FY2006 Human Ecology (I), June 16

Long-term Change of Adaptation

UMEZAKI, Masahiro

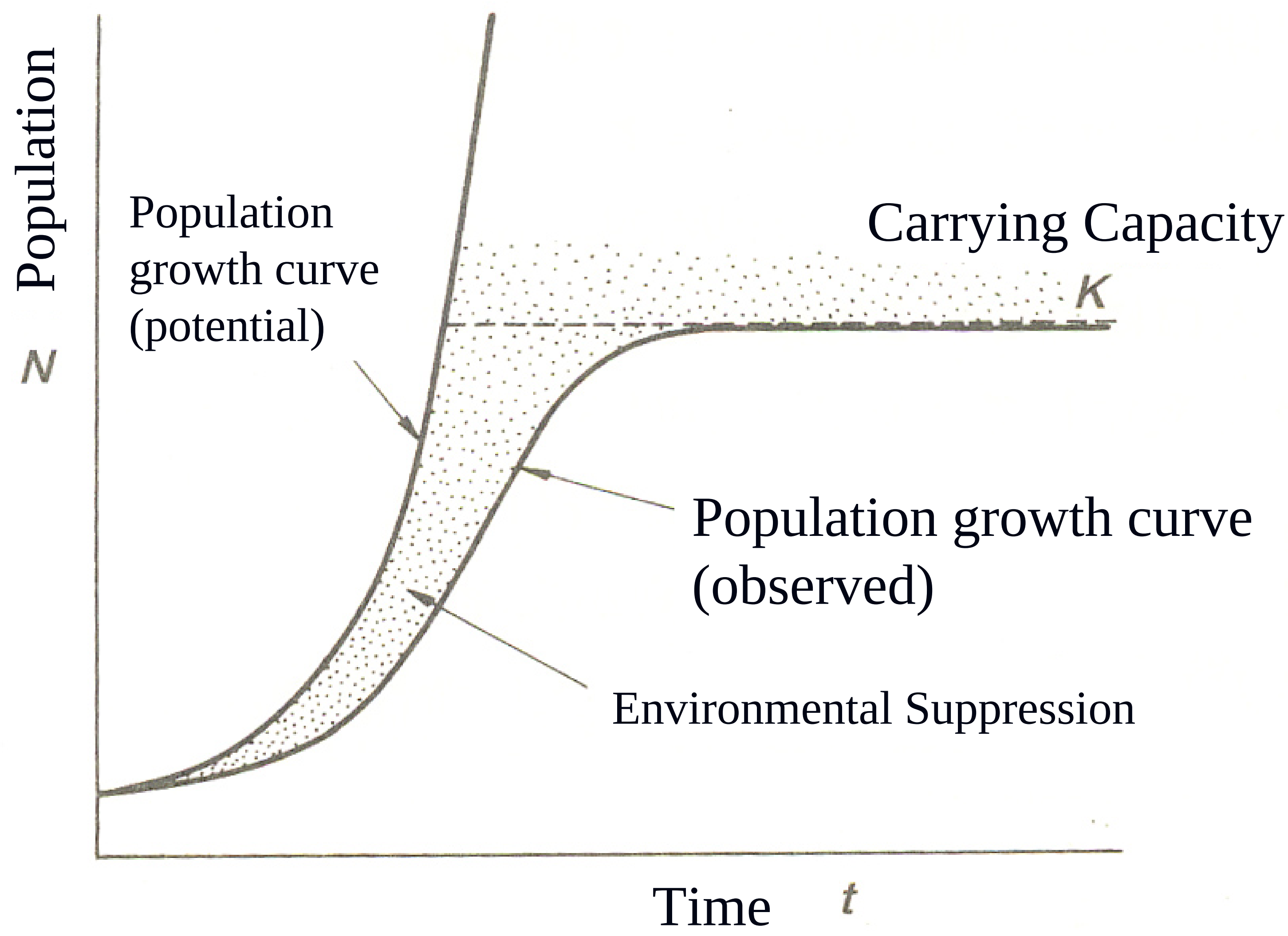


Figure. Population growth curve and carrying capacity

Many children
Long life
No disease

Net reproduction rate (NRR)
= average number of daughters who survived to marry per mother
= 2
Annual population increase rate (r)
= NRR^(1/y) – 1, y=time length between two generations
=2^(1/25)-1=0.028=2.8%

Many children
Short life
Disease burden

Net reproduction rate (NRR)
= 1.1
Annual population increase rate (r)
= NRR^(1/y) – 1 = 1.1^(1/25)-1=0.0038=0.38%

Few children
Long life
No disease

Net reproduction rate (NRR)
= 1.1
Annual population increase rate (r)
= NRR^(1/y) – 1 = 1.1^(1/25)-1=0.0038=0.38%

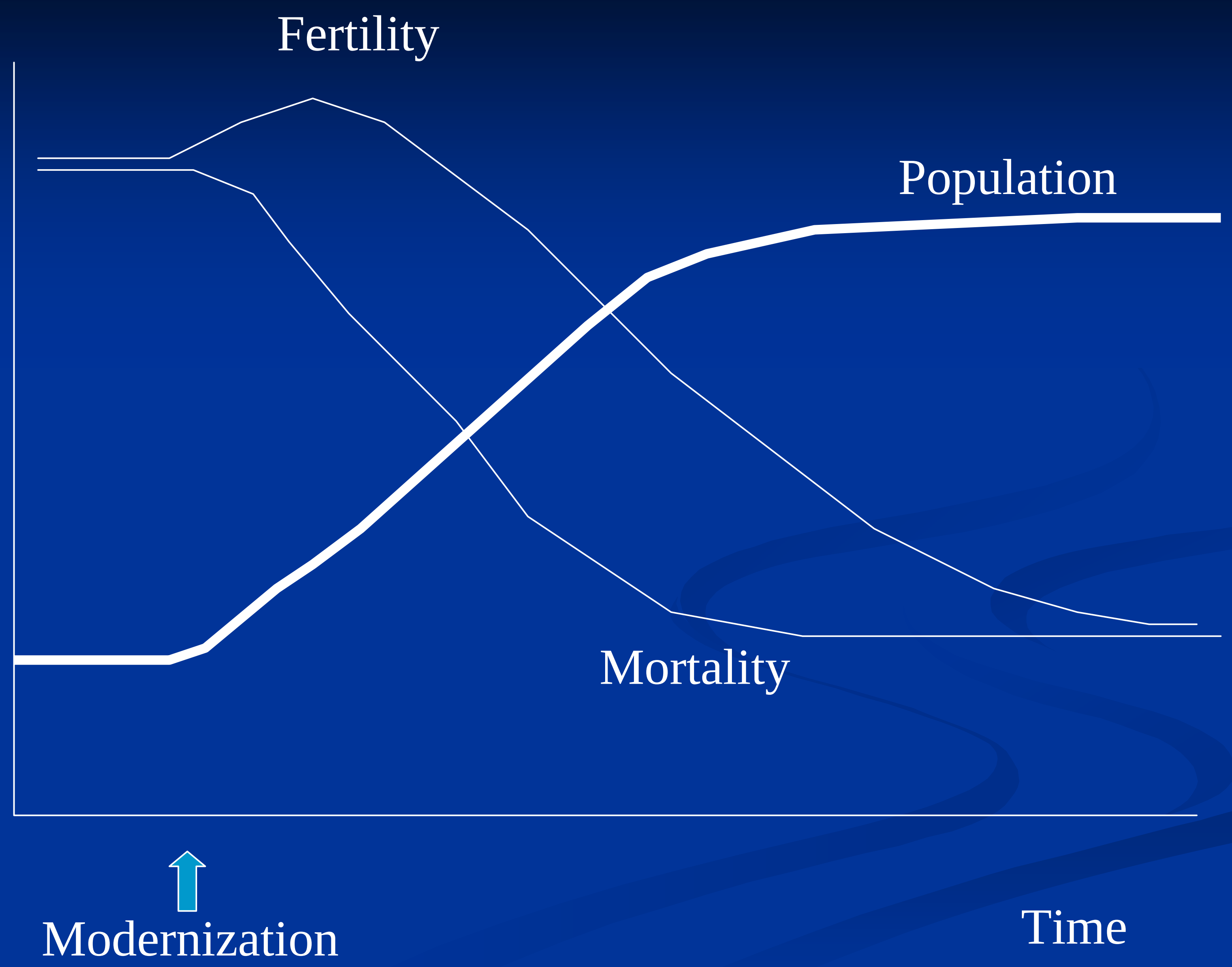
Very Few children
Long life
No disease

Net reproduction rate (NRR)
= 1.0
Annual population increase rate (r)
= NRR^(1/y) – 1 = 1.0^(1/25)-1=0.0038=0%

Fertility – Mortality = Population increase rate

5%	5%	=	0%
5%	2%	=	3%
3%	2%	=	1%
2%	2%	=	0%

Population growth rate %, annual	Initial population	100 years	1000 years	10,000 years	100,000 years	1,000,000 years
0.01	100	101	111	272	2201546	2.7×10^{45}
0.1	100	111	272	2191668	2.6×10^{45}	
0.5	100	165	14658	4.6×10^{23}	4.0×10^{218}	
1	100	270	2095916	1.6×10^{45}		
2	100	724	40 billion	1.0×10^{88}		


Fertility
Population
Mortality
Modernization
Time

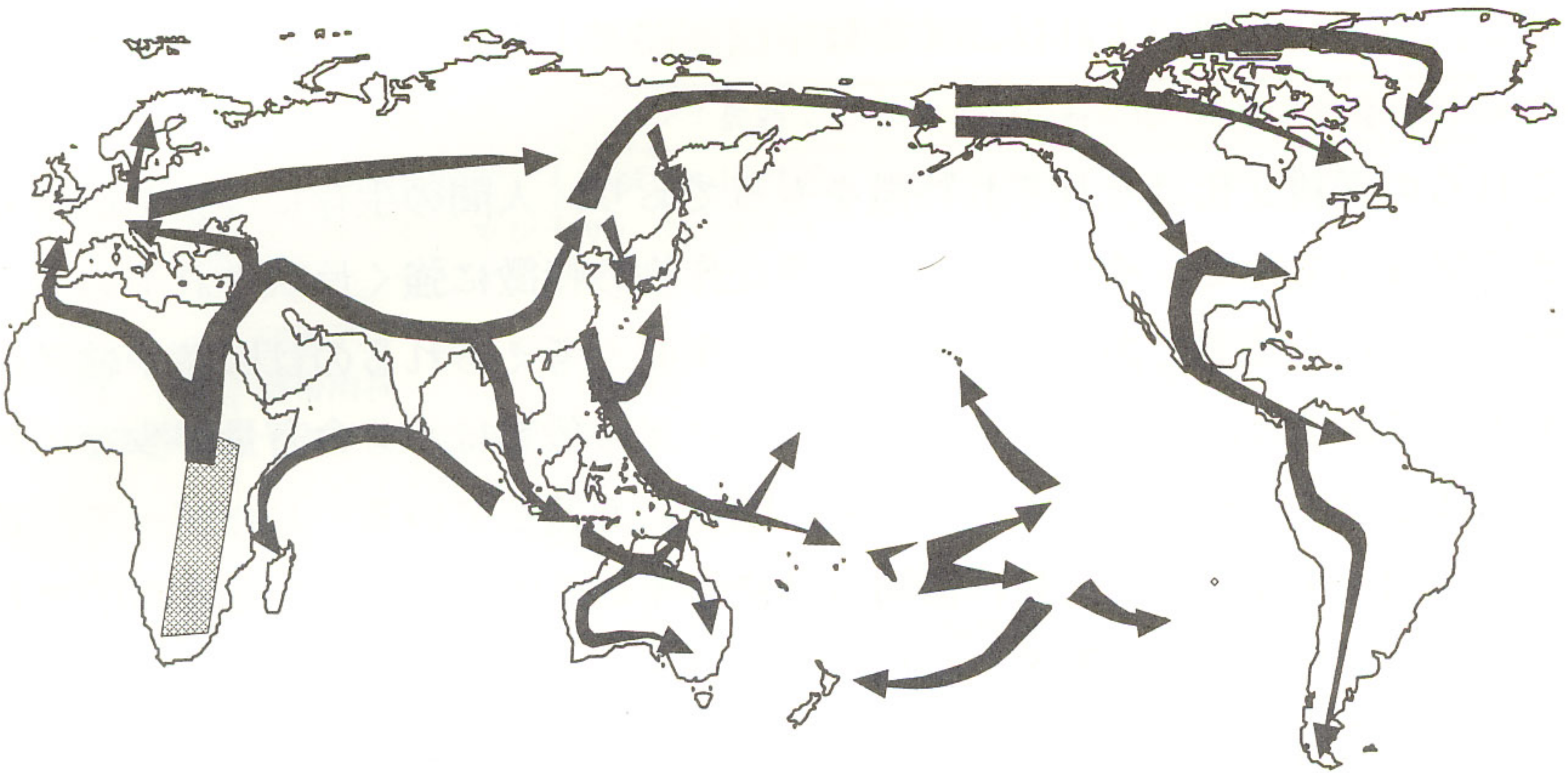
Study of food production system

Sweet potato

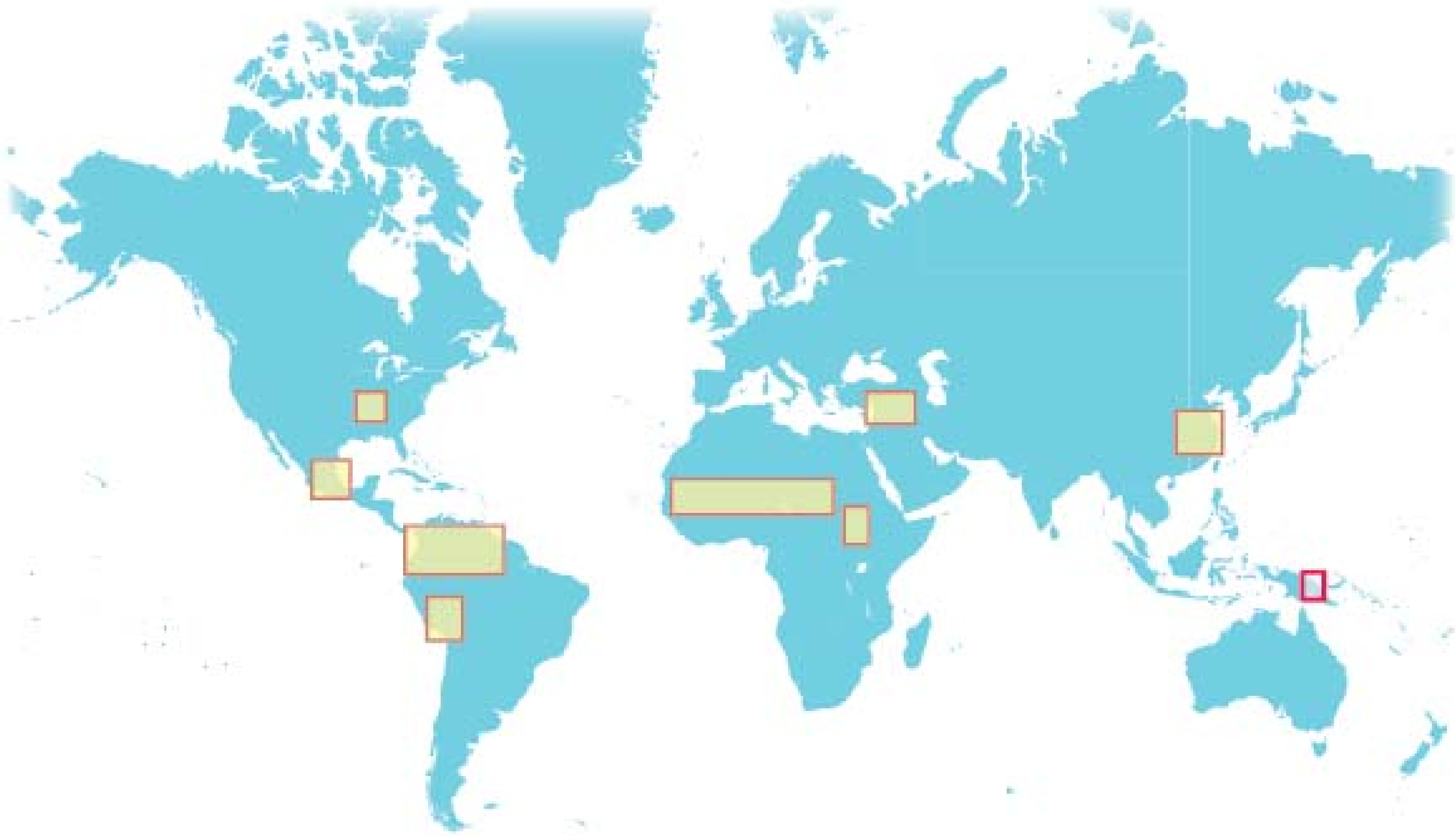
People

Pigs


焼畑農耕
常畑サツマイモ農耕
焼畑農耕＋サゴ澱粉採取
生業の地理的分布



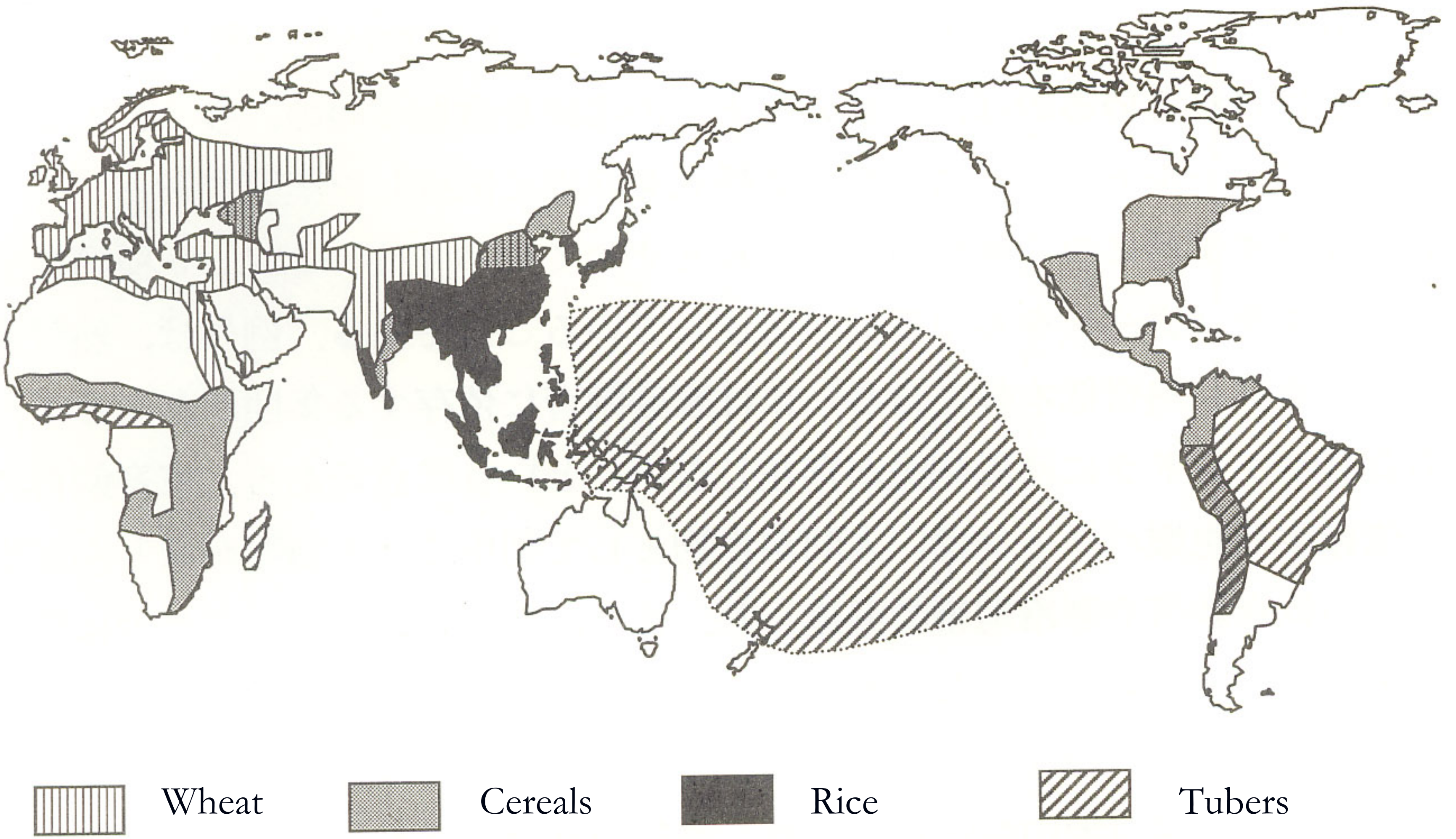
Past migration of *Homo Sapiens*



Centers of agricultural origins. New Guinea is marked in red.

(Science, 301: 5630, pp. 189-193)

Basic subsistence strategies before modernization (ca. 1500 AC)



You must survive in a mountain.
What would you do?

You could produce sufficient amount of crops in the first year. But the productivity decreased year by year. How do you cope with this?

Indigenous subsistence strategy

(e.g., rice cultivation)

↓

Intensification/modification (e.g., new crops, inter-cropping, indigenous technology)

or Industrialization/modernization

(e.g., fertilizer, hybrid species, pesticide, irrigation)

↓

Current subsistence strategy

(e.g., intensified rice cultivation)

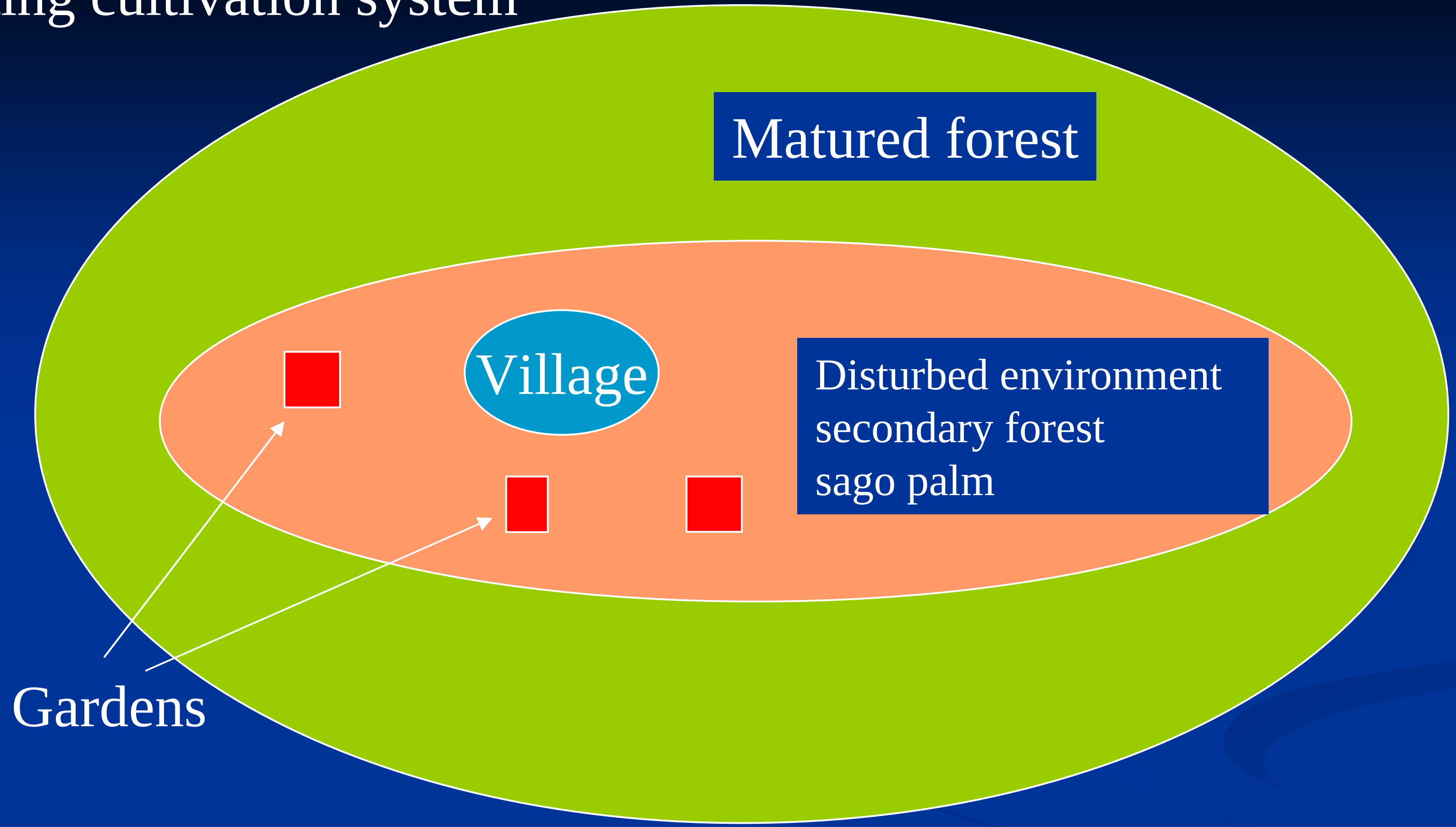
An example of subsistence change in Papua New Guinea

Current agricultural system in Papua New Guinea

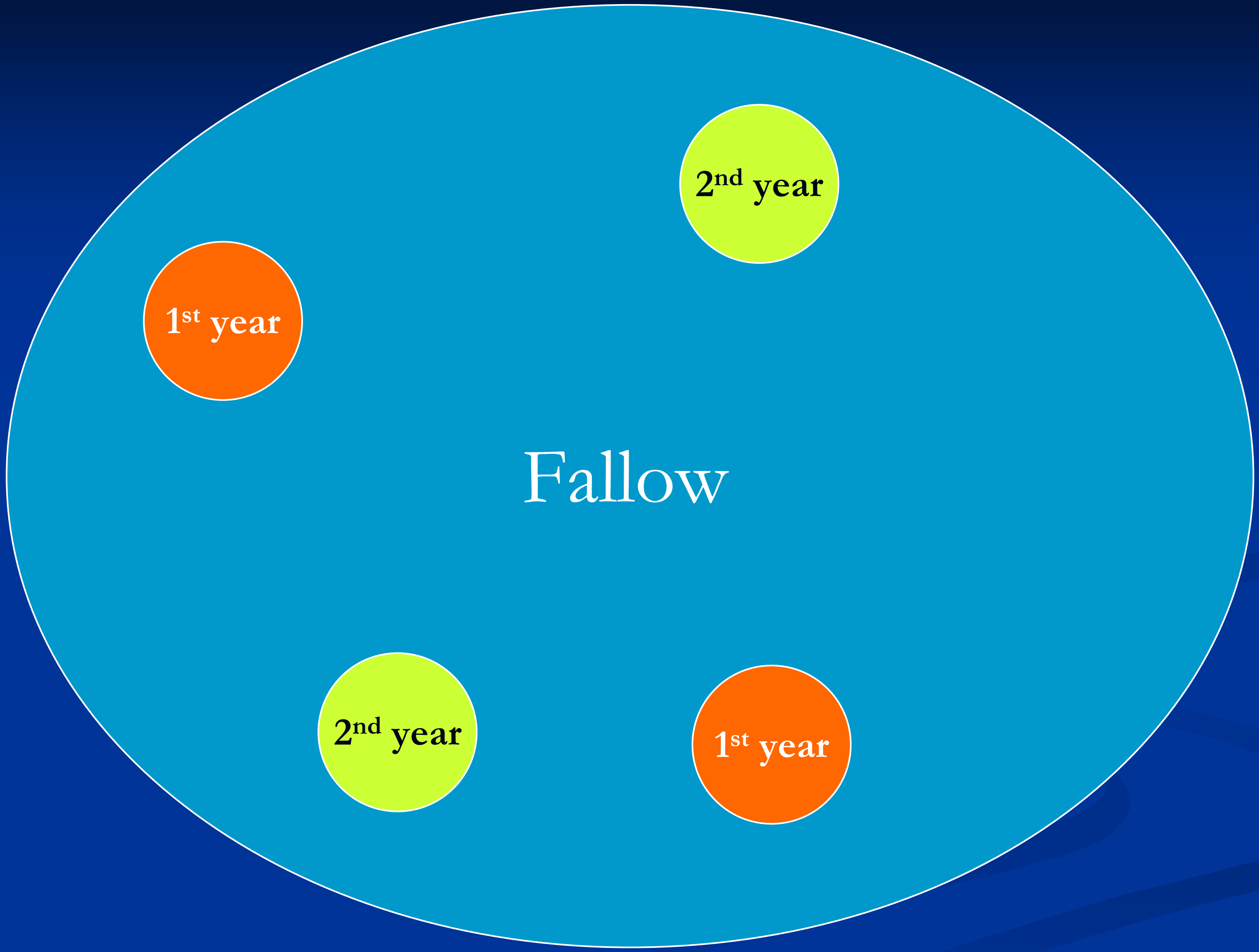
Shifting cultivation in Sepik of New Guinea

Taro, yam, banana, beans, sugarcane, sweet potato, corn

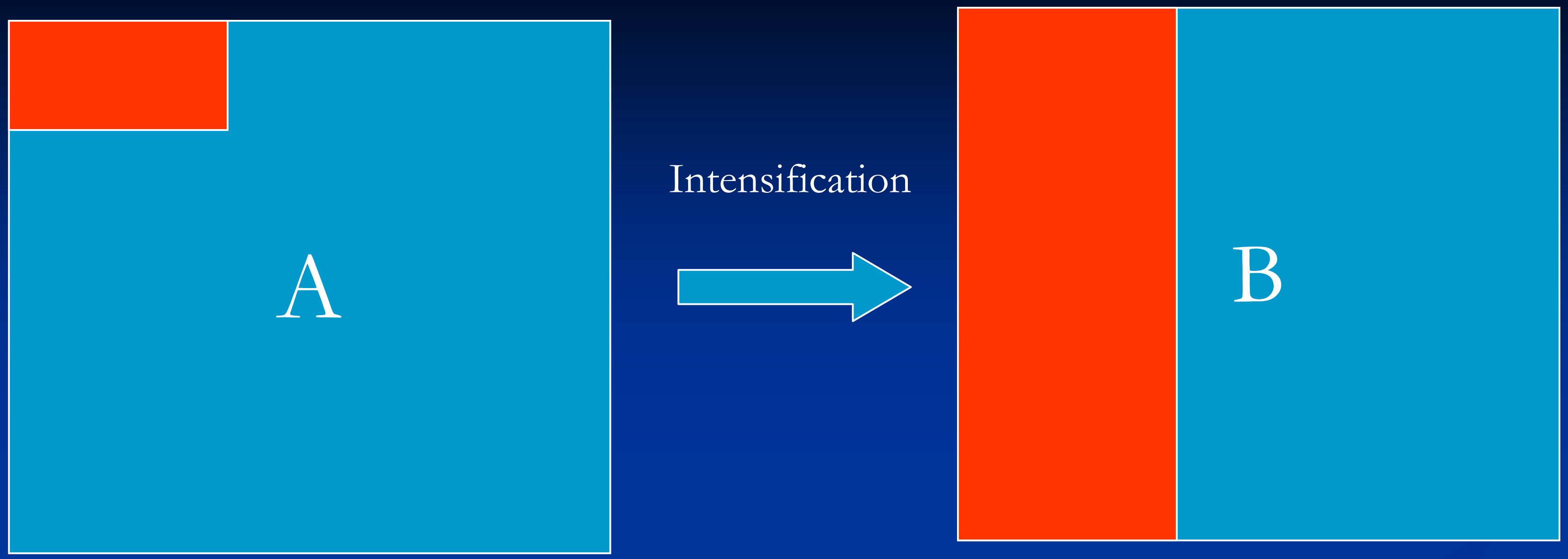
Shifting cultivation system



- Secondary forest provides suitable environment for wild animals and edible plants
- Secondary forest provides the space for pig rearing (female pigs under human control + wild male pig)



2nd year
1st year
Fallow
2nd year
1st year



A. Cultivation period (3 years) : fallow period (40 years)

→ gardens under cultivation : fallow = 3 ha : 40 ha

= totally 43 ha for annual cultivation of 3 ha of gardens

B. Cultivation period (5 years) : fallow period (10 years)

→ gardens under cultivation : fallow = 3 ha : 6 ha

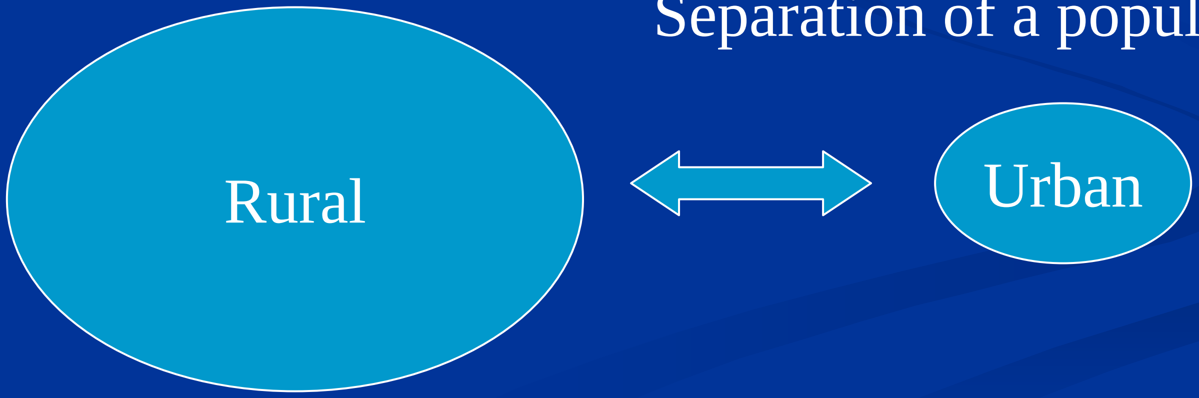
=totally 9 ha for annual cultivation of 3 ha of gardens

The Huli people in Papua New Guinea Highlands

Sweet potato cultivation and pig rearing
High population density
Less opportunity of cash-earning
Rural-urban and urban-rural migration since 1970s

Protein deficiency?
Food shortage?

Separation of a population



Subsistence Change in Papua New Guinea Highlands

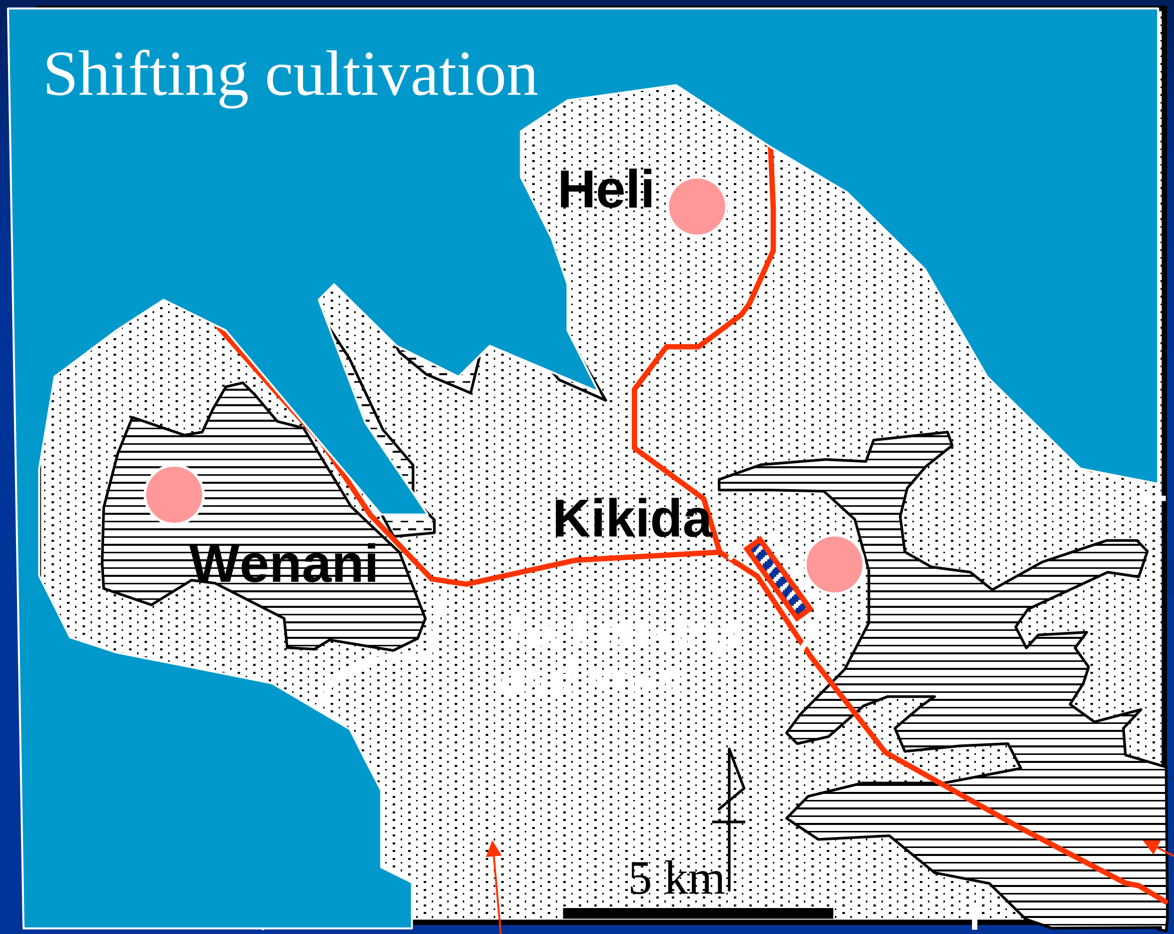
10000 BP	Domestication of Taro	Shifting cultivation
7000 BP	Domestication of Banana	
1700 BP	Intensification of Taro cultivation	
300 BP	Introduction of Sweet potato	Permanent cultivation
50 BP	予防接種，医療サービス	

300 BP – 50 BP： Population growth rate 1%/year

50 BP – present： Population growth rate >2%/year

QUESTION: P_300BP=100, P_current=?

過去250年間で人口が64倍に増加したことへの対応



5°50´

Permanent cultivation

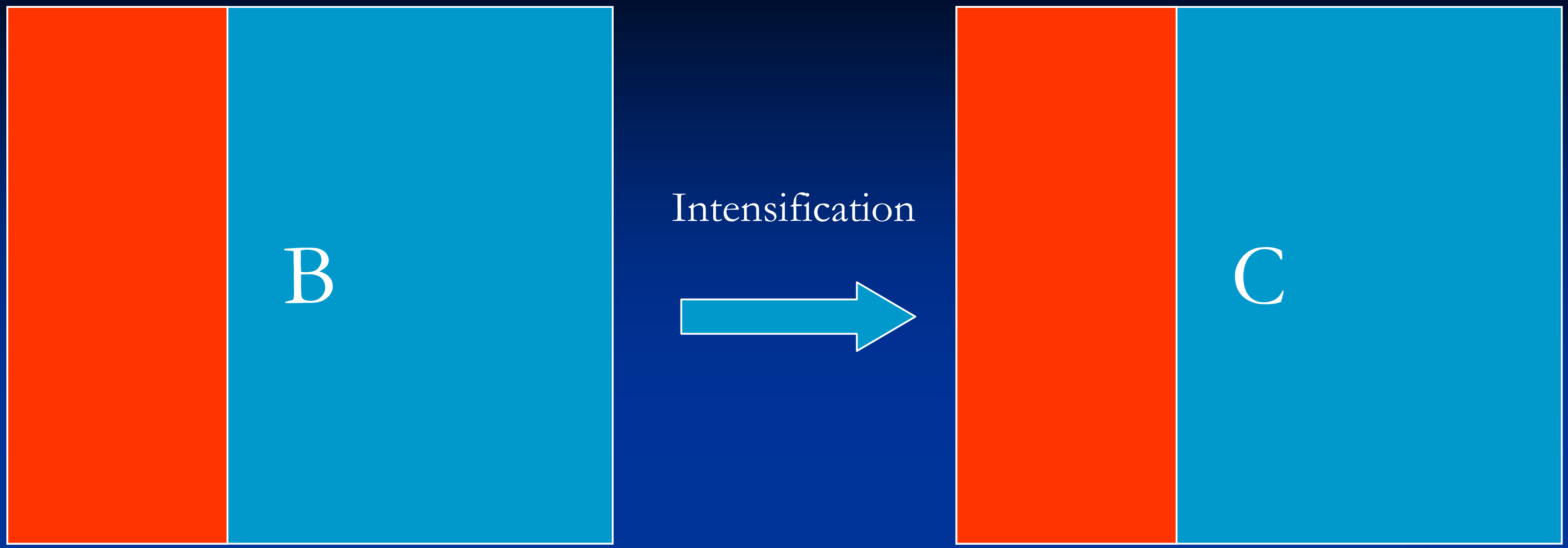
Wet

142°50´

143°00´

Dry

パプアニューギニア高地の集約的サツマイモ栽培



B. Cultivation period (5 years) : fallow period (10 years)
→ gardens under cultivation : fallow = 3 ha : 6 ha
=totally 9 ha for annual cultivation of 3 ha of gardens

C. Cultivation period (>100 years) : fallow (0 year)

= totally 3 ha for annual cultivation of 3 ha of gardens

Intensification

Increase of land productivity

Shifting cultivation → Permanent cultivation

Problems

Nutrients removed by crops from soils should be compensated for sustainable production

(e.g., fallow, chemical fertilizer)

How did the PNG people cope with this problem?

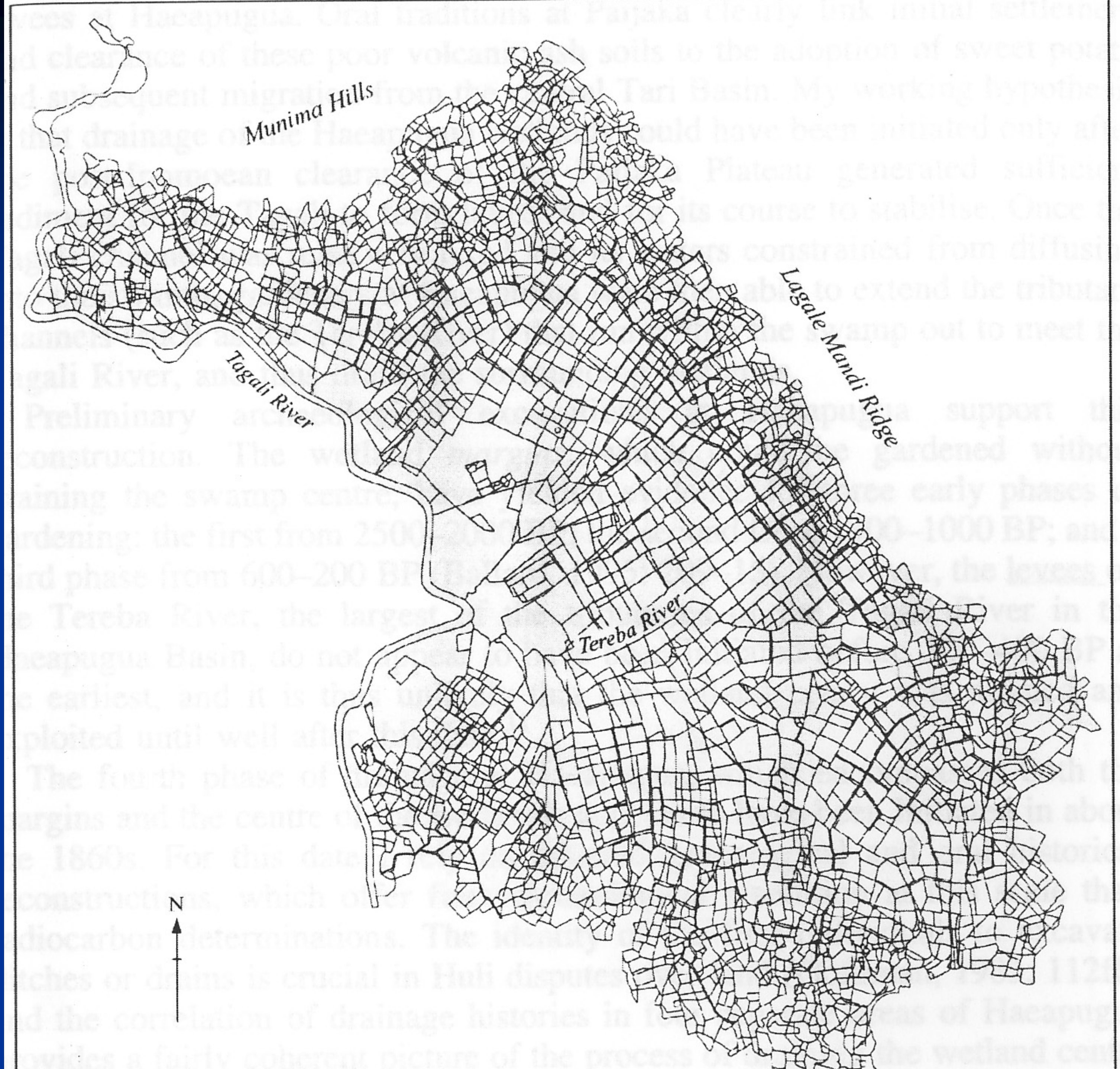
Answer: Artificial control of natural vegetation of the landscape

by planting “good” trees
by leaving “good” trees
by weeding “bad” grasses
by leaving “good” grasses

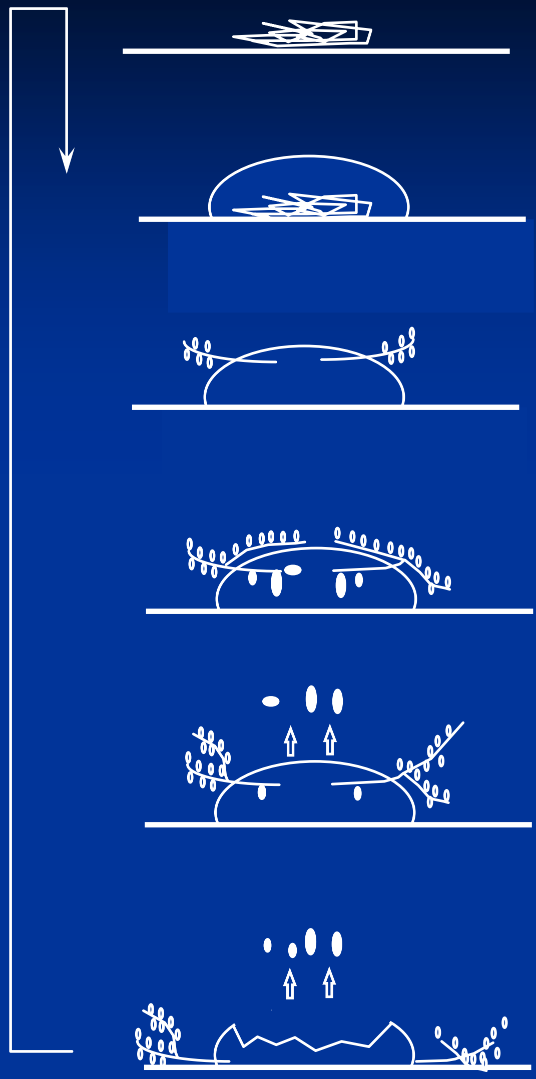
↓

The physical environment has been modified, which enabled the sustainable production of food crops without using chemical fertilizer.

Drainage



Munima Hills
Tagali River
Lagale Mandi Ridge
Tereba River
N

A. Put grasses

B. Cover the grasses with soil

C. Plant sweet potato vines

D. Ready to harvest after 5 months from planting

E. First harvest for large tubers only

F. Final harvest after 1 year from planting; Destroy the mound and remove all tubers.

Cultivation system of sweet potatoes

Plant “good” trees in the gardens

"Good" trees in the gardens

Juveniles of "good" trees

Effort to maintain the vegetation ideal for sweet potato production

- Plant “good” trees in the gardens
  e.g., *Casuarina oligodon*, *Albizia falcataria*, *Castanopsis acuminatissima*, *Ficus copiosa* etc.

- Leave “good” trees in the gardens
  e.g., *Albizia falcataria*, *Castanopsis acuminatissima*, *Ficus* sp.

- Maintain “good” grasses in thegardens
  e.g., *Ischaemum timorense*, *Histiopteris incisa*, *Nothofagus* sp.

Technological innovation of agriculture

Green revolution, hybrid species of maize or rice,
Genetically modified crops, fertilizer, pesticides
FAO/IRRI

Food production that utilized the function of ecosystem

UNU PLEC projects (1998-2002)
UNESCO South-South cooperation

- QUESTIONS?
- COMMENTS?

Land productivity has been increased. What is the problems?

-Mono-cropping of sweet potatoes
-No wild animals
-Little wild edible plants

Reduced "elasticity" to climatic perturbation

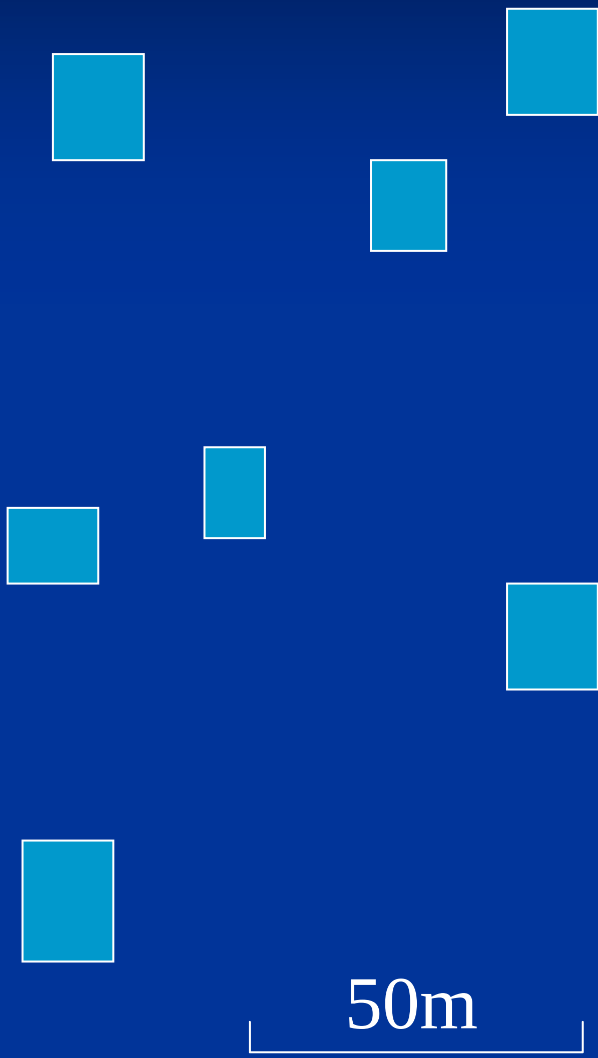
Nutritional deficiency
Health problem

Nutritional Adequacy of Sweet potato diet

Consumption of sweet potato=2 kg/d per male adult
Consumption of animal protein <10 g/d per male adult

Protein Deficiency??

Food consumption: direct measurement



Harvest → animal, gift

↓

Raw → skin

↓

Edible portion

↓

Cooked → abandoned

↓

consumed

TABLE I

Per 100 g contents of energy, protein, and fat for food items taken in the present surveys

Name	Botanical name	Edible portion	Energy (kJ)	Protein (g)	Fat (g)	Source
Tubers						
Sweet potato*	*Ipomoea batatas*	0.88	561	1.4	0.3	P
Cassava	*Manihot utilissima*	0.80	623	0.4	0.2	A
Taro	*Colocasia esculenta*	0.80	556	1.2	0.2	A
Leafy vegetables						
Aluba	*Amaranthus* spp.	1.00	88	3.1	0.1	P
Awa	*Rorippa* spp.	1.00	117	2.0	0.3	C
Cabbage	*Brassica* spp.	1.00	100	1.4	0.1	D
Fern	?	0.72	301	4.1	0.0	P
Kereba	*Rungia klossii*	0.85	159	2.9	0.1	P
Kora	?	1.00	117	2.0	0.3	C
Poge	*Ficus copiosa*	1.00	130	3.5	0.1	P
Pumpkin leaves	*Cucurbita maxima*	0.85	109	3.0	0.1	P
Tigibi	*Oenanthe javanica*	0.93	134	2.1	0.1	P
Watercress	*Nasturtium officinale*	1.00	75	2.6	0.0	P

TABLE I (*continued*)

Name	Botanical name	Edible portion	Energy (kJ)	Protein (g)	Fat (g)	Source
Other plants						
Avocado		0.70	799	2.5	18.7	D
Banana		0.60	498	1.1	0.1	A
Beans		1.00	1423	21.0	1.6	E
Corn		0.25	435	3.4	0.8	P
Mushroom		1.00	96	1.2	0.3	B
Onion		0.95	180	1.8	0.2	G
Passion fruit		0.10	293	1.5	2.0	H
Highlands pitpit	*Setaria palmifolia*	0.25	71	2.0	0.2	P
Poge fruit	*Ficus copiosa*	0.90	632	6.0	0.5	H/I
Pumpkin		0.83	163	1.1	0.1	P
Sugar cane	*Saccharum officinarum*	0.50	243	0.4	0.0	B
Choko	*Sechium edule*	1.00	29	0.9	0.0	I
Tomato		0.95	92	0.9	0.0	B
Animals						
Egg		0.89	661	13.0	11.5	C
Fish		0.50	561	19.8	5.3	D
Pig (separable fat)		1.00	2971	2.6	74.3	D
Pig (meat)		1.00	908	17.5	15.1	D
Sheep meat		0.75	1008	16.9	18.0	D
Purchased foods						
Biscuit		1.00	1879	5.9	17.7	C
Cooking oil		1.00	3766	0.0	0.0	C
Soft drink		1.00	218	1.2	0.1	D
Tin-beef tallow		1.00	3933	0.2	99.8	D
Wheat flour		1.00	1197	7.2	0.9	F
Gum		1.00	1297	0.0	0.0	D
Instant noodle		1.00	1812	10.4	16.9	D
Rice		1.00	1435	5.6	0.5	A
Tin-corn beef		1.00	1004	21.0	17.3	A
Tin-fish		1.00	753	18.0	12.0	A

* Mean values of major eight cultivars in the Tari Basin.
Sources: The authors' samples in the Tari Basin (shown as "P") and those compiled in Hongo and Ohtsuka (1993). Original sources in Hongo and Ohtsuka (1993) are: A: Hongo and Ohtsuka (1993); B: Hodges *et al*. (1950); C: South Pacific Commission (1983); D: Japanese Resources Council (1982); E: Bailey (1968); F: Norgan *et al*. (1979); G: Silitoe (1983); H: May (1984); I: French (1986).
Note: 1 kcal = 4.184 kJ.

Food consumption in Heli and Wenani

TABLE II

Energy and nutrient intake per day per male adult by five food categories

	Heli			Wenani		
	Energy (kJ)	Protein (g)	Fat (g)	Energy (kJ)	Protein (g)	Fat (g)
Tubers	4980	13	3	9302	24	5
Leafy vegetables	211	5	0	404	10	0
Other plants	303	2	0	709	5	1
Animals	200	2	4	486	10	8
Purchased foods	2059	13	15	2028	7	19
Total	7754	35	23	12929	56	33

Note: 1 kcal = 4.184 kJ.

Adaptation to low-protein diet

Previous study suggested (Koishi, 199X):

- Increased utilization of urea
- Increased storage of N when over-consumed
- Low level of minimum N excretion
- Different intestinal bacterial flora
- <u>Sweet potatoes that contained "good" quality of protein</u>

PROTEIN CONTENT AND AMINO ACID SCORES OF SWEET POTATOES IN PAPUA NEW GUINEA HIGHLANDS

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Protein content and amino acid scores of sweet potatoes were determined in Papua New Guinea Highlands where sweet potatoes contributed approximately 50% of the total protein intake. Major cultivars of sweet potatoes in the Tari basin and the Asaro valley, 15 in total, were sampled and their nitrogen and amino acid contents were analyzed. Sweet potatoes in the Tari basin and the Asaro valley contained, respectively, 1.4% and 0.8% of protein in fresh weight basis. The concentration was 1.7 times higher in the former than in the latter (t-test, $p < .01$). The first limiting amino acid was leucine in the samples from both areas and amino acid scores were 87 in the Tari samples and 85 in the Asaro samples, using values of FAO/WHO (1973). Protein content and amino acid scores of sweet potatoes in the Tari basin were higher than those previously reported in Papua New Guinea Highlands probably because of introduction of new cultivars in recent decades, and thus protein intake of the inhabitants may have been increased.

KEY WORDS: Sweet potato, plant protein, amino acid score, Papua New Guinea Highlands

Sweet potatoes in the Tari basin

- Number of cultivars grown= 40
- Effort to maintain various cultivars in the gardens
- Rapid replacement of cultivars

  e.g., cultivars grown 50 y before were completely different from the current cultivars
- Strong interest to the new cultivars

SP cultivars (N=7) in Tari

Where the people heavily depended on sweet potato for their daily diet,

SP cultivars (N=8) in Asaro

Where the people have various food items for their daily diet

$\boxed{\text{Protein content} \times \text{amino acid score}}$

Amount × Quality

Protein content of SP in Tari and Asaro

TABLE I

Percent weight of edible portion, dry matter, and crude protein, and energy content for sweet potatoes from the Tari basin and the Asaro valley

Local name	Area	Total weight of samples (g)	Edible portion (%wt)	Dry matter (%wt)	Crude protein (%wt)		Energy (kJ/100 g)
					Dry matter basis	Fresh weight basis	Dry matter basis
Wanumuni	Tari	308	90.9	37.2	6.4	2.36	1641
Iba	Tari	202	98.0	34.5	4.8	1.64	1647
Po	Tari	256	96.1	32.4	4.5	1.47	1641
Penaria	Tari	324	97.5	37.6	4.4	1.65	1650
Brau	Tari	282	97.2	29.2	3.7	1.09	1645
Yagahaba	Tari	160	92.5	32.6	3.1	1.02	1643
Warari-Pagabua	Tari	282	88.7	29.3	2.6	0.77	1642
Opume	Asaro	121	72.8	30.0	5.2	1.56	1626
Kula	Asaro	460	83.7	31.6	3.4	1.08	1627
Tony	Asaro	590	83.9	29.1	3.2	0.93	1624
Gurohe	Asaro	420	71.4	32.9	2.5	0.81	1649
Gasiri	Asaro	420	71.4	25.6	2.2	0.57	1643
Ikisavena	Asaro	430	82.3	34.9	1.8	0.61	1657
Konimejo	Asaro	641	88.9	32.1	1.6	0.53	1651
Okapa	Asaro	453	79.6	34.8	1.6	0.56	1653
Tari ($n = 7$)	Mean	259	94.4	33.2	4.2 *	1.4 *	1644
	SD	46	3.7	3.4	1.2	0.5	3.4
Asaro ($n = 8$)	Mean	442	79.2	31.4	2.7 *	0.8 *	1641
	SD	94	6.6	3.1	1.2	0.4	13.6

Difference between the samples from the Tari basin and the Asaro valley statistically significant at *$p < .01$ by t-test.

Amino acid score: index of protein quality

TABLE II

Amino acid concentrations per g of nitrogen and the calculated amino acid scores

			Ile	Leu	Lys	Met + Cys	Phe + Tyr	Thr	Trp	Val
Amino acid (mg/N(g))	Tari ($n = 7$)	Mean	240	382	298	196	490	276	80	339
		SD	9	24	23	21	43	27	6	24
	Asaro ($n = 8$)	Mean	231	374	308	210	511	284	84	331
		SD	24	34	26	17	45	25	8	40
Amino acid scores using FAO/WHO (1973)	Tari		96	87	88	89	129	111	134	109
	Asaro		92	85	91	95	134	114	140	107
Amino Acid Scores using FAO/WHO/UNU (1985)	Tari		133	93	83	122	126	132	114	154
	Asaro		128	91	86	131	131	135	120	150

Ile: Isoleucine; Leu: Leucine; Lys: Lysin; Met: Methionine; Cys: Cystine; Phe: Phenylalanine; Tyr: Tyrosine; Thr: Threonine; Trp: Tryptphan; Val: Valine.

Amino acid pattern by FAO/WHO (1973): Ile 250, Leu 440, Lys 340, Met + Cys 220, Phe + Tyr 380, Thr 250, Trp 60, and Val 310.

Amino acid pattern by FAO/WHO/UNU (1985) for 2–5 year old children: Ile 270, Leu 306, Lys 270, Met + Cys 270, Phe + Tyr 360, Thr 180, Trp 90, and Val 270.

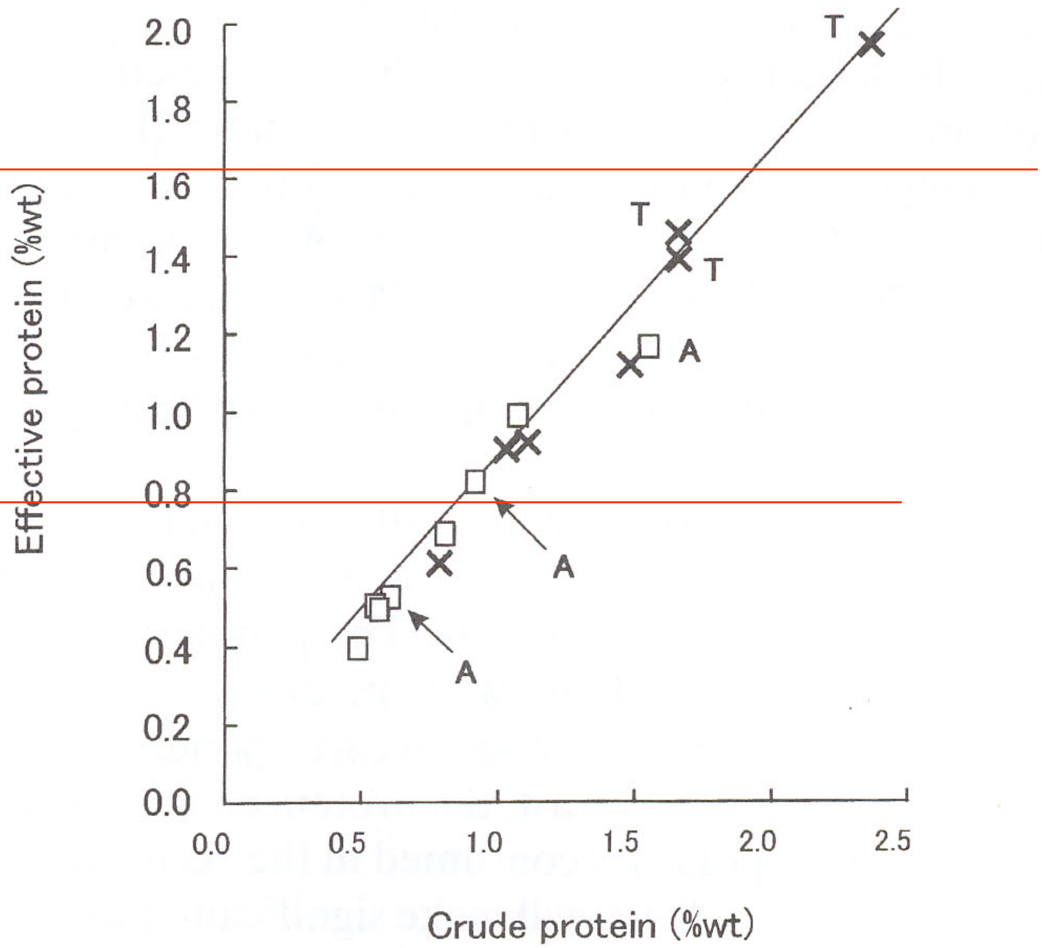


FIGURE 1 %weight of effective protein (fresh basis) is plotted against %weight of crude protein (fresh basis); **x**: samples from the Tari basin; □: samples from the Asaro valley; "T" shows three dominant cultivars from the Tari basin and "A" shows those from the Asaro valley. Effective Protein = $0.81 \times$ Crude protein + 0.04, $R^2 = 0.98$.

Sweet potatoes in Tari contained more effective protein (×２) than those in Asaro

Unintended selection of nutritionally “suitable” sweet potatoes in the Tari basin?

<u>Implication to the “child nutrition” in protein-deficient regions.</u>

Reduced “elasticity” to climatic perturbation

Impact of population growth on food production was visible only when the people experienced climatic perturbation or “not-normal” conditions

Subsistence Change in Papua New Guinea Highlands

10000 BP	Domestication of Taro	Shifting cultivation
7000 BP	Domestication of Banana	
1700 BP	Intensification of Taro cultivation	
300 BP	Introduction of Sweet potato	Permanent cultivation
50 BP	予防接種，医療サービス	

300 BP – 50 BP： Population growth rate 1%/year

50 BP – present： Population growth rate >2%/year

QUESTION: P_300BP=100, P_current=?

Data

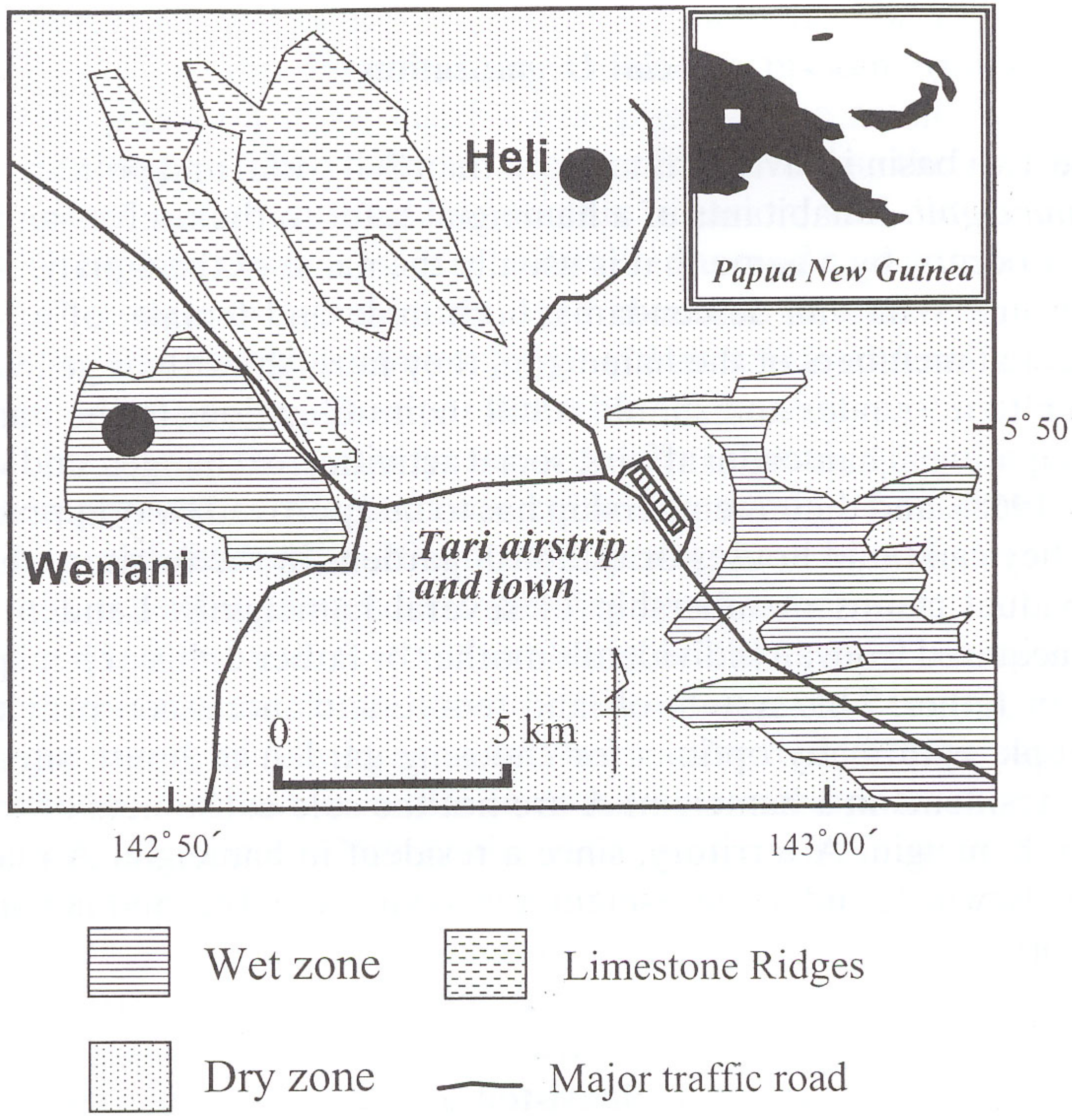


Fig. 1. Environmental zones in the Tari basin and location of the communities studied.

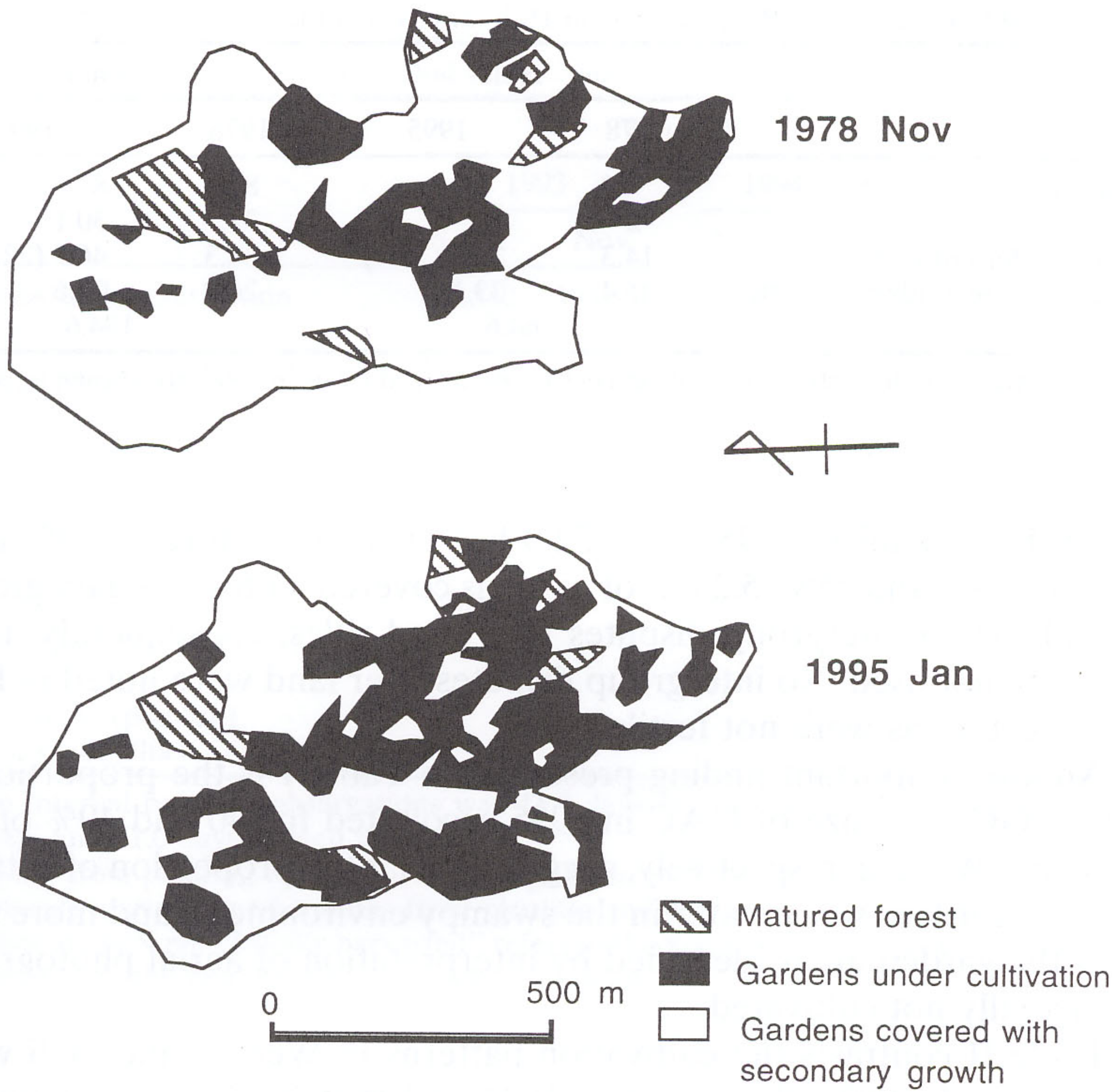


Fig. 3. Land use maps in Heli in 1978 and 1995.

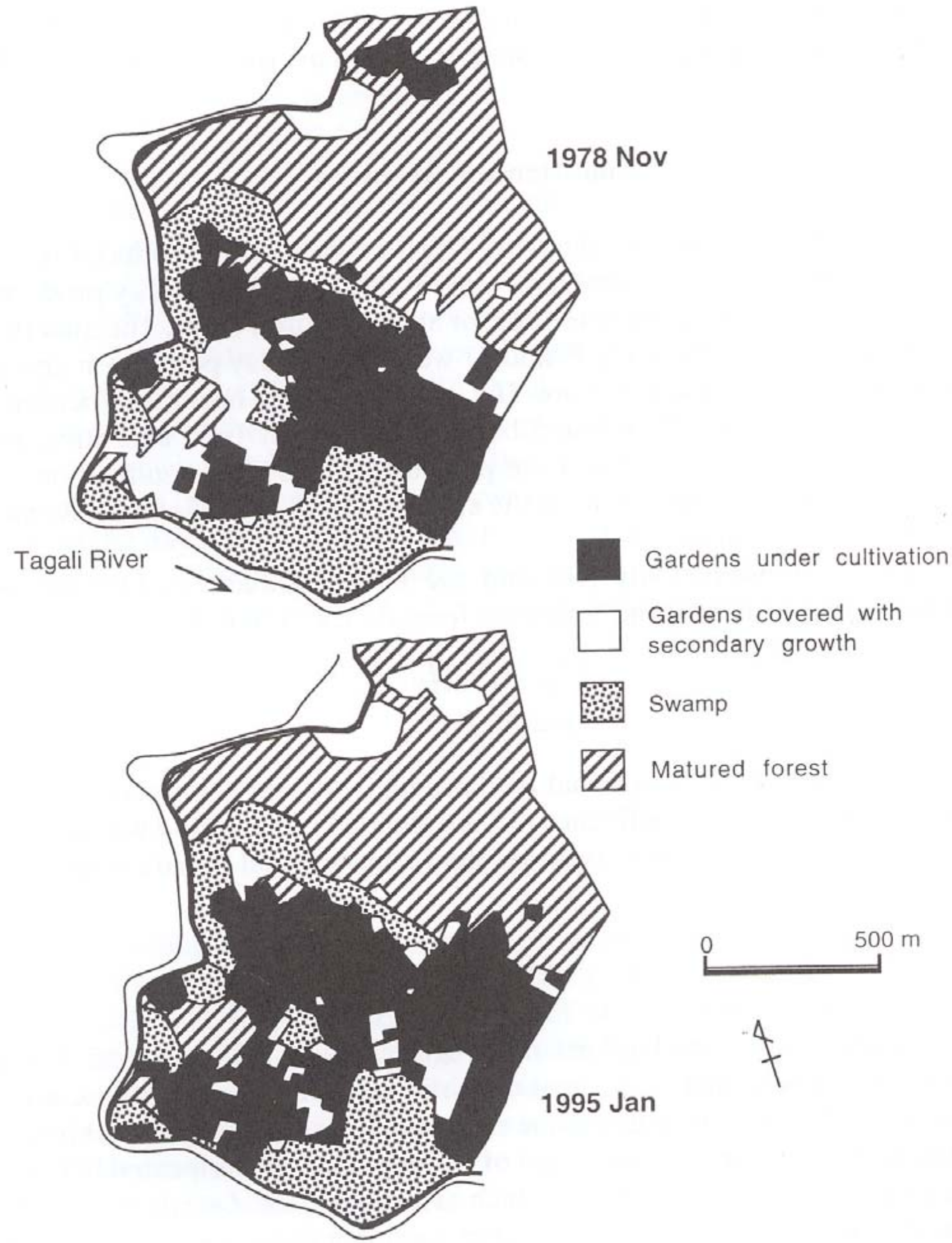


Fig. 2. Land use maps in Wenani in 1978 and 1995.

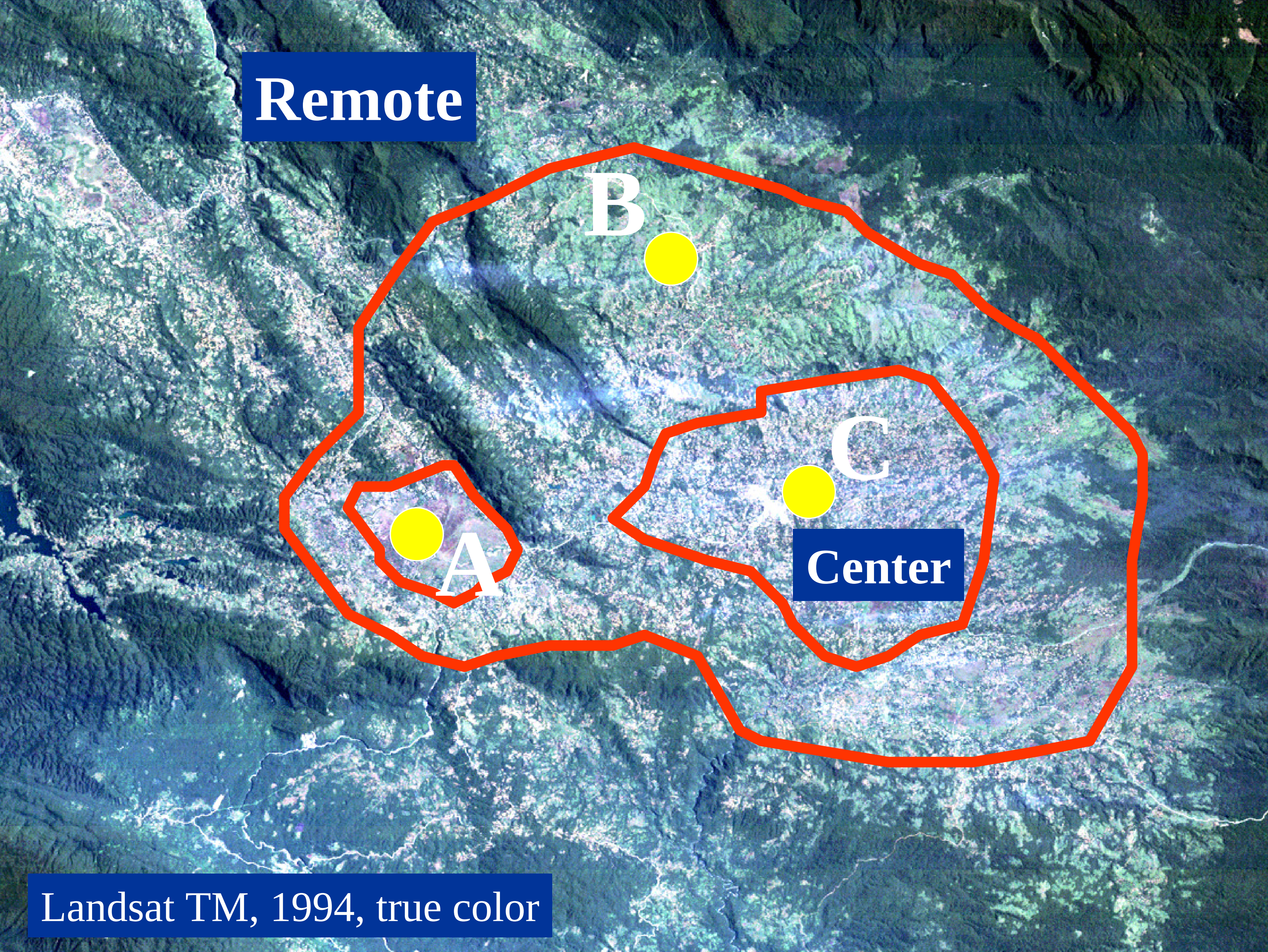

Remote
B
C
A
Center
Landsat TM, 1994, true color

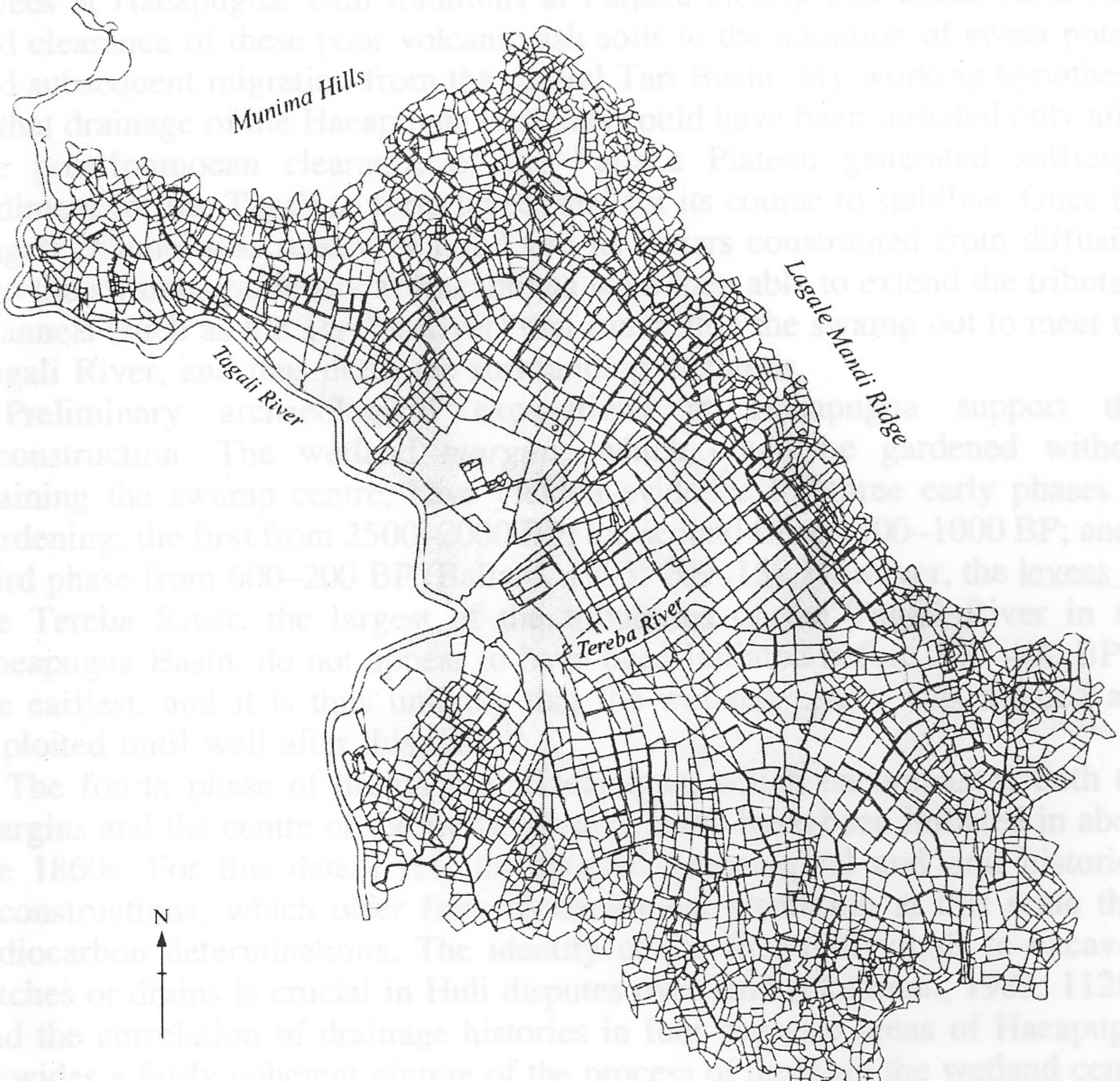
Table I. Land Use Patterns (ha) in Heli and Wenani in 1978 and 1995

	Heli		Wenani	
	1978	1995	1978	1995
Matured forest	4.8	4.2	87.6	87.6
Swamp	0	0	31.7	30.1
Gardens under cultivation	14.3	27.3 (10.8)[a]	38.3	46.2 (22.5)[a]
Gardens with secondary growth	45.4	33.1	26.9	20.6
Total	64.6		184.6	

[a] Areas of gardens under actual cultivation (GAC) measured by us in 1995 are shown in parentheses.

Gardens under cultivation : gardens under fallow = cultivation period : fallow period

To what extent the fallow period of Heli reduced?



Munima Hills
Lagale Mandi Ridge
Tagali River
Tereba River
N


DIET AMONG THE HULI IN PAPUA NEW GUINEA HIGHLANDS WHEN THEY WERE INFLUENCED BY THE EXTENDED RAINY PERIOD

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Household food consumption surveys (weighed records for 7 days) were conducted in two Huli-speaking communities, Heli in the slope zone and Wenani in the flat plain, in Papua New Guinea Highlands when their food productivity had decreased after an extended rainy period in 1994. Despite lowered productivity of garden crops in both communities, daily adult male energy and protein intakes in Wenani (12930 kJ, 3090 kcal and 56 g, respectively) exceeded the requirement and safe levels by FAO/WHO/UNU (1985), whereas those in Heli (7750 kJ, 1852 kcal and 35 g) were below both levels. The difference was mostly attributable to three times higher productivity of food energy in the normal period in Wenani than in Heli. The findings are relevant to the maintenance of food security among Papua New Guinea Highlanders.

KEY WORDS: Food consumption, dietary intake, population pressure, climatic perturbation, modernization, Papua New Guinea Highlands

1994 July-August: <u>long-lasted rain</u>

↓

Bad effect for the sweet potato that were just planted

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Productivity reduced to 60% of normal in October-November 1994

Long rain

Lowered productivity

7 8 9 10 11 12 1 2 3

Heli lost the adaptability to climatic perturbation

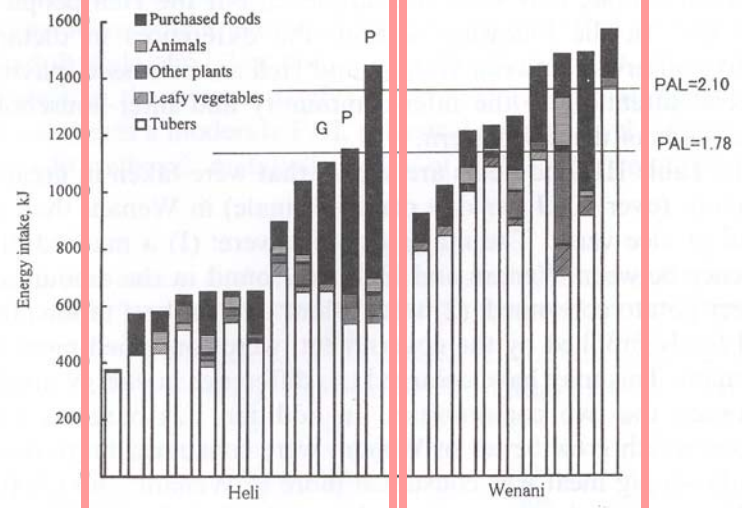


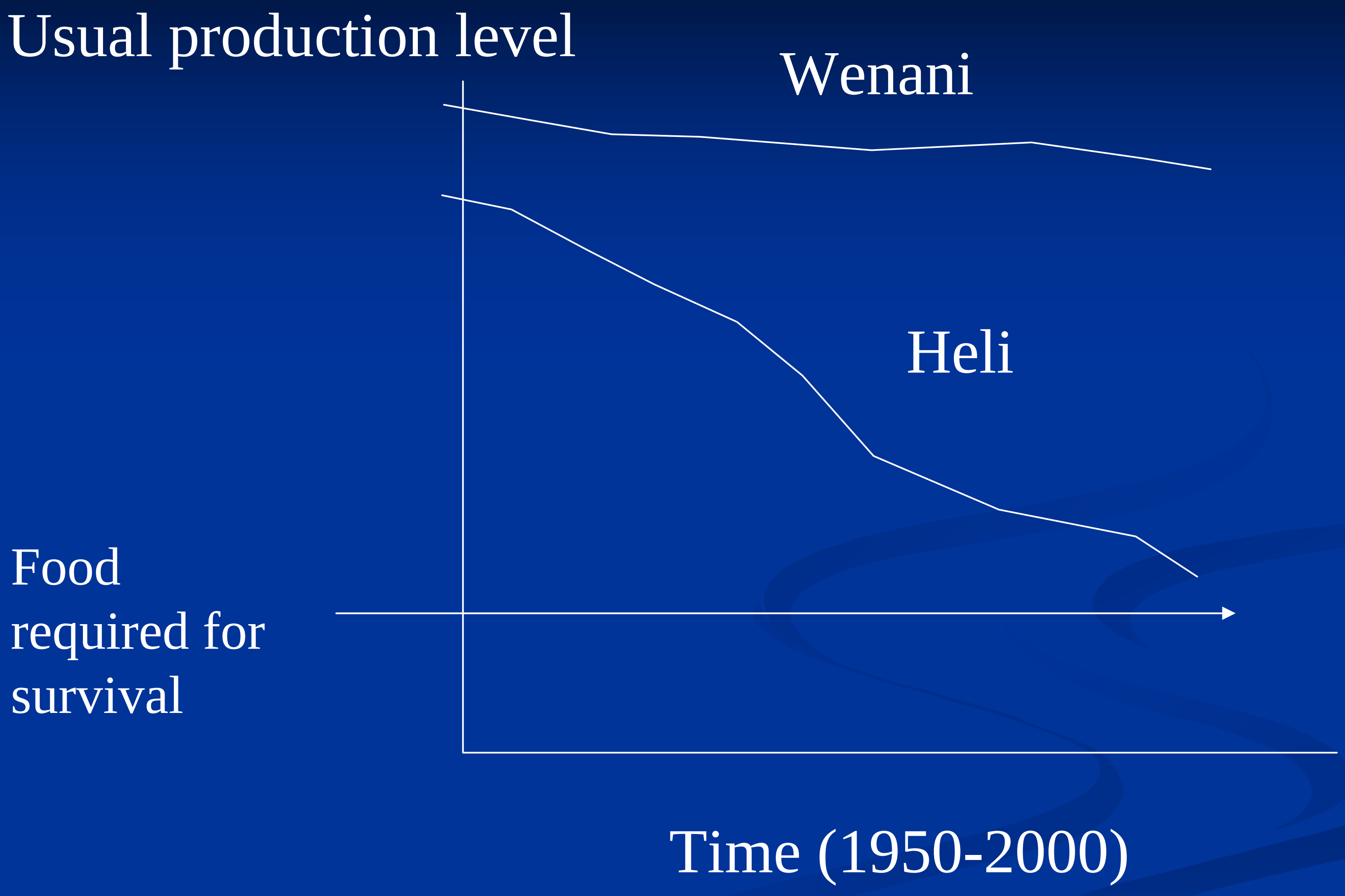
FIGURE 1 Inter-household variation in energy intake (adjusted to per-day values for a male adult with 57.7 kg of body weight) in Heli and Wenani, broken down by food category. Energy requirement levels for an individual whose physical activity level (PAL) was moderate and heavy are shown; see the text for details. P: the household whose head was employed; G: the household whose head brought gold from the mining field.

Wenani maintained the adaptability to climatic perturbation

Table II. Changes in Garden Size, Number of Mounds by Growth Stage, and Cultivation Cycle During the Normal Period in 1993 and the Extended Rainy Period in 1994

	Wenani[a]				Heli[a]	
	1993		1994–1995		1994	
	Sept.	Nov.	Nov.	Jan.	Oct.	Dec.
Gardens under cultivation (m^2)	187,540	194,650	168,670	177,040	87,520	97,390
Number of mounds in Stage A[b]	13,385	14,156	12,075	12,983	5,606	4,662
Number of mounds in Stage B[b]	7,095	7,388	7,004	6,857	4,349	6,319
% of mounds in Stage A	65%	66%	63%	65%	56%	42%
Initially harvested mounds[c]/day/ha	2.9		4.7		5	
Finally harvested mounds[c]/day/ha	2.6		4.7		1.9	
Newly made (planted) mounds/day/ha	3.9		5.3		3.5	

[a]Mean interval between observations was 43.9 days in 1993 and 86.3 days in 1994–1995 in Wenani and 71.0 days in Heli in 1994.
[b]Stage A, from planting to first harvest; Stage B, from first harvest to final harvest.
[c]Harvesting starts about 6 months from planting and continues for several months until the mounds are broken. "Intially harvested" refers to the first harvest since planting, and "finally harvested" to the final harvest by breaking mounds.


Usual production level
Wenani
Heli
Food
required for
survival
Time (1950-2000)

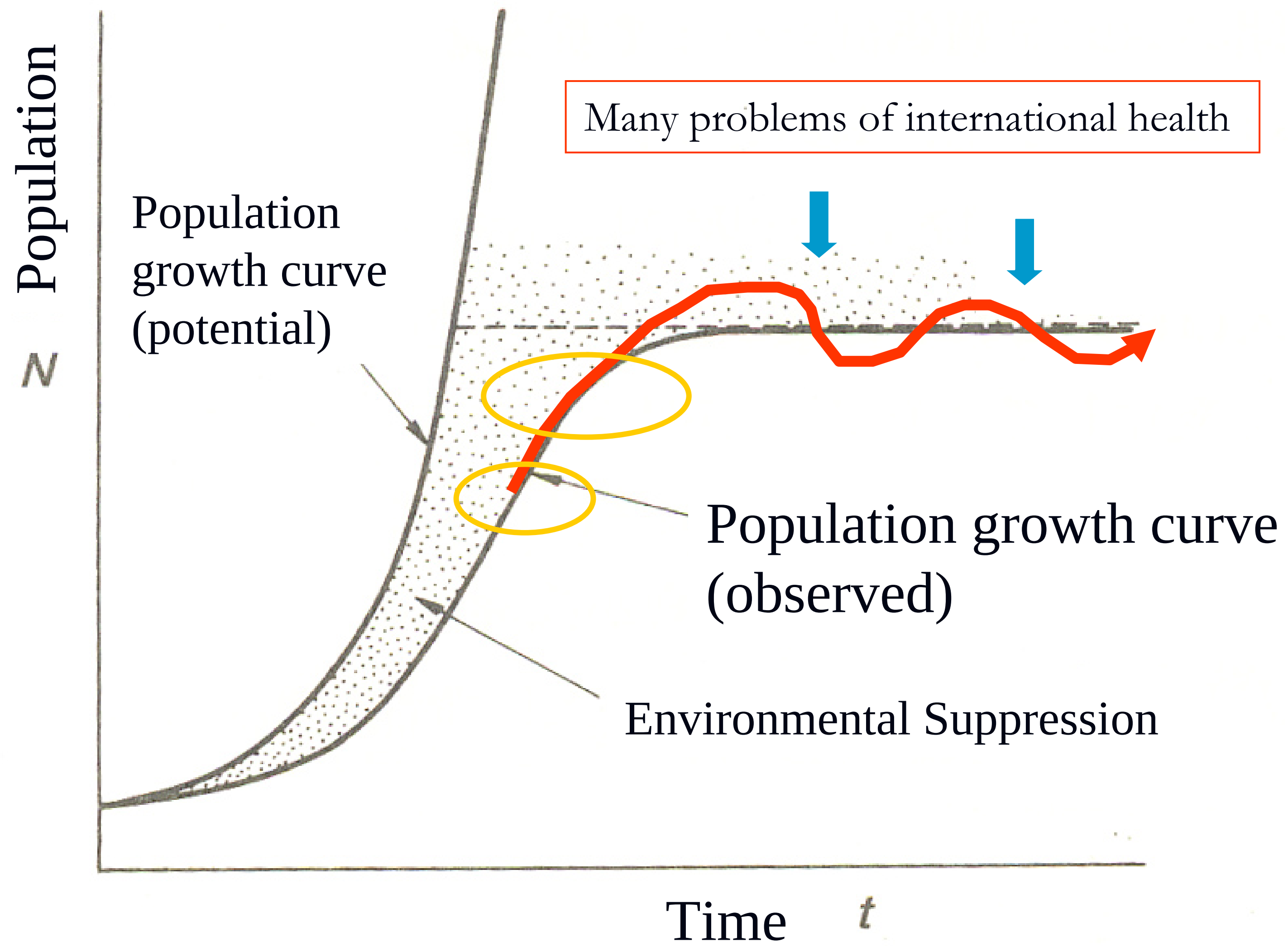


Figure. Population growth curve and carrying capacity

Ecological setting of Heli and Wenani:

How different?
Why?

Impact of Population Pressure on Food Production: An Analysis of Land Use Change and Subsistence Pattern in the Tari Basin in Papua New Guinea Highlands

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and Ryutaro Ohtsuka[1]

The impact of increase in population on land use and subsistence pattern was examined in two environmentally contrasting Huli-speaking communities, Heli and Wenani, in the Tari basin in Papua New Guinea Highlands. Despite the similar extent of population increase in both communities, the damage to land differed markedly. In Heli, a decrease in land productivity owing to excessive agricultural use has induced farmers to shorten the fallow duration, which in turn has led to further land degradation and difficulties in increasing food production. In contrast, Wenani villagers have coped with the population increase by enlarging areas for cultivation and possibly will be able to double their present production level, although increasingly frequent disputes over land rights have restricted peoples' access to fertile areas. During a period of climatic perturbations in 1994, land and labor productivities of crops were three times higher in Wenani than in Heli, which suffered a severe food shortage. This difference in ability to cope with climatic perturbations may have increased with population growth. The findings in the present study suggest that the effects of population pressure on food production may differ between communities, depending on the indigenous environment and subsistence pattern.

KEY WORDS: land use; population pressure; environmental degradation; Papua New Guinea Highlands.

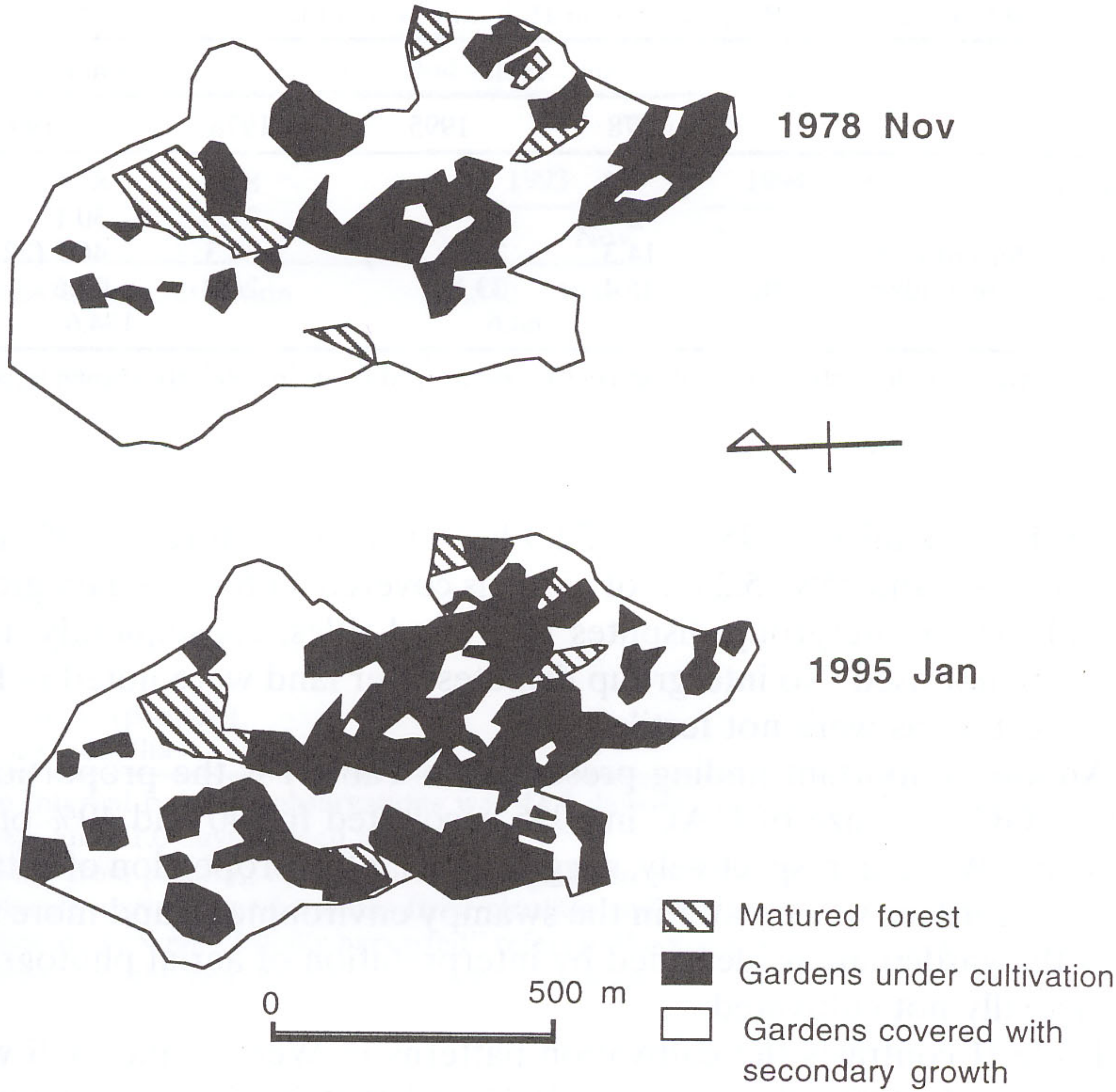

Fig. 3. Land use maps in Heli in 1978 and 1995.

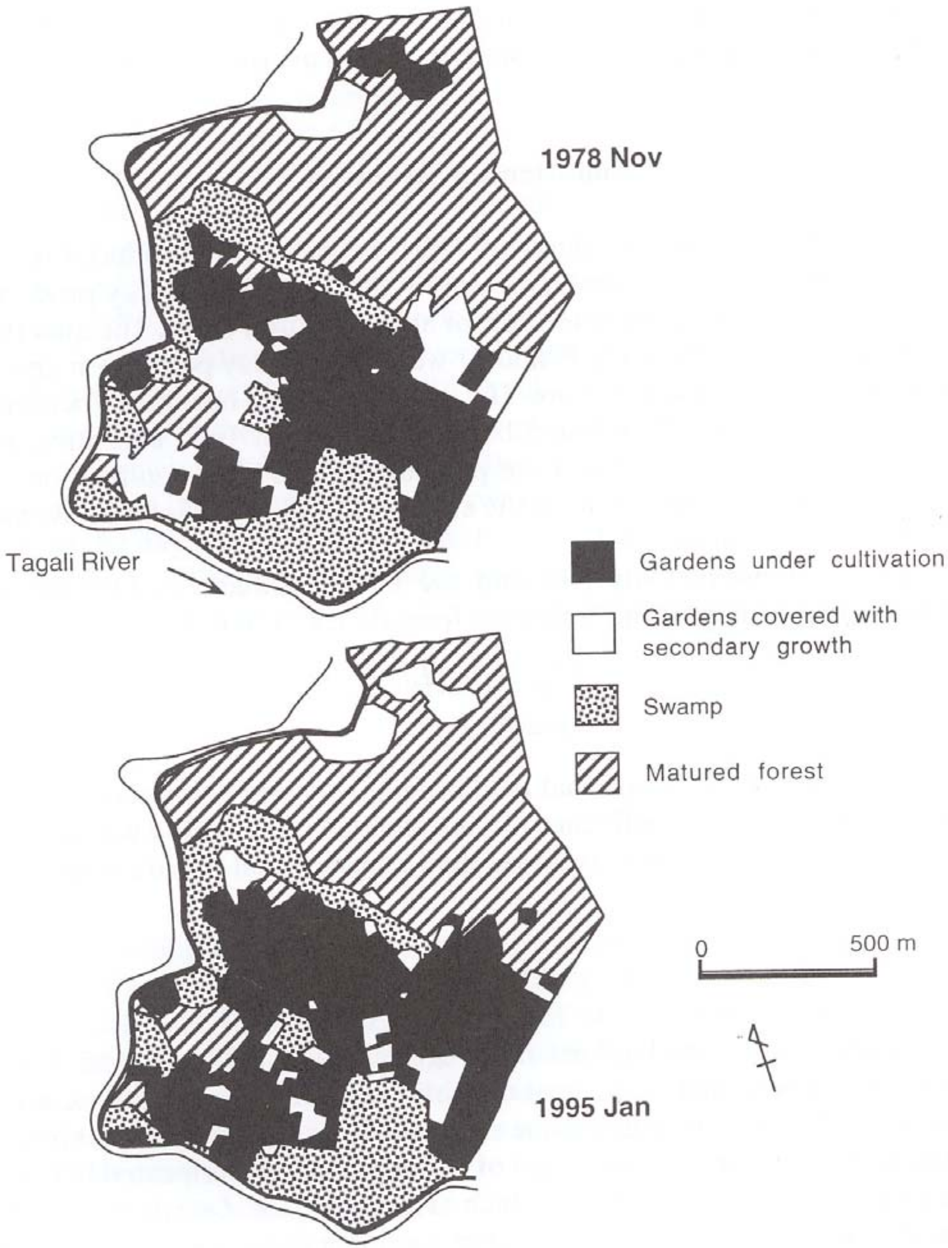

Fig. 2. Land use maps in Wenani in 1978 and 1995.

Table IV. Per Person Figures for Ecological Variables

	Wenani	Heli
Time spent in horticulture in a day[a] (min)	98	85
Sweet potato fed to a pig per day (kcal)	2064	1545
Number of pigs per person	1.9	0.6
Energy intake from garden crops (kcal)	1723	865
Energy intake from pigs and other animal (kcal)	80	32
Energy intake from purchased foods (kcal)	336	324
Annual labor hours (hr/ha)	4847	4370
Land productivity (kcal/ha)	$16.6 \cdot 10^6$	$5.7 \cdot 10^6$
Labor productivity (kcal/hr)	3419	1300

[a]Time spent in horticulture by an adult was converted to per person time using the proportion of adults in all members of the households under study (14/30 in Wenani and 21/53 in Heli); time spent in horticulture by a nonadult was negligible.

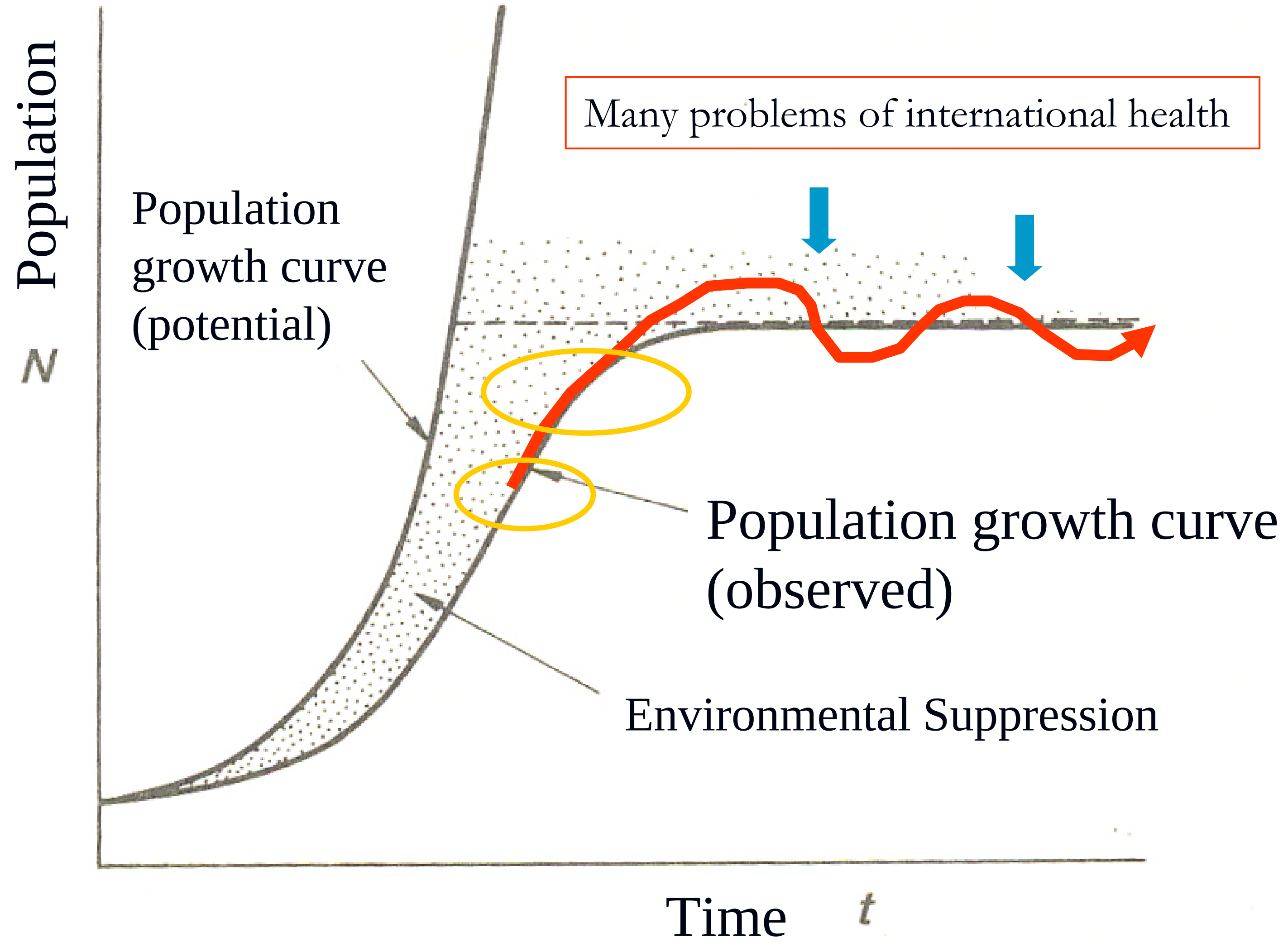

Figure. Population growth curve and carrying capacity

Elasticity to climatic perturbation:

Appropriate indicators for the evaluation of sustainability of the subject communities

Population growth in rural areas

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Rural-urban migration
Health problems in urban areas
Vulnerable communities in urban areas

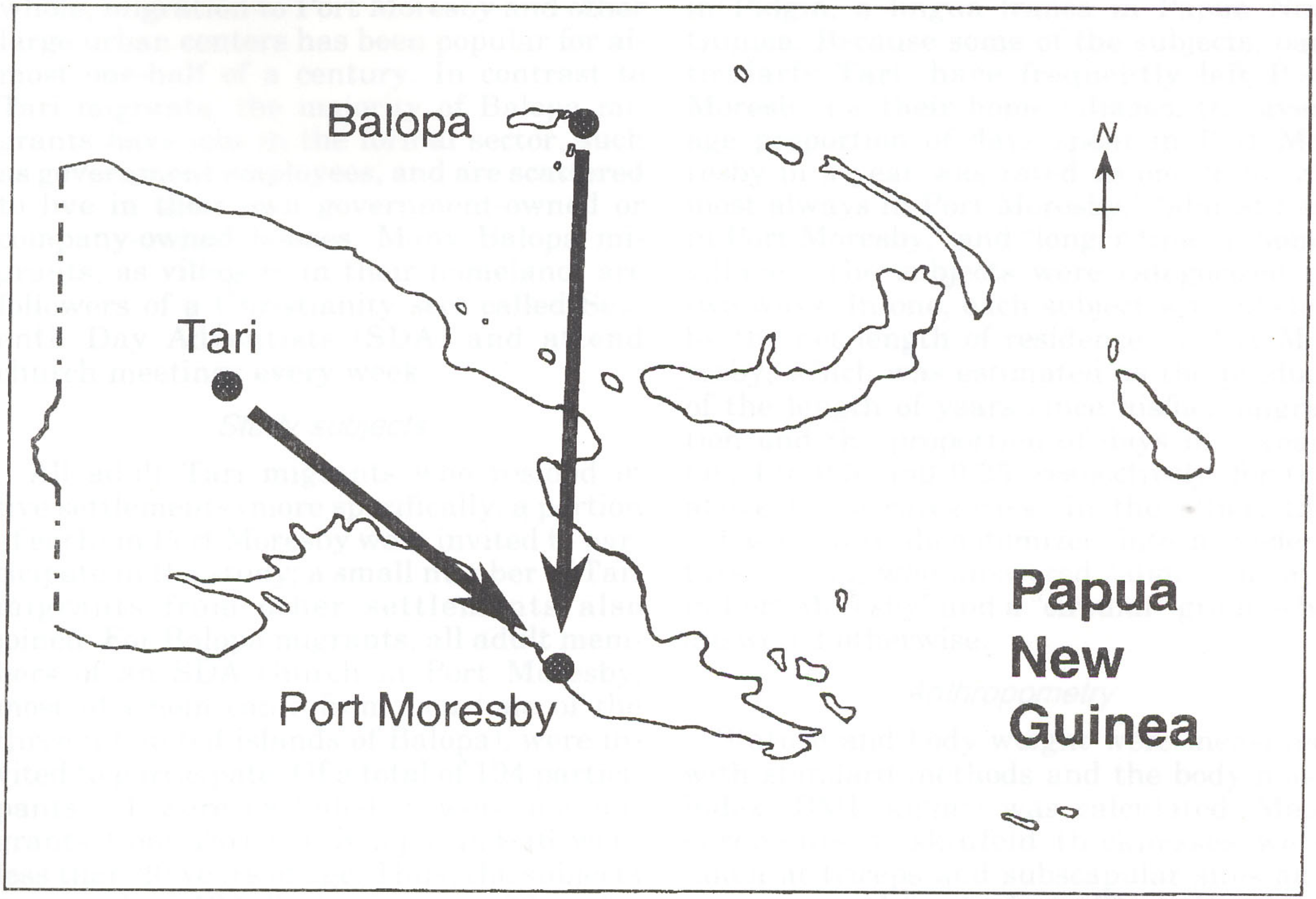

Fig. 1. Location of Port Moresby and homelands of Balopa and Tari migrants.

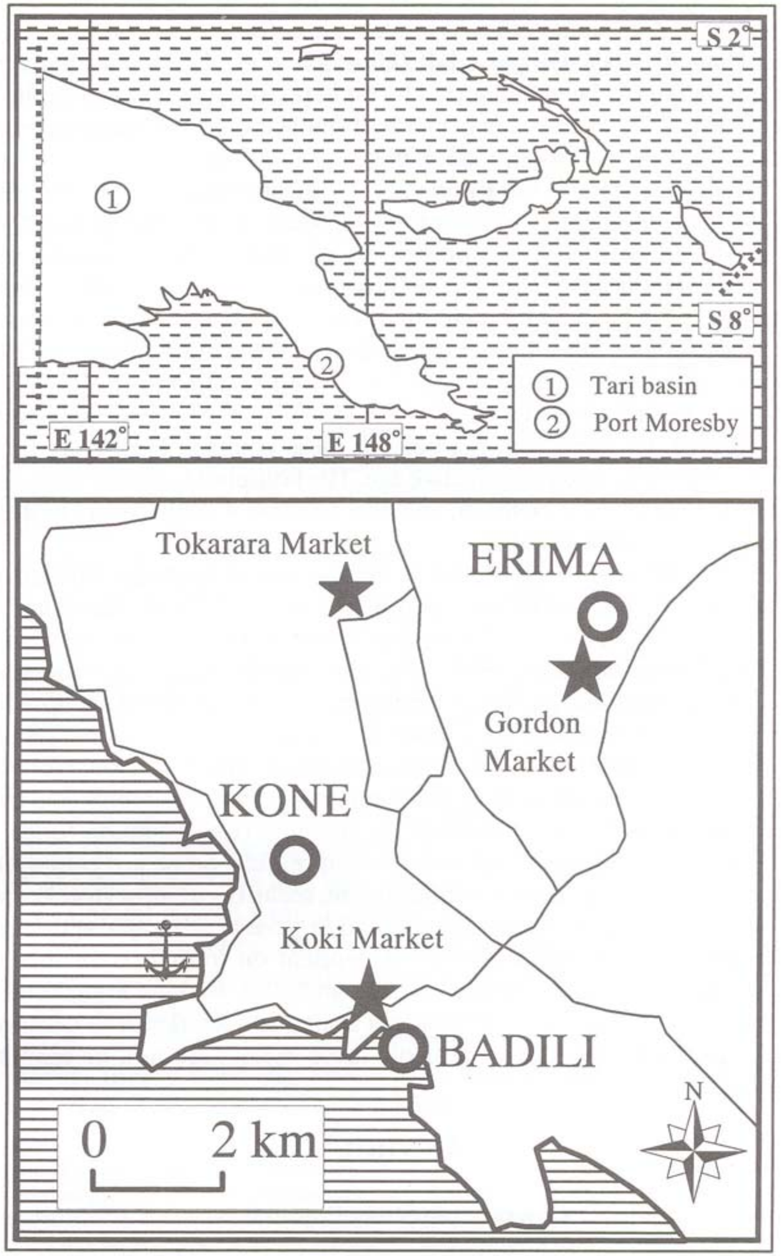

Fig. 1. Location of the Tari basin and the national capital of Port Moresby (upper), and location of the subject settlements and major markets in Port Moresby (lower).

Adaptive Strategies of Highlands-Origin Migrant Settlers in Port Moresby, Papua New Guinea

Masahiro Umezaki[1,2,3] **and Ryutaro Ohtsuka**[1]

This study examined adaptive strategies of Huli-speaking migrants from the Tari Basin in the Southern Highlands Province to Port Moresby, the capital of Papua New Guinea. An interview survey of all migrant dwellers in two Huli communities, and time allocation and food consumption studies in their three primary settlements revealed that the subject households relied for their livelihood on a variety of activities in the informal sector (e.g., vending, small-scale retailing, moneylending, and chicken rearing) and jobs in the formal sector (e.g., driver, public servant, security guard, and storekeeper). Unexpectedly, the average income of households that exclusively depended on informal sector jobs was equivalent to, or higher than, that of households which included an employee in the formal sector. In addition, the average working hours were shorter in the former. Large interhousehold variation characterized the sample. The residential environment and composition of each household influenced economic strategies, which in turn determined the income, labor hours, and labor efficiency. However, food and nutrient intakes did not vary widely because leveling mechanisms among households, which are social norms in their homeland, still function in the urban settlements. The roles of settlements in Port Moresby are also discussed in relation to "urban problems" and rural-urban connections.

KEY WORDS: rural–urban migration; informal sector; interhousehold variation; leveling mechanisms; Port Moresby, Papua New Guinea.

Genealogical charts in rural communities

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54 migrants in port Moresby

N=54

Table I. Place of Residence, Sex, and Marital Status of the 54 Huli Migrants

	Place of residence				
	Urban areas[a]		Settlements and urban villages[a]		% Individuals employed in the formal sector
	Married	Single	Married	Single	
Male	7	2	6	16	23
Female	8	2	6	7	9
Total	15	4	12	23	17

Note. The 54 migrants were listed in the genealogical charts for Wenani and Heli communities in the Tari basin. See text for details.

[a] According to the definition by the National Census Bureau of Papua New Guinea.

Table II. Characteristics of the 23 Households of the Huli Migrants in Port Moresby

		Number per household				
	Total	Mean	*SD*	Median	Maximum	Minimum
Family members (parents and children)	114	5.0	2.7	5	11	1
Cohabitants (single)	111	4.8	4.3	3	15	0
Cohabitants (ever-married)	35	1.5	2.4	1	9	0
% Households located in settlements	48					
% Pipe-water-equipped	91					
% Electricity-equipped	65					

Table III. The Number of Economic Activities Reported by the 260 Huli Migrants of 23 Households

Informal sector	
Selling	
Betel nut/cigarettes	6
Egg	5
Meat	3
Scone	1
Onion/potato	1
Chocolate	1
Store owner	8
Storekeeper	4
Billiard table owner	3
Beer retailer	3
Bottle collector	2
Moneylending	2
Video screener	1
Contract worker	1
Part-time paperworker	1
Formal sector	
Public servant	4
Regional member	1
Preacher	1
Company employee	
Security guard	13
Driver	3
Factory worker	2
Electrician	1
Hotel worker	1
Carpenter	1
Total	69

Table V. Economic Activities Conducted by Eight Huli Households in the Three Settlements

Activities	Badili			Kone			Erima	
	A	B	C	D	E	F	G	H
Informal sector								
Selling								
Betel nuts	●				○	●	○	○
Cigarettes	○				○	○	○	
Fried fish				○				
Fried lamb							○	
Ice blocks							○	
Cigarette (called Mutrus)	○					○	○	
Scones		●		○				
Small-scale retailing				○			○	
Beer retailing				●			●	
Money lending	○	○					○	
Chicken rearing				○			○	
Rental billiard tables							○	
Formal sector								
Policeman			●					
Driver					●			
Carpenter		○						●

●: Activity from which the household earned the largest amount of money during the study period.
○: Other activities conducted during the study period.

Table VI. Activity Type-Based Cost-Profit Relations, Based on the Time Allocation and Household Economic Surveys for the Eight Households

Activities	Observation unit (days)	n	Total observation days	Mean: Prime cost	Mean: Other cost	Mean: Gross earnings	Mean: Net earnings	Mean: Gross earnings/ total cost	Mean: Net earnings/ day
Informal sector									
Selling									
Betel nuts	1–2	26	34	12.5 (19.8)[a]	0.7 (0.5)[a]	18.7 (24.1)[a]	5.5 (6.1)[a]	1.6 (0.4)[a]	4.3 (4.7)[a]
Other items	1–3	25	52	14.6 (15.7)[a]	0.3 (0.6)[a]	21.9 (21.9)[a]	7.0 (6.5)[a]	1.7 (0.6)[a]	3.7 (3.5)[a]
Scone selling	1–2	7	15	19.9 (12.9)[a]	0.4 (1.0)[a]	65.6 (43.3)[a]	45.2 (32.7)[a]	3.4 (1.1)[a]	20.8 (12.6)[a]
Beer retailing	7	2	14	1575.3 (1240–1910)[b]	54 (6–102)[b]	2041.9 (1680–2403)[b]	412.6 (338–487)[b]	1.3 (1.3–1.3)[b]	58.9 (48.3–69.6)[b]
Moneylending	7	1	7	100	0	130	30	1.3	4.3
Chicken rearing	60	1	60	470.6	0	1000	529.4	2.1	8.8
Formal sector	7	3	21	—	—		252 (60–125)[b]		12 (8.7–17.9)[b]

Note. Days required for one observation ranged from 1 (betel nuts that were bought in the morning were sold out in a day) to 60 (chicken rearing, from buying chicks to having sold out all chickens). n is the number of observation cycles. Prime cost included money for buying items for selling or retailing, for moneylending, and money for buying chicks for chicken rearing, while other cost included cost of transportation and buying equipment. Gross earning minus total cost is net earnings. For each activity, the ratio of gross earnings to total cost and net earnings per day were calculated as indexes of efficiency.

[a]mean and *SD*.

[b]Mean and range.

Table VII. Household-Based Cost-Profits, and Energy and Nutrient Intakes for the Eight Households

	Households/economic activities										
	Betel nuts		Scone	Waged works			Beer				
	A	F	B	C	E	H	D	G	Mean	*SD*	CV (%)
Number of adults (15 years or older)	2	2	4	3	3	4	5	5			
Number of nonadults	3	1	2	1	2	4	1	4			
Total consumption unit (CU)	3.2	2.4	4.8	3.4	3.7	5.9	5.2	5.9			
Per adult weekly labor hours (h)	38.5	41.5	36.5	17.7	46.0	8.8	12.8	17.2	27.4	14.7	53.7
Net earnings per working hour (kina/h)	1.5	1.5	2.2	1.3	1.1	1.1	6.6	6.8	2.8	2.5	89.2
Per adult net earnings in a week (kina)	57.8	61.0	82.1	22.5	49.8	9.4	83.9	117.2	60.5	34.7	57.3
Per CU net earnings in a week (kina)	36.1	50.8	68.4	19.9	40.4	6.4	80.6	99.3	50.2	31.2	62.1
Per CU expense for foods (kina)	28.9	16.5	17.1	25.1	19.4	16.1	24.6	25.7	21.7	5.0	22.9
Energy intake (kcal)[a]	2744	2092	2423	2241	2455	2218	2429	2661	2408.0	221.6	9.2
Protein intake (g)[a]	91	62	67	69	69	59	79	74	71.1	10.2	14.4
Fat intake (g)[a]	101	33	78	75	61	61	89	79	72.2	20.6	28.6

Note. Significant correlation was found between per adult net earnings in a week and per CU net earnings in a week (Pearson's correlation coefficient, $r = 0.98$, $p < 0.001$). While correlations were found between per CU expense for foods and nutritional intakes ($r = 0.71$, $p = 0.049$, for energy; $r = 0.87$, $p = 0.005$, for protein; and $r = 0.78$, $p = 0.023$, for fat), no correlations were found between per CU net earnings in a week and per CU expense for foods ($r = 0.24$, $p = 0.56$), nor between per CU net earnings in a week and nutritional intakes ($r = 0.44$, $p = 0.27$, for energy; $r = 0.30$, $p = 0.48$, for protein; and $r = 0.23$, $p = 0.58$, for fat).

[a] 1 kcal = 4.184 kJ. An adult male with average body weight (72.6 kg) was defined as 1.0 consumption unit (CU) and each individual was assigned a relative ratio on the basis of his/her energy requirement (FAO/WHO/UNU, 1985). Intakes of energy, protein and fat are adjusted to the value per CU.

Large variation of income levels among households

Small variation of food consumption

Norms that stem from rural society:

- Rich people are supposed to spend more money to maintain tie with rural people
- Rich people are supposed to feed more people

TIME ALLOCATION TO SUBSISTENCE ACTIVITIES AMONG THE HULI IN RURAL AND URBAN PAPUA NEW GUINEA

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Summary. Time spent on subsistence activities was compared between rural sedentes and urban migrants of the Huli population in Papua New Guinea. Person-day observation data were collected for rural sedentes (441) in the Tari basin and for urban migrants in Port Moresby (175). The time spent on subsistence activities by males was longer in the urban area than in rural areas, while that by females was similar in both areas. Conspicuous gender inequality with respect to labour hours in rural areas seems to diminish when people move to urban areas, reflecting the different subsistence regime between rural and urban environments.

Table IV. Daily Time Allocation (in Hours) of the Subject Adults (15 Years or Older) by Sex

Activities	Male ($n = 13$)	Female ($n = 12$)
Economic activities	3.6	4.3
Job hunting	0.8	0.0
Preparing food	0.1	1.0
Eating	0.4	0.6
Washing	0.1	0.6
Resting/idle	4.2	5.3
Sleeping	7.8	8.7
Drinking beer	1.1	0.0
Leisure	1.0	0.2
Church activities	0.2	0.3
Schooling	0.3	0.0
Visiting hospital/clinic	0.0	0.2
Shopping	0.1	0.4
Visiting friends	3.8	1.8
Miscellaneous	0.5	0.6

Table 1. Time spent on subsistence activities by rural and urban subjects by activity category and sex (in hours)

	Rural sedentes		Urban migrants	
	Male	Female	Male	Female
n	24	53	13	12
Person-days	134	307	91	84
Subsistence activity				
Horticulture	1·66 (1·76)	3·95 (1·48)		
Constructing ditches and pig sties	0·75 (1·30)	0·00 (0·04)		
Pig rearing	0·32 (0·42)	0·32 (0·44)		
Collecting wild plants, fishing and hunting	0·06 (0·21)	0·21 (0·92)		
Informal sector			1·71 (2·11)	4·30 (2·53)
Paid job			1·89 (3·51)	0·00 —
Job hunting			0·85 (2·04)	0·00 —
Total	2·79 (2·17)	4·50 (1·42)	4·45 (3·47)	4·30 (2·53)

Standard deviations are shown in parentheses. Total time spent on subsistence was: different between males and females of the rural sedentes with statistical significance (Wilcoxon test, p=0·0007); different between rural and urban males with marginal significance (t-test, p=0·09). No significant difference was found between males and females of the urban migrants or between rural and urban females. Appropriate statistical tests were used based on the results of the Shapiro–Wilk W test (test of normality) and the test of equal variances.

Cardiovascular Risk Factors of Migrants in Port Moresby From the Highlands and Island Villages, Papua New Guinea

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ABSTRACT This study examined cardiovascular disease (CVD) risk factors, i.e., obesity, blood pressures, and serum lipoproteins and apoproteins, in relation to sociocultural characteristics in two rural–urban migrant populations (n = 173 adult males and females) in Port Moresby, the capital of Papua New Guinea. Tari migrants from the highlands and Balopa migrants from the islands differ genetically. More importantly, the lifestyle of the latter is more Westernized than that of the former in both Port Moresby and their homelands. The results demonstrate that CVD risk factors vary markedly among the origin/sex groups and that the length of stay in Port Moresby on CVD risk factors was significant only in Balopa males, most of whom had professional or skilled full-time jobs and were considered to have more stress. This study identified different CVD risk factors in the migrant groups: obesity or fatness for the Balopa migrants, and serum lipoproteins and apoproteins, particularly lipoprotein(a), for the Tari migrants. Am. J. Hum. Biol. 12:655–664, 2000.

Table 2. Energy and nutritional intake per day per male adult of the Huli in rural and urban areas

	Urban area (Port Moresby)				Rural area (Tari)			
	Energy (kJ)	Protein (g)	Fat (g)	Crude fiber (g)	Energy (kJ)	Protein (g)	Fat (g)	Crude fiber (g)
tuber and sago starch	837	2.1	0.4	1.3	7141	18.2	3.7	11.3
cereals	3336	16.4	1.8	0.5	1076	4.7	0.5	0.2
leafy vegetable	224	3.9	0.2	2.0	308	7.5	0.3	4.4
other vegetable	144	0.8	0.5	0.6	146	1.3	0.1	0.7
bean	38	0.5	0.4	0.1	115	1.7	0.1	0.4
fruit	495	1.1	0.1	0.7	236	0.7	0.4	0.3
fish, meat, and egg	2325	38.6	44.0	0.0	590	11.1	10.2	0
oil	971	2.2	19.3	0.0	695	0.0	12.3	0
fastfood	270	2.9	2.9	0.1	0	0	0	0
confectionery	514	1.9	5.5	0.1	30	0.1	0.3	0.0
beverage	890	1.4	0.2	0.0	1	0.0	0.0	0
others	199	0.2	0.3	0.0	3 0	0.0	0.0	0.0
Total	10243	72.1	75.7	5.3	10341	45.4	27.8	17.2

Mean body weight for the rural subjects was 57.7 kg and that for the urban subjects was 72.6 kg.

Table 4. Height, weight and body mass index (BMI) for the Huli in rural and urban a

		n	Height (SD*)	Weight (SD)	BMI (SD)
Male	Rural	110	157.5 (5.7)	59.4 (6.6)	23.9 (2.1)
	Urban	101	161.8 (5.3)	65.5 (7.2)	25.0 (2.4)
Female	Rural	58	147.5 (4.1)	50.0 (6.5)	22.9 (2.5)
	Urban	39	151.5 (5.3)	62.1 (11.3)	27.1 (4.5)

Means of height, weight and BMI were smaller among the rural people than among the urban people in males and females with a statistical significance of $P<0.001$. The statistical method used was the t-test, or Welch's test in case of inequal variation.

* SD: standard deviation.

Table 6. LSMEANS and standard error of body physics, blood pressure, and serum lipids by softdrink consumption (age, sex, marital status, and occupation

	Soft drinks		
	＜2.5 bottles	2.5 bottles≦	*P*
n	49	50	
BODY PHYSIQUE			
Body mass index (kg/m2)	26.3±0.6	27.4±0.6	0.04
%fat	21.5±0.9	23.6±0.9	0.02
Sum of skinfold thicknesses (mm)	28.6±2.0	32.5±1.9	0.04
BLOOD PRESSURE			
Systolic BP (mmHg)	113.9±2.3	116.9±2.2	0.16
Diastolic BP (mmHg)	68.2±1.8	72.1±1.7	0.02
SERUM LIPIDS			
Total cholesterol (mg/dl)	183.4±8.4	207.7±8.0	＜0.01
HDL cholesterol (mg/dl)	36.6±1.6	36.9±1.5	0.83

TABLE 1. *Age, migrant history, and sociodemographic and lifestyle characteristics of males and females from Manus and Tari*

		Males		Females	
		Balopa n = 24	Tari n = 96	Balopa n = 20	Tari n = 33
Age	<35 years	18	54	9	15
	≥35 years	6	42	11	18
Length of residence in Port Moresby[a]	<5 years	7*	55	2*	15
	5–<15 years	11	25	9	13
	≥15 years	6	16	9	5
Residential pattern in Port Moresby[b]	Sedentary	19	80	20	29
	Circular	5	16	0	4
Length of education (including vocational schools)	No	1*	33	0*	13
	<7	2	36	2	14
	7–<10	7	22	8	6
	≥10	14	5	10	0
Employment	Full-time	17*	16	12*	0
	Part-time	1	7	0	0
	Informal sector[c]	0	16	0	9
	Jobless	4	55	7	24
	Student	2	2	1	0
Housing	Own	16*	27	18	31
	Lodging	8	69	2	2
Smoking[d]	No	13*	30	20*	20
	Yes	11	64	0	13
Drinking alcohol	No	13	32	19	33
	Yes	11	62	1	0
Beverages	<3 cans or bottles/day	24*	41	18*	18
	≥3 cans or bottles/day	0	52	2	15

[a]Length of residence in Port Moresby was calculated as follows; (number of years since migration to Port Moresby) × (residential habit index). Residential habit index: 1 = almost always in Port Moresby, 0.5 = almost half in Port Moresby, 0.25 = almost always in home village.
[b]Residential habit: sedentary = almost always in Port Moresby, circular = almost half in Port Moresby and almost always in home village.
[c]Activities such as small-scale retailing and street vending; goods sold were betel nuts, iceblocks, and various small things.
[d]The data of smoking and drinking alcohol for two Tari males and beverages for three Tari males were missing.
*Significantly different between Balopa and Tari groups of either sex at $P < 0.05$.

*TABLE 2. Means and standard deviations of age, anthropometric, and blood pressure variables in Balopa and Tari migrants by sex**

Variable (unit)	Males				Females			
	Balopa (n = 24)		Tari (n = 96)		Balopa (n = 20)		Tari (n = 33)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age (years)	32.1	11.6	32.6	9.1	35.4	9.2	33.3	7.0
Body mass index (kg/m^2)	26.4	4.7	25.1	2.3	27.8	6.4	27.7	4.3
Sum of skinfold thicknesses[a] (mm)	28.5	14.3[d]	21.4	5.6	55.2	18.2[e]	39.1	14.8
Fat free mass[b] (kg)	60.1	7.7[e]	55.0	4.8	43.9	6.7	44.9	5.2
Centripetal fat ratio[c]	0.68	0.04	0.69	0.06	0.59	0.06[e]	0.67	0.09
Systolic BP (mmHg)	118	13	117	12	118	23	112	11
Diastolic BP (mmHg)	74	10	70	9	75	15	70	10

*Note: Wilcoxon test was used to compare migrant groups.
[a]Triceps skinfold + subscapla skinfold.
[b]Fat-free mass was calculated using the equations by Durnin and Womersley (1974).
[c]CFR: Subscapular/(Subscapular + Triceps) skinfold thicknesses.
[d]Significantly different between Balopa and Tari groups of either sex at $P < 0.05$.
[e]$P < 0.01$.

*TABLE 3. Means and standard deviations of serum lipoproteins and apoproteins in Balopa and Tari migrants by sex**

Variable (unit)	Males				Females			
	Balopa (n = 24)		Tari (n = 96)		Balopa (n = 20)		Tari (n = 33)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total cholesterol (mg/dl)	179	38	189	40	187	38	202	40
HDL cholesterol (mg/dl)	41	7[c]	33	8	42	14	39	7
Total/HDL cholesterol	4.55	1.34[c]	6.03	2.05	4.83	1.63	5.42	1.89
Apoprotein-A1 (mg/dl)	126	17[c]	108	18	126	27	118	14
Apoprotein-B (mg/dl)	94	26[b]	114	28	103	33	117	31
Apo-B/Apo-A1	0.76	0.26[c]	1.10	0.37	0.86	0.32	1.02	0.35
β lipoprotein (mg/dl)	395	98[a]	445	107	412	121	449	120
Lipoprotein(a) (mg/dl)	10.5	9.4[c]	29.1	27.6	11.0	11.9*	25.8	27.5

*Note: Wilcoxon test was used to compare the migrant groups.
[a]Significantly different betwen Balopa and Tari groups of either sex at $P < 0.05$.
[b]$P < 0.01$.
[c]$P < 0.001$.

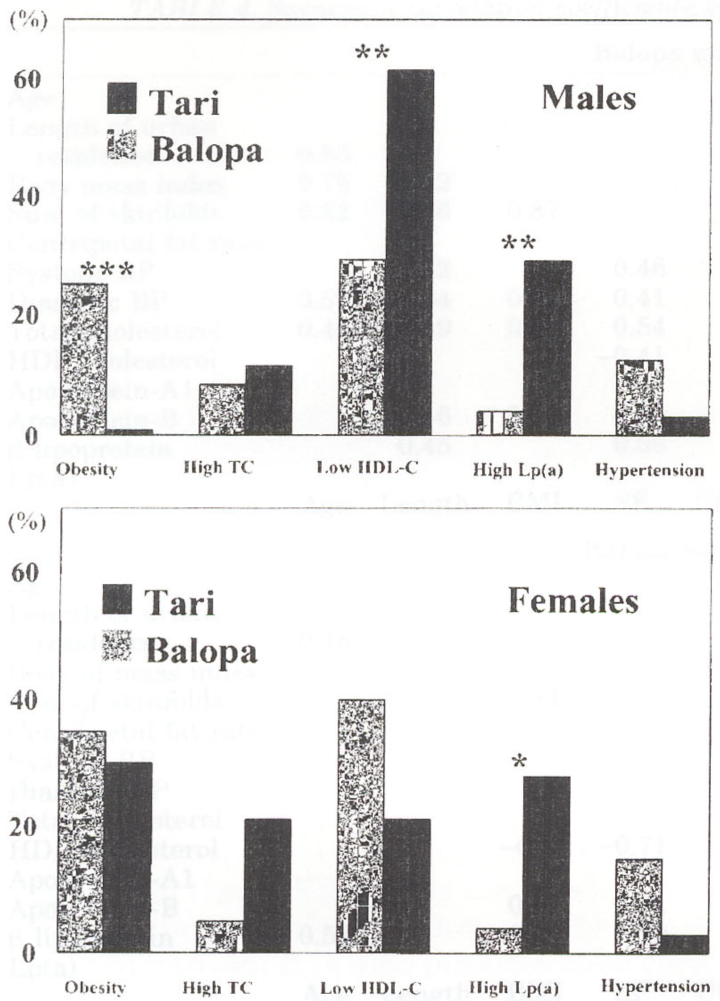

Fig. 2. Percentages of high risk individuals in Balopa and Tari migrants. Obesity: >30 kg/m² (BMI), high TC: >240 mg/dl, low HDL-C: <35 mg/dl, high Lp(a): >40 mg/dl, hypertension: >140 mmHg systolic blood pressure or >90 diastolic blood pressure. *Significantly different between Balopa and Tari for either sex at $P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$.

Human Ecology= holistic approach =human nature

Rural

Nutrition
Reproduction
Labor
Culture
Economics

Nutrition
Reproduction
Labor
Culture
Environment

Urban

2. Fundamental Questions

1. International aid is really justifiable?
2. Human or *Homo sapience*?
3. Birth is good and death is bad?

"Ethnocentrism"

International aid is to help the people who have insufficient understanding or ability to cope with their problem. Bad habits (eating raw pork, too much drinking liquor) will cause health problems to the people, so they should be stopped.

"Cultural relativism"

Each society has its own culture and adaptation system. Even the habits that seems inappropriate for the external people have their own logic in each society.
We should understand the uniqueness of culture and avoid intervention from outside.

Each society has its own culture. Even the habits that seems inappropriate for the external people have their own logic in each society.

However, ignorance of such problems will contribute to the maintenance of current economic inequality in the world.

We need objective or scientific understanding of the problems in the context of each society.