the range of major crop and livestock enterprises within the area.

TABLE 33. Summary of Reporting Households Producing and Selling Crops and Livestock

	Producing & Selling		Selling		Producing Not Selling		Not Producing	
	No.	%(1)	No.	%(2)	No.	%(2)	No.	%(1)
Rice	573	87.0	26	4.5	547	95.5	86	13.0
Vegetables	283	42.9	129	45.6	154	54.4	376	57.1
Fruit	614	93.2	240	39.1	374	60.9	45	6.8
Sago	45	6.8	9	20.0	36	80.0	614	93.2
Others	133	20.2	53	39.8	80	60.2	526	79.8
Buffalo/Cattle	363	55.1	50	13.8	313	86.2	296	44.9
Pigs	143	21.7	96	67.1	47	32.9	516	78.3
Chickens	612	92.9	76	12.4	536	87.6	47	7.1

(1) Percentage of sample.

(2) Percentage of those producing.

TABLE 34. Number of Selling Households Reporting by Ethnic Group and Income Value

> B$800	Rice	Vegetables	Fruit	Sago	Others	Buff./Cattle	Chickens	Pigs
Malay	1	7	8	-	-	10	1	-
Kedayan	-	1	5	-	-	-	-	-
Indigenous	1	5	7	1	-	7	-	8
Chinese	-	10	7	1	1	-	3	7
B$200 - 800								
Malay	7	6	28	-	5	14	3	-
Kedayan	-	3	16	-	1	4	2	-
Indigenous	2	10	13	2	8	14	6	53
Chinese	-	4	4	-	-	1	-	4
< B$200								
Malay	5	30	52	-	11	-	19	-
Kedayan	6	30	40	1	12	-	9	-
Indigenous	4	21	54	4	14	-	33	24
Chinese	-	2	6	-	1	-	2	-
No Sales								
Malay	275	245	200	288	272	264	265	288
Kedayan	116	88	61	121	109	118	111	122
Indigenous	202	173	135	202	187	188	170	124
Chinese	40	24	23	39	38	39	35	29

TABLE 35. Number of Selling Households Reporting by Mukim and Income Value

> B$800	Rice	Vegetables	Fruit	Sago	Others	Buff./Cattle	Chickens	Pigs
Rambai	1	-	-	-	-	1	1	5
Keriam	1	6	2	-	-	7	1	1
Lamunin	-	5	17	1	1	-	-	2
Kiudang	-	12	8	1	-	9	2	7
Tutong	-	-	-	-	-	-	-	-
B$200 - 800	2	-	-	-	1	2	3	18
Keriam	3	1	11	-	3	15	1	4
Lamunin	4	11	26	-	3	3	-	16
Kiudang	-	11	22	2	6	13	6	19
Tutong	-	-	2	-	1	-	1	-
< B$200								
Rambai	-	3	5	-	1	-	8	12
Keriam	7	22	32	-	7	-	16	-
Lamunin	4	31	44	2	9	-	13	7
Kiudang	4	25	62	3	20	-	26	5
Tutong	-	2	9	-	1	-	-	-
No Sales								
Rambai	53	53	51	56	54	53	44	21
Keriam	143	125	109	154	144	132	136	149
Lamunin	169	130	90	174	164	174	164	152
Kiudang	204	160	116	202	182	186	174	177
Tutong	64	62	53	64	62	44	63	64

Apart from the subsistence enterprises of rice, buffalo/cattle and chicken, with a high number of households producing but a low number selling, it is difficult to categorise the enterprises into producing or selling groups. In financial terms even these three have completely different characteristics with the rice a marginal sales exercise, the chicken kept by a small number of commercial and a large number of subsistence producers, and the buffalo/cattle only being financially significant because of the high value of each unit of sale. Therefore, it is necessary to look for other distinguishing criteria which can be used to define those households, areas or groups which are the most productive. In this analysis we confine ourselves to sellers and a summary of the locational and ethnic aspects of those households are tabulated in Tables 34 and 35.

From this a number of generalised interpretations can be made.

(i) Isolated individuals of all ethnic groups throughout the area sell rice.

(ii) Larger numbers of individuals sell fruit, again with a fairly even distribution between the ethnic groups.

(iii) Vegetables are sold mainly by the Kedayans and Chinese in the Mukims of Keriam, Lamunin and Kiudang.

(iv) Sago is sold almost exclusively by the indigenous people and Chinese in the Mukims of Lamunin and Kiudang.

(v) The category designated "other crops" is sold more by the Kedayans and indigenous people.

(vi) Sales of pigs are distributed throughout the area but ethnically limited to the indigenous and Chinese groups, with the emphasis on the former.

(vii) Sales of chicken follow suit, with the minority of sales in the hands of Kedayans and Malays.

This type of approach however has little interpretive use as it is picking out only individual enterprises and locations. Also, all the items of income detailed in the preceding sections are relevant only to a certain number of households in the sample. The number and distribution of these households for each enterprise within the project area are different as each household farms a different combination and intensity of enterprises which are not consistent throughout the project area. Therefore, any average figure of gross farm household income either by ethnic group or by area would not provide data that could be related to an identifiable group of farmers on the ground. What is required is an analysis of the households by gross farm income obtained from the sale of goods from any specific enterprise or combination of enterprises.

At the lower end of the spectrum there is a large number of households, 400 or 61 per cent of those surveyed, which reported a maximum of B$200 of farm sales in the year. The distribution of these by location and ethnic group is summarized in Table 36.

TABLE 36. Distribution of Households with an Income of Less than B$200 per annum from Farm Sales

Mukim	No Sales	< B$200
Rambai	27	12
Keriam	80	17
Lamunin	43	41
Kiudang	80	40
Pekan Tutong	52	8
Ethnic Group		
Malay	156	48
Kedayan	32	23
Chinese	9	4
Indigenous	85	43

The distribution of households with higher farm incomes is illustrated in Figures 22, 23 and 24.

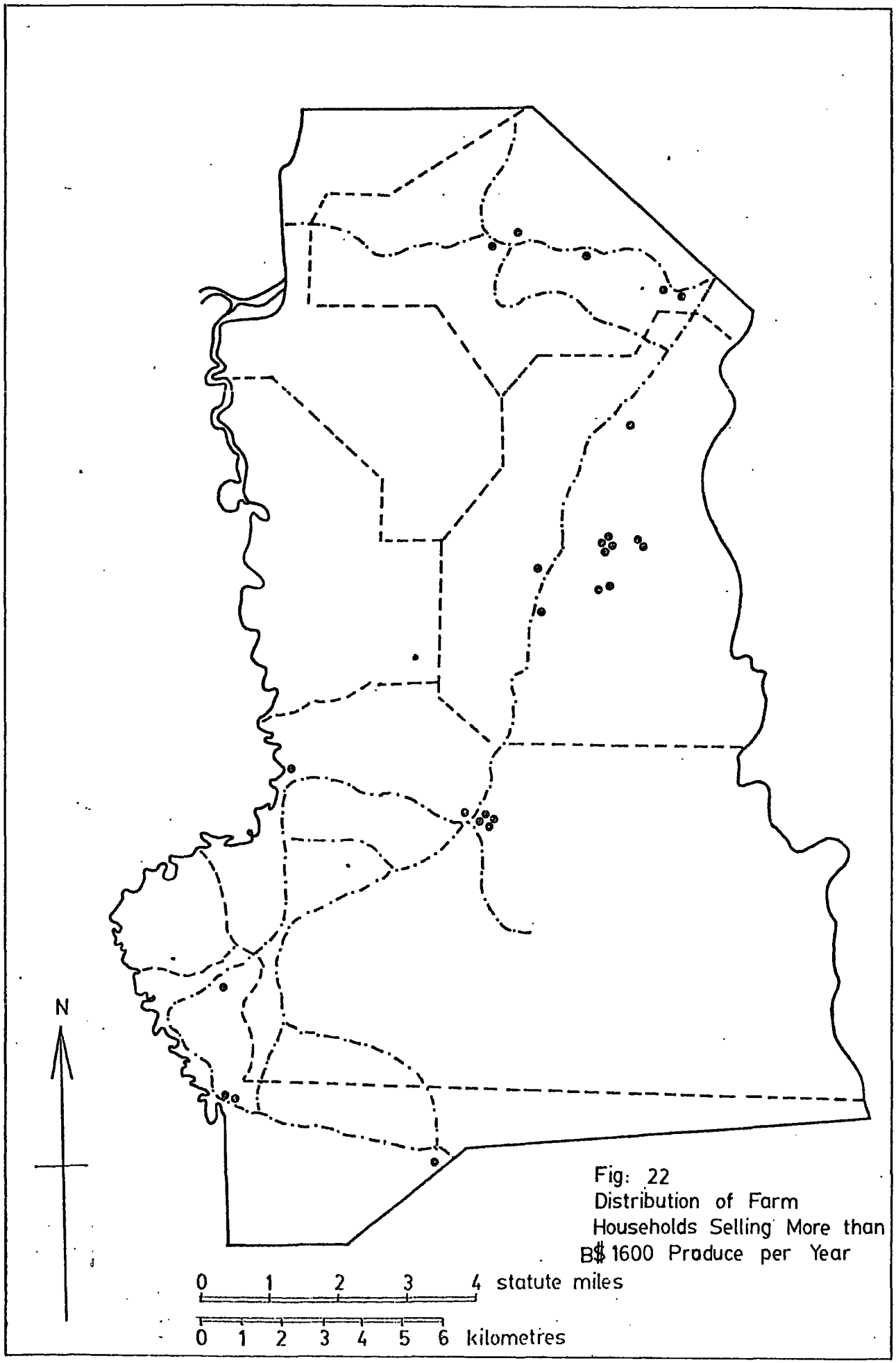


Fig: 22
Distribution of Farm Households Selling More than B$ 1600 Produce per Year

A certain locational pattern can be distinguished in relation to different levels of farm income. The higher the income obtained from the farm holding the more discrete are the units and the more isolated from the main paved highway. As a percentage of sample households by far the majority of high sellers came from Mukim Rambai and Kiudang (7.1% and 5.6% of the population respectively as compared with 3.2% and 3.0% for Mukims Keriam and Lamunin).

Generally, all households producing over B$800 per year of produce are situated on the edges of areas of residual soil and adjacent to or on alluvial soils. In line with this location pattern, access to these higher earning households is by road and it is only in the lower farm income groups and in Mukim Rambai that the households are located in proximity to navigable waterways.

Ethnically, there is no strong distinction in absolute numbers between the groups (Table 37). However, as a proportion of each sample the Malays have the lowest farm earning power and the Chinese the highest. On a Mukim basis the orientation is towards fruit and vegetables on the crops side and buffalo/cattle and pigs on the livestock side.

TABLE 37. Ethnic Distinction between Selling Groups

Income Group (B$)	Ethnic Group				
	Malay	Kedayan	Indigenous	Chinese	Total
0 - 200	48	33	33	4	118
201 - 800	45	43	45	8	141
801-1,600	33	10	34	15	92
> 1,600	6	4	12	4	26
% Sample	45	73	59	77	-

Related to this higher income from farm earnings is a corresponding increase in capital investment in farm buildings and equipment. These are detailed by earning group in Table 38.

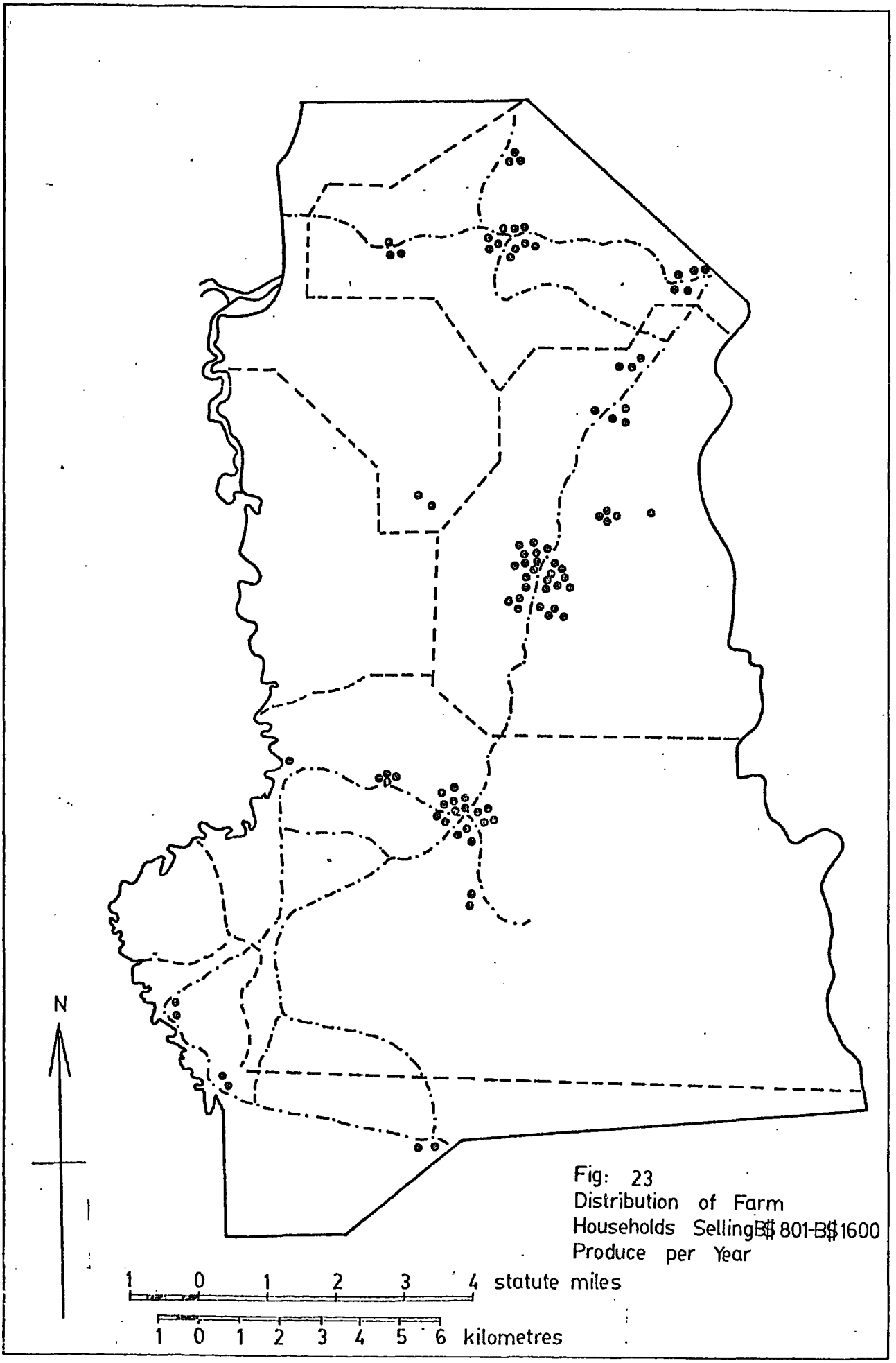


Fig: 23
Distribution of Farm Households Selling B$ 801-B$ 1600 Produce per Year

TABLE 38. Value of Capital Assets by Income Group

Income Group	Capital Assets
	B$
0	2,314
1 - 200	4,919
201 - 800	5,048
801 - 1,600	5,248
> 1,600	5,806

There is more than a doubling of assets from those households with no farm income to those with up to B$200. On the other hand, there is only a 20 per cent increase between those with an earning power of B$200 per annum and those with more than B$1,600 per annum.

3.9 Farm Expenses

The major farm expenses incurred are related to fixed and variable farm inputs. The former comprises land rentals, subsidised cultivation services and rice milling: a total estimated at B$28 per household per year. The variable costs consist of purchase of animal feed, fertilizers, herbicides and pesticides. Table 39 details the distribution of these by situation and ethnic group.

TABLE 39. Variable Farm Expenses per Household Reporting

Ethnic Group	Pig Feed	Poultry Feed	Fertilizer	Herb-icides	Pest-icides
			B$		
Malay	-	131	24	48	24
Kedayan	-	87	19	46	36
Indigenous	185	110	60	32	51
Chinese	664	966	448	193	125
Mukim					
Rambai	164	222	5	42	22
Keriam	-	222	95	56	76
Lamunin	194	123	96	65	44
Kiudang	321	163	192	48	60
Tutong	-	11	10	42	14
No. House-holds Reporting	95	430	144	305	53

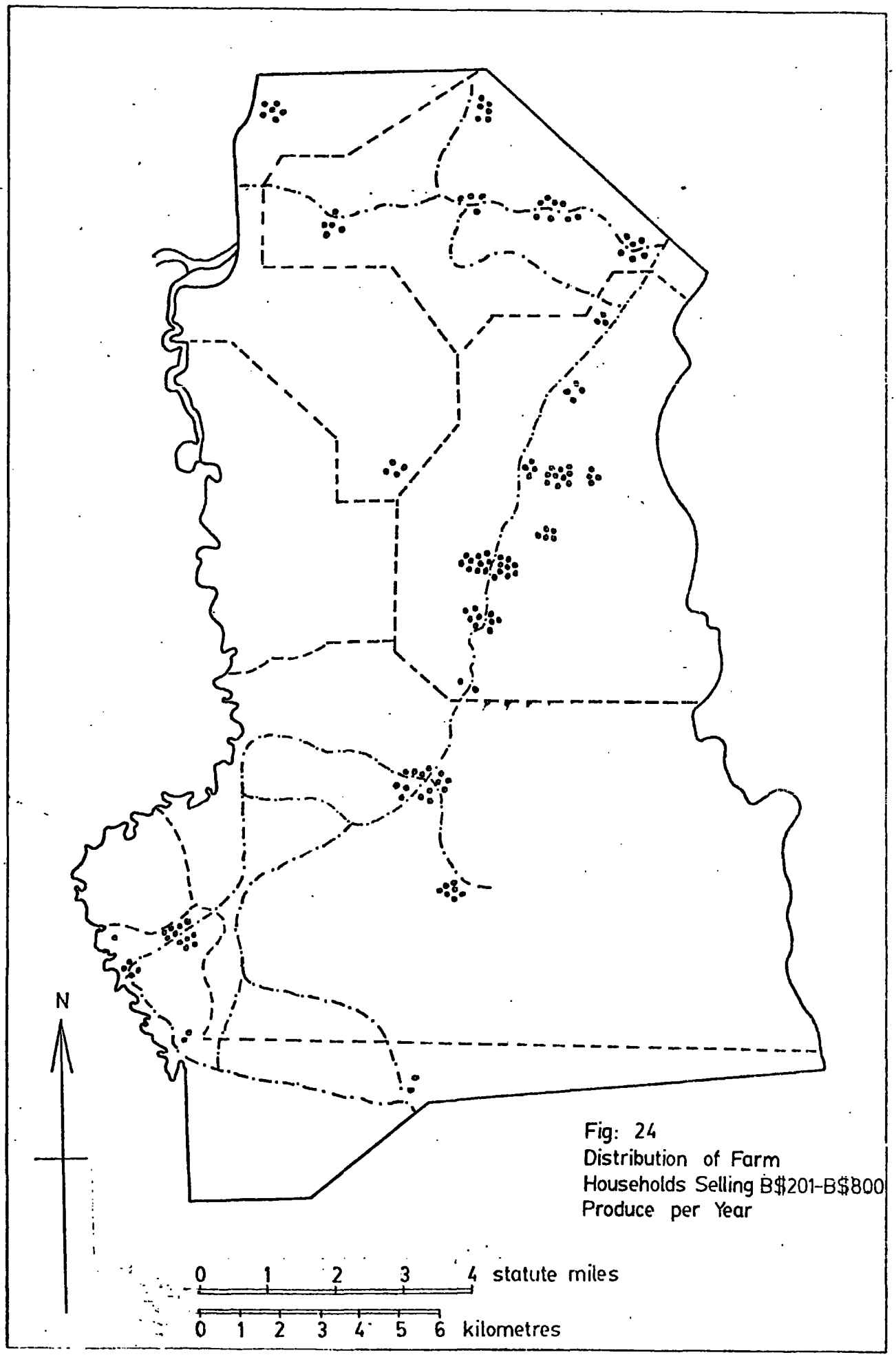


Fig: 24
Distribution of Farm Households Selling B$201-B$800 Produce per Year

3.10 Non-Farm Income

Cash contributions to the gross household income from other than farm sales originated from a variety of non-rural sources. These ranged from non-farm work, Government pensions and social benefits to contributions in the form of cash gifts from relations, usually siblings or contemporary blood relatives. An estimate of this income by source is given in Table 40 stratified by ethnic group and situation.

TABLE 40. Annual Non-Farm Household Income
(Average Income for Households Reporting)

Ethnic Group	Non-farm work		Pension & Benefits		Gifts	
	B$	No. Households	B$	No. Households	B$	No. Households
Malay	4,653	267	474	71	717	79
Kedayan	2,899	99	460	20	347	24
Indigenous	2,317	152	382	66	401	62
Chinese	4,570	32	324	6	622	9
Mukim						
Rambai	2,559	45	369	13	598	15
Keriam	4,520	144	494	40	453	32
Lamunin	3,246	137	405	50	494	51
Kiudang	2,925	160	386	47	661	61
Tutong	5,454	64	543	13	430	15

Five hundred and fifty or 83 per cent of the households surveyed had alternative sources of income to farming. These benefitting households were not isolated to those in the road-side villages and the distribution by ethnic group and location is shown in Table 41. Non-farm income must therefore be looked at in more detail as it forms such an important contribution to total household income. One hundred and sixty three (25%) of the households reported contributions to total income from pensions and benefits and one hundred and seventy four (26%) received gifts from the sources mentioned above.

TABLE 41. Households Reporting Non-Agricultural Sources of Income

	Malay	Kedayan	Indig.	Chinese	Total	% of Categories
Rambai	5	4	34	2	45	80
Keriam	94	37	11	2	144	94
Lamunin	46	26	51	14	137	77
Kiudang	67	31	48	14	160	77
Tutong	55	0	9	0	64	100
Total	267	98	153	32	550	
% of Categories	93	80	73	80		83

The distribution of these wage earners appears to be broadly inversely proportional to the farm earning capacity of the households. As an example figures of income are tabulated by farm income group in Table 42.

TABLE 42. Non-Farm Income by Farm Income Group for Households Reporting

Farm Income (B$)	Non-Farm[1] Income	Non-Farm Income (B$)
0	78	4,195
1 - 200	76	3,572
201 - 800	77	3,445
801 - 1,600	73	3,271
> 1,600	69	3,052

(1) Percentage of households reporting.

Farm income thus represents a very minor proportion of total household income and agriculture generally is considered largely on a subsistence basis to provide food products for the house. These products act as financial or economic famine reserves (large livestock and rice, respectively), can be produced more cheaply (poultry and vegetables) or are not available within the market (local rice varieties).

Any programme to promote agricultural production must look not only at making these current subsistence farming systems more efficient or more rewarding to the individual farmer but must also introduce them as new entrepreneurial systems to provide employment in the rural environment. As Virone (1969) (126) suggested, new agricultural technologies must compare favourably at the psychological, sociological and economic level before they can be expected to be considered by the rural dweller in his decision making process.

4. LIVESTOCK PRODUCTION POSSIBILITIES

4.1 Alternatives

As detailed in Chapter 3, by far the larger proportion of total household income of the inhabitants within the project area is derived from non-farm earnings. As these are obtained on a wage or allowance basis a cash orientated society has developed which, if it is to be stimulated back to investment in agriculture, must be directed towards high unit income farming enterprises. From the households reporting in the survey, those selling buffalo and cattle had the highest annual income on a per household per enterprise basis (Table 29).

For any enterprise to succeed it must also be considered by the major ethnic groups within the area as being of considerable social standing or else of introducing acceptable technical innovations. Buffalo catching is considered an important skill within the Malay village (Subramaniam, personal communication, 1974) and the keeping of buffalo and cattle is one possible external manifestation of wealth within the majority of Southeast Asian societies. Also, the possibilities of using technical innovations in the form of new fencing materials, grasses and improved cattle breed types are all logical and visible innovations which would make the idea of cattle or buffalo production acceptable to the village communities.

From a development viewpoint, land availability for expansion of any agricultural enterprise is relatively limited in Brunei, with the greatest restriction in availability of non-peat flat land (i.e. land suitable for planting grass). However, the uncultivable land of the deep peat swamps can only perhaps be orientated to extensive buffalo farming. Such a complementarity of enterprises indicates a great potential for beef production as a whole within the State. The Brunei Government Department of Agriculture has appreciated this position and allocated approaching one third of its capital resources within the 1975 - 1979 National Development Plan period to the promotion of the cattle industry (Woodroofe, personal communication, 1975). This amounts to some B$6m. out of a total agricultural development budget of B$21m.

Apart from this development in relation to the rural environment and the farming community, cattle and buffalo for slaughter offer significant opportunities for the creation of secondary and tertiary industries. These would, in essence, provide rurally based jobs and thus help to distribute job opportunities throughout the State.

What has been achieved in livestock production in the region to date? Unfortunately, little or no work had been carried out into swamp buffalo production and management anywhere in Southeast Asia up until the 1970's and little work had been published on cattle production. There had apparently been only a replication of animal production systems from high technology areas with animals such as monogastric pigs and poultry, mostly unaffected by monsoonal climate conditions that do not require local expertise in the production of their food crops. The monsoonal environment of Southeast Asia with its dual hazards of excess and deficiency of rainfall (137) and lack of livestock management skills (56) has proved a most difficult environment in which to farm ruminant livestock well with ensured economic success from year to year.

4.2 Smallholder Pilot Project

Work has been carried out in Brunei into smallholder agriculture since 1965 by Brunei Shell Petroleum Company Limited at their Agricultural Centre in Kampong Sinaut, in the north of the project area (6, 7 and 8). The Company, conscious of its position in the State, wished to contribute positively to the diversification of the State's economy. It did this by sponsoring an investigation into smallholder agriculture (55). Land clearance work was carried out during 1966 and monoculture smallholdings of pepper, rubber, grass for beef cattle and rice were established, each with a vegetable garden and housing for a resident farm family.

4.3 Unit Development

Grass trials for the cattle unit were started in 1966 to determine the most suitable species for the paddock grazing system

envisaged. The first two species grown were Guatamala grass, Tripsacum laxum and Napier grass, Pennisetum purpureum. These performed well and fresh weight cuts were comparable to those achieved in Johore (12). However, these species were dismissed as it was thought that they could only be used under a high technology labour intensive cut-and-carry feeding regime alien to the level of husbandry practiced by rural stock-keepers in Brunei. Also, Dunsmore and Ong (1969) (34) in Sarawak calculated that with these grasses, under any manual harvesting system, eight man hours were required to cut enough fodder for a ten cow herd.

Work then centred on grazing grasses and specifically on Pangola grass, Digitaria decumbens and Signal grass, Brachiaria brizantha. Growth rates of the latter verified the encouraging results of the original trials work carried out in Sabah (117). Also, following on from work in Sarawak (96), strains of D. decumbens, were mixed with B. brizantha to produce a good pasture carrying four to five livestock units per hectare (120). The sward only suffered from minor problems similar to those encountered elsewhere in Northwest Borneo (24 and 34).

4.4 Cattle Production Results

The following data summarise the field data collected over a period of four years from crosses reared on the smallholder cattle unit (6, 7 and 8).

TABLE 43. Liveweight Gain of Half-Bred Crosses Born at Sinaut between 1970 and 1973

Cross No.	(1) (2) KK x SG 5	(3) (4) ½B x ½AA 12	½SG x ½ AA 2	½AA x ½AA
Birth wt.(kg)	19.1	21.9	26.1	18.2
3 month wt.(kg)	87.4	71.2	81.8	68.2
6 month wt.(kg)	131.4	103.2	120.5	115.9
9 month wt.(kg)	169.1	158.6	146.6	158.2
12 month wt.(kg)	204.5	180.7	205.7	163.6
Livewt. gain(g/day)				
0 - 6 months	624	452	542	543
0 - 12 months	508	435	492	398
7 - 12 months	406	431	473	265

(1) Kedah Kelantan
(2) Santa Gertrudis
(3) Brahman
(4) Aberdeen Angus

Source: 55

The half Santa Gertrudis crosses did very well with an average liveweight gain up to six months of 624 g per day and 508 g per day up to twelve months. These were all better than the results of the half-bred intercrosses between Brahman, Aberdeen Angus and Santa Gertrudis partly due to a lower stocking rate, although the best of this latter group, the half Santa Gertrudis cross Aberdeen Angus showed the best post-weaning growth rates of all the half-breds.

The growth rates of the quarter-bred stock (see Table 44) improved over the three year period to achieve, during 1973, average gains almost as good as the average for the half-breds. However, the average gains over the three years were only 478 g per day up to six months of age and 270 day weaning weights of 130 kg.

TABLE 44. Liveweight Gains of Quarter-Bred Aberdeen Angus Crosses Born at Sinaut between 1971 and 1973

Year	1971	1972	1973	Av. 1971/73
No.	15	9	9	33
Birth wt.(kg)	19.4	16.8	21.5	19.3
3 month wt.(kg)	64.4	59.3	73.5	65.5
6 month wt.(kg)	95.9	106.8	119.6	105.3
9 month wt.(kg)	103.0	140.7	164.5	130.1
12 month wt.(kg)	125.0	175.6	218.9	164.4
Liveweight gain (g/day)				
0 - 6 months	423	500	546	478
0 - 12 months	291	432	549	398
7 - 12 months	164	377	553	328

Source: 55.

The stocking rate for the period 1971-1973 averaged 5.0 livestock units per hectare. Even at this high rate the mature cattle weights showed a 22 per cent increase over the period.

4.5 Cattle Management and Disease

Local practice in Brunei is to bring cattle into a compound close to the house at night and if possible during heavy rain during the day. With a commercial unit with high stocking rates on fenced paddocks, this practice was not considered possible or necessary. Therefore, the animals remained on the pastures day and night, were provided with ad lib. piped water, trough-fed salt and shade trees mostly of coconut palm.

Calving took place outside at all times. No parturition problems occurred with any of the crosses but post-natal care of the calf was initially a time consuming excercise. Infection of the umbilicus occurred due to fly strike from Dipterous maggots. Also,

other ectoparasites caused significant disease problems with the stock. Trypanosomiasis was diagnosed in some of the adult stock during October, 1971. The probable vector of this was Lyperosia exigua (100) although other biting Dipterous insects, notably Tabanids, might also act as vectors (McCrae, personal communication, 1974). Bovine babesiosis, most likely transmitted by Boophilus microplus, was diagnosed during 1972 in animals between six and twelve months of age (Subramanium, personal communication, 1972). Regular spraying of the stock in the handling yard with organophosphate insecticides reduced the fly and tick populations and eradicated the problems of infection.

4.6 Cost Elements

Capital development costs of the cattle unit calculated on the project in 1969 at prevailing prices were approaching B$3,400 per hectare (55). During the following decade, with the introduction of improved planting and management techniques it is estimated that these cost levels would be reduced to those indicated in the 1977 model column of Table 45. (Woodford, personal communication, 1977)

TABLE 45. Per Hectare Cattle Unit Development Costs in 1969 and 1977

Item	Sinaut 1969	Model 1977
	B$	
Land clearance	540	796
Planting(1)	958	916
Drainage	850	147
Fencing	485	755
Water	532	245
Total	3,365	2,859

(1) Excluding cultivation

The subsidised variable costs and labour inputs per hectare at 1976 prices on the Sinaut cattle unit average for the period 1970-1973 are shown in Table 46 along with the estimated 1977-78 Government subsidised costs.

TABLE 46. Per Hectare Variable, Fixed and Labour Costs 1970-73 and 1977-78

Item	1970-73	1977-78
	B$	
Fertilizer	381	421
Herbicide	37	25
Veterinary materials	90	free supply
Supplementary feeds	61	353
Miscellaneous	20	32
Sub-total	589	831
Labour	552	1,020
Grand Total	1,141	1,850

Source: 55.

These costs and levels of production were monitored from a model cattle unit of approximately five hectares. This carried both adult male and female stock as well as the young growing entire stock under investigation. Under this regime, a simple cattle production unit consisting of a breeding cow either dry or with calf at foot, a yearling, perhaps a fattening animal and a proportion of a bull would total 1.95 livestock units or a stocking rate equivalent to 2.7 production units per hectare. Given an 85 per cent calving index and a further five per cent mortality during the year (Woodford, personal communication, 1977), the liveweight gain per hectare per year would be approximately 740 kg. working on averaged half-bred growth rate data from Table 43.

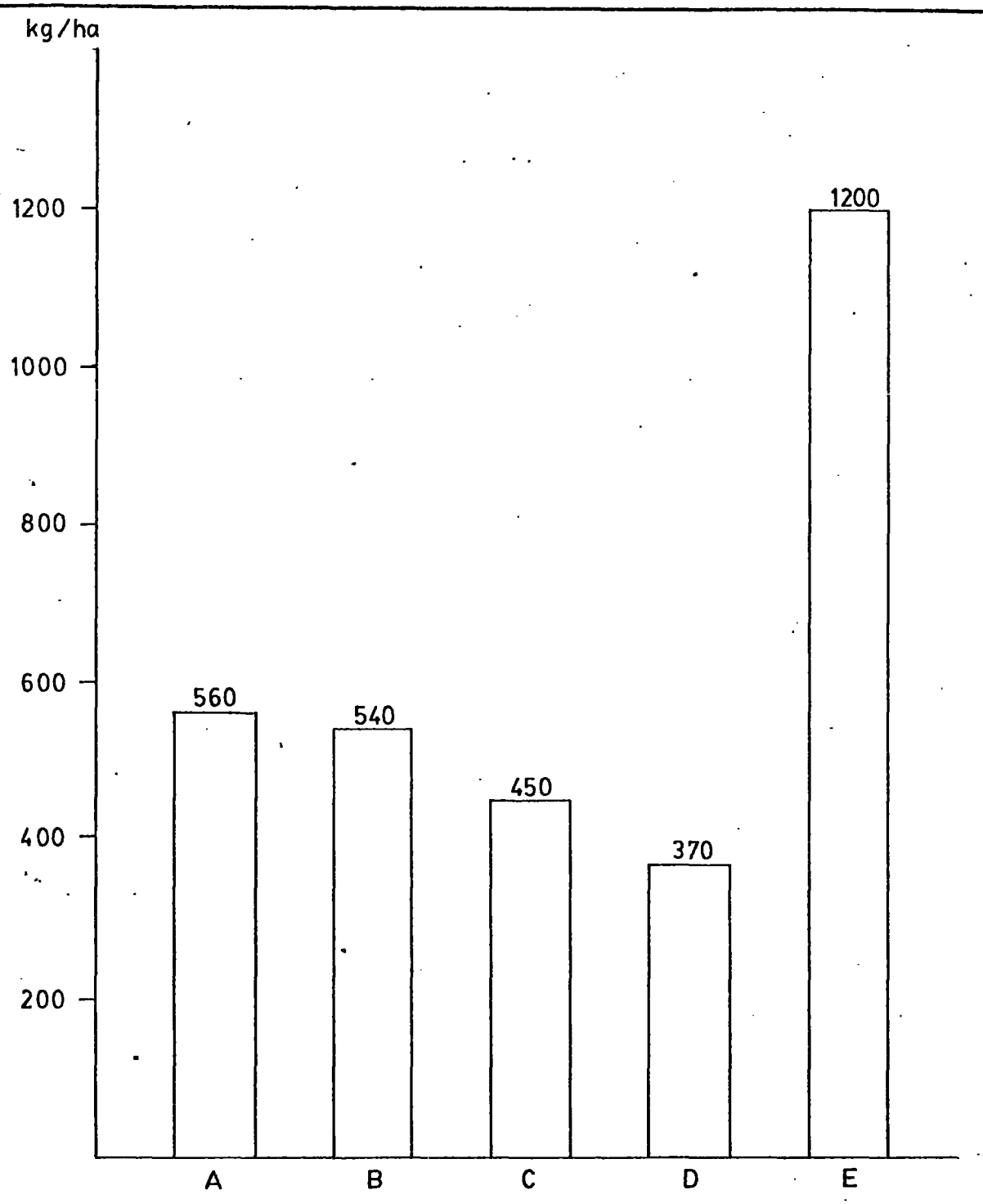
Using this base data recorded from the model unit it is possible to calculate the expected liveweight gains under a range of management systems. These are illustrated in graphical form in Figure 25 and the margins against variable and fixed costs, labour and capital outlay are tabulated in Table 47.

TABLE 47. Margins against Total Cost Elements for Range of Cattle Management Systems

System	Production Income	Farm Profit ~~Net~~	Net Income	Management & Investment Income
		B$ per Hectare per Year		
A. Breed/Sell mature	1,725	1,996	976	776
B. Breed/Sell 18 mths.	1,663	832	188	-2
C. Breed/Sell 12 mths.	1,386	555	-465	-665
D. Breed/Sell weaner	1,140	309	-711	-911
E. Buy weaner/ Sell mature	3,696	2,865	1,845	1,645

The most profitable system examined is system E. This is also the one most appropriate for smallholder management as it avoids the major technical problems of cow/bull management, fertility and calf rearing. At the same time the complexities of pasture management can be partly alleviated by the drafting in and out of stock by the external organising body to utilise flushes of grass or reduce the poaching of the pastures.

From an administrative standpoint, the lack of necessity to progeny test and distribute bulls, record births and mark calves on individual's farms does away with much of the field paper work. At the same time, the sale of weaned stock to farmers and the purchase from them of semi-finished or finished stock for the market allows the manipulation of the supply and pricing levels.



A: Breed & Sell mature.
B: Breed and sell at 18 months.
C: Breed and sell at 12 months.
D: Breed and sell weaner.
E: Buy weaner and sell mature.

Fig: 25
Annual per Hectare Cattle Liveweight Gains under Different Management Systems.

5. DEVELOPMENT PROPOSALS

5.1 Current Situation

Slaughterings of cattle and buffalo at the registered Municipal slaughter-houses in Bandar Seri Begawan and Kuala Belait between 1973 and 1977 are shown in Table 48. A fifteen per cent loading has been added on the advice of the Department of Agriculture to take account of unofficial village slaughterings (Subramaniam, personal communication, 1976). Buffaloes are bought direct from farmers by butchers registered with the government and transported in open-backed trucks to the particular market. Imported cattle are bought by the butchers at the government holding yards 24 km west of the capital, Bandar Seri Begawan. The stock are then transported in Department of Agriculture cattle trucks, daily to Bandar Seri Begawan and twice weekly the 100 km to Kuala Belait.

TABLE 48. Slaughter Figures for Cattle and Buffalo in Brunei, 1973-1977

	1973	1974 Number	1975	1976 (est.)	1977 (est.)
Buffalo	2,995	2,236	850	737	652
Local cattle	243	255	92	124	105
Imported cattle	-	-	643(1)	1,472	2,400
Total	3,238	2,491	1,585	2,333	3,157

Source: 51, 52 and 53.

Various estimates have been made within the Southeast Asian region of the average liveweight of local cattle and buffalo and also dressing percentages. Using the average figures produced by Hussein and Nordin (1973) (64) for local stock and those from the Department of Agriculture for imported stock the locally slaughtered production ranged from 324 tonnes to 695 tonnes over the period under discussion. The details are shown in Table 49 with the addition of import figures of beef and beef products to obtain total beef consumption figures excluding all processed and tinned beef and veal products.

TABLE 49. Total Estimated Consumption of Unprocessed Beef and Offals, 1973-1977

	1973	1974	1975	1976	1977
		tonnes			
Importations(1)					
Frozen/chilled beef	146	209	240	n.a.	n.a.
Offals of ruminants	24	36	42	n.a.	n.a.
Sub-total	170	245	282	297(est.)	341(est.)
Local slaughter	600	460	324	500	695
Total	770	705	606	797(est.)	1,036(est.)

(1) Source: 51, 52 and 53.

Relating such total consumption tonnage to total population figures, per capita consumption figures have been calculated at between 4.0 - 6.4 kg per annum over the period. However, such broad brush consumption figures cannot be considered reliable enough to base consumption projections upon; social, financial and religious contraints severely control the consumption pattern of the different ethnic groups within the community.

In determining the extent of these constraints difficulties were encountered in obtaining data on average household numbers by income and ethnic group. The 1971 census figure for working males over fifteen years of age, stratified by income and ethnic origin reduced in proportion to the total number of household heads (113) was finally used in the calculation (Shahri bin Awg. Hj. Besar, personal communication, 1976). When this adjusted total for all the households was raised by the net annual population growth rate percentage to provide an estimate for 1976 a direct comparison can be made with the total annual consumption figure given in Table 49.

TABLE 50. Beef Consumption per Household by Income Group and Ethnic Group, 1976/1977

Income Group	Ethnic Group				
	Malay	Indigenous	Chinese	Indian	Other
	kg/month/household				
More than $2,000/month	5.5	5.5	3.6	4.1	7.3
Between $1,000-1,999/ month	3.6	2.3	2.7	1.8	3.6
Between $550-$1,099 month	2.7	2.7	2.7	0.9	0.9
Less than $550/month	0.9	0.9	0.9	0.9	0.9

TABLE 51. Annual Beef Consumption Estimate by Ethnic Group in 1976

Total	Malay	Indigenous	Chinese	Indian	Others
		tonnes/year			
810	452	48	215	13	82

Future levels of demand for beef will be affected by two major factors. Firstly, gross population growth rate predictions published for Brunei (Economic Planning Unit, personal communication, 1977) show the State as having the highest net population growth rate within the Southeast Asian region and there do not appear to be any social or economic constraints to stop this from continuing at least into the first quarter of the twenty first century. Secondly, trends in employment enumerated in the last three census reports (69 and 113) show a dramatic movement of employed persons from production to service and commercial activities.

Beef requirements may, therefore, in the future rise in excess of the population growth rate. Estimates to 1984 are given in the following table which take account of (i) a steady reduction in the percentage of population in the labour class, (ii) continuing rises in wages in excess of the regional price escalation rate, (iii) rise in aspirations due to improved formal and informal education, and (iv) changes in dietary habit due to increased international contact.

TABLE 52. Estimated Beef Consumption by Ethnic Group in 1984

	Malay	Indigenous	Chinese	Indian	Other	Total
Population 1976 ('000's)	103	12	37	4	5	161
Population increase (per cent per annum)	4.0	3.5	3.0	3.0	2.0	-
Extra consumption (per cent 1976-84)	30	20	30	20	-	-
Consumption 1984 (est. tonnes)	823	75	362	20	97	1,377

In terms of carcasses this is a requirement of 6,800-7,000 beasts equivalent to an increase of one third in total consumption in the seven year period from 1977.

5.2 General Proposals

In contrast to the authors of the State National Development Plan it is not thought possible from these projections for Brunei to become completely self-sufficient in beef production by 1984. Also, it is not considered within the brief of this discussion to postulate numerical production levels for the different sectors of the beef industry in the future. Importations of frozen beef and offals as well as slaughter stock are likely to continue for many years and the margin produced by home production must, from the outset, be recognised as needing protection (78). The major current method of beef importation, through Government controlled air and sea shipments of live animals, can go a long way to protect local production as imports can be adjusted to balance local production with day to day demand.

It has been seen from the socio-economic survey that there is a definite orientation to subsistence cropping within the segment of the Brunei rural community analysed. This has been blamed not only on the climate and the opportunity of alternative less physically demanding occupations (55) but also on the lack of availability of land (63). Internationally, the dependence of the rural community on subsistence crops has been related to such short-comings as the restrictions of capital, labour and management ability (13, 61 and 131).

All such factors play some part in the individual farmer's decision making but, in Brunei, the dominating influence has been the possibility of cash employment and the guaranteed income this contributes to the household income. Any programmes for livestock development must therefore be competative at the wage-earning level.

Traditionally in Brunei, buffalo are considered as superior to cattle, not inferior as described by De Boer, (1976b) (21) in an analysis of regional beef demand. This is not only because of their larger size and more docile nature but because of their limited management requirement, less visible scavenging habit compared with cattle and meat palatability. However, the management macro-problems for both types are similar to those defined by Khairudin (1973) (70); low numbers, small size and low productivity as the remnants of indiscriminate slaughter and also a lack of graminaceous species that as mono-crops can be productive, easily managed and palatable.

To the expatriate livestock planner, however, cattle have been seen as the key element in diversifying protein supplies in the region because of the opportunity to duplicate already well documented and proven management systems. However, increases in beef production within Southeast Asia have almost entirely been due to an increase in cattle numbers and not unit productivity (20). Within the Brunei situation, the rural sociologist and agricultural economist must consider buffalo as having a place in the meat supply spectrum as its inclusion would satisfy farmer "felt needs", its production would be independent of any fluctuation in imported feeds or other variable inputs and its increase in numbers independent of the development of improved pastures. Also, the agricultural technologist must consider it as having a similarly important place with its superior capacity to digest high fibre, unpalatable fodders and its efficient protein synthesis of non-protein nitrogen sources (32).

It seems, therefore, important to invest in the simultaneous development of both cattle and buffalo production. However, the orientation and emphasis of development should be specific to each type. Development should be orientated to people when there is sufficient local technological information to anticipate on-farm management problems and when micro-economic (individual holding)

budgets and systems can be honestly quantified on past experience. Where technologies are uncertain and management experience lacking - but development nevertheless urgently needed - then the development process should be enterprise orientated and planned with emphasis on farmer groups. Individual farm plans should be devised for farmers in cattle production and broad-brush technological plans, backed by Government money, introduced for the development of buffalo production.

5.3 Detailed Proposals

With an estimated State-wide remnant population of under 8,500 head, the project area with 2,326 head of cattle and buffalo combined, contains some twenty seven per cent of the State's beef animals. The distribution differs considerably between the two species as the cattle are much less widespread and are found in smaller, more discrete units than the buffaloes. There is also a locational distinction as the cattle are mainly found in the Mukims of Keriam and Tutong in the north of the project area whilst the buffaloes are more centrally located with the bulk of their population in the Mukims of Kiudang and Lamunin. The main sellers for both cattle and buffalo are Malays and indigenous inhabitants.

Any form of development proposals must be defined in relation to a number of locational restrictions, the major one of which is accessibility. The mud-topped roads south of Kg. Lamunin and Kg. Layong (both in Mukim Lamunin) are passable to pedestrians and light vehicles at the majority of times in the year but regular access by four wheel drive or double axle vehicles would be restricted to the eight months between March and October. It is thus suggested that within the first phase of any development programme the Mukim of Rambai, containing an estimated forty households keeping cattle or buffaloes, is considered separately.

Even within the remaining Mukims, locational constraints in the main areas of concentration of cattle owners are likely to cause problems for any plans to greatly expand the cattle industry. Once areas of unsuitable peat soil, alienated land and land of a slope of over 25° are excluded from the Mukims of Tutong and Keriam, there are only very small areas left. It would seem sensible, therefore, in an attempt to obtain the maximum immediate development, to work with the current cattle owners on the land they hold now under some form of lease. By the selection of suitable areas of their leasehold land and

the piecemeal acquisition of any favourable unalienated adjacent land it should be possible to obtain sufficient areas for initial development purposes.

Land for buffalo production is not affected by the same locational problems. Within the main ownership areas there is adequate suitable land which has not been alienated to any individual. The major problem with these areas is that, although they are often designated as State land, they are used by the local buffalo owners as commercial grazing areas. Any development must involve and satisfy all these individuals so that technical or management innovations will be acceptable to all in the group.

Cattle improvement within the northern Mukims of the project area should therefore be orientated to the requirements of the individual owner, with land as an introduced resource. Buffalo development and cattle development in Mukim Rambai should be organised to satisfy the requirements of the group.

Any innovation introduced to the farming community should, at the early stages of the change process, be husbandry orientated and not involve too much of an alteration to the individual's present management system (125). Whyte (1976) (139) in his list of the seven stages of intensification of livestock production considers the sowing of synthetic stands for grazing, carried out on the Sinaut project described in Chapter 4, as being only two stages up the scale from the current management system with cattle in Brunei. It is therefore likely that such an innovation would be acceptable to the cattle owners in the project area.

The order of introduction of such technological livestock innovations is considered in the literature to be fairly fixed. Ayre-Smith(1974) (11) suggests that the nutrition of the stock should be improved first, along with the control of any high incidence of disease. Only then would benefits be derived from an improvement in management and finally the genotype.

Technological innovations arrived at improving nutrition e.g. the use of inorganic ferlitizers (for grassland) and the use of herbicides (to control weeds in pasture) have been shown from the

survey to be quite acceptable already to the individual farmers within the project area. Forty six per cent of the households interviewed used herbicides and twenty two per cent regularly used inorganic fertilizers. However, there is a basic shortage of breeding stock of both cattle and buffalo within the State. It would seem unwise, for the sake of conformity, to import more of the inferior genetic material already in the country or multiply it along its already in-bred lines. It would seem far better, right from the start, to introduce improved genetic material in the form of proven foundation stock from livestock exporting areas in similar humid tropical locations such as the coastal areas of Northern Queensland.

Such a task as importation of breeding stock cannot and should not be undertaken by the individual farmer or even at the initial stages by the commercial sector; Government must import the foundation stock for both cattle and buffalo to maintain the necessary disease control standards. The cattle stock should be Bos taurus cross Bos indicus stock similar to that which performed best under the Sinaut model-farm conditions. These should be imported as yearlings and preferably established in foundation herds under government management on their research stations and on newly developed breeding ranches outside the project area. The breeding ranches would provide weaner or yearling stock to farmers who would grow them on to maturity and dispose of them back to government or direct into the market.

The additional buffalo stock would have to be imported as young stock from other countries in Southeast Asia and quarantined under strict government control. A number of offshore islands are perhaps suitable for such an exercise (Smith, personal communication, 1977). Such animals could then be drafted out to farmer groups to increase the population and improve the genotype of the local herds.

Any such programme of development and introduction of innovations must be actively promoted by Government and financially supported by them. The individual farm units are so small, discrete and under-capitalised that in the initial stages the individual smallholders can be expected to do little more than supply the land and labour. Management expertise and inputs would have to be provided by the Department of Agriculture.

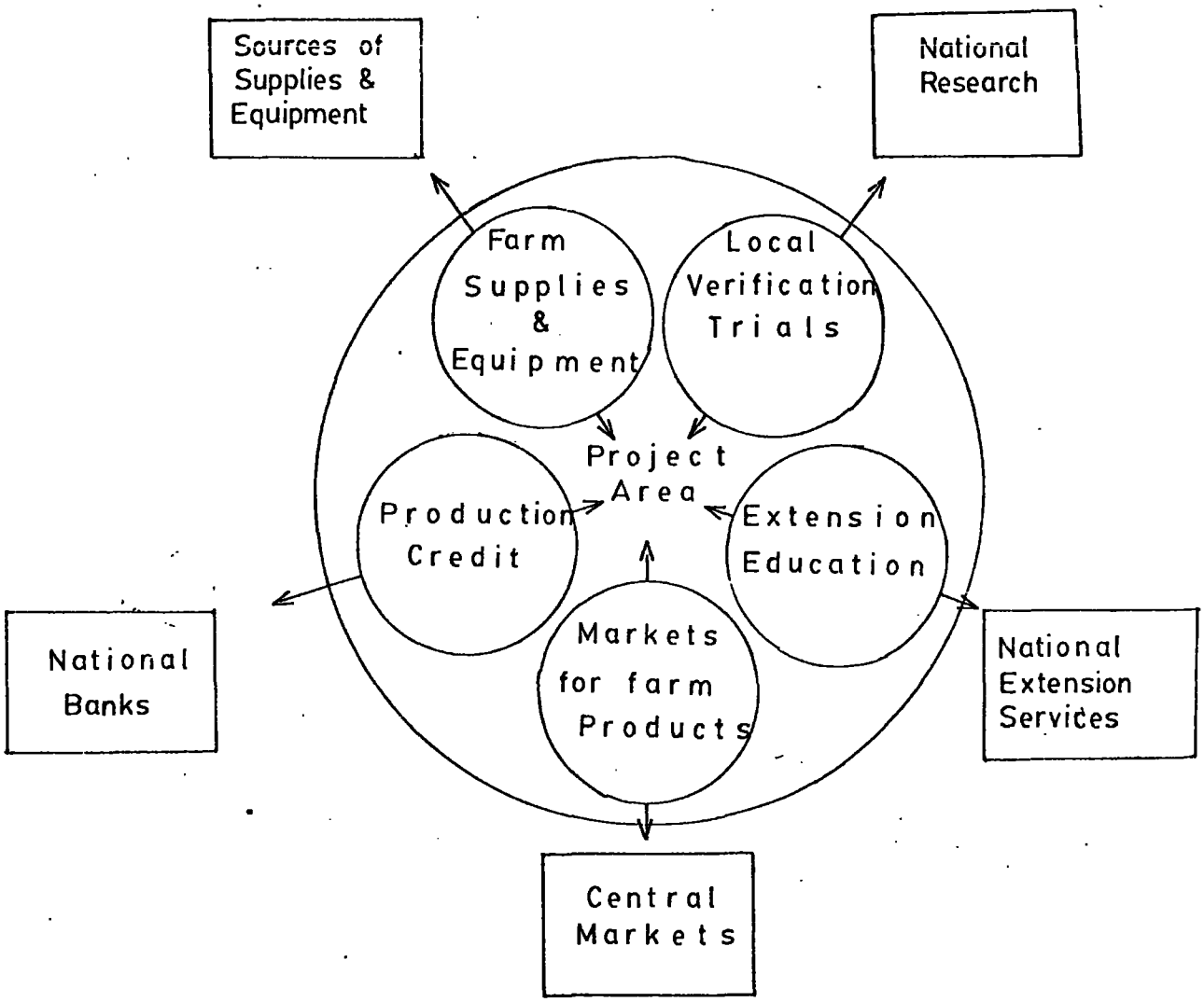
It was proposed in Chapter 1, Section 1.2 that effective development encompassed the simultaneous provision of technical agricultural and agricultural service subsystems. These activities may be foreseen and planned at the individual level for cattle and group orientated programmes constructed for buffalo development. Figure 26 illustrates the bases of these inter-related technical and support systems.

Initially, for cattle each of the estimated ninety households owning animals in the four Mukims would be contacted and details of land and stock tabulated. The former would be through the mapping of individual holdings at a scale of 1:5,000 or larger with accompanying topographic, soils and vegetation data recorded from sample transects and conventional photography. The easiest way to identify the stock would be by a letter and number code system of cold branding. This would be preferable to hot branding, tagging or ear of tail notching, all of which break the skin and allow the possibility of entry of infection.

The five aspects defined in Figure 26 should be discussed in detail with the individual smallholders and this format will be used here to detail the programme. Local verification trials of grower grazing should continue at the Sinaut Agricultural Centre in close liaison with the veterinary and livestock husbandry sections of the Department of Agriculture. They should aim to demonstrate the viability of smallholder beef production. Half-yearly reports should be produced monitoring technical results against understandable farm management standards. These should be liveweight gain per acre (imperial measure is the acceptable local Brunei measure), gross margin per acre and management and investment income per acre. A comparison of the last two would indicate the possible return to labour as, at present, none of the farms in the project area employ labour. This data could be used in a simple graphical form in regularly produced extension leaflets.

At a national level, research into alternative more intensive forms of cattle rearing could be conducted at government research stations to the west of the project area. These would indicate possible future improvements that could take place at the local level.

Fig: 26 Organizational Needs of Agri. Support Activity



Source: After Mosher, A.T. (1969)

Large enough accessible and isolated areas for national buffalo research are not available anywhere within the State and any trials work must be orientated to the local level. As mentioned in Section 5.2 the introduction of new genetic material into typical herd groups would enable empirical studies to go hand in hand with herd management improvement. The data required would be on group structures in the herds, breeding statistics covering the complete breeding cycle, mortality patterns at all ages and veterinary problems. Initially, such efforts should be concentrated on the four larger groups of buffalo owners in the Mukims of Lamunin, Kiudang and Keriam. This type of investigation will similarly require mapping and stock identification plus expenditure on fencing and handling yards. These aspects of infrastructure must, in the first investigation phase, be financed and maintained by government.

At the smaller, more local level, new stock should be sold through smaller groups to replace unproductive or old animals on individual farms.

Technicians in livestock husbandry extension and veterinary services will be required on a very intensive basis from the initiation of the development programme. Classical disputes between clinic and field husbandry technicians can be reduced to a minimum by little or job description differentiation in the field and their allocation to discrete farming localities (79) as illustrated in Figure 27.

A staffing rate of one extension staff to twenty cattle smallholders and one staff to fifty buffalo smallholders should be one objective of the programme. Individuals should be allocated to the specific farming localities and, as far as possible, live within these areas. Staff for the Mukims of Pekan Tutong and Keriam should be based at the Sinaut Agricultural Centre, those for Mukim Kiudang at the Birau Agricultural Station and those for Mukim Lamunin at the Kg. Lamunin agricultural office (see Fig. 9). The numbers of staff are detailed in Table 53.

Fig: 27 Cattle Development Locality Centres in Project Area.

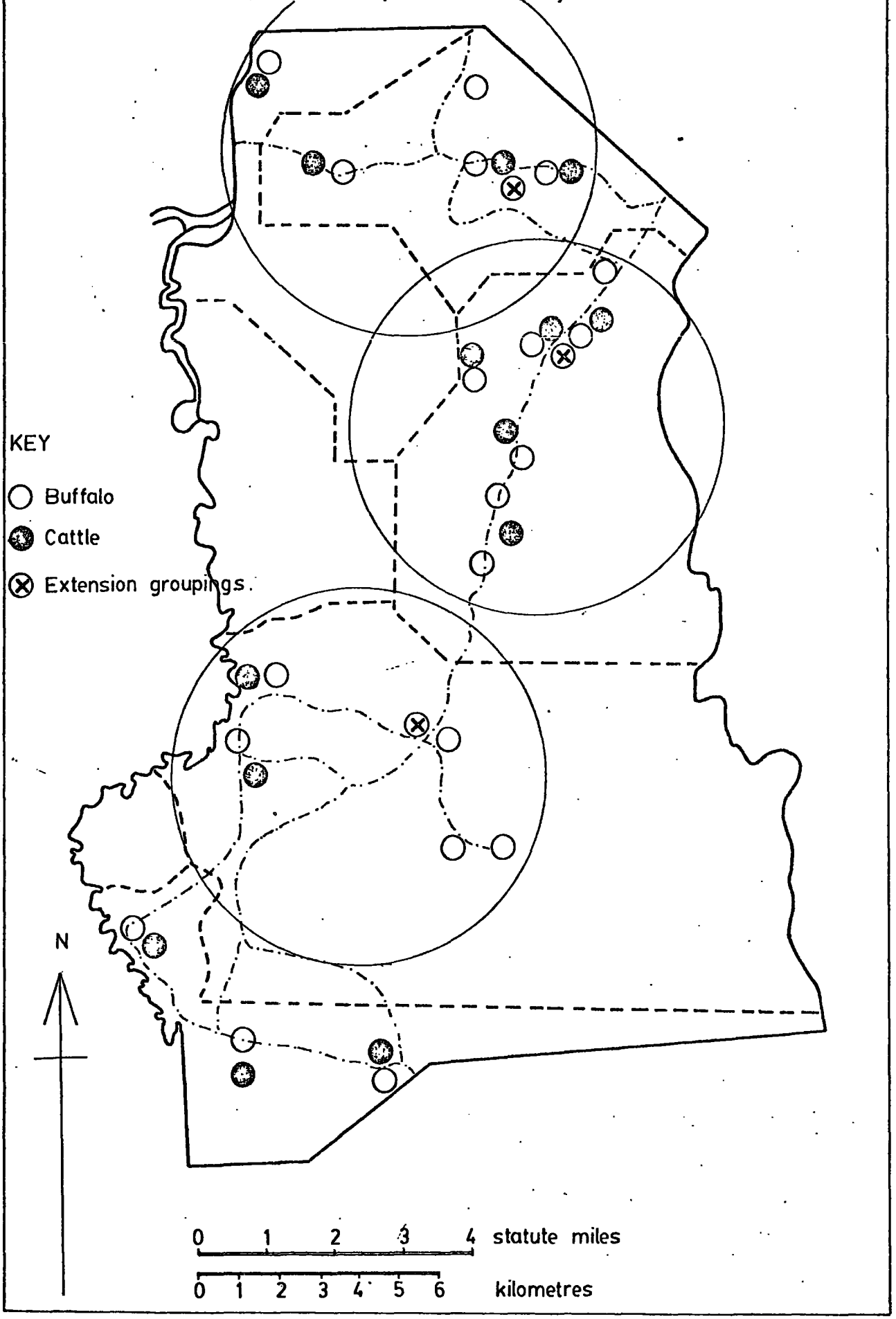


TABLE 53. Proposed Extension Staffing Rates for Farming Localities

Farming Locality	Extension Staff	
	Cattle	Buffalo
Tutong & Keriam	2	2
Lamunin	1	2
Kiudang	1	3
Total	4	7

Unfortunately, such a concentration of field staff seriously deprives the rest of the State of over half of their livestock extension officers. This should not deter the agricultural planners from such a programme; development concerns people and without intensive communication between the service administering change and the smallholder, fundamental technical and farm management improvements can never be effectively or efficiently carried out.

To counteract this problem, a national level manpower planning exercise for livestock development should be initiated. Staff requirements will be related to the growth potential and numbers of localities in other development areas.

A national marketing structure for beef has already been established for imported livestock and the price system is adhered to strictly at the farm purchase end of the spectrum. It is traditional for butchers to buy cattle or buffalo for cash at the farm gate on a visual appraisal. To protect the farmer, the installation of weigh-bridges at the abattoirs and a simple receipt system would ensure accuracy. Such a system could also be used with a guaranteed price farmer payment system. However, the market in Brunei appears to be currently self-regulating because of its small size and inter-related human factions.

Financial support for agriculture both at national and local level has been traditionally provided through government channels. Subsidised variable and fixed inputs have recently been joined by land development grants. It has often been suggested that an extension officer should not also be considered by his clients as a salesman or

debt collector. Each group of buffalo owners and the locational group of cattle owners should be persuaded to form a co-operative buying group which can obtain their variable inputs either through government, or preferably direct from a commercial company on a redermable subsidy chit system. Annual estimates may be provided by the extension staff back to government for subsidy budgeting and to commercial companies for quantity ordering. It is through such a co-operative buying and selling venture that the smallholders within Mukim Rambai can be drawn into the project, whereby the major movements of goods are programmed with the group to be made available during the dry season.

A situation has thus been reached where the Brunei Government Department of Agriculture becomes responsible for the supply of improved genetic material and variable inputs at controlled prices. These are distributed through the network of roads at seasons when communications are possible to locality farmer grower individuals and later groups for cattle and to breeder and grower groups for buffalo. The finished animals would be purchased by wholesalers under the control of government who would regulate the price levels.

The economic viability of the programme is monitored from a model unit within the project area for cattle and on three or four large scale production ranches for buffalo. It is therefore ensured over the long term that livestock production remains a financially competative means of employment within the Tutong project area.

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