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Birthweight and environment at Tari

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SUMMARY

The weights at birth of 4767 children born in the Tari area between 1979 and 1986 were analyzed after the children had been allocated to seven environmental zones. The environments differ in the quality of land from which the staple food, sweet potato (*Ipomoea batatas*), is produced. Mean birthweight varies significantly by environment. Women do much of the day-to-day agricultural work. It is argued that women living in the poorer quality environments produce less food, suffer chronic malnourishment and have lighter babies as a result. From time to time, however, El Niño-Southern Oscillation (ENSO) events can result in sharp and severe shortages in food in both favoured and poorer environments. The cause is complex and involves rainfall and women's work rates. These food shortages cause decreases in mean birthweight of up to 285 g for one or more years and an increase in the rate of low-weight births, even in the best environments. The implications for the long-term improvement of health are raised.

Introduction

The purpose of this paper is, first, to show that the birthweight of children born in the Tari area between 1979 and 1986 varied significantly, depending on the place where their mothers lived prior to giving birth, and that this variation is associated with differences in the quality of land in the Tari area and the agricultural production that can be achieved from different types of land. Second, it is to show that ENSO (El Niño-Southern Oscillation) events, which occur around every 10 to 15 years, also result in significant reductions in mean birthweight and possibly impact more on good quality environments than on poorer ones.

It is well established that women who are stressed nutritionally during pregnancy, either because of insufficient food or because they must carry out hard physical labour, give birth to infants of lower weight (1-3). Nutritional stress is commonly found to be associated with lower socioeconomic status (4,5). More evidence is now emerging that birthweight is a predictor of long-term adult health status (6,7), of psychological health (8) and of the birthweights of a second generation of children born to women who were themselves exposed to nutritional stress in utero (9). These findings raise serious questions about the long-term health of women and children in rural Papua New Guinea (PNG) who are either chronically malnourished or who suffer malnourishment from time to time because of short-term failure in the food supply system. This paper uses data on birthweight, environmental quality and rainfall to demonstrate how environment and climate result in variations in the supply of sweet potato (*Ipomoea batatas*), the staple food of more than 2 million people in the highlands of PNG. These variations in food supply are shown to be associated with differences in mean birthweight, which vary from place to place and over time, that are significant enough to threaten the long-term health of many people.

Birth registers and the data

The first maternity facilities and birth registers at Tari were begun at Walidegambu

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(near Halenguali, approximately 3.5 km northwest of Tari) and at Walete (near Tani, on the Koroba road, on the eastern side of the Haeapugua swamp) in 1957 by the Asia Pacific Christian Mission (APCM). Facilities and registers were then established at Hoiebia (about 4 km north of Tari) by the Methodist mission, and at Tari District Hospital by the government. By the end of 1986, the mission facilities at Walete and Hoiebia (Hoyabia) had closed and new government health centres had opened at Paijaka, Wabia and Karida.

Between 1979 and 1982, of 3500 births recorded by epidemiological monitoring by the Tari Research Unit (TRU), 48% occurred in a health centre or hospital (10). This relatively high level of usage of delivery facilities appears to be a consequence of traditional birthing practices. Huli people believed it was dangerous for men, and women other than the mother, to have contact with the newborn infant or the placenta until some days after the birth. Births took place in isolated, rough, temporary huts; women were expected to cope on their own and would only call for help from another woman if they were in serious difficulties (11). Many women took advantage of the provision of birthing facilities to avoid what was a lonely, frightening and dangerous experience.

In 1979 birthweights from 1957 to 1978 were extracted from the Walidegambu and Walete registers and analyzed by Heywood (12). In 1982 Heywood and Lehmann used the registers at Tari District Hospital, Walidegambu, Walete, Pureni and Hoiebia, to obtain the weight at birth of 1222 newborn children recorded by the surveillance system of the Tari Research Unit between 1979 and 1982 (10). They then used the TRU deaths register to examine the association between weight at birth and subsequent risk of death in the first year of life. These data and the analyses did not include the residence of the mother as a variable. In August 1986, data for 5537 births were extracted by the author and others from registers at Tari hospital and Walidegambu, Walete, Hoiebia and Paijaka health centres, for births occurring between 1978 and July 1986. These data included the month and year of the birth, the mother's residence, the mother's parity, the sex and weight of the baby and whether the baby was stillborn.

These data were recorded over a period of almost 30 years by people with a wide range of skills and experience, using different instruments, under difficult conditions. They contain measurement errors resulting from inaccurate balances, observation errors from the incorrect reading of the balances, original recording errors and subsequent copying errors. However, because they were recorded at five independent centres, with overlapping catchments, there is little likelihood that they contain errors which would systematically bias the data by space or time.

A preliminary examination of the data revealed a number of obviously or probably incorrect weights, the result of observation, recording or copying errors. The great majority of these erroneous weights were recorded in 1978, when the unit of measure changed from pounds to kilograms. This resulted in a period of confusion over which units were actually being observed and recorded, so all records from this year were excluded. The data from 1978 to July 1986 contained 10 stillbirths and 42 sets of twins. Most of the stillbirths were not weighed. The mean birthweight of the twins was 2.47 kg. They were excluded from the analysis. In addition all birthweights less than 1.75 kg (1.6%) or greater than 4.0 kg (0.8%) were also excluded to eliminate possibly erroneous records. This reduced the number of records to 5283.

Any attempt to examine geographical distributions of data in the Tari area is beset by the problem that the exact location of the residence of the person to whom the data refer is rarely accurately known. The Huli occupy named territories, known as *hamegini* (also called 'parishes' by anthropologists), and belong to named social groups also known as *hamegini*, organized around descent from putative ancestors. The residents of a territory are not necessarily all from the same social group and the members of a social group do not all live in the same territory. They may trace their descent, and hence their right to belong to a group and to occupy land, through male and female ancestors (13). People do not live in villages, but in isolated homesteads, scattered across areas of cultivation. Men commonly maintain more than one residence, moving back and forth between them. This is particularly the case if they have more than one wife. However, women and their children rarely move from a single residence, from where they walk to nearby gardens to work in the fields almost every day.

In the case of the birth registers it is not certain what Huli mothers, or the nurses who recorded the information, understood by 'residence'. During the establishment of a colonial administration in the 1950s, in the absence of any real understanding of *hamegini,* Australian officers established a number of census points and required people to assemble at these places for regular censuses. What is written in the registers suggests that most women responded with the name of the place at which they were censused. It is likely, because they were interacting with 'government' or 'mission' in the form of a health service, that they used a place name and location prescribed by these colonial organizations, rather than a *hamegini* name, which is part of the precolonial or customary realm.

The records of mother's residence were standardized to one of 40 census point locations. Of the 5283 records, 151 could not be given a satisfactory location and were excluded. A further 106 proved to be records of women married to public servants living at Tari, 17 were from other parts of Papua New Guinea, 11 were Duna women from the Lake Kopiago area and 231 were Huli women living outside of the Tari area. The number of records and mean birthweights (both sexes and all parities) at these locations were Benaria (19, 3.26 kg); Hedamari (23, 3.00 kg); Kandep (4, -); Komo (45, 2.98 kg); Koroba (93, 3.13 kg); Magarima (22, 3.05 kg); Pabaluma (7, -); Pimaga (1, -); Pureni (17, 3.03 kg). This left 4767 records in the analysis.

People and environment

The Tari Basin and surrounding higher areas are located in the west of the Southern Highlands Province between 1400 m and 2400 m above sea level. The Huli people have a common language and culture, and practise agriculture in a similar manner. Population densities are high, between 50 and 160 persons per km^2. Although there is some intermarriage with people on their borders, the people that are described in this study are likely to be more genetically similar than dissimilar. The Huli produce sweet potato continuously from permanent cultivated fields, enclosed by ditches. The sweet potato is grown on composted mounds. Once a field is established, women become largely responsible for the day-to-day labour of mounding, composting, planting and harvesting.

Wood (14-16) defined 12 environmental zones at Tari on the basis of a combination of landscape characteristics which include geology, altitude, slope steepness, soil type and vegetation. He collected detailed information on soils and agricultural productivity in 11 zones. In order to investigate the influence of environment on birthweight, the 40 census points were allocated to 7 of the zones described by Wood (Table 1).

Birthweight at Tari

The mean birthweight of the 4767 infants was 3.04 kg. Boys were on average 69 g heavier than females. Sex and parity were significant determinants of birthweight. No discernible secular increase or decrease in birthweight occurred for the period 1979 to July 1986. However, a comparison between this data set and the two data sets previously extracted from the birth registers shows an increase in mean annual birthweight from 2.82 kg in 1957 to 2.86 kg in 1977, 3.01 kg between 1979 and 1982, and 3.04 kg between 1979 and 1986. The change between 1977 and 1982 coincides with the extension of the Highlands Highway to Tari. At the nearby Nembi Plateau, the mean birthweight at Pumberel health centre between 1979 and 1986 was 2.84 kg (n=833, SD=0.38 kg) (17). Elsewhere in the highlands, mean birthweight was 3.14 kg at Goroka and 3.12 kg at Kainantu hospitals, respectively, in the 1980s (18). A nonsignificant secular increase of 76 g per decade in birthweight has occurred at Tari between 1957 and 1986. This compares to 130 g per decade at Kapuna (19) in the Purari Delta between 1969 and 1996 and 110 g per decade at Yagaum, near Madang (12), between 1954 and 1981, both lowlands locations.

Time series analyses of these data, and the

TABLE 1

THE ALLOCATION OF CENSUS POINTS TO WOOD'S ENVIRONMENTAL ZONES

Wood's zones	Description	Census points allocated to zone	Births
Debi floodplain	Narrow alluvial strip along the course of main rivers – wetlands	No census points within zone. Some people in Tari Plains zone have access to this zone	-
Haibuga (Haeapugua) Swamp	Large alluvial swamp, partially drained – wetlands	Hiwanda, Tauanda, Tindima	477
Wabia Plains	Poorly drained, colluvial mudflow material – wetlands	Dauli, Piangwanda, Tigibi, Urama, Wabia, Yangome	502
Tari Plains	Low relief, lower altitude, volcanic ash soils – dryland	Halenguali, Hambuali, Hoiebia, Kikida, Kuandi, Pari, Kupari, Nagia, Kugu, Piribu	1926
Poro Plains	Low relief limestone, with volcanic ash soils – dryland	Halimbu, Hare, Karida, Munima, Waralo	637
Tagali Valley	Alluvial soils along the upper Tagali River – dryland	No census points within zone. Some people in Paijaka Plateau zone have access to this zone	-
Andowari Plains	Higher altitude, steeper land on lower slopes of Mt Ambua, volcanic ash soils – dryland	Andowari, Hewate, Hangapo, Idipu, Kela	496
Yangali Hills	Lower altitude hill south of Tari, volcanic ash – dryland	Relatively small area. Points in this zone allocated to Tari Plains	-
Iumu Hills	Older volcanics, steeper, more weathered hills – dryland	Idawi, Kobalu, Undibi	139
Paijaka Plateau	Older volcanics, low relief, weathered – dryland	Dulup, Eganda, Halengo, Henganda, Kaijagari, Kwangiabi, Paijaka, Puijero	590
Porame and other limestone ridges	Steep hogback limestone ridges	Kaijagari and Kwangiabi allocated to Paijaka Plateau	-

previous data, suggest strongly that there is no regular, within year, or 'seasonal' variation in birthweights in the Tari area. This is not surprising because the climate at Tari has been classified as 'non-seasonal' (20).

The proportion of low-weight births (less than 2500 g) at Tari was consistently around 15% between 1957 and 1977 but had fallen to between 5.5% and 7.1% between 1979 and 1986.

However, a highly significant variation occurred in 1982 and 1983 when mean birthweight fell to 2.97 kg (Figure 1). The years 1981 and 1982 were ENSO event years (21). ENSO events occur on average every 13 years and it is tempting to associate this depression in birthweights with this event. Food shortages were reported from Tari District in October 1981 and September and October 1982 (17). Yet these were relatively short periods. In reports, the 1981 shortage was associated with a failure of sweet potato to produce tubers and the 1982 shortage with the effect of drought on sweet potato. The rainfall

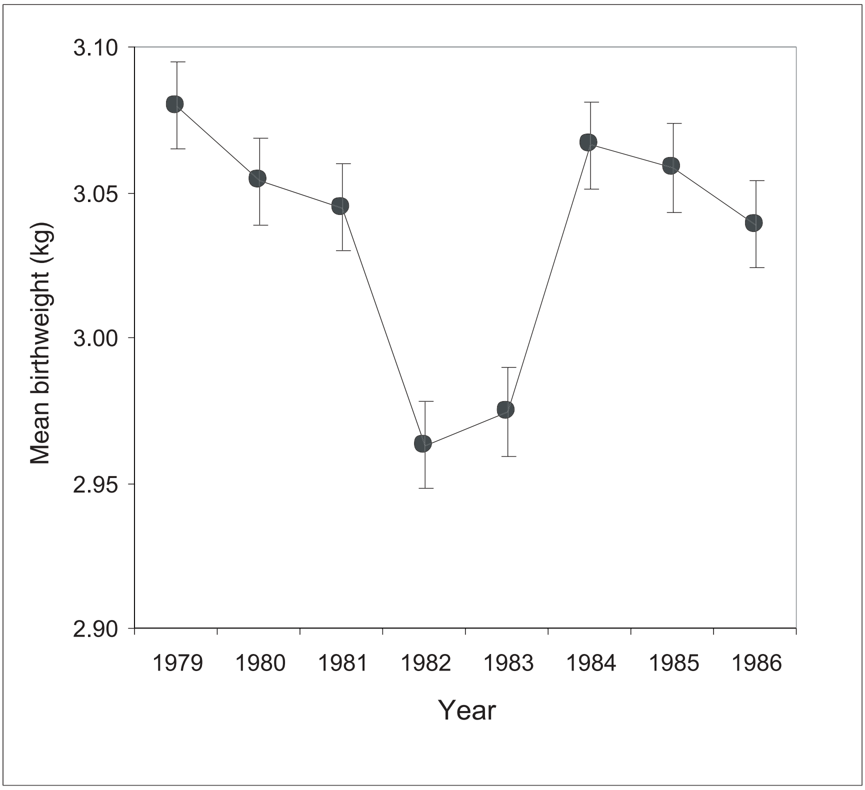

Figure 1. Mean annual birthweight 1979 to July 1986, Tari, Papua New Guinea. Error bars = ± 1 standard error of the mean.

record from Mendi, where rainfall is significantly correlated with rainfall at Tari, shows that dry periods occurred three times between 1956 and 1985, in 1965, 1972 and 1982. These are all ENSO event years.

The statistically significant differences between mean birthweights in 1982 and 1983 and all other years (Figure 1) require that two separate analyses be carried out, one for all years except 1982 and 1983, and another for those two years.

Birthweight and environment

A statistically significant difference in mean birthweight (adjusted for sex and parity) exists between children born to mothers resident in the seven environments described above, for the years 1979 to 1981 and 1984 to 1986. This analysis suggests that in a 'normal' year, children born around the Haeapugua Swamp are on average 195 g heavier at birth than those born in the Andowari Plains zone, on the lower slopes of Mt Ambua, and 130-190 g heavier than those born in the Paijaka Plateau, Tari Plains and Wabia Plains zones (Table 2).

Significant differences also occurred between mean birthweight by environmental zone for the years 1982 to 1983, with only a slight reduction in statistical significance (Table 3). However, the ranking of some of the zones changed considerably during this period (Figure 2 and Tables 2 and 3).

In Haeapugua Swamp, the zone where mean birthweights were highest from 1979 to 1981 and 1984 to 1986, mean birthweight fell by 285 g between 1982 and 1983, the largest fall in any zone. In Iumu Hills zone, mean birthweight fell by 213 g. Andowari Plains, the zone with the lowest mean birthweights from 1979 to 1981 and 1984 to 1986, was depressed even further by 140 g during 1982 to 1983, and remained the lowest mean birthweight zone. Birthweights in Poro Plains

TABLE 2

MEAN BIRTHWEIGHTS (ADJUSTED FOR SEX AND PARITY) BY ENVIRONMENTAL ZONE, 1979-1981 AND 1984-1986

Environmental zone	Number of births	Mean birthweight kg	Standard deviation
Haeapugua Swamp	380	3.1889	0.4836
Poro Plains	497	3.1252	0.4090
Iumu Hills	107	3.0981	0.4315
Paijaka Plateau	458	3.0546	0.3871
Tari Plains	1470	3.0380	0.4101
Wabia Plains	421	2.9974	0.4076
Andowari Plains	372	2.9940	0.4146
All births	3705	3.0601	0.4201

zone fell by 108 g. In Tari Plains, Paijaka Plateau and Wabia Plains zones, mean birthweights showed less change.

These changes in mean birthweight were also reflected in changes in the number of low-weight births. The rate of low-weight births in 1983 rose to 135 per 1000 live births from around 60 per 1000 for the previous four years (Table 4). The rates in all zones except Paijaka Plateau increased in 1983, but those in Haeapugua Swamp increased the most, from around 20 per 1000 live births to 360, falling sharply again in the following year, but still remaining at three times the pre-1983 rate for the rest of the period 1984-1986.

In four zones (Haeapugua Swamp, Poro Plains, Andowari Plains and Iumu Hills) the low birthweight rate remained higher after 1983 than before, in one (Paijaka Plateau) it fell and in two (Tari Plains and Wabia Plains) the elevated rates of 1983 fell to much the same level as they were before 1983.

Discussion

A statistically significant difference in average birthweights can be shown to exist between the children born to women who were living in a number of contrasting environmental zones in the Tari area from 1979 to 1986. In 1981 and 1982 an ENSO event

TABLE 3

MEAN BIRTHWEIGHTS (ADJUSTED FOR SEX AND PARITY) BY ENVIRONMENTAL ZONE, 1982-1983

Environmental zone	Number of births	Mean birthweight kg	Standard deviation
Wabia Plains	81	3.0543	0.4075
Paijaka Plateau	132	3.0326	0.4920
Poro Plains	140	3.0171	0.4216
Tari Plains	456	2.9721	0.3937
Haeapugua Swamp	97	2.9041	0.4215
Iumu Hills	32	2.8844	0.4129
Andowari Plains	124	2.8532	0.4151
All births	1062	2.9570	0.4203

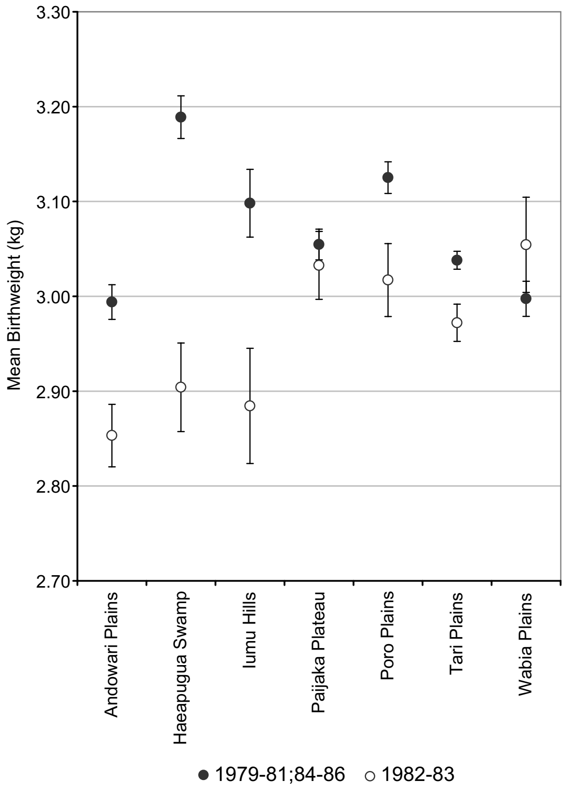

Figure 2. Mean birthweight by environmental zone, 1979-1981 and 1984-1986; 1982-1983. Error bars = ± 1 standard error of the mean.

was associated with above average rainfall (1981) and below average rainfall (1982) in the Tari area. In the three years following 1982 significant changes occurred to the pattern of birthweights from those observed in the years before 1982.

From 1979 to 1981 and 1984 to 1986, mean birthweights were highest in the Haeapugua Swamp and the Poro Plains. Children born to women resident in the Haeapugua Swamp zone were on average about 190 g heavier than children born to women resident in the Wabia

TABLE 4

RATE OF LOW-WEIGHT BIRTHS (<2500 G) PER 1000 LIVE BIRTHS, TARI, PAPUA NEW GUINEA, 1979-1986

Environmental zone	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**All Years**
Andowari Plains	90	77	79	77	111	91	113	56	91
Haeapugua Swamp	14	0	20	21	360	69	67	56	71
Iumu Hills	0	83	0	63	188	133	43	67	79
Paijaka Plateau	43	60	36	52	54	53	27	22	44
Poro Plains	24	0	27	79	109	41	89	24	50
Tari Plains	61	61	93	79	129	77	66	57	79
Wabia Plains	88	148	115	29	106	40	93	129	88
All zones	56	57	63	66	135	68	71	56	72

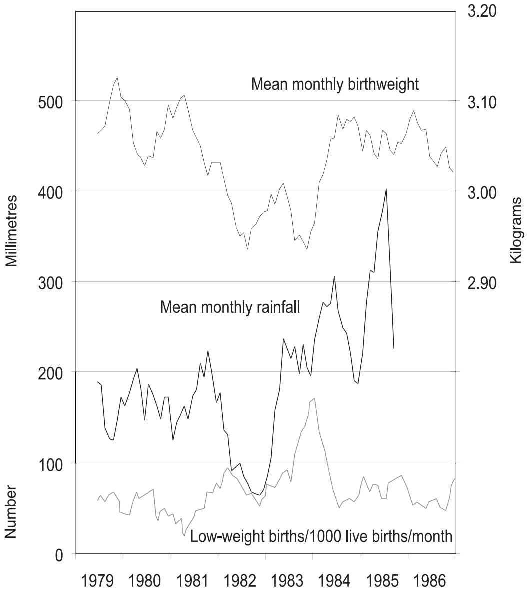

Figure 3. Association between mean monthly birthweight, rate of low-weight births (<2500 g) and mean monthly rainfall, Tari, Papua New Guinea 1979-86. Monthly figures are five-month moving averages.

Plains zone and 195 g heavier than women living in the Andowari Plains zone. Wood (14) provides detailed descriptions of the agricultural attributes of these environments and their relative productivity, and summarizes his findings as follows (14:29):

> Marked differences in sweet potato yields occur between environments, with the wetlands producing almost twice the yields of the drylands ... sweet potato yields decline fairly rapidly over time in dryland environments, whereas they are maintained at high levels for long time periods in wetland environments ... the most rapid yield decline occurs in the higher altitude environments of the Paijaka plateau and Andowari plains.

The long-term, or 'normal', mean birthweight pattern (Table 2) and the pattern of low-weight births (Table 4) by zone follows Wood's assessment. The differences between Haeapugua and Andowari are stark. But the Poro Plains zone is a dryland environment and Wabia Plains a wetland environment, and thus their relative positions are the reversal of what a simple prediction based on Wood would suggest.

This 'normal' pattern was thrown into disarray following 1982. The mean birthweight in Haeapugua Swamp zone fell by 285 g in 1982 and 1983, and in Iumu Hills by 213 g, following the 1981 and 1982 ENSO event (Tables 2 and 3). Mean birthweight also fell in Poro Plains zone by 108 g. Andowari Plains zone remained lowest overall and birthweights fell there by an average 140 g. Decreases in Paijaka Plateau and Tari Plains zones were much smaller and in Wabia Plains zone average birthweights actually increased by almost 60 g (Figure 2). Rates of low-weight births followed a similar pattern (Table 4), except that in 1983 all zones, except Paijaka Plateau, experienced considerable rises in rates, and Haeapugua Swamp recorded the highest relative rise. Figure 3 summarizes the changes for all records in the three factors being examined, rainfall, mean birthweight and rate of low birthweight.

Two questions are posed by these results. First, why does the quality of agricultural land influence the weight of newborn infants? Second, why is this relationship changed by variations in rainfall from what can be termed 'normal' patterns?

In answer to the first question, it has been shown that birthweight is associated with the nutritional status of the mother. We know from Wood that, on a per hectare basis, the same amount of work in Haeapugua Swamp zone will produce roughly twice as much sweet potato as it will in the Andowari Plains zone. Either women in poorer environments work harder to produce about the same amount of food as women in better environments, or women in poorer environments produce less food for about the same amount of work.

Yamauchi and Ohtsuka's work (22) strongly suggests that women in the higher, dryland environments expend the same amount of energy in agricultural work as women in the lower, wetland environments, but that they consume significantly less energy and protein and as a result they are significantly less well nourished. It is concluded that because they are unable to produce enough of their staple food, they are chronically undernourished, and that this is the most probable reason why lighter babies are born to them. The Dutch case suggests that other long-term damage may occur in babies whose mothers are nutritionally stressed during their pregnancy (6).

The answer to the second question is more complex. It relates to the behaviour of sweet potato, which produces poorly in saturated soils, but will produce well under reasonably dry conditions; and to the manner in which women, who do most of the planting, react to the way the sweet potato production varies as an outcome of variation in soil moisture. For the purposes of this argument, soil moisture is directly associated with rainfall. Using data from Aiyura and Nembi, Bourke (17) proposes a model that explains the variation in food supply in highlands sweet potato systems. The model is based on a number of assumptions:

1. That high soil moisture has the greatest effect on sweet potato during the period when the plant is setting tubers, around six weeks after planting. This is reflected in a fall in production six to eight months later.
2. That low soil moisture has the greatest effect on sweet potato production during the rapid tuber bulking stage, around 4 months after planting, and that this will reduce production during the actual period of low soil moisture conditions and for a month or so after soil moisture is restored to 'normal'.
3. That when sweet potato production is low, women plant sweet potato (in units of square metres per day) at a higher than normal rate and that when sweet potato production is high, they reduce the planting rate. Variations in the rate at which women plant sweet potato can produce fluctuations in production of up to 25%.

If average to good sweet potato production occurs before an ENSO event, women will respond by reducing planting rates to an average level. In 1980 conditions at Tari were probably good for sweet potato production, with rainfall interspersed with short dry periods. However, the higher than average rainfall that characterizes the first part of an ENSO event in PNG reduces sweet potato production 6 to 8 months later. Rainfall increased in 1981 to the point where some food shortages were reported from Tari late in that same year. They were said to be the result of a failure of sweet potato to tuberize, which is the characteristic reaction of sweet potato to saturated soils. If planting rates at Tari increased in response to the fall in production (there are no data on planting rates from Tari), then the increased areas of sweet potato would have been maturing as the sharp decline in rainfall occurred in 1982, further depressing production until 1983. In 1983 rainfall was again well above average, a situation that continued into 1984. The outcomes of this continuing wet period are not known, but are likely to have caused ongoing food supply difficulties, especially in poorly drained areas.

If this model is applied to Tari's environmental zones it suggests that, under 'normal' rainfall conditions, the drained alluvial soils of the fringes of Haeapugua Swamp are ideal for sweet potato production, and consequently birthweights there are usually higher than elsewhere. Heavy rainfall, however, can create problems, with gardens ponded and large drains backed up from the main river outfalls. But when rainfall declines the alluvial and peaty soils of the swamp can quickly dry out. Severe droughts cause the cultivated swamps at Tari to dry out enough for the peat to burn. During the 1997 drought the author witnessed a peaty swamp on fire at Kandep and Huli people tell of the Urufufugwa near Kugu burning for weeks in 1941. These situations may explain the high level of fluctuations in birthweights in the Haeapugua Swamp zone observed between 1981 and 1983. Wetter than normal weather continued to depress production beyond 1983 and, indirectly, resulted in the failure of birthweights to recover to pre-1982 levels.

Wabia Plains zone is naturally poorly drained because it is formed from landslide material. Even with drains, it is probably too wet for optimum sweet potato production, although it is excellent for the production of taro and greens; hence birthweights are lower than would be expected at first glance. Additional water will depress yields of sweet potato, but a drought allows the soils to dry out and sweet potato production is improved, balancing out the reduction during the wet period.

The dryland, slope environments are mostly well drained, especially the limestone environments, such as Poro Plains. Sweet potato production here is depressed, but less by the high rainfall preceding the drought than by the drought itself. However, in the upland environments like Andowari, a long-term decline in sweet potato production is chronic, as a result of soil erosion and the loss of soil, and high rainfall followed by drought depresses production even further.

It is concluded that the birthweight of children at Tari is not independent of environmental conditions or climatic perturbations. These findings have considerable implications for the long-term health of the women, children and men who occupy the upper dryland environments of Tari, and similar environments elsewhere in the Papua New Guinea highlands. It is clear that attempts to improve the health status of these people will have to involve more than improved medical and obstetrical facilities. Such attempts will need to include improvements to agricultural production and an increased capacity to earn cash incomes.

Elsewhere in the highlands of Papua New Guinea, people use cash earned from coffee sales to purchase food, mainly imported rice, to compensate for shortfalls in sweet potato. But in places like Tari, altitude and poor soils constrain cash crop production just as they constrain sweet potato production. The findings also alert us to the fact that even in apparently ideal environments for food production, like the Haeapugua Swamp, where birthweights under normal conditions are highest, periodic swings in rainfall from one extreme to the other caused by ENSO events can cause serious disruptions to food supply that continue for a considerable period of time after the event has concluded. Every 10-15 years, a cohort of children are born who have experienced prenatal stress and who may experience adverse health outcomes in childhood, adolescence or adulthood.

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