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SOFUS CHRISTIANSEN

Subsistence on Bellona Island (Mungiki)

A Study of the Cultural Ecology of a Polynesian Outlier in the British Solomon Islands Protectorate

Summary in Danish

KØBENHAVN
C. A. REITZELS FORLAG
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København, den 16/11 1972.

Morten Lange
decanus

. . . *'Ka noko tu'u ai ba'i me'a: na niu ma na pua, ma na pita, ma na mei, ma na 'uhingaba, ma na 'uhi, ma na suinamo, ma na tango, ma na huti, ma na beetape, ma na abubu . . .'.*

(. . . 'and all things there were: coconut trees, and betel palms, and pepper plants, and breadfruits, and *'uhingaba* yams, and *'uhi* yams, and *suinamo* yams, and taro, and bananas, and *beetape* yams, and *abubu* yams . . .'

Elbert and Monberg, 1965: 'From the Two Canoes' – text 8 'Nukuahea' – concerning the heavenly abode of the great god Tehu'aingabenga and his store of all good things. Monberg's translation; plant names slightly modified.

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Acknowledgements

It is customary in a work of this nature to try to trace it back to its very beginnings, thanking everybody who might in any way have influenced it during its growth. Quite apart from the impracticability of such an enterprise, one is hesitant to name persons who may wish to take no responsibility for the final result. I shall therefore thank only the most involved minority, and only because of the help and encouragement they have given me.

Thanks to my rural boyhood I have taken a lasting interest in rural landscapes and in the workers of the fields. Understandably, those of my teachers who nourished this inherent interest in man-land relations attracted an unproportionate share of my attention. Thus to my respected teachers, Johs. Reumert, Professor C. G. Feilberg (who early drew my attention to the Tikopian '*fakatau ki te kai*' principle of balance between population and resources), Professor Niels Nielsen (a sceptical measurer of all phenomena), and Professor Axel Schou (who gave me an opportunity to join the 'Noona Dan' expedition), I owe my best thanks.

One of the most memorable events of my life has been to participate in the 'Noona Dan' cruise in Melanesian waters in 1962. To meet the tropics for the first time in the company of gifted naturalists and able sailors was an unforgettable experience. A week's discussions on Honiara roads with Dr. Torben Monberg during a period of enforced quarantine, aroused a strong curiosity in me to see his study object, Bellona (*Mungiki*). He asked me provocatively if I could tell him how many people could live on Bellona? Not only he provided me with much-needed background knowledge of the island, but also gave me much support in the later hardships of field work. Several members of the 'Bellona Club' growing around Monberg's initiatives have also given me valuable help, notably Rolf Kuschel M.A.

Earlier 'man-land' ideas were transformed into more definite ecological hypotheses after discussions in the Geographical Department and impressions from the expedition; in this procedure my colleague Hans Kuhlman took a very active part.

In 1965 and 1966 I was again in the Solomon Islands trying to put the 'new' ideas to work on Bellona Island. Financial support was provided by DANIDA (Styrelsen for Teknisk Samarbejde med Udviklingslandene) and the Danish State Research Foundation. On Bellona I enjoyed the eager assistance of two young scientists, Kristian Dalsgaard, M.Sc. in 1965, and Hearne Pardee, M.A. in 1966.

I must have caused much frustrating work for a great many people in the Solomons. British authorities, in spite of this, provided every assistance needed. I am greatly indebted to them all: unfortunately too many to mention. Some people of Her Majesty's Service must, however, be explicitly mentioned: James L. O. Tedder, District Commissioner, Central District; John C. Grover of the Geological Survey; and especially Dr. R. B. M. Thompson, Director of the Geological Survey Department. Without the facilities of the Herbarium of the Forestry Department most of our botanical collections would have deteriorated beyond identification. The Department of Lands and Surveys assisted us in obtaining up-to-date aerial photographs of Bellona; these proved invaluable in later work, especially when used in conjunction with older photographs put at our disposal by the Royal Air Force and the U.S. Air Force.

Apart from all the scientific advice readily given by friends in Honiara a lot of practical assistance helped to make life comfortable. I still remember the luxury of resting on Dr. Thompson's camping bed with all the busy ants and termites at a happy distance.

Without the patient cooperation of the people of Bellona, however, everything would have been in vain. They gave us all their support, and some of them proved to be devoted assistants. Especially two Bellonese, Taupongi and Sengeika Tepuke, revealed admirable skills in this new work. I am greatly indebted to them for their assistance and friendship. May this book be a memorial to the people of Bellona and a way of life quickly vanishing.

In Denmark I have been assisted by various institutions and people. I am very grateful for the assistance of the Royal Danish Geodetic Institute in preparing aerial photos and a preliminary contour map of Bellona; for help with soil analyses rendered by the Laboratory for Agricultural Chemistry in the Royal Veterinary and Agricultural College, Copenhagen. Invaluable assistance was also given me by the Institute for Botanical Ecology, University of Copenhagen, and not least by Dr. Bertel Hansen, the Botanical Museum, Copenhagen.

The secretary, Mrs. Kirsten Winther, and Jørgen Ulrich, cartographer, of the Geographical Department worked indefatigably helping me to materialize my ideas. Mrs. Jonna Rasmussen has assisted in preparing the work diaries. A first draft of the manuscript has been read by Dr. Caroline Ralston and a final one by Professor Samuel H. Elbert, Dr.h.c. Both have tried to make the text readable. I hope their efforts have not been totally wasted. I admire their patience in spite of my persistent errors. They can certainly not be held responsible for the remaining ones.

In 1972 Dr. Monberg and Dr. Kuschel revisited Bellona and offered me a chance for checking parts of the text in the field. I was happy to accept their generous help, which brought about many minor and some important corrections.

The burdens imposed on my family members by my Bellonese fancy have been very great. They are in spite of this still patient listeners to news from 'the island'.

Without financial aid from the State Research Foundation and The Carlsberg Foundation printing of this volume would have been impossible. The support is gratefully acknowledged.

The manuscript has been long underway: A rough outline appeared in reports 1965 and 1966, but because of numerous delays the raw manuscript was first submitted to the faculty 1972. I am sorry to admit that the long time passed only to a limited extent has been utilizable for improving the manuscript and prevent it from growing obsolete.

Sofus Christiansen

Notes to the reader

1) All measures (except local Bellonese ones) are given in the MKSA system; in this, abbreviations are standardized as for example:
   cm, m, km for centimetre(s), metre(s), and kilometre(s);
   m^2, km^2, ha for square metre(s), sq.kilometre(s), and hectares (à 10,000 m^2).
   m^3 for cubic metre(s).
   g, kg, t for gramme(s), kilogramme(s), and metric ton(s).
   Temperature is in degrees centigrades (°C).
   Energy figures are in kJ for kilojoule or MJ for Megajoule (= 10^6 Joule); the alternative units kcal and Mcal for kilocalories and megacalories (= 10^6cal) were initially used and have been retained for convenience (1 kcal = 4.1840 kJ).

2) Other abbreviations:
   per cent is written %. Australian Dollars = Aus.$.
   Bellona, Bellonese, and Rennell, Rennellese are written Be., Re. in appendices.
   SDA is Seventh Day Adventist Mission.
   SSEC means South Seas Evangelical Church.
   References to S. H. Elbert and T. Monberg, 1965: "From the Two Canoes" are given as e.g. Canoes T277 or Canoes N216, referring to text 277 or note to text 216 respectively.
   Other references are given with author's name and year of printing; a fuller list is found at the back of the volume.

3) On the use of Be. words:
   Be. words except names are in italics. Long vowels are written with double letters: 'long a' is thus 'aa'. In the appendices the reader should look for entries with double vowels, if an entry with single vowel is not found.
   Alphabetization in appendices has been a problem since 'ng' and 'gh' both designate a single sound in Be., 'ng' is a sound similar to 'ng' in 'singer' – 'gh' is a hard 'g' as in 'grave'. Illogically, but conveniently it is hoped, 'ng' and 'gh' have been alphabetized as if part of normal spelling: initial letters 'gh' have been entered under 'g', and 'ng' under 'n'.
   Apart from this digression, it has been tried to bring the Be. words used in correspondance with S. H. Elbert, 1975: "Dictionary of the language of Rennell and Bellona". To this book the reader is referred for further information.

Contents

Maps (in seperate envelope with this volume):

0. Introduction

0.1 Objects of the research

From the outset the intention behind the research reported in this book has been to investigate, describe in detail, and attempt an evaluation of the 'rationality' of the functions on a local subsistence basis of a shifting cultivation type of agriculture, here plainly understood as agriculture or horticulture employing a fallow period long enough to allow regrowth of scrub or trees for the restoration of fertility. This definition does not, contrary to some commonly held beliefs, imply that shifting cultivators use fire to turn fallows into fields/gardens, nor the question of permanency or nonpermanency of settlements of the cultivators. It is felt that a shifting cultivation definition based solely on land use is advantageous, in accordance with more recent views (R. F. Watters 1960, H. C. Conklin 1963, E. Boserup 1965, H. Ruthenberg 1971).

The detailed description should encompass plants utilized, cultivation techniques applied, patterns of fields/gardens, seasonal cycle, and if possible, reconstruction of a full cycle of cultivation, as inspired by the brilliant example set by P. de Schlippe's early work (P. de Schlippe 1956). Also the intentions were, wherever possible, to add quantitative aspects of production (as amounts of labour used and yields achieved).

Evaluation of 'rationality' of function presents the difficult question of which yard-sticks to use: rationality according to Western scientific concepts, or to local concepts. The problem is dealt with in chapter 0.5, but logically the Western concepts have been inevitably dominant.

For the analyses an ecological framework of concepts has been attempted with emphasis on such concepts as 'carrying capacity', 'adaptation to environment', and 'stability', though difficulties in doing so were envisaged from the beginning.

Without penetrating deeply into the subject, a few lines on the historical background for the use of ecological concepts in description of traditional (agricultural) societies may be inserted here. – For fuller bibliographies, see J. Helm (1962), M. Bates (1962), and S. Christiansen (1967).

In cultural geography there has been an early tradition of using ecological ideas, even though theories have been only vaguely expressed and often had a form approaching an environmental determinism. Continental European geography has fostered schools based on such ideas, notably in France about 1920 (V. de la Blache, J. Brunhes, M. Sorré), but also in Denmark (H. P. Steensby and G. Hatt). Apart from C. O. Sauer and his followers, ecology was only hesitantly accepted as a basis for their subject by American geographers; an exception was H. Barrows, but his attempt was without immediate consequences.

Within social anthropology a tradition for well-documented analyses of local societies always had an ecological notation (R. Firth, E. Evans-Pritchard); a later train of thought (J. Steward, C. Geertz, M. Sahlins, F. Barth) expressly applied analogies to biological ecology.

Perhaps the present work has been even more inspired by such modern biologists as E. Odum and R. Fosberg, as seems to be the case with other scientists working in the Pacific area (H. C. Brookfield, P. Vayda, R. Rappaport). In Odum's and Fosberg's works key notions have been the essential ecological concepts referred to in the following paragraphs.

'Carrying capacity' has also been used in earlier works, especially by Trapnell, Allan, and their East African School (see W. Allan 1949 and 1965). Carrying capacity may simply be understood as the maximum population able to live at a minimum standard on a definite area by a certain type of production, external conditions being stable. The concept is closely related to a fundamental geographic term, the maximum density of population for an area (P. Gourou 1953). Even where agricultural production is constant, the maximum density is difficult to assess as it applies only for an area where the 'subsistence law' is valid; local production + storage must equal local consumption, excepting a certain subsistence surplus to meet production risks (W. Allan 1965).

Adaptation to environment is naturally achieved by some degree for any society living on local resources. Ambitions for the survey were to ascertain if adaptation could at least partly be made measurable. If a local limit of biological production could be assessed, the performance of local subsistence production could be related to the limit, thus giving a rough approximation of 'adaptation', understood as efficiency of the local productive system.

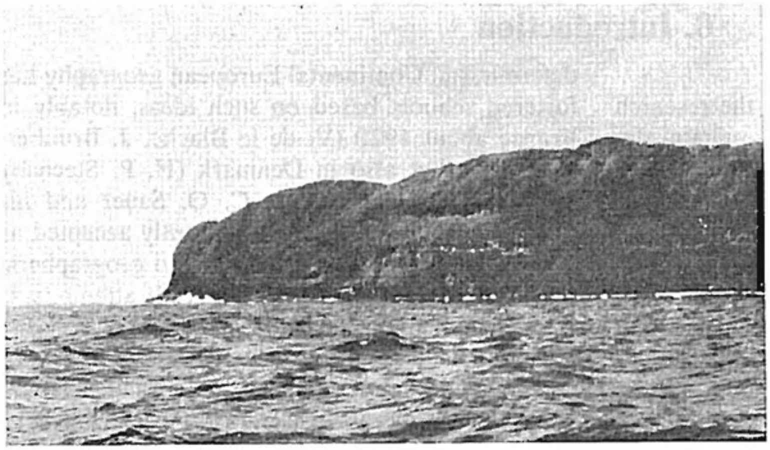


Fig. 1. The steep cliffs of Bellona, about 50 m high, display a series of wave-cut notches. Several trails give access to the sea for the Bellonese; these trails are all but impassable for aliens.

In fact, stability may be conceived as another aspect of adaptation; it is the proof of the local productive system, telling whether this may go on infinitely or not. For societies living on a subsistence basis, stability and efficiency are intimately connected or should be. If, in case of increased population pressure, efficiency should be increased, stability may be threatened. It was already initially imagined that assessment of stability could only be very approximate.

The balance between increase in population pressure and increase in efficiency of the productive system was considered of interest. An area for the field work where population was growing was hence given high priority. On the other hand no great time depth might be attached to the survey. In most former subsistence societies this may only be acquired by archaeological means. Still it was hoped that observations, even if indirect, might add an understanding of some causes and effects to the research, at least the common idea of a static character of subsistence societies might by chance be studied. The way cultivation techniques change was considered worth observing. To evaluate geographical methods where changes in land utilization are emphasized, it was intended to reconsider these on a background where many phenomena should be simultaneously recorded.

Though many of the assumptions mentioned may indicate the contrary, the project was not planned to be of practical consequences except by adding to general knowledge which may be of later use in developmental research.

To sum up: for the field work an area with shifting cultivation, with a self-sustained but changing population, should be found. For easing the survey an isolated area making imports and exports negligible, and also stressing the adaptative aspect would be preferable. It goes without saying that size of area and population to be surveyed should be kept as small as possible but still largely acting as a self-contained unit. To choose an island as the area to investigate would be attractive for: 'One cannot help but suspect that small, insular populations are either consciously more aware of resource needs, or have developed necessarily good cultural adaptations to resource development! (M. Bates 1963).

0.2 Bellona (Mungiki): the area selected for field work

On the following pages a description of some relevant properties of the island Bellona is given with some of the reasons for its selection for the field work. Quite early the island seemed to fulfill the requirements previously listed, but also some additional advantageous aspects are referred to.

Bellona is a former atoll, nearly elliptical in shape, being about 10 km by 2 km in extent. Its area from available mapping was estimated to be about 20 km^2, a handy size for area surveys with limited resources of time and labour involved.

It lies in the Western Pacific within Melanesia in the British Solomon Protectorate: position approximately 11° 11′ S.lat., 159° 15′ E.long. The elevation of the former atoll rim is about 55 m above sea level. It appears that the elevation took place after late Tertiary. As sea level changes interfered with tectonic movements, the process of elevation was quite complicated, which can be

Fig. 2. The interior of Bellona seen westwards from an isolated hillock, Te ongo i Tengauase, in the eastern part of the island. Far back the coral rim encircling the whole island may be discerned.

seen from a series of wave-cut notches in the uplifted coral rim (fig. 1). The former lagoon floor is now a fertile plain (lowest point about 7 m) above sea level protected by the high coral rim of the former reefs (fig. 2). Encircling the plain are found terraces at slightly higher elevation, which widen into plateaus at the two ends of the island. The plateau surfaces are covered with quite coarse material (oolithic sand), whereas the central plain is covered with fine materials, in places with high phosphatic contents (see White & Warin, 1965). The soils of the plain are usually very fertile, partly because of better hydraulic conditions; the terraces are less fertile, more 'karst' like, and the elevated rims are quite stony except for small pockets of fertile materials, (for a general account of geology see: J. C. Grover, 1957 and 1960). These variations of landscape were found an advantage as they permit observation of adaptations if any to different milieus.

Climate on Bellona is of a low-latitude tropical type with high humidity. The daily temperature varies from 17 to 34 °C. Seasonal changes are relatively slight; usually there are periods of strong trade winds with weather patterns dominated by radiation: cool nights, very hot, cloudless and dry days, but even the dominant trade wind periods are broken by spells of changing winds, resulting in more monsoon-like weather patterns. The latter result in humid, rainy, even torrential weather with almost constant temperatures. Anybody familiar with the climate in the doldrums will recognise this climate; it needs only to be added that annual precipitation (from 2 years' observations) is more than 3 m. As the Bellonese soils are low in water retention capacity, this precipitation is, however, not always adequate for cultivated vegetation.

The natural vegetation is a lush growth of multi-storied trocipal forest. It must be remembered, however, that the flora of the small oceanic islands in the Western Pacific is an impoverished one, compared with the abundance of species of the Indo-Malaysian flora. The same may be said of the fauna; except for some species of bats, the Pacific rat and a rare, irregularly sighted whale, no mammals are found on or off Bellona. For a fuller account of the wild Bellonese flora and fauna, the reader is referred to T. Wolff (1969 and 1973), B. Hansen and S. E. Sandermann Olsen (1967); for utilized plants and animals see appendices B1–B5.

The biological paucity is of course related to the isolation of Bellona and its neighbouring island, Rennell. The distances between islands do not reveal the isolation in full; they must be considered with the predominant ocean currents and winds in mind.

One of the desirable properties of the field work area was isolation, mainly understood as a state in which cultural and technical development has taken place on a local base of knowledge and resources. Foreign influences on development should at least be easily identifiable and non-dominant.

To judge from Bellonese lore, the island has been isolated for long periods, that is, if the neighbouring island, Rennell, is excepted. In appendix A, an outline of the geographical knowledge contained in traditions, perhaps in a disguised form, has been summed up. A majority of the islands known on traditional Bellona seem not to be

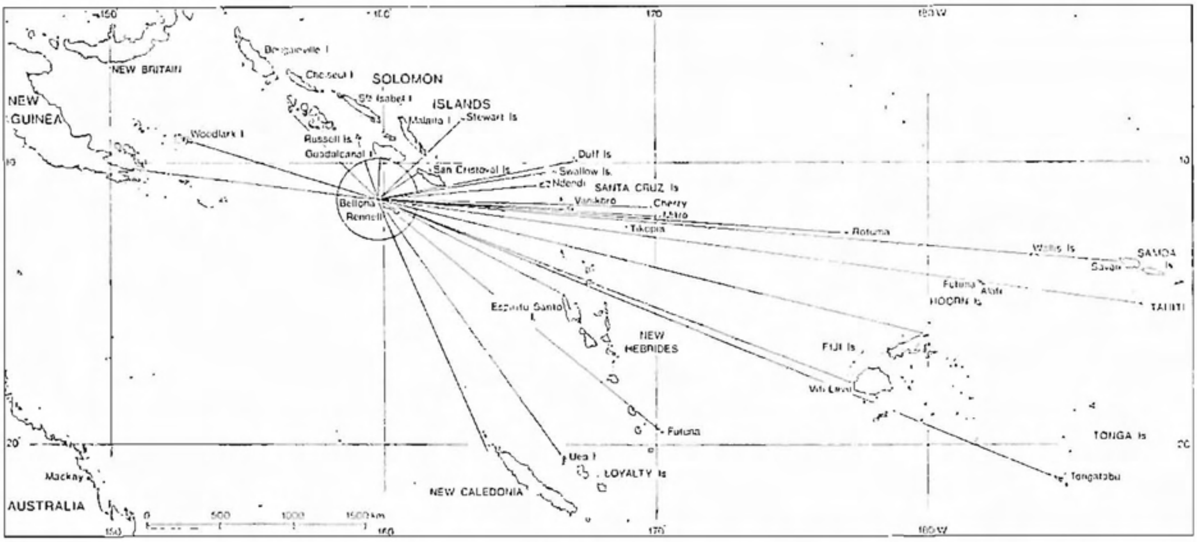


Fig. 3. Directions to some nearby islands (see also table 1). Almost due east of Bellona (in "the 90–100° corridor") a string of islands is found with closely related cultures such as Tikopia, Rotuma, Futuna, Wallis, and Samoa.

known because of direct proximity. In fact remarkably few contacts are reported from the island-umbrella stretching from N 78° to N 315° (turning clockwise) though some are as near as 89 nautical miles (fig. 3 and table 1). On the contrary most islands frequently recorded in traditions are found in the angular gap from about N 90° to N 100°; these '90°–100° corridor' islands are closely culturally related, according to K. Birket-Smith (1956). One must consider prevalent winds and currents as aids in establishing these contacts. For the purpose of the research it is important to note that traditional contacts all seem to stem from communities with basically identical types of subsistence techniques as the island to be investigated. From Birket-Smith (1956) it may also be inferred that these in the Bellonese form seem to be of a more simple type than found on the neighbouring islands (except Rennell). This fact seems to testify to the scarcity of contacts reported in traditions, and consequently a development on local resources.

The most stable ocean current comes from the vast islands-empty spaces of the Pacific. Probably this accounts for the fact that the Bellonese are of Polynesian culture, even though they are found almost in the heart of Melanesia. An admixture of Melanesian elements seems probable. This goes also for the language, 'one of the most difficult and aberrant Polynesian languages', S. H. Elbert (1962), but still it is definitely Polynesian with many archaic features, as are other cultural features (religion, see T. Monberg 1966).

Recently the population totalled about 780, though usually only about 550 reside on the island. The proximity of Rennell is of great importance because of exogamous rules, which add a population of more than 1200 to the genetical unit of which the Bellonese are a part.

The Bellonese contacts with the outside world are reflected in the local history and at least four periods may be separated (see further appendix D). The first was the period of the *hiti,* according to oral traditions the original population of Bellona (Canoes, chapter 9).

Archaeological evidence is still unable to give clues as to the origin of the *hiti* or the Bellonese, but radio carbon dating of excavated items dates habitation as early as about 1500 b.p. See J. Poulsen (1972).

The present population is said to stem from one great migration from *'Ubea* (presumably Wallis Island, Uvea) 24 generations back (Canoes, chapter 8). There are no outstanding historical events by which to differentiate the period of the Bellonese until the time of the first European contacts. In this context the European discovery was an insignificant feature; it seems to have been made March 4th, 1793, at 1 a.m. by M. Boyd, captain on the East Indiaman 'Bellona'. The first

TABLE 1.

Approximate directions and distances from Bellona (Mungiki) to other islands and Australia (nearest points). Bellonese name in brackets.

From Bellona to:	Contacts reported	Direction: degrees from N. through E.	km	Miles	N. Miles
Rennell Is. [Mugaba]	+	138°	22.5	14	12.2
Guadalcanal [Kenga]	+	2°	164	102	88.5
San Christobal (Makira, Bauro) [Paungo]	+	63°	191	119	103
Russell Is. Cape March [Kepumase]	+	356°	246	153	133
Stewart Is., Sikaiana [Sikaiana]	?	41°	452	281	244
Santa Cruz, Ndendi [Teni]	+	84°	656	408	355
New Hebrides, Esperitu Santo	-	117°	685	426	370
Reef Is., Swallow Group [Nupani]	?	76°	696	433	376
Liuaniua, Lord Howe, Ontong Java [Nguaniua]	?	(indirect courses)	750	468	405
Duff Is., Taumako [Taumako]	+	78°	777	484	420
Woodlark Is., Murua [Mungua]	+	288°	796	495	430
Tikopia [Kopia]	-	96°	963	598	520
New Guinea	-	97°	982	611	530
Cherry, Anuta via Vanikoro [Anuta]	?	91°	1048	652	565
Mitre, Fataka	?	93°	1070	668	580
New Britain, Rabaul	-	313°	1220	758	660
Loyalty Is., Ubea, via Rennell	?	144°	1252	778	675
Australian Mainland	-	230°	1455	905	785
Rotuma [Ngotuma]	+	94°	1892	1173	1020
Australia, Brisbane	-	338°	1965	1222	1060
Fiji, Viti Levu [Biti]	?	111°	2005	1242	1080
Hoorn Is. Horne Is., Futuna [Hutuna]	?	97°	2420	1508	1310
Wallis Is., Uvea ['Ubea]	?	95°	2650	1621	1410
Tonga Is., Tongatabu [Tonga]	?	112°	2918	1813	1575
Samoa Is., Savaii [Sa'amoa]	?	95°	2943	1830	1590
Cook Is., Rarotonga ?	-	105°	4380	2710	2362
Society Is., Tahiti ?	-	97°	5375	3340	2900
Marquesas Is., Hiva-Oa [Siba?]	?	88°	6650	4150	3600

\+ Contact
\- No contact
? Possibly contact

visits of white men were possibly in 1856, when Bishop Selwyn and Bishop Patteson of the Melanesian Mission visited at least Rennell. Probably visits were made by whalers before, but only contacts with labour-recruiting ships from Queensland in the 1880s or 1890s seem to have resulted in introductions of significant cultivated plants and artifacts (iron), see Canoes, T232.

The 'early' period with only Polynesian (and casual Melanesian?) contacts was not very different from the first part of the post (European) contact period. Visits were infrequent and imports quite few, hardly enough to change the Bellonese ways of life to any extent. A great change occurred, on the contrary, when Christianity was introduced 1938, and it seems reasonable to date recent history of Bellona from that time of profound changes. Even so, more intimate contacts with the modern world took place only after the end of WW II, or rather after 1947 when a native Melanesian teacher Gheela came to Bellona. Still, the changes of the original Bellonese ways of subsisting did not occur to be more than superficial. The desire to investigate into a locally developed, self-sustained productive system with few and traceable cultural imports could be reasonably fulfilled with Bellona selected for the survey; in fact even modern Bellonese rarely saw more than

TABLE 2

Field work on Rennell (R) and Bellona (B), 1951-1965.

1951	The Danish Galathea Deep-Sea Expedition	Dr. K. Birket-Smith, ethnologist with a photographer	5 weeks, Oct.-Nov.	R
		Dr. T. Wolff, zoologist	- - -	-
		H. Knudsen, zoologist	- - -	-
1957-58		Prof. S. Elbert, American, linguist	6 months	R&B
1958-59		Dr. T. Monberg, anthropologist	4 months, Oct.-Feb.	R&B
1962	The Danish Noona-Dan Expedition	Dr. T. Wolff, zoologist	3 weeks, Aug.-Sep.	R
		William Buch, technical entomologist	- - -	-
		Henry Dissing, botanist	- - -	-
		Sofus Christiansen, geographer	- - -	-
		Prof. S. Elbert, linguist	4 months, Aug.-Dec.	R&B
		Dr. T. Monberg, anthropologist	2 months, Aug.-Oct.	-
		Leif Christensen, cultural sociologist	- - -	-
1963		Dr. T. Monberg, anthropologist	Oct.-Nov.	B

one ship a month at the most, when the author's field work started in 1965.

The short description of some features of the area selected for field work contains only a fraction of the background knowledge acquired of the island. One of the most important reasons to select Bellona for the research was that up to 1965 several Danish and other scientists had been working on Rennell or Bellona, see table 2 compiled by Dr. C. Ralston, 1972. It goes almost without saying that the already acquired knowledge was considered a necessity without which field work would be impossible within the limits set by time and labour force.

An additional fact making the island attractive for the investigation was that the presence of Pidgin-English speakers in the local population did away with the necessity of investing an unknown amount of time in acquiring knowledge of the essentials of the local language. Further the islanders were known to make good informants and to be easy to communicate with. This last was overwhelmingly true, but to learn a basic Bellonese proved indispensable!

0.3 A brief field work diary

1965: K. Dalsgaard and the author left Copenhagen 3 March, and arrived in Honiara 10 March. Taupongi, who had been 9 months in Denmark working with Elbert and Monberg, came back with us. We joined Dr. Torben Wolff, who had arranged our transfer to Bellona with the 'Coriolis'. We arrived on Bellona March 13. Thanks to Taupongi we were given a grand reception, were swiftly installed in his house, and had no difficulties in starting work immediately. We used approximately one week to set up meteorological equipment and to run a levelling line along the main track of the island in very bad weather, usually more than 50 mm of rain every day. We conducted interviews on land tenure, and studied gardens. These differed quite a lot from what we had expected. Necessarily we started a botanical collection. Dalsgaard sampled soil for me on land which was used under a rotation system; doing an excellent job, he was left with very little time for his own soil studies. It was attempted to survey every garden cultivated that year, but many were left undiscovered as the owners were away. Sengeika, Baiabe, and Haikiu of Sa'aiho were very helpful with work in this district. In Ghongau, Philip Tuhaika, R. Puia and Haman Sau proved indispensable. Also Sa'engeika solved many problems. In his quiet way A. Mau'eha revealed a great fund of knowledge. In Matangi district, dresser Tongaka was our main source of information. Unfortunately, many people were sick from influenza, which had a tendency to develop into pneumonia. We were chocked by the effects of this disease on the Bellonese, as were the Bellonese themselves, and tried to do the little we could to relieve them. Quite apart from humanitarian aspects, the outbreak of sickness reduced our working possibilities considerably. Still, we managed to plot nearly all gardens presently cultivated, and to get a rough idea of land tenure. The questionnaires we brought with us proved nearly useless, since ownership and use were not directly coherent. Everybody was lending or borrowing garden areas. An attempt to investigate property other than land proved easier. Land is certainly a crucial issue; because of questioning about the ownership of a certain plot, a duel with bush-knife and axe was barely avoided. Dalsgaard and I left Bellona in a 90 mm shower causing water to drip from our eyes, on May 26th. After about a week's work in Honiara, we returned to Copenhagen.

1966: The first period of field work had left us with two serious problems: the need to be sure no gardens were overlooked in the survey, and the need to see what conditions were like in a different season. To remedy these a second field trip was felt necessary. To solve the 'detective problem' aerial photography was obviously the easiest solution, especially if combined with a ground follow-up. However, this proved difficult to arrange. An effective ally was found in the Department of Lands and Surveys, Honiara. Megapode Airways converted one of their planes into a temporary air-reconnaissance plane using an adapted, Fijian owned, Wild Aviogon camera. Because of bad weather the actual flying was, however, postponed for a long time. On 9 September Hearne Pardee, Torben Monberg, and the author arrived on Bellona without photographs, but cheered by a festive assembly on the beach. The collecting of plants for our herbarium of utilized plants, and weighing people was immediately started. The weighing was regarded as another of the white man's incredible fancies to the extent that it hampered the enterprise, as people could barely sit upon the swing attached to the scales because of laughing. Hearne Pardee (who was given leave to join the work by Dr. J. Barrau, whom we had the good luck to meet in Honiara) did an excellent job collecting plants and even became involved in the ethno-botanical problems himself. On the 21st, the KOVALA arrived with the photographs, which were better than we had dared to expect. Torben Monberg left with the ship, so afterwards translation and many other problems were much harder to solve. Hard work to get all the gardens mapped and to trace the development of fallow areas ensued. The religious division on Bellona into two churches proved to be advantageous for field work; workless days could be avoided, as Saturday was observed by the SDA's and Sunday by the SSEC's. Torben Monberg's census, based on lineage, gave a total number of Bellonese exactly equalling the number found by a household check of the island, when migrations were considered. Pardee left Bellona on 21 October on the KWAI. The last period on Bellona was one of strenuous hard work to get everything finished. Almost everybody assisted in some way or another. We left Bellona 30 October and arrived at Honiara after a short stay in western Rennell, which was more different from Bellona than expected. I stayed in Honiara from 4–9 November, doing some office work, and then returned to Copenhagen.

1969: During a brief visit to the Solomons a survey was made of a village, Hatagua, in western Rennell, in cooperation with Torben Monberg. There was no chance to revisit Bellona. Some of the findings were of relevance to the work on Bellona. The Rennellese gardening for instance, appears to be more archaic than the Bellonese; major differences are probably due to a quite different milieu, e.g. small isolated garden areas, rather than to differences in cultural background.

0.4 Data collecting in the field. The informants

Clearly the objectives sketched in the preceding paragraphs required data collecting in the field. Many data could naturally be obtained by direct observation, either during field work or later in the laboratory. Generally observations on environment presented no other problems than adaptation to sometimes rather primitive field work conditions. An extension of such observations to encompass periods where no 'alien' observers were available did not present serious obstacles, as the training of local assistants was quite easy.

A lot of information was obtained by interviewing. Often this presented serious problems of translation. Where concepts of subject matters match exactly between Bellonese and Europeans, the problems were usually overcome with little effort. With some questions a type of participant observation could be used: a description of an agricultural technique could be verified by the observer by attempting to apply the technique in the field according to local instructions. Some informants very soon grasped the idea of 'translating' in this way. Though it is not included in a normal Bellonese education, some of our informants developed a skill in drawing. Even though practically everybody on Bellona delivered some kind of information and as a rule many informants worked together, often in large assemblies, it must be admitted that the most active informants deserve the label of research assistants, or even researchers rather than informants. Two outstanding examples of this were Taupongi Ngibauika and Sengeika Tepuke, both of Matahenua, Sa'aiho.

A few informants must be noted separately (for details on some of the informants, see Canoes, chapter 2). Specialists in traditional subsistence techniques included Matiu Sa'omoana, Polo Sa'engeika, and Sanga'eha; also younger men including R. Puia, Takiika, Philip Tuhaika, Andrew Mau'eha, Naiham Tamua, Tongaka, and Kumingau contributed a wealth of information. Still younger people, as Taupongi, Sengeika, W. Baiabe, Haikiu, Tepaikea, Haman Sau and others were in some respects still learners but within their special areas of interests fully fledged experts. Performance of the informants was really amazing: A few samples may suffice: Taupongi reconstructed detailed censuses of the population as of 1938 and 1943, each encompassing more than 400 persons, within few days. After months of cross-checking and endless interviews only minor corrections were necessary; Nathan Tamua gave a detailed list of his 27 changing gardens back to about 1950. The gaps in his list coincided exactly with his stays in Honiara, which were later confirmed. Such skills may be understood only because historical knowledge on Bellona almost solely relied on oral tradition.

One serious restriction to informants must be noticed: their information is only valid if the concepts of the informant correspond to those of the informed, i.e. that 'translation' is of concept to concept type. Some of the differences are of the type met, for example when translating words for wood and trees from English to German or vice versa (forest, wood, tree – Wald, Holz, Baum). By gradually applying more and more Bellonese words in interviews and making sure of the translations, this problem was gradually overcome. Most interviews were totally in a primitive (but technically specialized) Bellonese in the later period of field work, which added much to speed and exactness. However, many problems remained because of more fundamental differences in concepts. A rough sketch of some local concepts within the subjects of the investigation is attempted in the following paragraph to give a general background and to shed light on some of the areas in which concepts are at variance.

0.5 Some Bellonese measures and concepts of physical environment

The objects set for the research were found to have no direct equivalents in Bellonese concepts, but the difficulties in making them comprehensible for informants varied widely. 'Carrying capacity' finds a parallel concept on Tikopia, where R. Firth (1939) described a principle of balancing population with available resources, locally named '*fakatau ki te kai*' (making [the population] appropriate to the food [available]). It is interesting that the same concept never seems to have been formulated on Bellona otherwise in many ways so similar to Tikopia. Of course the absence of a short formulation does not mean that the idea in disguised form may not be found, nor that it is incomprehensible for a Bellonese mind! General concepts as ecological adaptation and stability seem similarly to be lacking, but there is on the other hand a body of empirical knowledge on such matters as fitness of crops to soils, or indications of even a faint depletion of soil. Often generalizations differ in Bellonese from those customary in Western languages; there are no specific word for 'weather' or 'plant'. To achieve the objects of this survey it was often necessary to collect specific information and try to fit it into a general framework of ideas alien to the locally used.

Some of the main ideas of the investigation do at least contain an abstraction not found in Bellonese, but the following short survey may show also that what might be termed basic elements are differently conceived. This applies to such substantial subjects as measures, so basic to convey quantitative information.

Following this a survey of some basic concepts within environmental subjects shall be given.

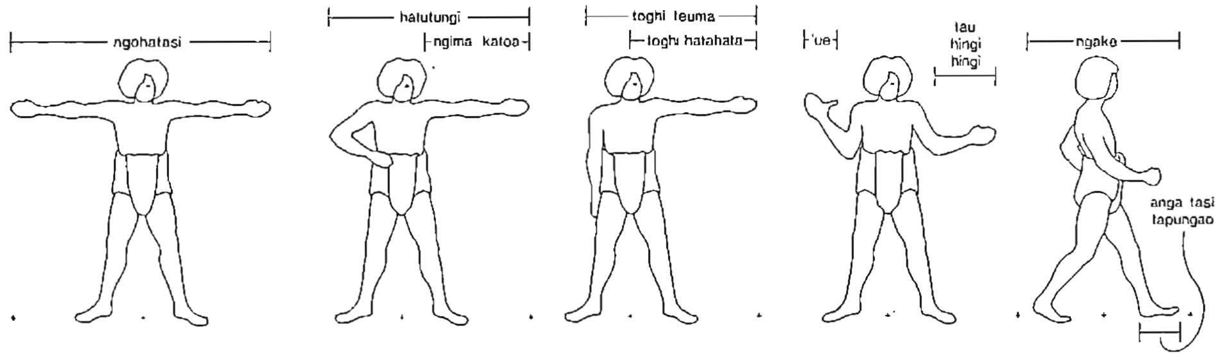


Fig. 4. Some traditional Bellonese measures of length.

0.5.1 Measures
(lengths, volumes, weight, time)

Most fundamental is a system of numbers. The Bellonese system is basically a decimal one. Numbers from 1 to 10 are similar to those generally used in Polynesia.

Further numerals are generated in a way also similar to that in Polynesia, analogous to the decimal system. Difficulty occurs because the numerals in some respects differ according to category of the objects enumerated. These have been described by S. H. Elbert (1975) in his dictionary. It seems that distinctions are related mainly to form; round objects and flat objects are thus classed separately. The difficulties of this problem will not be entered into here, but it may be added that a further problem arises from the custom of differential counting of aggregated objects; it is possibly derived from an old system of equivalent 'values'.

Two *'uhi* yams are counted as one.

Ten (or sometimes eight) *'uhingaba* yams are counted as one.

Twelve (or sometimes twenty-two) taros are counted as one.

The type of counting is often marked by adding a prefix to the numeral; with taro: *mata tasi* ('one' = twelve taro), *matangua;* ('two' = twenty four taro) etc. (See table 3).

A fundamental issue in the problems of measures is if concepts of length, weight, and time exist. From these units most others are easily derived. On Bellona a variety of measures for length exist, but they are almost unconnected; no general difinitions are found by which one measure can be related to another. Further the measures are not standardized, as they are taken from body-dimensions of any grown man.

Some common measures of length (*ngangaha, ngakangaka*) referring to fig. 4 are mentioned below:

Measures	Used for
1) *ngaka* measuring by steps	gardens, walking distances, etc.
2) *ngangaha* measuring by 'fathoms'	canoes, fishing lines, trees, fine sleeping mats
3) *hatutungi* measuring by 'bow-spans' cf. fig. 4	small mats, etc., when whole *ngaha* cannot be applied
4) probably new expression: *nga'ahinga* measuring from one shoulder to outstretched fingers on opposite arm	same objects as 3)
5) *toghi hatahata* measuring by 'half-fathoms'	for width of regular-sized *malikope mats*
6) *tunga ghupo* full length of arm	irregular mats, such as made for white people
7) *tau hingihingi* measuring from fingertip to elbow	(as 6)
8) *anga tasi* fingerspan	no specific uses, but becoming more and more generally used as for floors, canoes, etc.

The problems arising from use of the local measures of length are similar to those of many ancient European measures. Definition is weak, but within limits measures are usable; much more difficult problems arise from the fact that measures of area are not commonly used in Bel-

TABLE 3.

Some Bellonese counting systems. (Informants: Taikona, Sengeika Tepuke, Sa'engeika).

Common system	Count of: potu 'umanga (garden divisions)	Count of: 'uhi and beetape yams and mei (breadfruits)	Count of: 'uhingaba yams
1 tasi	do	do (Counted 2 for one: 'uhi, beetape, abubu, mei etc.)	('uhingaba counted 10 for one " " 8 " " if big ones 7 " ")
2 ngua	-	-	
3 tongu	-	-	
4 haa	-	-	
5 ngima	-	-	
6 ono	-	-	
7 hitu	-	-	
8 bangu	-	-	
9 iba	-	-	
10 katoa	angahungu	kau'uhi	tini
11 - ma tasi	- ma tasi	- ma tasi	- ma tasi
20 nguakatoa	nguahungu	nguangakau	
30 tongukatoa	tongungahungu	tongungakau	
40 haakatoa	haangahungu	haangakau	
100 ahe	bangoahe	kauhusi (= ahe)	ahe
1000	?	noa	noa
100000 bane (same as used by hiti)	(that many potu do not exist!)	bane	

lonese. Usually comparisons are made with objects fairly well-known, as palms of hands, sleeping mats, etc. Areas of gardens can often be approximately found by their number of divisions, but still actual areas vary widely.

Weights are almost impossible to assess in Bellonese; they may be given in comparison to everyday objects but no generalization and standardization has taken place until recently. Sometimes weight of one item is roughly estimated by referring to normal burdens, carried by women or men, or by the number of persons necessary to lift the item. Now British weights are gradually being introduced; pounds are used now and then, and also the metric weights are getting known.

Determination of time was made by means of the most obvious units, day (*'aso*) and night (*poo*) as almost everywhere on earth. But a further division of the day was difficult except for distinction between early in the day, before noon (*maho-'ata*) and late afternoon (*nga'aa pange*) about 2 to 5 p.m. An approximate height of the sun is sometimes used to give a better defined time, but smaller units of time than half-days are difficult in traditional Bellonese terms. Two expressions, *gholoba* and *mi'igholoba* are used commonly. The first is used for any period of time, and the last for short periods. Nowadays many persons on Bellona have acquired watches. 'Bells' of the churches announce services morning and afternoon.

The division of the year into months was made by watching the cycles of the moon. Some details may be seen from the 'agricultural calendar' (chapter 2.1.6). Like all moon calendars this method gave rise to difficulties because twelve moons are not equivalent to a solar year. This was compensated for by the insertion of an extra month, when it was felt necessary. No general agreement, except with the gods, was required to do this. At the time of the introduction of Christianity the question of the date was said to have given rise to special trouble since 'personal' calendars were used. Later the Council of Rennell and Bellona specifically forbade this 'changing time'.

The year was also used as a unit, or rather the interval from harvest to harvest (*ghapu*). No precise length of the year was defined, as may be gathered from the note on the moon calendar, but corrections were applied by watching arrival of

Count of: tango (taro), sasabe (flying fish)	Count of: huti (bananas)	Count of: patito (sweet potatoes)	Count of: polo (coco-nuts) or other round objects
matatasi matangua matatongu (tango ngeka 12 for one tango sua 22 for one) matangahungu	(huti: 4 bunches counted like one pile) 'aasea	tini	(polo and mamiapu counted one for one) heniu
matangahungu ma tasi	ma tasi		ma tasi nguangaheniu
matatengau	mano		hua
noa	noa		mano
bane			kiu

migratory birds (especially the *sibiu,* Pacific Golden Plover). The changes of season are rather undefined, so the *sibiu* marked the time when planting of crops should be started.

Larger spans of time than years were measured with life time of persons; genealogies were apparently well-established and sometimes used for rough chronologies. An attempt to establish a chronology of recent history may be seen in appendix E. As a basis was used generally known features as killing of the missionaries (1910) and adoption of Christianity (1938).

Already from these notes on measures it may be gathered that Bellonese ideas comparable to carrying capacity are not derived from measurable units, but rather from empirical findings of a number of people able to make a living on a given piece of land.

Though measures were faintly developed and would be rather dissatisfying to a European mind, it may be borne in mind that there were probably no demand in Bellonese traditional daily life for improvements in units of measures until contacts with European civilization began.

0.5.2 Land classes

On Bellona concepts of environmental features differ in many respects from usual scientific or even popular Western ones. From the following paragraphs attempting to describe briefly land, soils, weather, and vegetation in Bellonese terms, some points of variance may be illustrated.

Bellonese terms describing land focus on features of importance for sustenance. Considering landscape, its use in the subsistence cycle evidently stamps the descriptive vocabulary; this is not to say that other factors are totally disregarded. In fact, intangibles play a great part in the life of the Bellonese; great attention is given to places mentioned in traditions. Still subsistence production has an especially rich associated vocabulary. It conveys meanings on any relevant subject with a precision and economy that defies direct translation into English.

Bellona is by its inhabitants apparently conceived as a huge canoe heading into the waves of the southeast trade wind. At least the southeastern point (*mu'a te henua*) is the 'fore' and the northwestern cape (*mungi te henua*) the 'aft'. Bellona is considered to consist of two symmetrical parts,

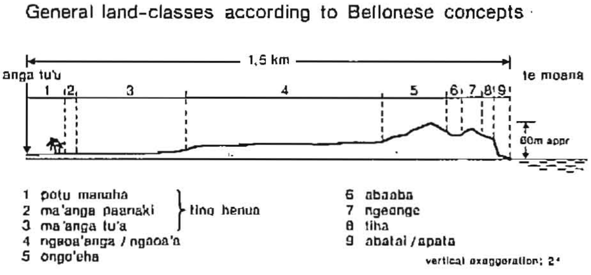


Fig. 5. Idealized cross section from the central trail to the sea showing general land classes.

divided by the permanent trail (*angatu'u*) running from Ahanga bay to Tingoa. Therefore in fig. 5 showing a section of the island with landscape terms according to Bellonese concepts only one part of the section from *angatu'u* to the sea has been shown. The elements sketched are briefly discussed below in an attempt to explore the semantics of the terms used.

Together the main trail, the homesteads (*manaha*) and the garden areas (*ma'anga*) bordering the trail, form what is called 'the body of the land' (*tino henua*). The last term (also *uso henua*, 'the core of the land') usually includes the garden areas immediately behind the *manaha* area proper: *tau mungi* is the collective term for the garden areas between the houses and the main trail. As a land form *tino henua* appears as an almost level plain, but the fact that it is flat (*papa*) is not of major interest to the Bellonese. It is primarily characterized by its good soils and is the largest homogeneous land area suited for gardening on Bellona. The highly fertile core land is the light of the eye of every Bellonese, and proudly demonstrated to any visitor. *Tino henua* was originally the bottom of a lagoon with its sedimentary cover.

The *ngaoa'anga* borders the plain on both sides. It rises often gently from a level of 8–12 m above sea level to heights of about 20 m or more (it should probably be identified as the lagoonward parts of the inner reefs). This, however, is of no relevance to the Bellonese, since there is no local understanding of the origin of the landscapes. *Ngaoa'anga* means a place too stony to be cultivated with traditional crops. Here and there in the *ngaoa'anga* some hillocks (*ongo*) may be found. These appear to be remnants of former solitary patch-reefs or coral knolls. Although very much eroded, some of the hills stand tower-like and overgrown, almost inaccessible. (Larger level plateaus are called *kenge mahonga*, such as that near Ghongau).

Sometimes small areas of cultivable soils appear in *ngaoa'anga* which are usually called *ngaohie*. Another term customarily applied to such places is *abaaba*, lit., valley. Pot-holed land of distinct 'karst' character is usually called *hepu'apu'a'aki*. For the utilized land the term *kunga henua* is often employed.

The hilly rims of calcareous rocks (no doubt a former series of reefs), *ongo'eha*, are found seawards from *ngaoa'anga*. In most places there are two such rims encircling the entire island except at the two ends where they are replaced by highlying plateaus. The greater altitude of the inner rim is the only feature which distinguishes it from the outer one. Usually the separation of the two is clearly marked by a depression, a trough-like valley called *abanga* if uncultivated and *abaaba* if homesteads have been established in it. Often the term *uso mouku* is applied to the inner rim (lit., the core of the forest). *Mouku* is sometimes used to designate both rims and valley although it lit. means 'wild, uncultivated growth'. The term usually suggests the idea of very rough country: *heo'ao'a'aki*.

From the outer rim the sea can be seen. In front of it a terrace-like land form is usually found. Sometimes it is called *abanga*, but the proper term is *hongaa tiha* or *hongaa ngenge* (the top of the cliff). Some small plots are cultivated on this terrace. The coastal trails (*anga ki tai*) are of great importance to the Bellonese.

Very often the sea can only be reached, if at all, by descending the very steep cliff face (*ngenge*, 'the top of the cliff', or *tiha*, meaning the cliff itself). In the cliff face many traces of former positions of sea level are seen. These are most conspicuous where caves (*'ana*) have been formed.

At the base of the cliffs (*tungi ngenge*) a well developed coastal terrace is usually found, or in some places a series of two or three terraces. Where accessible, this coastal ledge is important as a fishing place. If a little soil is found, it may be cultivated and is then termed *abatai*. The noncultivable part is called *apata*. Often access to the sea is hampered by the presence of a low rocky ledge (*lunga*) the place where land and sea meet. Only in a few places is a beach (*'one*) found where canoe landing is easy.

In front of the ledge, there is usually a shallowwatered reef flat (*ngoto*). The outermost part of the reef flat shows a slight rise of algal origin, the grooved front (*'ungu'ungu*) of which descends swiftly to the great depths of the ocean.

It would be meaningless for the Bellonese to stop here. The sea (*moana* or *tai*) is part of their living space. The refraction pattern of waves formed round Bellona gives rise to certain areas of interference (*moa*) recognizable by their short-crested, toppled seas. According to modern geophysists as W. Pierson (1951) the crossing of wave-orthogonals in the lee of an island causes an 'envelope' of breaking waves to develop in specific locations. These are familiar to Bellonese who use them as reference places for navigation. It seems that fishing is only done within a modest radius off Bellona. No special fishing banks are known other than Indispensable Reefs far to the south, and off Bellona depths are soon of oceanic character, offering neither reasons nor means to differentiate in terminology.

The distinctions in landscape terminology used by the Bellonese coincide with the differences in modes of utilization. *Tino henua* is the area used for housing, for gardening, and for most transportation; *ngaoa'anga* is used mainly for collecting and only in rather restricted areas for gardening. *Mouku* (forest) should not be ignored as a provider of important edibles for the Bellonese: in the *abaaba* gardens can be made, often providing earlier planting than in the *tino henua*. But of equal if not greater importance is the *mouku* as a provider of collected food (*utunga mouku*). In times of food shortage (*kangakanga*) the forest is indispensable. Besides providing emergency food the forest yields almost all the timber available. This fact all grown-up male Bellonese fully recognize and their timber reserves for canoe hulls are evidence of their quite conservationist methods.

Since the locations of dwellings have changed greatly through time, and traditions adequately preserve knowledge of the quality of formerly cultivated areas Bellonese find it unlikely that new cultivable land can be found. Of the total land area, approx. 60 % is forest, about one third of which reveals traces of the use of fire and axe, while the remaining two thirds are virgin. An additional 10 % is occupied by old fallow (*bao matu'a* or *baoa'a*). These 'old fallow' areas are of rather limited utility; most of them were only used under special circumstances and have remained unused since 1943. They can only be regarded as a marginal land reserve under present conditions. If the areas were cultivated, they would demand more effort in cultivation and also a longer period of fallow – up to 15–20 years would not be unusual – which means that these areas compared with others are of a very reduced, almost negligible utility.

The usable land amounts to about 26 % of the total land area. Village areas (*manaha kakai*) occupy less than 1 % of the total. They cannot be considered as horticultural reserve for the following reasons: the fruit trees and other cultivated trees have been excluded from the total given which means that village areas are occupied by houses, trails, or village greens only. Village greens are – when of some age – uncultivable because the soil is 'dead'. An example is seen in the former site of the village Kapata which existed between 1940–1957. The village area has still not recovered its fertility and it looks as if at least part of it will remain infertile. The Bellonese say that the soils have been turned into dust (*tobeabu*). On the coastal terrace some usable areas are found; presently about 5 % of the terrace areas are cultivated with coconuts. Under prevailing conditions further cultivation even of coconuts would be unprofitable, though transport conditions make coconuts the best adapted crop. To sum up, it can be estimated that about 420 ha. of good land and the equivalent of an additional 45 ha. (totalling about 465 ha.) were accessible for subsistence crops on Bellona in 1965–66, according to local classification of land (for details on land use, see table 12).

0.5.3 Soils

The most important and sought after qualities in land is, naturally enough, whether it has enough soil. Any land with top soil that can be dug is termed *kenge ngau*; the rest is *mouku 'atua* or *mouku maase'i*, lit., 'useless or bad' wilderness. The major divisions of soils are *kenge* and *malanga*, a distinction based on size of grains. *Kenge* has invisible individual grains, and *malanga* visible ones. Roughly the division coincides with the common one made between silt/clay, and sand. (For an analysis of Bellonese soils, see Kr. Dalsgaard 1970.) Besides these classes of soils, there is also *'one*, beach sand, which the Bellonese do not consider a soil type at all, as it is not found in the interior of the island except where it has been put on old graves. What is usually termed 'sand' may be found there, but is then called *malanga 'one*. Another type of *malanga* is also distinguished as *malanga ahatu* 'stony *malanga*'; it has coarser grains.

Within the *kenge*-class at least five types of top soils are classified:

1) *kenge tanahu,* whitish and sandy type considered of low fertility.
2) *kenge lanoaka,* soil of mixed colours.
3) *kenge toaha* 'hard soil', stiff and clayey, hard to dig, fertile.
4) *kenge mea* 'red soil', usually only found further down.
5) *kenge tobeabu* 'dusty soil' e.g., overcultivated.

An additional soil type (*kenge pisi*) which looks as though it has been burst by fire, is thought by some to be the result of too hot garden fires and is considered of low value. People are ashamed if accused of producing *kenge pisi* or *kenge tobeabu*. Another term, *ghinaghina,* designates not a soil type in the usual sense, but should rather be translated 'barren', and can thus be used for any soil type bereft of fertility.

Kenge ngau or *kenge 'ungi* (dark soil) is regarded as a sixth, 'normal' type of usable soil, besides being a general name for all cultivable soils. *Kenge hingo* 'mixed' soil is something between a *kenge* and a *malanga* type, having both coarse particles and fine invisible particles. The Bellonese, it must be added, rely not only on visible qualities (grain-size, colour) when evaluating soils. Tactile properties of grains (rounded or angular forms) are considered and also other qualities such as smell.

The qualifications on which the soil types are distinguished are very similar to those used by farmers of the industrialized parts of the world; without technical apparatus they seem difficult to improve further.

Further the Bellonese keenly observe stratification of soils. The top soil proper is called *kenge pingo,* below this is found a *kenge mea* horizon of red soil, and sometimes a mixed layer *kenge hingo* between the two. *Kenge hingo* is here understood in the literal meaning of 'mixed soil', the mixing occurring, according to the Bellonese, by modern cultivation practices. Below the red *kenge mea* horizon is often seen an irregular layer of *kenge tanahu,* considered to be the softened upper surface of the rock below, *hatu.* A few Bellonese have used the name *kenge meenga* for everything between the hard rock and the top soil, but this usage must at present stand unverified.

The distinctions in soil types made by the Bellonese are based on easily distinguishable properties and are of relevance to cultivation. The division into *kenge* and *malanga* types is decisive with regard to the development of various crops. In *malanga,* for instance, the bulbil-developing yam types grow better than in *kenge* soils, whereas the contrary is the case with tuber-developing yam types. This is not an isolated case of the distinct growing potentialities of the two kinds of soil.

The different water-retention capacities of the two soil types are easily recognized. In heavy, long lasting rains the *malanga* crops develop better, since these soils are better naturally drained. When droughts threaten the crops, the *kenge* soils reveal the importance of their available water resources. Taros grown on *malanga* are said to wither more than a week earlier than those on *kenge* in droughts. Generally *kenge* is considered more valuable than *malanga,* largely because fallow regrowth is faster, and therefore *kenge* can grow crops more frequently.

In general traditional Bellonese knowledge of local soils seems to correspond in kind to what was known by practical farmers in the Western world before about 1850. Interest is evidently focused on cultivation quality. It is noticable that Bellonese often associate soil quality and vegetative cover; 'Fertility' is clearly considered a quality partly based on soil, partly on development of vegetative cover.

0.5.4 Weather

Of course the Bellonese, like all of us, live surrounded by unexplained daily weather phenomena. They have probably no less desire for explanations and coherence in their mental world than we in the Western world have, but coherence is difficult to create without a scientific basis. In the end myths, legends, and religious beliefs offer explanations for the most peculiar or important daily riddles. Similarly, animal peculiarities are sometimes explained by deeds of gods or heroes. Each of the wind directions 'belonged' to a god(dess), Canoes T28. Some directions were associated with the places where gods were believed to live. These matters are beyond the scope of this work and are mentioned only because they reveal the Bellonese in a light other than the breadwinning, empirical sceptic who is usually met with in this book.

Regarding the weather, the Bellonese realize that experience is a good teacher. The seasonal changes have been and are carefully observed. It is traditional knowledge that when the *hetu'u tata* (lit. [specific] stars coming down slowly) appear in the sky, the rainy and windy season begins. Afterwards the season of easterly, steady trades comes and this again is followed by a season of calms, the season for fishing, *ta'uika,* with warm water on the sea surface and great abundance of flying fish. (See the Bellonese agricultural calendar 2.1.6.) Such knowledge is precious; even though phenomena are left unexplained they permit rational planning; as when to have ready new canoes for fishing and for voyaging (*hongau*).

Daily wind behaviour is also keenly observed by the Bellonese. The trade (*tonga tu'u*) has its special ways. Literally the term means 'steady southeaster', but in the mind of every Bellonese much more is conveyed. In fact it brings to mind a whole weather pattern; a steady wind, both in direction and force, a few high white clouds, little or no rain, opportunity for burning.

By Bellonese observers it has been noted that wind directions tend to change systematically and tend to be deflected more and more to the left. This coincides with Buy-Ballot's law for wind in the southern hemisphere, and is a remarkable example of empiricism resulting in formulation of a general principle.

Naturally precise descriptions of wind easily lead to a definition of terms for wind directions. Apparently directional terms are referring to two different systems (see fig. 6). One relates winds to the axis of the island: winds from behind (*matangi tu'a henua*) in front, i.e. against the eastern cape of the island (*mu'atootonu* or *matangi ki mu'a*). The other system of reference is to the seasonal globe winds: the southeastern trade, *tonga tu'u,* and a monsoonlike *tokengau.* A more southerly trade is called *tonga ngango,* lit., a low trade.

It is considered important to distinguish winds with a steady direction from those changing. On Bellona a steady easterly with increasing force is *matangi ngaoa'a*; a wind usually starting from the east turning all the way round is described laconically as *ngibu te matangi,* turning wind. Left turns by the wind is called *ngibu hakasema,*

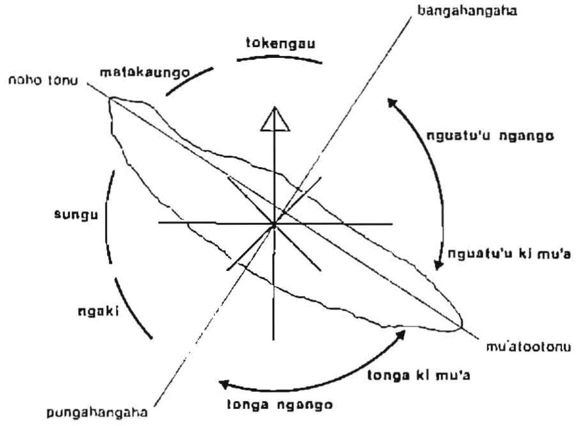


Fig. 6. Local terms for wind directions. Apparently one set of terms refers to the island, another (with bold-faced letters) refers to prominent, seasonal winds.

right turns (rare) *ngibu hakamaui.* A wind turning (as from *mu'atootonu* to the *tonga ngango* direction) anti-clockwise and expected to turn back again within a day is termed *songo mungi* (*te matangi*), a term also applied when a *tonga ki mu'a* is turning to *mu'atootonu.* If a wind turns all the way round and dies down it is said to be *hano hiti,* or *hano hakasema o hiti.*

Winds are conceived as 'bad' or 'good', depending mainly on their effects on fishing. *Tonga ngango* is a bad wind because: 'cold water will come up, making the flying fish leave the northern coast' where they otherwise could have been caught in the shelter of the island. The *tonga tu'u* is regarded good (if not too strong) as is *nguatu'u.* Both are usually rather constant and allow fishing.

In 1965 the cups of the anemometer were barely moved by the wind. There were consequently little opportunity to collect terminology of wind forces, comparing them to measurements. A quiet sea in no wind is *mangino,* a strong wind is *hungi,* and a hurricane is *hungi kenge.* Squalls are termed *angomaka.*

Clouds are thought to be steam as is formed when hot stones are put into water, *hakatio.* The clouds are keenly observed because of their connection with precipitation. Like all agricultural people, the Bellonese are deeply concerned with sufficiency of rain. White clouds (*'ao tea*) are known as relatively stable, whereas dark clouds (*'ao 'ungi* or *'ao hatu*) may produce rain. Also fog or ground mist (*usa'i*) rising like smoke from the sea or wet ground is of some importance for the crops, as is dew (*sau*).

A rich vocabulary exists for rain (*'ua*). Gentle rain with tiny, almost invisible drops is *'ua a pingikoke* (for origin of the term see Canoes T58); a little rain is *gholigholi 'ua*. Heavy rain (*'ua mamaha* or *hu'ai 'ua*) is feared because of its harm to crops. Long-lasting drenching rain is known to cause rot in yams. Just right for crops is *toota'ebasa*, mixed rain and sun.

Air temperatures are beyond observation of the Bellonese, but it is observed and often commented upon how air temperature (including effects of humidity) is felt.

0.5.5 Plants, especially cultivated plants

For scientific classification and identification of plants the fundamental criteria of Linné still apply. According to Linné, any classification is based on morphology, specifically of sexual organs, and classes are arranged in an encompassing hierarchical system. Recent developments have allowed an additional genetical analysis, at least of some parts of the plant world. Application of Linnéan concepts have led to remarkable advances in botany, obvious when more and more data indicated a meaningful correlation between Linnéan systematics and phylogeny: closely classified forms are actually closely related genetically.

Before Linné made his significant contributions, classifications were both in science and in popular knowledge based on criteria as form of growth, utility and general morphology. The still useful divisions into trees, bushes, and herbs, and into herbs and weeds are of this ancient type.

Bellonese taxonomy of plants shows similarities to the popular European concepts, but has also elements of an application of genetical principles. This makes identification of plants only approximately transferable from Bellonese to systematic concepts.

Some of the conspicuous features of Bellonese classification of plants will be discussed a little further. Although some general classes are distinguished it seems obvious that interest in forming a coherent system is lacking. A word for 'plant' is not found, but some general names at about the 'class' or 'order' level do exist, e.g. *ngimu* (algae), *taanginga* (mushrooms), *muningobo* (mosses), *sanisani* (Lycopodiaceae, club mosses), *mutie* (grasses), *bungu* (rushes). General names are also found describing units of lower rank, e.g. *ghasughui* (almost = orchids), *'uhi* (almost = yams), *hanga* (almost = screwpines), *'aoa* (almost = ficus trees). Such local distinctions are often at variance with scientific systematics; e.g. two screwpines *kie* and *baghu* are considered only distantly related to other screwpines; *isi* and *isi 'atua* are two trees locally considered closely related, but actually belonging to different families (admittedly within the difficult LEGUMINOSAE). On the other hand it is amazing how often Bellonese classifications at the species level fit into the scientific one. Bellonese systematic basic units especially with cultivated plants often equal the scientific subspecies or varietas level. See appendix B-2 for examples, easily found within DIOSCOREACEAE and ARACEAE. Bellonese systematics differ from Western taxonomies by basing categories on growth form and usefulness of the plants. In table 4 is sketched a division of food crops in which these features are evident.

The classification in table 4 reveals that plants closely related according to scientific taxonomy may be put into widely separated divisions. For example two types of Dioscorea bulbifera, *abubu* and *soi* are placed with *me'a sanga* and *me'a mouku* respectively because of relatively slight differencies in concentration of a toxic element, dioscorein.

Sometimes the Bellonese are aware of genetical relations between cultivars, because they have observed the origin of new kinds. This was recorded by T. Monberg in a small report, directly translated: 'Pongi (Ngikobaka lineage, generation 19) planted *bootebo* yam, watched it, and something different came of it. It was red inside, both [new and old were] long, but *bootebo* white. The red one is called *'uhi a Pongi* [Pongi's Dioscorea alata-yam]. It [still] has red tubers'. Words in brackets have been added for clarification; the sequence 'something different came of it' is expressed with a single Bellonese word: *ngingiu*, which contains the equivalent of 'to mutate'. For some varieties of yams relations are well known, as in the example of *singasinga*, a coarse variety of the alata yam. Observed development of mutants are shown below:

singasinga { *kakenuku* / *'uhi a Tepuke* } { *pangighisu* (or *pangingisu*) / *maingenuku* }

TABLE 4.

A tentative classification of food plants.

Selfpropagating: malubu, maatika	Cultivated: sanga
utunga mai mouku (food from forests)	utunga 'umanga (food from gardens)
a) nga'akau kai tona hua (trees with edible fruit) b) kaubango (vines) c) me'a mouku (wild plants with tubers) 'uhi Tonga, manungaghe (types of Dioscorea nummularia) soi (Dioscorea bulbifera) etc.	a) ghaingi, kai tona me'a (vines, esp. of yams) 1) me'a sanga, tubers of cultivated yams 'uhi (Dioscorea alata yams, several kinds) suinamo (Dioscorea nummularia, several kinds) 'uhingaba (Dioscorea esculenta, several kinds) beetape Dioscorea nummularia? Dioscorea alata? one species 2) abubu (Dioscorea bulbifera, several kinds) boiato (Dioscorea pentaphylla, several kinds) etc. meleni (melons) mena (pumpkins) b) utunga 'umanga, he'e ghaingi (non-vine garden crops) 1) tango (taro) kape (Giant Dry-land taro) huti (banana) aka (Pueraria triloba) etc. 2) koni (maize, corn) etc.

Probably the *'ngingiu'* concept also encompasses changes dũe to bastardization through cross pollination. Such bastardizations cannot occur with most yams which develop no flowers or infertile ones.

Referring to the list of used well known plants it may be underscored that those Bellonese who have acquired traditional skills are expert botanists capable of distinguishing at least 250 utilized plants. Their taxonomic criteria are based on properties bearing on the practical use of plants. The taxonomy can efficiently be used at a variety/subspecies level, of primary interest for the native grower, whereas differentiation within plant groups of no practical use is rudimentary. There seems to be little interest for or necessity of establishing an encompassing system nor to base it on generally applicable criteria. For the botanical field work it was therefore necessary to collect specimens of utilized plants identified by their vernacular names for a later application of scientific identification. In this field work scientific identifications would not have been adequate, whereas Bellonese names were; use of these alone would, however, have precluded any possibility of comparison of local material with the flora of other islands. Lists of Bellonese utilized plants are found in appendices B 1–3. In list B-1 the plants are arranged after Bellonese names with no local systematics applied except for a few general names. List B-2 is based on systematic species; it is evident from this that Bellonese basic taxa are at a finer level of subdivision.

0.6 Conclusion on applicability of local information for the investigation

From the short outline of local knowledge on the subjects briefly given in the preceding paragraphs (0.5.1–0.5.5) only some tentative conclusions can be drawn on applicability.

Bellonese information often lacks quantitative dimensions. As shown, it has not a general basis of reference in standardized measures. There are no units enabling us to measure yields per ha. or amount of work done per ha. For the assessing of carrying capacity, adaptation and stability local information is hence of no direct utility.

For a detailed description of subsistence production field experience proves that local information is eminently and directly useful for the investigator. Descriptions of land classes and cultivated plants can be made by far more accurate and appropriate when related to local concepts.

With other subjects, as soils and weather, local information may be used as an appropriate basis for further analyses on a scientific basis. This is almost to say that subsistence societies must be investigated in a cognitive way, 'on their own terms', but that the limits for such investigations set by local concepts can be surmounted only by application of scientific methods.

1. The 'subsistence syndrome'

1.0 Subsistence production of Bellona as 'material base' for society

In the introduction the classic geographical man-land relationships (or society-nature theme) was reformulated to accord with the objects of this research: detailed functional description of a society under subsistence conditions in an ecological, theoretical framework. The theoretical aspects of the objects shall here be further analysed to explain which subjects were included in the field work and why the way of presenting the results in this book was chosen.

Tradition in geography at least since the appearance of Malbrun's 'Traité de la Géographie Universelle' (1810–29), has been to start geographical descriptions with chapters on the natural environment. This has become increasingly difficult because it raises the question of selecting relevant material. If relevance here means 'of importance as to material base of societal life', environmental qualities have relevance mainly if they are resource bases conditioning societal production and life. As natural resources only may be defined in relation to (local) applicable means of production, it is necessary to investigate (local) techniques and know-how before defining resources. Based on an understanding of functions of local means of production, the limits set by local natural resources may then be analysed, as well as the implications for a local society of the maximum available production for consumption by a certain work-force.

Hence the difference from traditional geographical thought lies mainly in the central position assigned to the mode of production: the technical and organizational side of the productive processes, and the importance assigned to production as material base for society. A similar theoretical importance is ascribed to productive processes in historical materialism, where they are thought to set the limits for and incentives to societal development, influencing both its direction and ensuing form. These considerations were expressed by K. Marx both by himself and his followers (e.g. K. A. Wittfogel 1932). Marx assigns fundamental importance to mode of production, 'the real process of production' or 'the metabolism between societal man and nature', by which both societal, produced and natural, non-produced productive forces cooperate.

In modern sociology the idea of an intimate interplay between the elements 'milieu', 'organization', 'technology' and 'population' has been advocated by Otis D. Duncan (1959). His well know diagram was modified by the author as shown in fig. 7.

In modern concepts of ecosystems, analogous themes are dealt with. To every population or single species apply functional characteristics describing the ability to exploit the environment and how the environment is transformed by this. Any given environment sets limits to and influences in many ways a population because functional abilities allow people only to draw on specific natural resources (niches).

A society living on a subsistence basis may be conceived as analogous to the ecological element, population, if its productive abilities acquired by training are treated as if they were 'specific inherited abilities' of a population. The concept is mainly applicable to subsistence societies when their means of production, techniques, are remaining constant during the period observed.

If changes in production techniques occur, the ecosystem analogue may still be applied. But then it must be known how such changes induce further changes. The model changes from a static to a dynamic model which is much more difficult to handle.

In consequence of the above, the productive processes in subsistence context are analysed in some detail in the following chapter, where the processes have been separated into food production, food processing, and production of other necessities (or subsistence goods as 'climatic shelter', canoes, and implements). For a single year total production is then analysed. Further, the constraints on production set by properties of population and environment are considered, together with some aspects of the interplay between societal organization and productive processes.

The connections between elements as productive processes, environment, and society (especially population and some organizational aspects) may be conceived as forming a whole, here termed

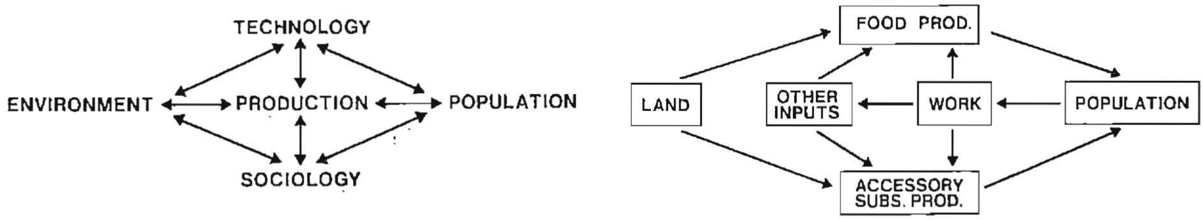


Fig. 7. Diagrams illustrating some aspects of the land/man theme.
a) Modified after O. Duncan. The social aspect is stressed by isolation of the element "sociology".
b) As treated in the present volume: the importance of subsistence production is stressed. Sociology is considered an aspect inherent in population.

the 'subsistence syndrome'. For a given static society the 'subsistence syndrome' is an important property; this implies some essential characteristics to be known as 'efficiency' (expressed as 'carrying capacity for population') and 'stability'; both combined express the otherwise unquantifiable 'adaptation to milieu', if related to some kind of 'cost of operation'.

The utility of applying the 'syndrome' concept lies mainly in its ability to supply a survey and a necessary clarification of elements and their connections; for practical purposes it may ease diagnostication of 'bottle-necks' in production.

It may be added that the idea of treating necessities understood as the basic needs for food and shelter was included in B. Malinowski's list of needs (1944) which also includes cultural and psychological needs not dealt with here.

It was tempting to apply the idea of a 'human ecosystem' instead. This has here been avoided. 'System' as used in systems analysis necessitates establishment of a matrix of a set of elements interrelated through a set of quantitatively described functions each of which describes how the change in the state of one element will influence each of the others. Briefly it may be said that an ecosystem description includes a very desirable dynamic aspect presently beyond feasability, whereas the 'syndrome' only encompasses a static description. To apply the ecosystem idea is very exacting, and the present inability to use it does not invalidate it as a tool for future research.

To trace the causes for some recent changes in Bellonese society, some static comparisons are finally made of the Bellona 'subsistence syndrome' as it was in some selected years after the introduction of Christianity.

2. Bellonese subsistence production

2.0 Some general remarks on subsistence production

Usually a production is described in relation to the technology applied and in economic terms. Inputs and outputs are measured in monetary values, as are balances. Subsistence economies are difficult to describe on a basis of conventional economic concepts because such economies are basically non-monetary. An alternative conceptual framework is not easily at hand. As analysed by M. Nash (1968), 'economy' in a description of traditional societies is therefore often reduced to mean 'rationality' in a broad sense.

Here an attempt is made to use an ecological instead of an economic framework, as explained earlier. Since the larger part of Bellonese production is non-monetarian by tradition, it seems the more feasible to concentrate on energy and matter. Essential needs such as food and fire are freely given and freely received, never bought or sold. Even so ecological ideas do not immediately supply an alternative set of concepts and measures. If certain basic items such as land, work, and capital are considered in a subsistence context, some differences between economy and ecology must be noted.

Instead of a generally applicable monetary unit, one of 'amount of work' or 'energy' may be used as the most universal, but it must be noted that the basic assets are measurable only with severe limitations. Land can hardly be bought on Bellona, and could definitely not be so in the traditional society. In the production process, land of course can be substituted by work to some degree, e.g. lack of land area can be counterset by applying higher inputs of labour. Another peculiarity is the very restricted possibility for accumulation of capital, here to be understood as 'stored energy or matter'. Very few items in traditional society were non-perishable or long-lasting enough to deserve the name of capital goods. The few available, houses and canoes for example, were of little importance as savings because demands to quantities were low as were keeping qualities. On Bellona today some items as knives, axes and calico can be termed 'capital goods'; still they mean little in the total economy. In general the degree to which values can be compared from category to category is quite low. Of course there is no market function in an economy as sketched, hence there is no concept in analogue to 'price'. Tentatively value of an object can be expressed by the amount of work used in producing the unit.

Recently a certain trade with the rest of the Solomon Islands has been developed. Of course prices of export goods could be used for calculating a 'shadow price system', especially as some of the items are also identical with articles of everyday consumption. But such prices have not been used, as Bellonese exports of these articles are quite marginal (see chapter 3.2); their application would lead to a gross underevaluation of general living standards or, at least to a conflict between different prices as on labour expended on plantations and on Bellona. Similarly wages attained by plantation work might have been used as a monetary measure for price of local work on Bellona. Evidently working conditions differed vastly between the two kinds; a direct comparison was therefore felt inappropriate.

The Bellonese draw mainly their livelihood from what may be termed a 'manipulated ecosystem' (see chapter 8) and also to some degree from a 'natural ecosystem'. Gardening refers to the first mentioned system, and gathering, collecting, and fishing to the latter one.
For convenience, Bellonese subsistence production has been divided into two main classes, which are again subdivided as below (ciphers refer to following paragraph)

- Subsistence production
  - Food production 2.1 – 2.4
    - horticulture 2.1
    - gathering, collecting, and hunting 2.2
    - fishing 2.3
    - food processing 2.4
  - Accessory subsistence production 2.5
    - personal comfort
      - climatic shelter (heating, clothing, mats, houses)
    - accessories for production
      - canoes, implements

[Market production, see chapter 3.]

A few main features of the subsistence production may be outlined here. The general food gaining strategy is aiming at an exploitation of a multitude of niches by the application of a simple technology. This has lead to development of a

Fig. 8. One of the numerous kinds of Winged Yam, Dioscorea alata L., ardently cultivated on Bellona.

Fig. 9. *'Uhingaba mai Laapani,* a kind of Lesser Yam. Dioscorea esculenta (Lour.) Burk. In 1966 this was perhaps the most widely cultivated yam.

large quantity of cultivated plants, and the use of a variety of fishing methods. The knowledge necessary to apply such strategies must be considered well developed, as may be demonstrated in the following. Inputs of labour have been found to be low and 'rational' (lower in gardening than in fishing if considered in relation to outputs). The production is not only economical, but has also achieved a level sufficient for local needs, as is demonstrated in chapter 4. Utilization of natural potential is, on the other hand, rather inefficient, but of great stability. This may be inferred from chapter 5.

2.1 Horticulture:

Bellonese agriculture is considered a type of 'gardening' for the following reasons: tilling is not practised, plants are individually placed in individually treated sites, the areas planted are usually small, and generally the plants used in these areas are annuals, vegetatively propagated (corms, tubers, bulbils, cuttings) and are thus not sown, but laid/planted. These elements are usually components in the accepted definitions of 'gardening'.

On Bellona, gardening is in principle a conversion of the forest into clearings very much like those nature herself produces when hurricanes hit, looking apart from aesthetic qualities. Local gardening is a rejuvenation of a natural ecosystem. According to ecological principles (E. Odum, 1969) juvenile ecosystems are characterized by their high production of biomass achieved by low diversity, i.e. relatively few species form the living part of the ecosystem. Even the multitude of cultivated plants are few compared with the number of species in the primary forest. To uphold soil fertility, a long fallow period is used during which wild plants extract plant nutrition ions from the soil and concentrate them in the tissues of the plants. From these reservoirs the ions may again

Fig. 10. *Boiato*, an ancient Five-finger-leaved Yam with only three-fingered leaves, Dioscorea pentaphylla L., now rarely cultivated. The edge of the photo in the fig. is about 24 cm.

Fig. 11. Taro, Colocasia esculenta (L.) Schott, is widely cultivated. The variety shown, *tango ngeka*, is considered both palatable and beautiful.

be set into circulation by burning or rotting for the use of a new crop. This is the principle of shifting cultivation. Bellonese shifting cultivation is of the forest or bush fallowing type, here requiring a fallow period from three and up to more than fifteen years.

In his important contribution on Zande agriculture de Schlippe (1956) made a distinction between the 'elements' and the 'structure' of an agricultural system. 'Elements' included ecological knowledge, crops, tools, field work, and crop processing; 'structure' the combination, interaction and succession of elements. His inspiring arrangement is not followed here, as it has been found difficult to sustain his rather rigid division of matters. Instead, utilized plants are dealt with separately, then their combination into garden types on a background of local knowledge of environmental qualities. Horticultural procedures with the few implements involved are described in 'gardening procedures', followed by a calendar of gardening, and finally an evaluation of the gardening economy is given.

2.1.1 Cultivated plants

According to principles previously mentioned, Bellonese gardening depends on use of a multitude of cultivated plants, necessary to utilize different types of milieus. Some of the plants are related to those invading and occupying openings in the forests made by hurricanes or fires. For a more detailed description of utilized plants see appendices B 1 to 3. Here only the most important groups, yams, taros, bananas, and a few more shall be mentioned with some major cultivation characteristics.

Among the herbaceous plants cultivated yams, *'uhi*, are probably the most important in food production. Five species of yams (family DIOSCOREACEAE) are found: Dioscorea alata L. [Water or Winged Yam], D. nummularia Lamk., D. bulbifera L. [Bulbil-bearing or Potato Yam], D. esculenta (Lour.) Burk. [Chinese or Lesser Yam], and D. pentaphylla L. [Five-finger Leaved Yam], see fig. 8–10. On Bellona several genetically different varieties are recognized, forming two groups: 'female' and 'male' yams (see appendix B-2); their tubers attain a multitude of forms making them usable in both deep and shallow soils. 'Female' yams are generally small and slowly growing, while 'male' yams are large, coarse, and fast-growing. Yams are usually planted in fertile soils after a fallow period of more than five years. The Winged Yam is the most demanding, whereas Bulbil-bearing Yam and Five-finger Leaved Yam grow well also in poor soils. Yams thrive in well-drained loose soils and resist droughts exceeding a couple of weeks, probably because of the water reserve of the tuber. To judge from yam types now growing wild in forests but said to have been cultivated earlier, the proportion of tuber weight to total weight of plant has been increased conspicuously through selection. Tubers of modern yams may weigh more than 20 kg each against a total weight of less than one single kg for the root-like tuber of the ancient types. Cultivated areas of yam types propagated by means of seed tubers are usually difficult to increase; with these, special methods are applied.

Nearly all yams develop enormous foliage; least so for Lesser Yam and Five-finger Leaved Yam. The last one has a tendency to spread the vines flatly on the ground. It must be staked, like any yam, to develop normally. Especially the Bulbil-bearing Yams develop edible bulbils, but these are usually only given full development when the tuber remains small, which is often the case in poor soils.

From the preceding it may be seen that cultivation potential of yams is great on Bellona. Only few disagreeable properties attach to this crop besides its demand for high fertility: it is vulnerable to high winds and it is a seasonal crop. If a storm breaks the supporting stakes, the crop may be severely damaged; but fortunately storms are rare. The seasonality of yams allows them to be planted within a period of about three months (August–October). Most yams are propagated by seed tubers, or bulbils. The tubers may be divided and left to sprout before planting. After planting a rapid development of the vine follows; most of the foliage is developed in a little more than two months after which the tuber starts to develop. Fast growing yams take about 4 months to develop tubers; the slowly growing take at least from 6 and up to 9 months to develop. The Bellonese have acquired a knowledge of properties of yams too profound to describe in detail here; generally it seems to be in accordance with that described

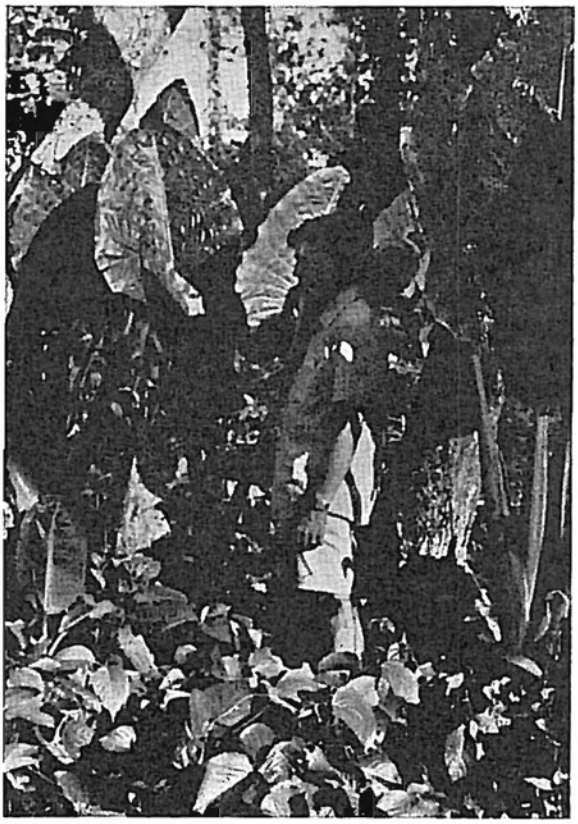


Fig. 12. *Kape*, Giant Dry-land Taro, Alocasia macrorhiza (L.) G. Don. is grown for its edible stalk and corm. It is biannual and hence often cultivated with bananas that grow equally long.

by D. G. Coursey (1967). Yams seem to have received little attention from researchers, and may still have potential development reserves for higher yields. The Bellonese seem on the other hand to exploit their limited access to varying forms of yams to the full. They watch their crops keenly and make selections of seed material to acquire crops of desired properties without losing diversity. Often methods similar to those used by plant breeders are applied, as for instance growing comparative material. Local knowledge of mutations has been mentioned in a preceding paragraph.

Both yam tubers and bulbils contain poisonous, bitter elements that are removed by cooking before eating. Both tubers and bulbils may keep for more than a month after digging.

Within the family ARACEAE cultivation of the species Common Taro, *tango*, Colocasia esculenta (L.) Schott, and the Giant Dry-land Taro, *kape*, are of importance (fig. 11 and 12). The two species mentioned are locally divided into several varieties (see appendix B 1 to 3). Within Colocasia esculenta two groups, a 'female' and 'male' are distinguished, mainly by length of growing period; the first group takes 3 months to develop their corms whereas the last one takes about 6 months. The soil fertility requirements of taro are low, but the soil must be humid without being wet. Usually three years of fallow build up a store of plant nutrients sufficient for the development of a good taro crop. Taro corms usually weigh about one kg; also the leaves form an important part of daily diet. Propagation is by means of the cut-off top of the corm with a few small leaves remaining; this way of propagation means that taro areas remain almost constant. Fortunately the taro plant sometimes develop extra layers. Planting is almost non-seasonal, but only successful if humidity is sufficient. To prevent drying, taros are planted in the shade of left-over, killed trees, often of small size. When taros are planted with other crops, they are usually found in the most shady parts of the garden, at the edges of the gardens, or beneath other crops. Taro is a very valuable crop, yielding palatable food and a fine staple in the yam-less seasons. It yields less than yams but is easier to grow. Though appreciated for food, it confers less prestige to its successful grower than does yam. This is shown in part by less florescence of vocabulary describing the growth stages and technologies.

The Giant Dry-land Taro is largely cultivated similarly to taro, but takes almost two years to develop. It grows vigorously and the edible lower part of the stem attains a spectacular size. The plants need little care and are hardy, especially in wet weather. Cultivation is decreasing, mainly because the tiny needle-like crystals cause sore throats.

The botany of bananas MUSACEAE is difficult, but nearly all cultivated bananas seem to belong either to the species Musa acuminata or to the species M. balbisiana or possibly to hybrids between the two, according to N. W. Simmonds (1966). In fact the combined sexual and vegetative reproduction of bananas has led to the formation of a wealth of clones, the interrelations of which are difficult to trace. In appendices B 1 to 3 the Linnéan names applied to the bananas cultivated on Bellona are not strictly correct. The true genetical relationships of Bellonese bananas are unknown, and the Linnéan names are given in the appendices merely to give an idea of a grouping based on superficial likenesses. It may be noted that the conventional idea of dividing bananas into 'true bananas' and 'plantains' finds no support in an existence of 'banana species' and 'plantain species'; within a given botanical species it seems that both bananas (with sweet fruit flesh) and plantains (with mealy fruit flesh) may occur. Within the multitude of Bellonese bananas a 'female' division and a 'male' one are distinguished, referring mainly to length of growing period. This is important; 'female' bananas length of growing is up to two years, whereas 'male' bananas are perennial. Hence 'female' bananas are grown in gardens; 'male' bananas are unsuitable for this purpose because garden areas are soon depleted of fertility. Instead they are often grown in village areas, especially behind kitchen houses, nourished by ashes and refuse (fig. 13).

Fig. 13. *Saukaba*, a plantain type of banana, develops short thick fruits; normally they are eaten cooked. Notice the leaves, torn by torrentuous rainfall.

All types of bananas demand high soil fertility.

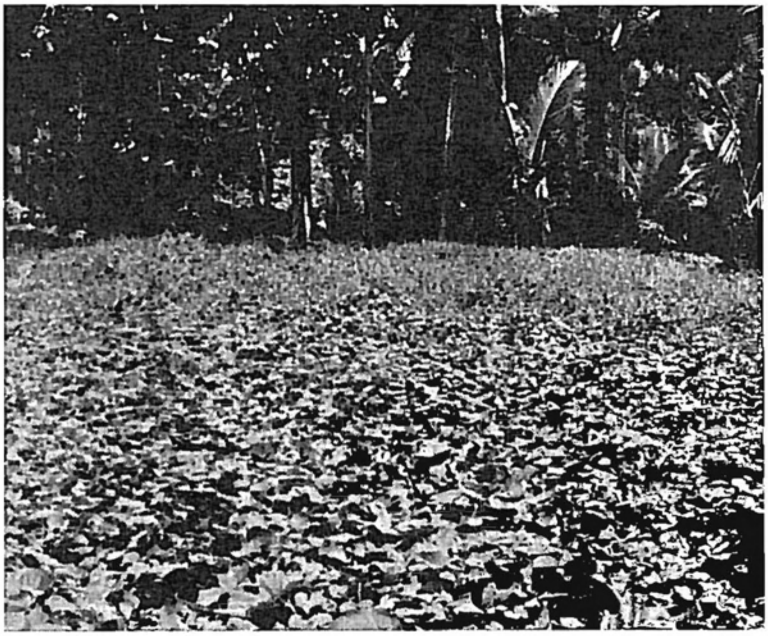


Fig. 14. Sweet Potato or Batate, Ipomoea batatas (L.) Lamk., is a late introduction increasingly cultivated. It develops a uniform cover over the garden area, unlike most other Bellonese crops.

They are seldom cultivated with less than six preceding fallow-years; often bananas are grown only when mature fallow (*bao matu'a*) is available. Such a 'mature' fallow has conspicuous trees that have been growing for at least twelve to fifteen years. For propagation, cuttings are made from the stems (ratoons), or natural suckers are used. Bananas are risky crops; yields fluctuate heavily, but they require little work for their cultivation. From these reasons they are well suited for cultivation in remote plots. They are a popular food but of low keeping qualities; they often fill a gap in seasonal provisions, as they are partly harvested in December–February. The fruits are often attacked by flying foxes.

Among the other crops cultivated, Sweet Potato or Batate, CONVOLVULACEAE is of increasing importance. The sweet potato is a crop of short tradition on Bellona, evidently introduced in the 1880s or 1890s. With more recent additions, there are several cultivated types on Bellona, mainly distinguished by differing tubers, colours, and leaf-forms. Sweet potatoes have low soil fertility requirements. A preceding fallow period of less than three years seems to be sufficient. Often the crop is planted immediately after yams with excellent results, but the regrowth of fallow vegetation seems to be hampered by this practice. Sweet potatoes require direct sunlight and endure prolonged droughts. The gardens are therefore open and bare (fig. 14); all fallow vegetation is cut and burnt before planting. For propagation, parts of vine with a few leaves are cut and stuck into the ground; nearly all will grow. The cost of 'seed' material is thus negligible. Sweet potatoes may be planted at almost any time of the year and harvested about three months later. They require much less work than yams do, but also yield less. The greatest advantage lies probably in the ability to provide food at all times of the year from almost any type of soil that is not too stony and has ample sunshine. Both tubers and leaves are appreciated but, like most Bellonese foods, are perishable.

Another major crop plant on Bellona is the Coconut Palm, Cocos nucifer L., PALMAE. It exists in many varieties on Bellona, most of which develop exceedingly large nuts compared with those of commercially grown palms in almost all of the world (fig. 15). Most Bellonese palms develop the usual high trunks with a crown of feathery leaves; dwarf varieties have only been recently introduced in small quantities. Almost all, if not all, palms have been planted; most grow inland. The palm cannot be vegetatively propagated. A palm takes about five years to start bearing and seems to attain an age of more than eighty years. Most Bellonese palms have been planted after 1947. Coconuts may grow almost everywhere, even in meagre soil, provided it is well-drained. The palm

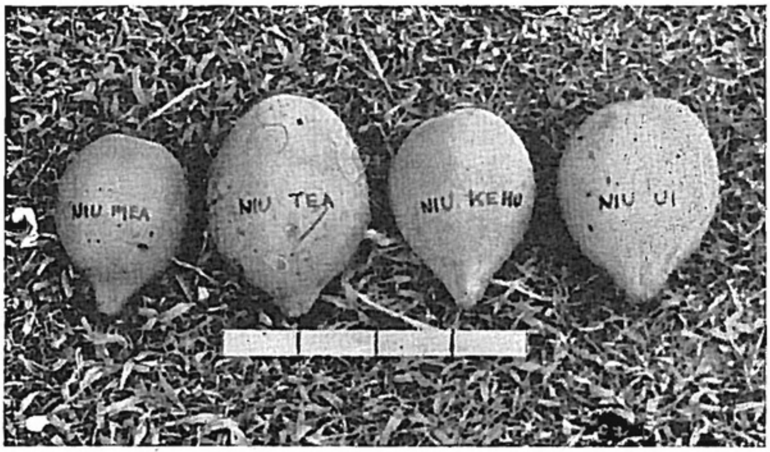


Fig. 15. Some of the most important types of coconuts produced on Rennell and Bellona. Especially *niu tea* and *n. 'ui* grow to enormous dimensions. The yardstick is 40 cm.

requires plenty of sunlight and must be kept free of shade when young. On an average Bellonese palms are estimated to bear between 75 and 100 nuts a year, a normal figure also in the Solomons (fig. 16). There is no special season for harvesting, but unfortunately yields drop sharply after a drought exceeding a few weeks. This is unfortunate as one of the main uses is for drinking. Sometimes hurricanes are very destructive to the palms, but usually they display great resistance to damage by high winds. Bellonese palms are only lightly attacked by the diseases and pests commonly found with coconuts.

Besides the major crops already described at least some minor groups including herbs and trees must be mentioned; they include traditionally cultivated and recently introduced taros and sweet potatoes.

Of traditional cultivation were also Pueraria triloba (Lour.) Makino, a leguminous plant, Amorphophallus campanulatus (Roxb.) Bl., ARACEA, and Tacca leontopetaloides (L.) Kuntze, TACCACEAE. (The two latter plants deliver 'arrowroot' flour.) These plants grow in rather rich soils and as to yields cannot compete with yams. Their tubers are, however, of outstanding keeping qualities; hence they represented a reliable extra supply during scarcities (fig. 17). A recent introduction, Manioc or Cassava, Manihot utilissima Pohl, fits into the same pattern. Its tubers develop in rather poor soils and have even more outstanding keep-

Fig. 16. The Coconut Palm, a plant of thousand uses, develops from 50 to 75 nuts a year. Its importance is seen alone from its use for demarcating rights in land.

Fig. 17. *Soi tea,* Tacca leontopetaloides (L.) O. Kuntze, of former cultivation but now growing wild, is eaten during scarcities.

Fig. 18. Corn, Zea mays L., can be grown on even very stony areas. It is a recent introduction, but has been rapidly accepted though it requires a cultivation technique widely differing from that of the traditional crops.

ing qualities than their traditional counterparts. Still, manioc occupies only a modest position in Bellonese provisions because its taste is disliked.

Among the herbaceous crops traditionally cultivated only a few besides yams were vines. Apparently some cucurbits were cultivated as Cucumis melo L., Canavalia microcarpa (DC) Merr. and evidently Trichosanthes ovigera Bl. None of them were of great importance. Non-vine herbaceous crop plants were of little use; one of the few was the sugar cane, Saccharum officinarium L., GRAMINAE.

The number of herbs cultivated were sharply increased when a Melanesian SDA missionary Gheèla arrived in 1947 as can be seen from appendix B. Some additional herbs were introduced more recently. Almost all the introductions receive little attention. This goes for cucurbits (cucumber, pumpkin, watermelon) for leguminoses (Brown Bean, Soy Bean, Peanut) and some SOLANACEAE (Eggplant, Tomato). Pineapple, Ananas comosus L., is cultivated more seriously, but still on a very small scale. Also corn, Zea mays L. is cultivated and seems to gain in interest, mainly because it will grow on very stony land (fig. 18). Probably the Papaya, Carica papaya L., introduced in the 1880s or 1890s, is still the most successful post-contact introduction. Papaya will grow on almost any type of cleared land with little or no care (fig. 19). It is doubtful if the papaya on Bellona can be termed 'cultivated' at all, since it usually is unintentionally sown; seeds are simply spat on the ground. Similarly great many plants are semicultivated. They are to some degree kept free of weeds and are left when the surrounding bush is cut.

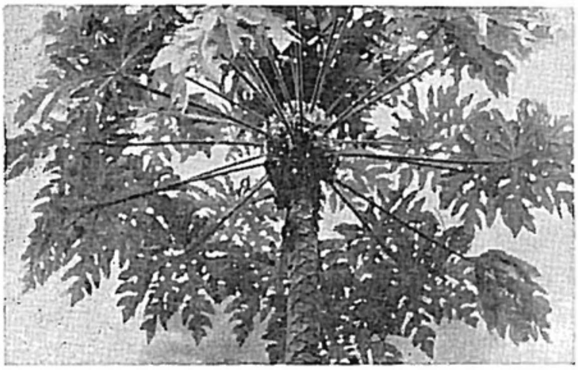


Fig. 19. Papaya or Melon Tree, Cacarica papaya L., is an example of the vast group of semicultivated plants. The *mamiapu* is usually left growing when vegetation is cleared. The photo shows a male plant.

Among the trees and bushes traditionally utilized for food, many are semicultivated in the sense mentioned above. Trees from some of the large tropical families deliver fruits; almost all are eaten raw. Some of the most notable families are briefly mentioned here (details to be found in appendix B-3): ANACARDIACEAE (Mangifera sp. [Mango trees]; Spondias sp. [Tahitian Apple]); APOCYNACEAE (Ochrosia sp.); BARRINGTONIACEAE (Barringtonia sp. ['*banga*']); BURSERACEAE (Canarium and Haplolobus sp. [called *ngali* in the Solomons]); CAESALPINACEAE

Fig. 20. Several kinds of Pandanus are utilized on Bellona. The one shown, *hanga Ngotuma*, is used for thatch and the fibrous fruits (keys) are chewed as a sweet.

(Afzelia sp. [*'isi'*]; MORACEAE (Artocarpus sp. [Breadfruit Tree; fruits eaten baked] and many Ficus spp.); MYRTACEAE (Syzygium spp. [Malay or Mountain Apple]); PANDANACEAE (Pandanus spp. [Screw Pines, fruits are often only chewed (fig. 20)]); RUBIACEAE (Morinda sp. [Indian Mulberry]; SAPOTACEAE (Burckella sp.). Besides these fruits seeds or kernels containing bitter elements were used after extraction with water. After removal of the oily skin the seeds within drupes of BURSERACEAE (Canarium sp., [Canarium Almond] Haplolobus sp.) are edible. Similar treatment was given the acrid seeds of some COMBRETACEAE (Terminalia sp.), CYCADACEAE (Cycas sp. [Malayan Palm-fern]), FLACOURTIACEAE (Xylosma sp.), GNETACEAE (Gnetum sp.), and SAPOTACEAE (Burckella sp.). The number of fruit trees has been increased by recent imports; the most important Papaya has already been mentioned. Nearly all of the RUTACEAE common in the tropics have been imported but lack interest among the Bellonese; (Citrus spp. [Grapefruit, Lemon, Mandarin, Orange, Pomelo]), and also a few others as ANONACEAE (Anona sp. [Soursop]), and BOMBACACEAE (Ceiba pentandra Gaertn. [Kapoke]).

There is no sharp line of division between collected and semicultivated plants. When a plant (of old cultivation) is considered inferior to another of similar use, its cultivation is gradually abolished. Such plants usually do not disappear, but are often found wild, at least in remote places of former cultivation. Traditions of former cultivation remain attached to them. Such information is compiled in appendix D, where an attempt is made to arrange the plants in historical strata to give a picture of a possible development of Bellonese cultivation.

The semicultivated plants, most of which are trees and bushes are the most numerous of the utilized plants. Because of the great number of food plants it is possible to find suitable plants for any type of soil.

An interesting selective principle is fundamental with the semicultivated plants. Every time forests or fallows are turned into gardens the strongest of the usable food trees are left uncut in the places they have invaded and occupied in competition with wild plants. Over centuries a selection along these lines may have sorted out trees capable of yielding heavily in spite of almost total neglect; further, they have sorted out some of the most suitable places for growth. The effects of the principle of selection in semicultivation are similar to those inherent in Bellonese cultivation of garden crops; the selection is efficient even if the 'semicultivators' are unaware of the long-term effects. Possibly semicultivation has played an important part in domestication of plants. Both cultivated and semicultivated plants tend to be put into places suitable for their growth on Bellona; this is important since possibilities of homogenizing the soil are small because of inadequate technology. Also variations in soil thickness and fertility are great enough as to make any homogenization of soil an exasperating work. With this background, distinguishing of a total of more than 250 varieties of food plants is important; the low keeping qualities of much food and the varying seasons for harvesting tend also to turn attention to a large number of food plants instead of concentrating on a few.

2.1.2 Garden types, combination of plants in gardens

Gardens are classified by time of planting. When planted in the main planting season, *launga 'eha* of the local calendar, gardens such as yam gardens are termed *'umanga ghapu*; if planted in the lean season, gardens are termed *'umanga kangakanga*.

Gardens may also be distinguished by plants used. The main types are: yam gardens (*'umanga 'uhi*), taro gardens (*'umanga tango*) and banana gardens (*'ungu huti*); more types with recently introduced crops exist, notably those planted with sweet potato (*'umanga pateto*) or sown with corn, but also smaller patches such as of cabbages or pineapples.

Gardens planted with only one kind of crop (*tanu hange tasi*) are rare. Traditionally prestige is attached to planting such gardens, probably because of the necessity of having a nearly homogeneous planting area and this is difficult to find. Monocrop yam gardens are distinguished by the following terminology:

Planted solely with:	Vernacular name:
Dioscorea alata L. (*'uhi*):	*tanu honga* (lit., planted spread or evenly)
D. esculenta Burk. (*'uhingaba*):	*'uhingaba*
D. nummularia Lamk. (*beetape, suinamo* etc.):	*beetape, suinamo*
D. pentaphylla L. (*boiato*):	*baakingi*
D. bulbifera L. (*abubu*):	*'umanga abubu* or *tu'unganga abubu* (a small *a.*garden)

Generally a single species or monocrop garden is named for its crop; in addition to the exceptions already listed are the taro gardens; they are termed *tango tanu honga* (lit., taro evenly planted). For gardens planted with bananas (*huti*) and Giant Dry-land Taro (*kape*) the term *'umanga* is not applied. The general term for such gardens is *'ungu* (lit., planted in clumps or clusters).

Usually different crops are planted together in gardens. Often such interplanting is called *tanu puupuu*, another term for 'mixed planting', *tanu hingohingo* perhaps additionally indicates an irregular planting pattern. One of the most common interplanted types of *'uhingaba* yam gardens is termed *baatunge*. Only *'uhi* or *beetape* yams may be used for interplanting in such gardens. Interplanting helps to utilize different soils in a garden and has several additional advantages. A mix of plants may grow more efficiently than single species because different species may create a local milieu and exploit it better. Taros and *kape* thrive in subdued light and in a damp environment such as exists below banana plants and give additional yields without much extra work. Because of requirements of plants and of differences in preparation of gardens, mixing of plants is practiced in gardens only in a restricted way. The most common types of interplanting are given below, arranged in order of decreasing fertility demands:

Main crop of garden:	bananas	yams	taro	sweet potatoes
Possible crops for interplanting arranged in order of 'fitness'.	*kape*, taro	taro, *kape*, bananas	bananas	nothing else

Choice of crop to be interplanted depends on milieu of the main crop, and also on the time needed for full development. *Kape* goes well within a banana garden because both *kape* and bananas take two years to mature, whereas taro develops in three to five months; hence taro is harvested at a stage when the bananas require little space. For the same reason taro is excellent as a mixture in yam gardens, especially in dark corners. *Kape* is usable because it is still small when the yams are harvested, after that it may take the area over alone. When yams are planted in an area where big trees are left over in a burnt state, even bananas are suitable as an intercrop because they develop a year after the yams have been harvested; the garden is then a wilderness of regrowing trees. It is difficult in a taro garden to interplant anything when it has been made from a young fallow area, as it usually is. If taros are planted below larger trees, bananas are suitable for interplanting, but yams can hardly be planted because the fallow has not been burnt. Sometimes an area fertile enough to be planted with bananas is used for a taro garden because of a need for extra supplies within a short period. In such gardens an interplanting with bananas is often seen. The low fertility and different microclimatic conditions of sweet potato gardens make them useless for interplanting with traditional crops. Now and then coconuts are planted in such gardens to save the young palms from competition from a vigorous wild fallow regrowth.

If analysed on a subspecies/variety level of taxonomy, most banana and yam gardens may be perceived as 'mixed-planted'. Some yam gardens were examined, and it was found that gardens termed *'umanga beetape* (*beetape* yam gardens) in fact contained less than 20 per cent *beetape* yams. Diversity within yam gardens is normally quite high, mainly because the areas are too heterogeneous to be planted thoroughly with one crop, sometimes also because too few seed yams have been available. In taro gardens this problem is small; homogeneity is generally high in this type of gardens. Very often all taros in a garden are of the same kind (most commonly the *tango ngeka* variety of taro). Other crops may be grown with perennial crops only when they are young. Coconut groves (*kiu*), and pandanus groves (*maalu*), are hence normally monocrop areas.

The traditional principles involved in combining plants to form a garden tend to lead a Bellonese gardener to make his gardens similar to natural ecosystems found in clearings of the forest. In some parts of the world (as Sudan; see de Schlippe 1956) development of gardens into multistoried, multi-niched ecosystems has achieved more refinement, possibly because of greater variety of available plant material. The constant interest in new plants of potentials for cultivation may lead the Bellonese to further future development along the inherent lines.

2.1.3 Planting patterns within garden types

Distribution of plants within areas prepared for gardening follows one of two systems: a regular one or a more haphazard one. Regular planting is controlled by the dividing (*tohitohi*) of the garden area into garden sections (*potu*), established according to soil fertility. Irregular gardens have no such divisions; they are 'planted everywhere' (*tanu katoâ*); this does not mean however, that rules of planting are not observed.

In fact simple rules of distribution govern all Bellonese planting, whether gardens are *tohitohi* or *tanu katoa*. These rules are of interest when determining yields.

When interviewed the Bellonese claimed that in a homogeneous garden area they aimed at planting 'with regular intervals, the plants standing in lines'. Such gardens may be arranged in several ways. A quadrangular system was proposed as a solution by the author (see fig. 21 a), but this was firmly rejected as not 'the way of Bellona here'. That pattern is only used when planting coconut groves. A hexagonal or triangular system (fig. 21 b), was without hesitation claimed to be 'right way of planting'. Theoretical knowledge of geometry is almost totally absent among the Bellonese. The pattern can therefore not have been calculated, so one has to explain this most

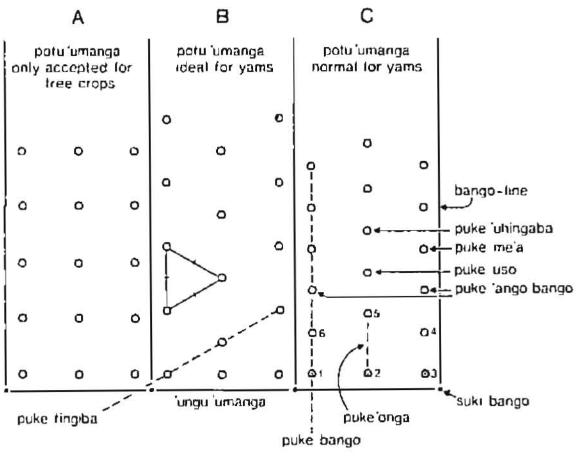


Fig. 21. Planting patterns on Bellona. Pattern A is not materialized in gardens with annual crops. The idea in pattern B was accepted by some informants, but is probably never used. Pattern C is commonly seen. Numbers indicate order of planting. Regularity of pattern is maintained while planting by keeping *puke bango* and *p. tingiba* straight. An alternative pattern (not shown) displays plants aligned in twos and threes athwarth the seed bed, *potu 'umanga.*

rational distribution of plants to practical experience alone. In practice the hexagonal pattern is often barely recognizable. It is probably too inflexible to use, and is certainly very hard to mark off in the field. Instead plants are placed as shown in fig. 21 c. The 'planting hills' (*puke me'a*) are dug successively as indicated by the numbers. The Bellonese constantly check that the plants are parallel to the division lines between garden parts if such are present or are at right angles to the garden front, and at the same time in oblique rows (*tingiba*). If the distances between *puke me'a* are kept constant, these practices will result in a regular hexagonal pattern. If distances are at variance (produced by irregularities in the ground), the impression of regularity will be very little affected. This planting method seems thus to ensure regularity, as long as the site is homogeneous enough, and at the same time to fullfil aesthetic requirements. Further these planting practices result in economical land use; distances between plants may be varied according to soil fertility, with little land wasted.

If this theory of economy in land use seems to contradict the fact that land lies fallow for several years, it must be remembered that the Bellonese have no real substitute for the fallowing technique to restore soil fertility. The value of land ready for planting after a long fallow is accordingly high

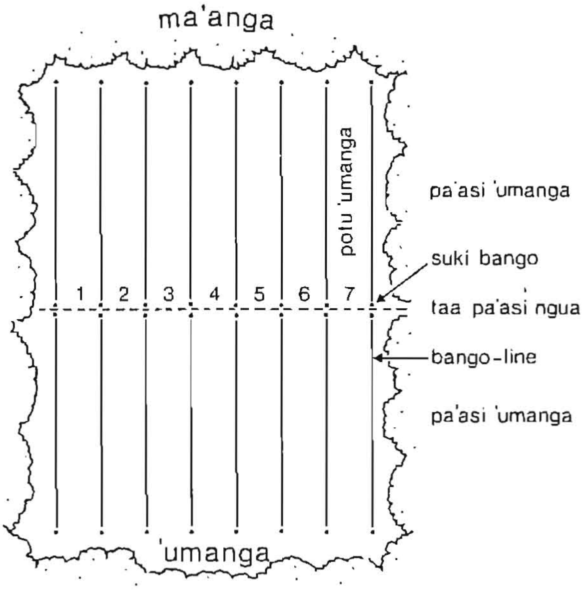


Fig. 22. Divisions of a large garden as sometimes seen on Bellona. On Rennell large gardens are frequently made; they are often planted in a more complicated pattern than shown here.

enough to promote economical handling. Land value rests primarily on productivity of land. The distribution of plants in gardens as described above is best suited to the divided gardens (*'umanga tohitohi*), but most gardens are, in fact, planted according to similar rules. The system of divisions however, serves other more important purposes than acting as a guideline for the distribution of plants over an area.

Although mainly based on oral information and few direct observations a plan of a slightly more intricately divided garden area (*'umanga tohinga*), is shown in fig. 22. Nowadays such gardens are commonly seen on Rennell; similar small arrangements may be seen occasionally on Bellona. They were previously seen more often when larger garden areas were cultivated, but nowadays the tradition for such mainly survive on Rennell. This may be due to the concentration of property on fewer landed 'big men' (*hakahua*) on Rennell, although the damper soils on Rennell also favour larger clearings.

The garden in fig. 22 was divided into five parts, but the number of divisions varies. The middle part (*uso 'umanga*) was cultivated by the owner of the garden, the other divisions (*tohinga*) by relatives or friends. Each of the divisions was further divided into parts (*pa'asi*), equalling the Bellonese *potu*.

The boundary lines used in garden division either run parallel to the long axis of the individual seedbeds or orthogonally to them and are distinctly termed accordingly. An elaborate arrangement similar to that of the large Rennellese gardens is found in many Melanesian islands. The arrangement as seen in the Rennellese 'big gardens' (*hu'ai'umanga*) shows similarities with that demonstrated by B. Malinowski (1935) in Kiriwina (cf fig. 22, with Malinowski's fig. 4, p. 89). Possibly this indicates a forgotten cultural connection between Rennell and Bellona and Melanesia, also supported by the great importance of yams. Both features seem to be unusual in the parts of Polynesia closest to Rennell and Bellona: Tikopia, Sikaiana, Ongtong Jawa, Samoa.

2.1.4 Gardening procedures

(*sanga 'umanga*)

For convenience the making of one type of garden – an *'uhi/'uhingaba* yam garden (*baatunge*), – is dealt with first. Afterwards a comparison will be made with other types of gardens.

The making of a garden starts with the planting season which is determined, at least partly, by the local moon calendar (see paragraph 2.1.6). For yams, planting usually begins in 'May' and 'June' the early planting season (*launga mu'a*), although they also belong to the yam harvest period (*ghapu*). Apart from astronomical indications, the time of planting is marked by the arrival of the Pacific Golden Plover (*sibiu*), a migrating bird not nesting on Bellona.

The search for a garden area (*lingo*)

If land is available on the would-be planter's own property he starts looking (*lingo*) for a suitable place. If the presumptive planter has no land himself, he must ask for permission to use another's land. Such a permission is readily given by relatives, the easier the closer the relationship. The most important factor indicating that an area is in a suitable state for new cultivation, is a certain minimum height of fallow vegetation of normal composition, together with a reasonably stoneless soil. A fallow which has reached a stage where it is well overgrown with high trees (*tangutangu matu'a*) is developed about five years after the last harvest (*tangipou ngimanga ghapu*). It is usable for making a *'uhi/'uhingaba* garden. A slightly less mature stage, overgrown but without large trees, (*tangu-tangu moto*), is usually reached a year before, but it is considered bad management to use such a fallow for *baatunge* gardens. On the other hand, older and better developed fallows are preferred if available, unless they have been set aside for planting of banana gardens (*'ungu huti*). When too stony (*hatuhatu*), an area is avoided, even if the vegetation is well developed. Also a soil too compact is deemed less desirable. This is tested by pulling *sungu* plants (an unidentified small tree with white flowers); if this is hard to pull up, the ground should be avoided. The quality of fallow vegetation (the most important indication of suitability) is, judged more from the volume of vegetation than from its composition, as long as the composition appears normal. Composition of fallow vegetation will be discussed later, so here only the two most predominant species in a 'good' fallaw vegetation will be mentioned: *hau* (Hibiscus tiliaceus L.) and *ngaupata* (Maccaranga tanarius Muell. Arg.). The *ghali* (Breynia cernua Muell. Arg.) is said to spoil gardens. All species are fast growing trees, quick-maturing and with low requirements in regard to soil fertility. These plants must have reached a height, exceeding about 3–4 fathoms, and their trunks must be thicker than a man's thigh before the fallow can be considered mature. If in addition to this, specific indicators of fertility like the *tii* plant (Cordyline terminalis Kunth) are found, the man looking for a garden site is convinced of the area's suitability. On the other hand he will probably take a careful second look at the land if he should find *nguna* plants (Morinda citrifolia L.). Usually it is hard even for the expert gardener to specify any single feature indicating a 'good' area: he assures himself of its fertility by observing its overall appearance. When a place has been found, it is usually *tukumaka* or *sangosango* i.e. reserved as by leaning a branch against a tree in the front of the area or by starting cut the bush.

Measuring of the garden (*ngangaha*)

Assuming the right to use the area has been obtained if necessary, the gardener now goes to 'measure' (*ngangaha*) the area for his garden.

The foremost idea implied in this action of measuring is not merely to determine the size of the future garden, but also to mark off its position in the forest. Often this is determined by the shape of the existing fallow; the garden is usually placed within a fallow area (*ma'anga*) of homogenous appearance making the form of the new garden a replica of a former one (except perhaps of a somewhat smaller size). If an entirely new garden is to be established, first taking of land (*toghi*) is said to take place. In these rare cases the rules for the orientation of a garden can be seen. Generally a garden is rectangular and is placed with its greatest extent at right angles to a trail to the sea (*anga ki tai*), or parallel to the permanent trail (*anga tu'u*), or – which means the same – parallel to one of the side trails (*anga baasi'a*), which in turn runs nearly parallel to the main trail either to the north or south of it. (See maps of land utilization, pl. 2 to 5.) The Bellonese explain that this is the correct way to place a garden 'because of the sunlight'. One advantage of this orientation of the gardens is that only small areas are wasted and shaded, and future gardens may keep a regular form. Further the orientation fits into Bellonese pattern of landholding since properties usually comprise strips of land (*huka*) from the main trail to the coast, nearly parallel to the trails to the sea. (This is a very widespread type.)

The factors regulating the size of planted areas are not as yet fully analysed. On the basis of collected information it seems that the areas for yam gardens are determined every year by the population then present in the following simple way: every grown-up male (*matu'a*) will plant about two *potu* (basic unit of garden measure) per adult and one per child in his household. However, when the number of persons present in the household changes, this is not a serious problem, since the gardener easily can add more *potu* to his gardens, which are often measured off rather generously. (The problem with other gardens is not so pressing, because they mature in 3–6 months, against 6–9 months and up to 2 years for banana/*kape* gardens.)

It is difficult to establish a standard size for Bellonese gardens in spite of their regular formation. The difficulty arises from the fact that a *potu* is not a fixed area. A *potu* for *'uhi* and *'uhingaba* yams is usually about 20 paces long (approx. 16 m.), and this does not vary much, since 'standard' walking paces are used (any trained surveyor will know how measuring by pacing can give amazingly reliable results). The width of the *potu* is also measured by pacing (*ngakangaka*), but here the standard is intentionally varied: if the soil is good, paces are made small, if poor (thin), paces are made longer. These decisions concerning the quality of the soil make possible a normal development of the planted crop and thus indirectly ensure smaller variations in the yields of the garden units.

From the above description, it should not be deduced that all Bellonese gardens are cultivated according to a rigid plan of food production. It must be emphasized that gardens are often made for another important side of Bellonese life: great communal feasts. Every year gardens (especially *baatunge* or *beetape* yam gardens) are set aside to be harvested for the celebration of some important events as New Year, marriages . . . Several of this kind were pointed out with pride to the author in 1965 and 1966. Communal celebrations are important for the Bellonese and it is felt to be an unbearable shame if one is unable to provide something on such occasions. (T. Monberg and the author have witnessed such rare instances.)

A typical garden will be from 5–12 *potu* and thus occupy an area of 16 m. by about 20–60 m., the area varying with soil quality.

When the garden's position and size have been finally determined, the gardener cuts small footpaths (if none are already present) along the front of the garden (*'ungu 'umanga*) and along the two sides (*taha*) as well. The back (*tu'a 'umanga*) is less clearly marked, if marked at all; this is unnecessary because of the recognized standard length of the *potu*. Whereas the reconnaissance (*lingo*) may take a long time, measuring off (*ngangaha*) takes less than one working day even for a gardener working alone.

Clearing of gardens (*bonga*)

When it appears that the weather will remain dry for some time, the brushing (*bonga*) is started. This is usually done only by men, who use bushknives (*kiba*) and axes (*'aakisi*) with great energy. Normally it takes about one day. The man starts from the permanent trail or from a side trail side of the garden cutting down most shrubs and small trees. However, those trees which are located in suitable places for use as climbing poles for yams are often left standing, although they are cut to about a man's height. Though rare on Bellona, yam garden areas have been observed in which everything was brushed (*sungi*), or cleared (*saungatia*). In one case this was said to be because more 'old-fashioned' Rennellese help was used, but it is, beyond doubt, an accepted procedure on Bellona too, especially when yam types with less vigorous growth are planted. In such cases tripod-like stakes (*beeghai*) are used, as is often the case with *'uhingaba*. Larger trees are left standing in the normal *bonga*-operation, or more often, cut down in a presumptive garden area a year ahead to have time to dry or rot, which eases the cutting up. Helpers, usually men, receive a fine meal as a reward for their work (*'oso hekau*).

Preparation of seed material (*tapasi, hakapungapunga*)

When the brushing has been done, the gardener starts preparing his seed yams (*pungapunga*). Formerly they were kept in a special yam house (*hange baka*, lit. canoe house). In modern times the use of a special small house has been almost totally given up and an unoccupied living house (*hange ti'aki*) is used instead. This makes no difference, except for aesthetic reasons, as the modern houses, built on poles, are airy and dark enough to keep the yams intact and to allow them to sprout without damage. Instead of using a sprouting house, tubers are sometimes planted in homesteads or gardens to sprout. Such tubers are called *lapenga*. Small tubers or, when only large ones are available (as from the single-tubered yam types), cut-off tuber ends with 'eyes' enough to ensure sprouting, are used for *pungapunga*. These pieces are prepared by cutting with clean knives, after which the usable piece is left to regenerate its surface for about two weeks. *Tapasi* is the name for such prepared pieces. The Bellonese are careful not to waste food unnecessarily by using too large pieces for *pungapunga;* with yam types developing bulbils, these are usually preferred to cuttings. It is very important that a careful selection of yams be made to ensure that yams with the desired genetical properties will be propagated. If an attack of sickness had been experienced among only a small group, an old practice was to burn all the foliage and tubers of the seed yams, since it was believed that they could have been the cause. Seed yams are ready for use when they have developed sprouts of about half a metre in length. If a gardener has not enough seed yams or he wishes to use different stock for a particular soil, he exchanges seed yams usually with kinsmen. A gift of seed yams has been observed quite often. Seed yams are sometimes kept in the usual plaited coconut-leaf baskets (*kete*), and always carried in them. Their transport to the planting area must await the completion of seed-bed preparations to avoid damaging the seed yams.

Drying of a garden (*maamala*)

The drying of the woody material of the cut garden is one phase causing much trouble in garden-making. Usually it takes from a few days up to one month depending on the weather. Though the Bellonese can light a fire even with very wet wood, they prefer to wait until the cut material is reasonably dry, otherwise they say the work of firing will be too tiring and the results unsatisfactory. Between July and the end of August drying is usually completed. When sufficiently dry the material is dragged together (*ase*) into small heaps.

Burning (*baakani*)

Burning is usually the next operation. Generally two purposes are fulfilled by burning. Firstly, fires' killing action is of great importance. The remaining trees are killed by firing a pile of twigs and cut branches at the base of their trunks. Further the weed-killing action of fire should not be overlooked. Some anthropologists have maintained that the most important aspect of burning is the weed-killing action. From Bellonese experience it is clear that burnt fields are almost weedless for a long time, but it is not quite clear if this is solely the result of burning. From observations of Bellonese gardens it is evident that burnt fields are clean from weeds for a long time, but so are unburnt fields. After a couple of months, however, it seems that the growth of weeds is most vigorous in an unburnt area. The explanation is probably that the development of weeds after clearing of an area takes some time; in a burnt area, further, most of the weed seeds have been killed by the fire, meaning that a growth of weeds depends on invasions from nearby areas. Some few weeds seem to increase their competitiveness after burning; it appears that the wild *soi* yam (Dioscorea bulbifera L.) grows vigorously in burnt areas. This lends support to the hypothesis that yam-gardening was 'naturally developed' from a practice of clearing forests by fire for other purposes. (See appendix D.)

Fig. 23. Women killing trees by fire. Only *pateto* and *koni* gardens are burnt totally. In this yam garden the trees are left standing in order to yield support and shade for the growing crop. A rich mulch of dead leaves covers the soil, preventing dessiccation and extreme soil temperatures.

In the works of Nye and Greenland (1960) and of others, the value of releasing the nutritious material stored in fallow regrowth for the new crops, by the use of fire, has been demonstrated. (In chapter 5.3 this point is further dealt with.) Since garden yields would be drastically reduced without this burning operation, it may be fairly judged that ash production during the firing of gardens is the most important aspect of the operation. However, this does not preclude the benefit of fire for weed control and tree-killing. In Bellonese gardening tree-killing and weed-killing are separate operations. When the trees have been killed, the many small heaps of wood spread over the garden area are fired (*lunu*). When burning is finished, the owner of the garden gives again a meal of reward for his helpers, who are usually predominantly women in this operation. Practically all of the firing is done by women (fig. 23); the men's part of the work is usually splitting firewood (*baakai*) and, sometimes, to burn out the big trees. The burning operation takes from one day to a week, depending on the manpower available, the size and age of the fallow, and the drying weather. It requires a good deal of knowledge to burn a garden properly. In European eyes the most serious difficulty is to get the firewood to burn initially, but the delicacy of the job is really to tend the fires so they are kept burning, and in the proper way. This means that the fire must be neither too intense (damaging the soil), nor too weak. If the latter is the case, the soil is left black with too much charcoal and unburnt wood. On the contrary, the well-burnt garden has a greyish-white colour with ashes in the proper places, and with all the remaining large trees dead. The withering leaves of these trees are very important as providers of fertilizing material and as a soil cover to prevent too rapid evaporation in the coming months. Usually the Bellonese get good results from their burning, but it takes varying amounts of work. The skilled people, taking advantage of the wind, will start from the windward, which makes it look as though the work goes by itself. Learners have a hard time, their fires tend to go out. (The author's shirt burnt before the firewood!). After the burning the subsequent stages in garden work are rushed. The weather is anxiously watched. Rain is a constant menace. Heavy showers are said to reduce garden yields by as much as half. A prolonged period of rain may make the area unusable for yams, and thus suited only for taro, if for anything at all.

Dividing of the garden (*tohitohi te 'umanga)*

If not done before burning, as is sometimes the case, dividing is now performed. *Tohitohi,* or *tohinga,* requires very little labour; it is usually done by the planter alone because it is considered important. The first act is to place small sticks (*puke*) at intervals of about three paces along the path closest to the main trail. As mentioned before, the art of *tohitohi* is to choose the correct intervals. The planter must have a sharp eye to analyse his garden area. In fig. 24 it can be observed how intervals between *puke* vary, evidently determined by changes in soil depth and the occurrence of large trees. With good soil (*kenge nga'u*), two large steps (*ngaka ngua*) are spacing enough, but three (*ngaka tongu*), or even four (*ngaka haa*) large steps are seen in infertile soil. When the widths of the divisions have been decided the next action is to mark off the divisions by stretching vines (*hakatenge bango*) along the ground at right angles to the front path from the *puke* sticks. For this purpose rattan cane (*bae ue*) or some other suitable bush vine is used. Care is taken that the lines are visible and neatly arranged. The divisions are referred to by counting from the corner next to the most important trail or from the east. To aid rapid identification every tenth marking stick has a small additional stick. To the Bellonese a well made

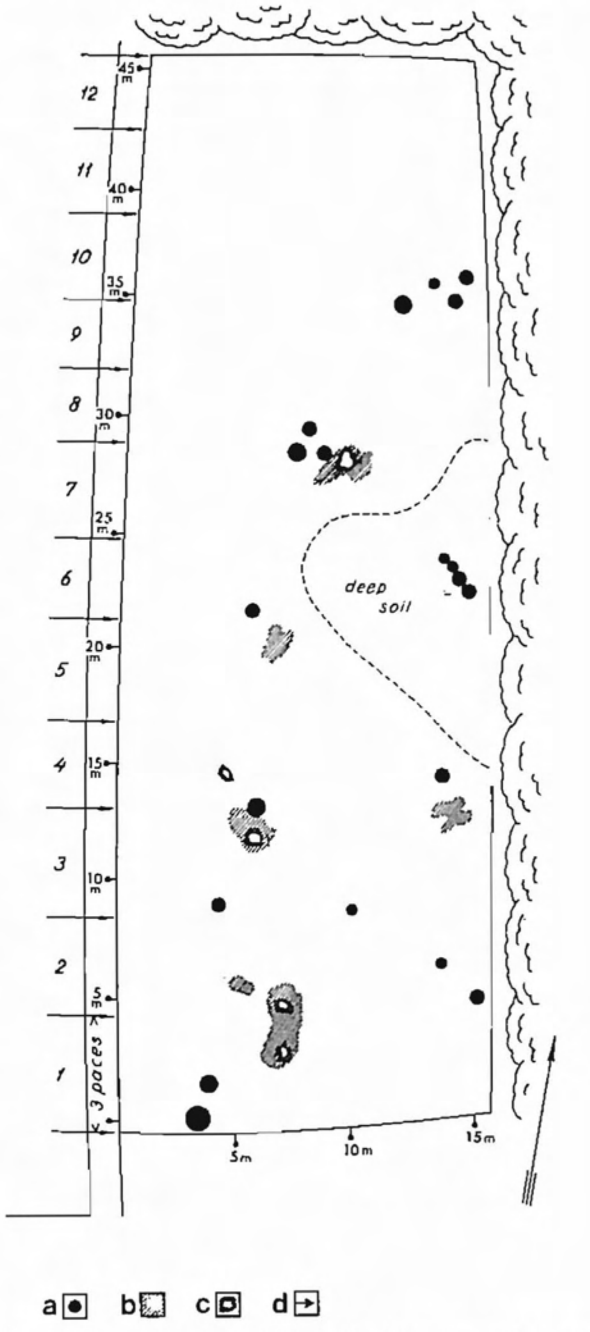


Fig. 24. A garden area behind Ngotokanaba, cultivated 1966. Explanation of symbols: a: Killed tree. b: Shallow soil. c: Rock outcrop. d: Limit of garden division. The width of the seed beds is seen to vary according to soil quality. The same garden is shown in figs. 27a and 28.

Fig. 25. A divided garden. The *bango* lines are marked by vines, and the neatly dug yam hills, *puke mea*, are ready for planting.

garden at this stage is considered beautiful (fig. 25) and full of promise.

The purposes of dividing the gardens, are multiple. Social and religious aspects are beyond doubt significant. From a materialistic point of view the dividing of the garden is also important because it facilitates a rapid completion of the next stage in the garden work; the success of the whole garden enterprise depends on speed. Great anxiety because of the unpredictability of the weather and great expectations concerning the digging of the garden fill the mind of the gardener, who often spends a restless night after the dividing. The gardener has sent word to his relatives and friends (*'api*), that he is going to dig his garden of so many *potu* at such and such a place the next day. Most of the people involved have heard by rumours already and are anxious to be asked to join. The gardener's wife and other women of his household have also been busy collecting food and preparing for the rewarding meal of the next day.

The digging of the garden (*nganga te 'umanga*)

Digging is performed in less than half a day (almost without exceptions). The garden workers (*kano hekau*) gather very early in the morning, while it is still cool. When a man of prestige (*hakahua*) is digging his garden a huge crowd may gather, including people only distantly related to the *hakahua* to whom they will probably pay their homage by offering their help. It is usually gladly received, largely because it adds very much to the *hakahua*'s prestige to have many helpers; it also adds to his obligations. Many of the people coming to help (*'aabaki hekau*) bring digging sticks or dibbles (*koso*) with them. If not, they hastily cut new ones of suitable hardwood, often *manguka* or *malanga* from the nearby bush. These useful implements look very coarse, but in fact their utility stems from the selection of the right material rather than from elaborate cutting. Often the end of the stick is pointed and the bark is removed. With the digging stick, the planting hills for the yams (*puke me'a*) are dug. A properly dug hill is about two feet in diameter and formed like a flat dome up to one foot in height. Recently there has been a tendency to make the seed hills smaller – 'everything is less well done nowadays' as an elderly gentleman remarked. Everybody is greatly concerned that the *puke me'a* are well dug. The digging stick is used with great force, driven deeply into the ground, and afterwards used like a crowbar to break the strong network of roots found in every inch of Bellonese soil (fig. 26). Comments on the work are shouted while the people are digging. 'Plenty of stones here' (*e hatuhatua te kunga nei!*) – 'This soil is good smelling' (*ngaoi te sa'ango o the kenge nei!*) Besides its use as a crowbar, the digging stick is used as a probe. The thickness of soil determines the type of yam that can be planted. *'Uhi* yams with their single, often deep-going tuber demand a soil thickness sometimes exceeding a full m. (three feet). When a yam hill with this soil depth has been completed it is marked by putting a small stick into it (*suki te puke 'uhi*). No such marking is made for *'uhingaba* yams.

Fig. 26. Use of the digging stick, *koso*. Here the web of roots is broken by using the stick as a crow-bar. Note the position of the gardener's hands. The digging stick is also used for estimating soil thickness, but rarely for turning soil as with a spade.

The digging of the *puke me'a* proceeds in a very orderly fashion. From the previous fig. 21 the order may be seen: first the front row (*'atu puke*) is dug, then the yam hill next to the *bango*-lines (*puke 'ango bango*); then the middle hill in front (*puke tingiba*). When interplanting is planned, places 'in between' (*puke 'onga*) are dug. The outside poles (*puke taha*), and the *bango*-lines are always sighted as the digging proceeds. The distances between the mid-row hills (*'ango la'a*) are always regulated to guarantee the individual plant the best opportunities for its proper development.

The result of the digging of our sample garden is shown in fig. 27. It is seen that planting distances vary, and that some of the variations probably are determined by the distribution of soil depth and of remaining trees. In larger gardens, especially on Rennell, the middle part of a garden (*'uso 'umanga*) is dug by the gardener himself; this is completed first. Afterwards the other parts (*pa'asi*) are dug.

Great speed and energy are displayed during the digging; small competitions take place between the men. Sometimes a digging stick breaks, and the pieces are thrown away with laughter ('too weak for a strong man'). The yam hills are commented upon, sometimes jokingly. Most commonly the work is fast and well done. Often it is finished by ten o'clock; then the food rewards are given, and the drinking nuts (*polo*) handed out are especially appreciated. The festivity of garden work is important for all Bellonese.

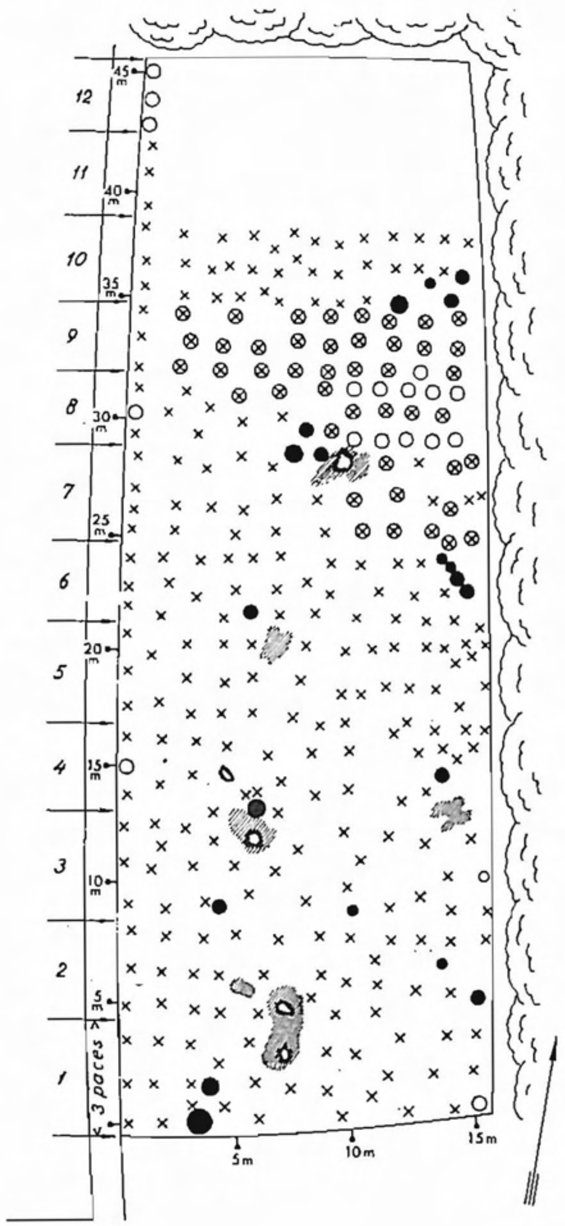
Sometimes the next phase of work is carried out on the same day as the digging, but usually this and the next procedures are carried out together, after a short rest.

Carrying of seed material (*to'o pungapunga*)

The seed material from the sprouting house is carried by the gardener, sometimes assisted by his wife. Because of the long sprouts, which at this stage are quite tender, the seed yams must be handled very carefully. The best time for the carrying is the early morning, while the dew is still present. Direct sun and desiccation are quite harmful to the young sprouts.

Planting (*ngongomi, sanga*)

The 'putting in' of the yams is usually done by the gardener. Women were not seen assisting in *ngongomi,* except where they had been responsible for the whole garden work, which sometimes happens. Very much depends on the planter's skill in deciding how to distribute his seed tubers properly over the area. There is a tendency, when *'uhingaba* yams are interplanted with *'uhi* yams (*baatunge*), to put *'uhingaba* yams in the more open parts of the area, and to reserve the dead trees for the big *'uhi* types. As seen from our sample garden (fig. 28), which is slightly more complicated than a typical *baatunge* garden, but shows the details better, *beetape* yams are planted under the same conditions as *'uhingaba.* The *'uhi* yams ar usually more demanding, thus best suited to places with deep soil, which is often where trees have reached spectacular heights. This is quite



a b c d e f g

Fig. 27a. Digging of the garden area shown in fig. 24. Explanation of symbols: a, b, c, and d: see fig. 24. e: Planted yam hill. f: Yam hill, not yet planted. g: Planted yam hill, crop unidentified. The density of yam hills is largely dependent on the presence of dead trees and/or deep soil; the planting pattern is constantly modified to suit local conditions.

convenient, as the falling leaves of these now dead trees provide nutriment and the trees themselves

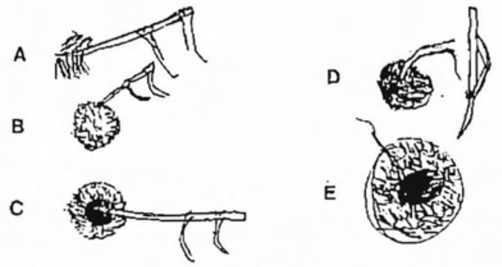


Fig. 27b. Planting a yam hill, *puke me'a*. Sketch by Sengeika Tepuke.

a) Breaking the roots (*lingibonga*).
b) Preparing the peripheri (*sua*).
c) Deepening the centre (*nganga*).
d) Removing small stones (*'au 'au na bianaku*).
e) The planted yam hill with its long sprout (*ngongomi*).

can be used as climbing poles for the luxuriant foliage of the yams. In Sa'omoana's garden, illustrated, the *beetape, 'uhingaba,* and *'uhi* yams were planted first, in the order mentioned. Afterwards bananas, taro, and *kape* (Giant Dry-land Taro) were implanted. The term 'implanted' is proper here, as these last plants are often – as in this garden – planted *puupuu* (inserted) between the regular planting spots. Section 9 was planted last – some days later – and the seed yams were not observed by the author; probably they were nearly all *'uhingaba* yams because of the rather shallow soil on this site (see fig. 29). Section 10 was used mainly for taro and was planted about a week later than the rest. Sa'omoana explained that taro had been chosen, because all the yams he needed were now planted (Sa'omoana had several gardens) and because this place was damp enough for them. Section 11 was to be planted with taro too, but he was not sure whether he would plant section 12; he believed it would possibly be too leached at that time.

The concentration of varying kinds of yams in the deep-soiled part of the garden is conspicuous. Sa'omoana stated that such places were good for the development of the tubers of *abubu* yams (Dioscorea bulbifera L.), which are also seen growing around big trees near the village. A wealth of rules governs the planting. One-tubered yam types (some with giant tubers) are, within certain species, planted one at a time (*tanu tasi*), while others are planted in pairs (*tanu ngua*). Some of the red yams known to develop rather weak vines are always planted together with a 'normal' yam to gain support. In case the sensitive

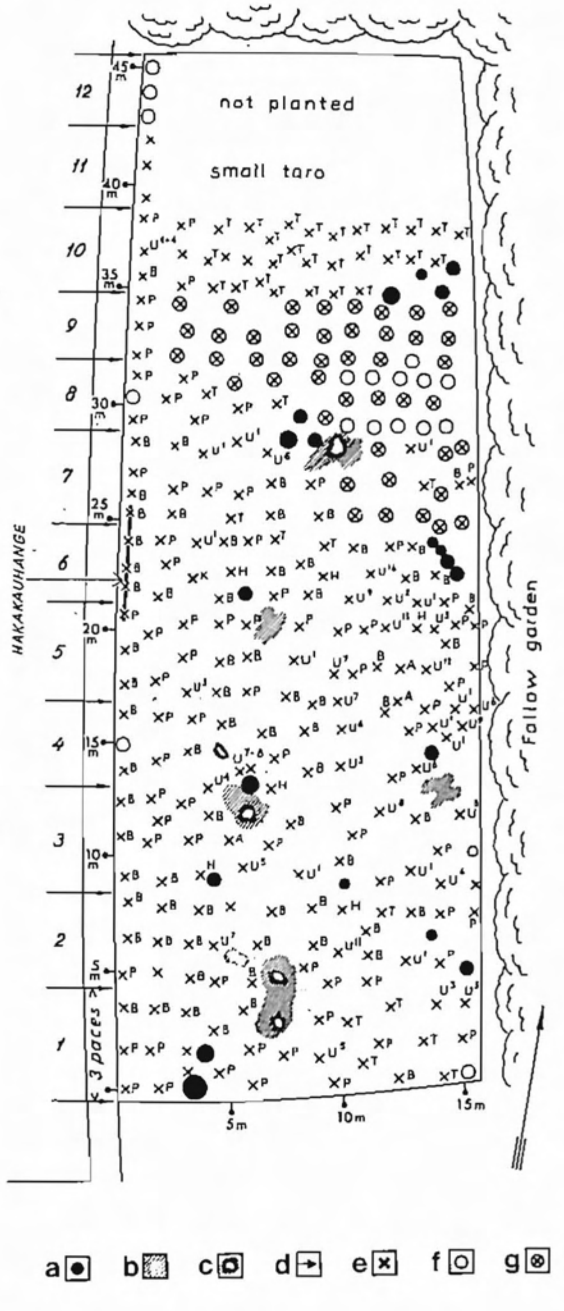


Fig. 28. Planting of the garden area shown in figs. 24 and 27a. Explanation of symbols: see fig. 27a. To utilize the area fully, a variety of plants has been used for planting this garden: B = *beetape* (type of D. alata or D. nummularia), P = *'uhingaba* (D. esculenta), U = *'uhi* (D. alata types except u^{12}) thus: U^1 = *moana*, U^2 = *'uhi a Timothy*, U^3 = *'uhi a Panoa*, U^4 = *'uhi mea*, U^5 = *kakenuku*, U^6 = *singasinga*, U^7 = *bootebo*, U^8 = *'uhi a Keiai*, U^9 = *tua*, U^{10} = *'uhi Kenga*, U^{11} = *'uhilangi*, U^{12} = *kumala* (a D. esculenta), U^{13} = *suitongo*, U^{14} = *'uhi too*, U^{15} = *pangighisu*, U^{16} = *'uhi a Temasi*. A = *abubu* (D. bulbifera), T = *tango* (Colocasia esculenta), K = *kape* (Alocasia macrorhiza), H = *huti*, esp. *baebae 'ungi* (a kind of banana).

red yam does not grow, a good spot is not wasted. Red yams are possibly planted because they are considered more tasty than the normal big yams, which are rather coarse. Yams are usually planted with the long axis of the tubers horizontal, but with some kinds this is said to be disastrous (the *tua* type of yam has to be planted vertically with the upper green end of the tuber visible.) *Boiato* yams are usually propagated by bulbils. Planting of such is called *hinginga.*

In the planting operation the digging stick is again used. Its importance in this operation should not be stressed, however. The planter's hands alone play the greater role. When the soil is mixed with pebbles these are sorted out to a depth of a full arm's length by means of the hands alone. Also roots are removed (*'au'au na bianaku*). For the proper development of tubers a loose soil without sharp coral fragments is aimed at. Gardener's hands are hence constantly soiled in the planting season and their finger nails are worn down.

When the weather is right – alternating sun and rain (*toota'ebasa*) – the development of the plants (*tupu me'a*) from the mother tubers (*langa me'a*) is quite fast. At the time of planting the seed yams have attained various lengths of sprouts; sound sprouts (*kaahaki*) have long live sprouts (fig. 30). A week after planting the sprout is visible above ground level. The garden is soon sprouting everywhere (*maalubu*). Then the time is ripe for further garden work, which must be done about the time when the shoot begins to twine (*hakangabu*).

To ensure high yields the heavy yam vines need support. If they are left unsupported, the vines creep along the ground (*seseke*), they get too little development and cannot utilize the sunlight properly. Different supporting arrangements are used (see fig. 31).

The simplest way to solve the problem of support is to leave convenient trees uncut in the garden area. They may be damaged or killed by burning to avoid undesirable competition to the crop. Usually the natural spacing of trees is not uniform enough for this purpose, however. When the soil is deep, poles are driven into the ground besides the yam hill. Such poles (*bongoghai*) may be taken

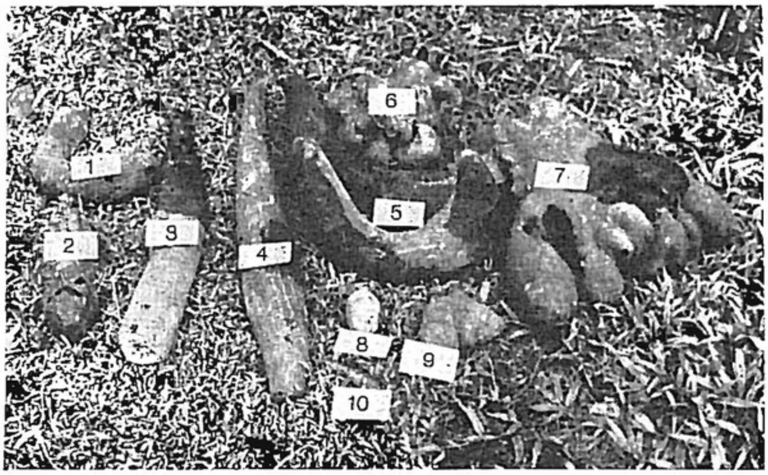


Fig. 29. Yam tubers (rhizomes) arranged to show variation of forms and size. The small types, ball-shaped or curved can be utilized even in shallow soils whereas the giant or pole-like types require deep and loose ground. The kinds of yams displayed are: 1) *singasinga*, 2) *tua sanga*, 3) *'uhi matapoko*, 4) *tua kau ngoa*, 5) *kakenuku*, 6) *'uhi a Keisaea*, 7) *'uhi a Pana*, 8) *'uhingaba mai Laapani*, 9) *'uhilangi*, 10) *'uhingaba ango*.

from the previously cut fallow vegetation. Sometimes branches are left on the pole to facilitate the climbing of the yams. *Bongoghai* staking gives problems. In strong wind the poles may break under the weight of the heavy foliage. To give more stability, the single pole is often supported by a big cut-off branch placed head-down leaning to it; such branches are termed *saangoi*. They are only used in the middle of the garden divisions.

On shallow soils tripodlike supports (*beeghai*) are used. Sometimes whole gardens are *beeghai*-staked, even though pockets of deep soil are present, possibly for aesthetic reasons. Commonly *beeghai* are found mainly in the middle part of garden divisions.

In the most elaborate systems of staking also *kauhange* is employed, a handrail-like arrange-

Fig. 30. Planting of yams. A small seed tuber or cutting is carefully set after some weeks sprouting. The metre-long sprout is extremely vulnerable; hence interring of yams is only entrusted experienced planters.

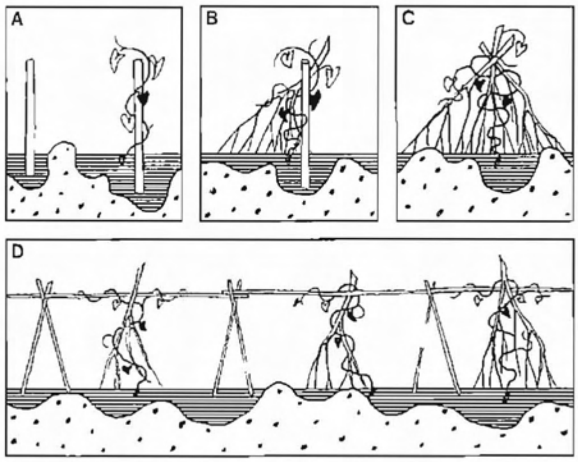


Fig. 31. Various forms of yam supports/staking. A) Poles driven into the ground or cut trees, *bongoghai*, previously growing on the spot, are used for support where the soil is deep. B) The simple pole supplemented with a lean-to branch, *saangoi*. C) A tripod-like arrangement, a *bongoghai* with *beeghai*, used on shallow soils and in the middle of gardens. D) A rail-like support, *kauhange*, often used along the sides of a garden.

Fig. 32. An old expert planter leaning to his *kauhange* yam support. Plans of the garden shown are found in figs. 34, 37a, and 38. The planter is Matiu Sa'omoana, deceased 1967, who supplied much information on traditional horticulture.

ment of beams, often placed on forked poles. To the *kauhange* 'rail' some poles are leaning. The slanting poles are placed at the planting hills. This supporting system is only used at the sides of the garden divisions, thus forming neat dividing lines. It is considered a very beautiful arrangement by the Bellonese; also it is very stable.

Some more special supports are used now and then. For a special crop as *boiato* yams (Dioscorea pentaphylla L.) short *beeghai* stakes are used. On Rennell a special grid-like horizontal supporting system is still but rarely used for this yam type, which is low-growing; the grid was said to promote development of bulbils (*hua*).

Both the 'rail' and the 'grid' are said to have counterparts in Melanesia (Murua, Woodlark Island?), but seem without parallels in Polynesia (?) (See J. Barrau 1958 and 1961.)

At the same time as the staking work, the garden area gets a final going-over; the garden perimeter is checked and protruding wild trees from the sides are cleared away to give more light (*hakabasa*). Afterwards the garden is left to grow for about a month without further work, except for visits to watch progress, to twine a vine here and there, rearrange a support, or the like (fig. 32).

An excerpt of the rich vocabulary describing the development of the yam vines comparing this with other garden crops is brought at the end of paragraph 2.1.4.

The growing period of a yam garden is generally about six months. During this time two, three, or more weedings (*kangaghi*) have been made. The first weeding, after about one month, requires a day's work or possibly two. Expert gardeners use much more weeding than others because prestige is attached to the tidy look of the garden. In early weedings all non-crop plants are removed; in the last one the weeds considered good for the fallow regrowth are left undisturbed.

Harvesting (*ghapu*)

Harvesting is carried out either completely at one time, as is usually done in divided gardens, or over a prolonged period which is done in gardens cultivated by an individual family. A multi-stage harvest is advantageous, because it allows a better development of the individual tubers, since these are removed one at a time and the smallest left to grow further. *'Uhingaba* yam is a crop well suited to this procedure.

When the harvest is completed at one time it is usually because the crop is to be used for a communal feast. For every participant in the previous garden work who is present in person a small pole (*puke*) is erected in a nearby ritual place (*ngotomanga'e*), and against this a pile of yams is heaped up (fig. 33). The distribution as observed on Bellona is reminiscent of elaborate rituals now only remembered by a few. If the owner of the garden does not own the land on which it was grown, one or more baskets are sometimes sent to the landowner (*hakahua o te kenge*), as a token gift. The amount of the gift is not determined by the area or yield of garden, and its significance is probably only as recognition of the ownership of the land, a matter formerly of deep concern to all Bellonese. The ancient custom

Fig. 33. A distribution of harvested yams. For each of the participants a small stick has been put into the ground; against this his share of yams is piled. Most of the yams seen on the photo are of the *'uhingaba mai Laapani*-type.

of sending gifts to the owner (*hakahitinga ma'anga*) is becoming rare nowadays.

Planting a sweet potato garden (*sanga patito*)

Since about 1947 the fallow (*tangipou*) of newly harvested yam gardens has with increasing frequency been cleared and all litter burnt (*hakapuu*). (See fig. 34). This involves little work, which is also true for the subsequent planting (*suki*) of sweet potatoes (Ipomoea batatas L.; *patito*) in the newly cleared field. Such gardens yield an additional harvest about three months later in a period of potential scarcity (*kangakanga*). Yields are greatly inferior to that of a yam garden, but as so little work is involved in the cultivation and the areas seem better utilized than when just left fallow, the planting of *patito* has increased rapidly. The speed with which this practice has spread is partly accounted for by the existence on Bellona of an old tradition of cultivating Ipomoea species (notably *bunge,* Ipomoea congesta R.Br.) that were very similar to the present-day *patito,* particularly in their simple cultivation requirements. Little care need be taken of a *patito* crop – no stakes are necessary and little, if any weeding is done. But the benefit of the crop is still a matter of discussion on Bellona, because of some of its drawbacks. Very conspicuous is the fact that the normal regrowth of fallow is delayed more than a year. As this is partially compensated for by extra output, it may be acceptable. The real problem is whether the stability of the gardens' pseudo-rotation is threatened by the planting of *patito*. Alarmingly some fallow areas have recently developed a vegetation containing more and more grasses and ferns, and a decreasing number of the normal

Fig. 34. Freshly prepared sweet potato garden. All trees have been cut down and all litter burnt; this impedes regrowth of a normal fallow. The two fallows in the background are of similar age, but one is after yams and the low one after sweet potatoes.

trees. Will Bellona be changed into a savannah? If this happens, yam gardening will be thoroughly changed. The clearing of forest will no longer be necessary; the much more arduous task of removing perennial grasses and other weeds will take its place. In all, the cultivation of yams will demand greatly increased amounts of work for the same yields in a savannah environment. Also a profound change of techniques will be necessary: hoes instead of digging sticks. This has already been the experience of some Solomon Islanders.

It has been proposed to grow sweet potatoes similarly as taro i.e. on fallow areas of three years age or more. From trials it appears that this method does not affect fallow regrowth, while it retains the advantage of filling the gap in provisions, with a plant of greater drought resistance than taro.

Garden work in non-yam gardens

For gardens other than the *'uhingaba/'uhi* yam gardens the cultivation procedure is somewhat simpler than that described above. The differences may be seen from table 5, where the three 'classical' Bellonese garden types are listed. Some modern types display a reduced number of operations. Except for the variations stemming from differences in form of crop growth (obviously supporting poles are necessary only for the twining yams) the change of work lies mainly in a new sequence of similar operations. In banana and taro gardens the burning is postponed until after planting. Details in work are also different, as for example a period of about a week as recovery time (*mangai*) for taro after it has been cut (*hasi*) to be used for replanting. It may be noticed that generally the more recently introduced crops (sweet potatoes, corn, melons, pineapples) are given a simple summary procedure; they are alien to traditional Bellonese garden work and not always successfully cultivated. There are, in fact, signs of a new development of better adapted methods for these crops.

Terms referring to the stages of growth in gardens

A detailed description of these terms is beyond the scope of this work, but there is in the Bellonese vocabulary an abundance of descriptive terms on the development of gardens. This proves the watchfulness, which is the natural attitude of the Bellonese towards their gardens. Such a vocabulary is useful in its own right since it permits short and precise formulation of information on garden matters. Just as, for instance, the Eskimo have specialized terms concerning ice and snow, the Bellonese may describe in one word a garden's conditions, which in equivalent English would demand several sentences. It should be added here that very many garden sites carry their own name, which further adds to the ease with which a Bellonese can discuss garden matters with precision and speculate on the likely state of food provisions in the near future. A survey of gardening operations has been given by Sengeika Tepuke, fig. 35. It is analogous to the flow chart given in fig. 36.

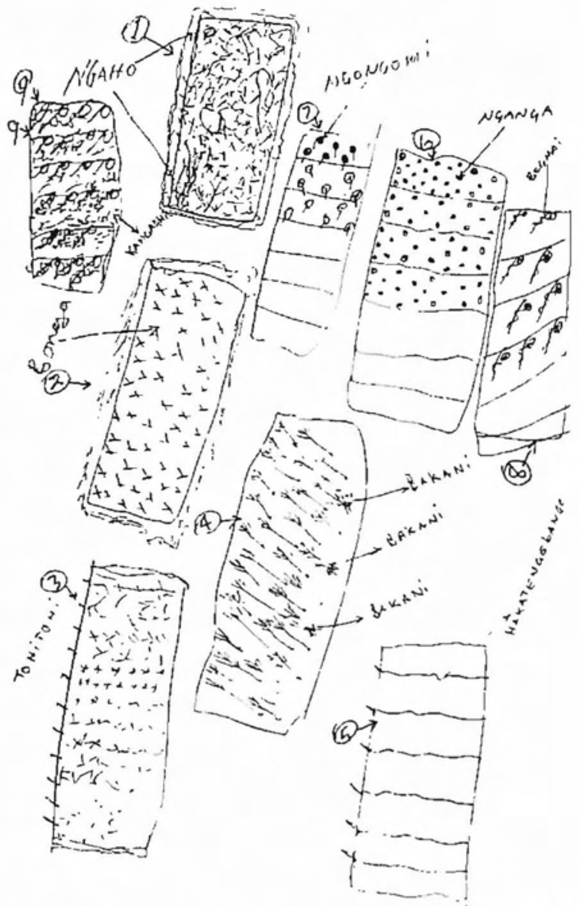


Fig. 35. A sketch summing up the main stages of garden-making (1 to 9). Drawn by Sengeika Tepuke.

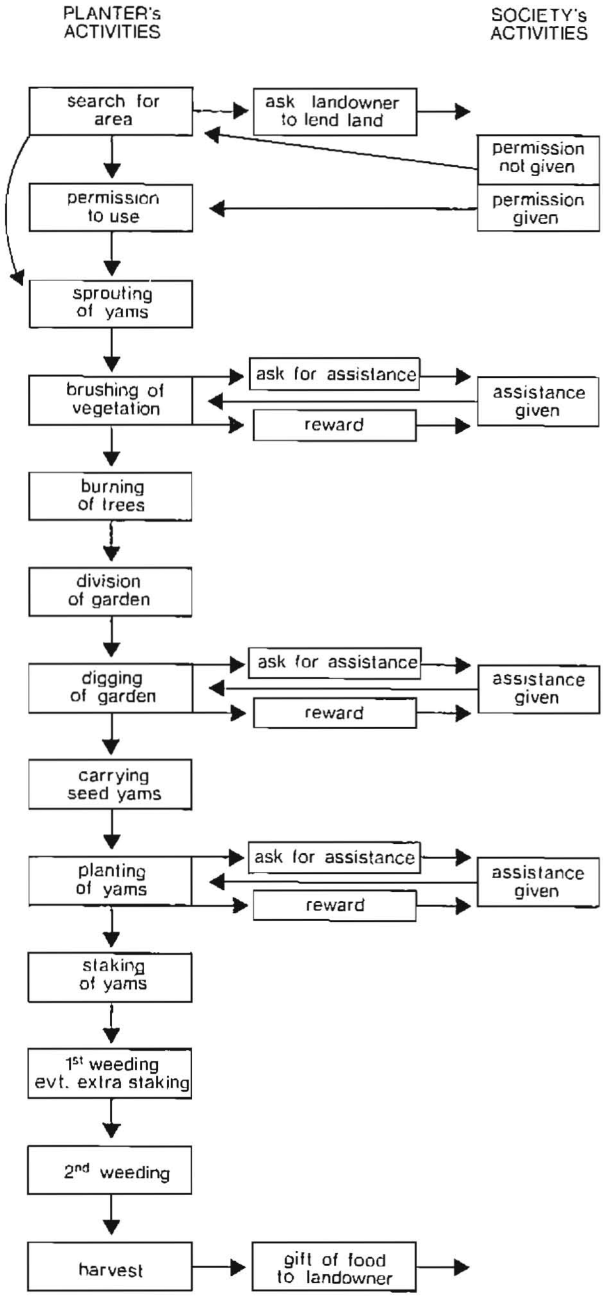


Fig. 36. Flow chart showing the work of a gardener planting a yam garden and his dependency on assistance. Sometimes minor changes will take place in the order of operations.

The following lists (table 5) are summary; translations are not litteral but aim at expressing essential meaning. Interested readers are referred to S. H. Elbert (1975): Dictionary of the Language of Rennell and Bellona.

Table 5

Terms describing stages of garden development.
(*Na kupu o te tupu 'anga 'umanga*)

a) Yam-gardens, (*'umanga 'uhi, 'uhingaba, beetape,* and *abubu, boiato, . . .*)

bonga, brushing
baakani, burning, especially large trees
sungi, clearing of undergrowth
hakatenge bongo, stretching of dividing vines
nganga, digging with digging stick (*koso*)
ngongomi, interring of seed tubers ⎤
beeghai, saangoi, ⎥ same stage
hakakauhange, putting up climbing poles of different types ⎦
sosomo na tupu, shoots beginning to be visible
ngabu, shoots beginning to twine
baangabu, shoots twined [by the gardener] ⎤ same stage
lango, first weeding ⎦
ngaungau, developing leaves, leafing out
ngaubai tama, leaf forming, young stage
ngaubai 'eha = *ngaubai matu'a,* leaf-forming, mature stage
hakatu'u nga'a, branches forming
puungou (sing. = *puungoungou*), vines climbing stakes
hetangotangohaki, vines making a mesh, entangling
kangaghi, (second) weeding
ngaumainge
ngaumemea, leaves changing colours
molu, withered garden
lange, tubers mature, vines tough, dried out
tangipou, harvested garden, first year of fallow

Development of tubers are especially described:

hakahua ghaapoli, tubers developed like *ghaapoli*-fruits (*'uhingaba* only)
sisina, tubers looking whitish (early stage as of *'uhi, beetape, abubu, boiato*)
hakahua taghoa, tubers developed to resemble ibis-eggs
motomoto, no longer young
hua matu'a, mature fruits
kingi molu, skin of tuber drying up
muimui, tubers numerous (especially *'uhingaba*)

Development of bulbils are especially described (for *abubu, boiato, ghope, soi . . .*):

pelini, beginning to develop
sisina, whitish
tauhua, hanging
hua matu'a, mature ⎤ same stage
kengi, dug [planted] ⎦

NB. Propagation of yams is by means of small seed tubers (*pungapunga*) or by pieces of larger

tubers (*tapasi*). These are either sprouted in a house or planted temporarily to sprout.
malubu, beginning to sprout
soosopu tupu, sprouted to the length required for planting
kaahaki, sprout developed too much for planting

b) Taro gardens (*'umanga tango*)
'umanga sanga ho'ou, newly planted garden
ngaangiti, beginning to unfold leaves
ngaungau, developing new leaves (*hakatungi*, making young plants)
ghape tea, taro with two to four leaves
lighapanga tama, new shoots developing
lighapanga matu'a, new shoots fully developed
ungiungi, 'becoming greener', developing new leaves (main stage of growth?)
ghape 'ungi, taro with five to seven leaves
mata'atea, leaves of light colour, garden just ready for first harvest
matu'a, mature plants ready for harvest
molu, fallen garden
NB. Taros are propagated by replanting of cut-off top of the mature plant; most leaves are removed first.

c) Banana gardens (*'ungu huti*)
soka, preparing of the ground and planting of bananas
ngangiti, leaves beginning to unfold [non-specific term]
hakahatu, stem having developed
hoohotu ungi, sprouting from bottom of stem
ngau ingi, small leaves 'fanning out', flowering begins
tu'u moa, upright fruit stalk forming
singa te moamoa, bending down of fruit stalk (except for *tongaka* bananas and related kinds)
suesue alo, very slight spreading of small fingers (of fruits) (*alo* = flower petal or fruit sheath)
matangatanga, fruits are fingersized, the fruit sheath (*alo*) has fallen off
mimingo, fruits clenched as a fist
mimingo 'atua, still somewhat clenched, but starting to open
sakasaka, opening a little (as a hand)
maamaangoo, fruits becoming larger
hai ke ngengeu, fruits about to ripen
tapongaponga, fully grown fruits, but still raw taste } almost same stage
ghabengangi, slightly ripened (but still green) } almost same stage
somosomo, almost ripe; yellowing
ngengeu, fully ripe, colour of mature fruit

Bananas are propagated in two different ways: young suckers from the basis of the stem are freed (*papao*) to form seedlings (*ungi huti*); before planting the leaf area is reduced (*ghangilae*) to prevent withering. Also stems may be chopped into 'ratoons' (*tapasi*) about a foot long to be planted after some days in sprouting house.

d) Giant dry-land taro (*'umanga kape*)
ngangiti, unfolding leaves
ngaungau, leaf forming
masenge, edible part of stem (*tino kape*) developing; lit., cutting through ground
tino 'ungi, darkening of stem
molu, withering garden

2.1.5 The fallow period

The harvested garden (*tangipou*) usually has a well-developed cover of weeds; these are in the last stages of garden development considered to have little effect on the yields. An exception to this is the sweet potato garden, where weed growth is almost absent. Disregarding left-over or self-regenerating crop plants (*hetui*), the differences between fallow areas following diverse crops are not very marked except for the fallow after bananas, which looks very different because of its luxurious growth, and probably after sweet potatoes. Minor differences may be observed between other fallow areas, but they are said to be of no importance with regard to the level of fertility, at least if the soil type is identical. During the fallow period vegetation of the area is gradually built up, first very fast but soon at a decreasing rate. In the vegetation of the fallow area the 'fertility' of the area is thought to be contained – a perception of much realism as plant nutrients are actually stored in the fallow regrowth.

A first year fallow (*tangipou tasinga ghapu*) is said to be unusable for cultivation except, perhaps, for sweet potatoes (fig. 37). On rare occasions taro may be planted. This has happened within the lifetime of some Bellonese who said that the taro was planted reluctantly, simply because the people, after a long period of hunger, were too weak to clear new land. The two-year fallow (*tangipou nguanga ghapu*) is also spared (fig. 38), but by the next year fallow (*tangipou tongunga ghapu*), fertility has risen to a level that is suitable for replanting with taro. The stage is sometimes termed *motomoto* (fig. 39). Experienced Bellonese horticulturists hesitate to call this stage a mature fallow.

Fig. 37. A regrown fallow about one year after harvest. Most of the plants identifiable on the photo are *hau*, Hibiscus tiliaceus L.

Fig. 38. A garden fallow for two years with bananas ready for harvesting. The regrowth encompasses both *hau* and *ghangaapuli*, Acalypha grandis Benth.

Early maturity is reached the following year (*haanga ghapu*), if the soil is not especially barren or thin (*ghinaghina*). The four-year fallow is often called *tangutangu moto*, or if properly developed, *kae tanu 'uhi* or *kae tanu 'uhingaba*. (There are severe doubts if the terms *'kae tanu . . .*:' are properly reproduced.) Only after five years of fallow (*tangipou ngimanga ghapu*) on normal, good soil, can the area be termed mature (*tangipou* or *ma'anga matu'a*). Such a fallow is ready to be cut and planted with any crop, even that of the highest demands: banana. The term, *kae tanu huti*, is thus appropriate though even older fallows are preferred for bananas. After about 15–20 years a fallow merges gradually into secondary forest (*bao singi* or *bao matu'a*).

From the above it seems obvious that the Bellonese concept of recovery of fertility in a fallow area means that the level of fertility after harvesting is independent of the crops as long as normal cultivation rules are obeyed. Only if a non-sufficient fallow period has been allowed will fertility decline. Bellonese also state that even though fertility is higher with longer fallow period it is advantageous with the present shortage of land to use minimum lengths of fallow periods. (These concepts are coincident with theories of modern science; se chapter 6.3.)

Fig. 39. A three year fallow with *hau* and, in the undergrowth, *bangitia* ferns (Nephrolepis sp.).

TABLE 6.

Successions of fallow plants, after traditional and modern cultivation.

	Traditional	Modern Esp. in sweet-potato fallows
first year fallow tangipou	hau (Hibiscus tiliaceus L.) ghangapuli (Accalypha grandis Benth.) ngaupata (Maccaranga tanarius Muell. Arg.) bugho (Melochia odorata L.)	hau (but poorly growing) bangitia (Nephrolepis sp.?) ngei (Paspalum conjugatum Berg.) miti (Passioflora sp.) (sometimes)
second year fallow tangipou nguangaghapu or ma'anga nguangaghapu	same as above, further developed plus bangitia (Nephrolepis sp.?) aatoka (not det.) ghali (Breynia cernua Muell.Arg.) if this dominates, maturity is delayed	hau still small ngei
third year fallow tangipou tongungaghapu	same as above, further developed new trees invading (several possibilities) mootomooto - mature for taro	hau ferns, various vines invading: aghaagha (Ipomoea congesta R.Br.) soopi 'atua (Merremia peltata (L.) Merr.) bangungo (Canavalia microcarpa Merr.) not mature except for sweet-potato
fourth year fallow tangipou haangaghapu	same as above, further developed tii (Cordyline fruticosa (L.) A. Cheval) [Cordyline terminalis Kunth] matu'a: mature for yams	trees gradually taking the lead miti and ngei, often declining mature for taro, but yams must be postponed
fifth year fallow tangipou ngimangaghapu	hau, ghangapuli, ngaupata, bugho often declining, other trees taking gradually lead matu'a: mature for bananas	same mature for yams, but staking a problem. Usually another year necessary before planting

A *bao matu'a* is a fallow old enough to resemble forests mainly because of size of trees; the true primary forest differs markedly by composition of vegetation.

The development of the fallow

From interviews it is easy to gain an impression of the kinds of plants which form the fast-developing cover of the fallow. There seem to be two trains of development: one with trees dominant, especially Hibiscus tiliaceus L. (*hau*), and one with grasses and ferns, notably *ngei* and *bangitia*, dominating. These are probably later succeeded by trees, but it takes trees a much longer time to develop (table 6).

The differences between the two developments described are partly due to inherent differences in soil fertility, but may also be caused by the greater demands on fertility resulting from cultivating two consecutive crops from the same piece of land, which frequently occurs since the establishment of the mission. But the introduction of new plants is also partly responsible. Here *ngei* (Paspalum conjugatum Berg) and *miti*, a passionflower, are mentioned. *Ngei* is considered an especially harmful weed in the fallow areas, capable of delaying the maturity of the fallow by some years. *Miti* is also stated to be annoying, but is usually killed by competition from the normal fallow plants at an early stage of development. This however, is not the case on meagre soils (*tanahu* or *ghinaghina*), where *miti* may completely stop development. In 1966 none of the feared Imperata-grasses had reached

Bellona, but they could easily be accidentally introduced as the *ngei* was in 1956 (probably adhering to a sleeping mat, previously used in a plantation and brought to Bellona via Teana, Rennell). The *miti* was possibly introduced from Honiara in 1942 and spread fast from its first growing place, Hanaakaba. Still another weed, *kangibi* (Euphorbia hirta) is reported to have spread all over the island. It was used as medicine against diarrhoea and is said to have come from Onepusu, Malaita, the SDA mission centre, in 1948. Starting from Ghongau it spread slowly at first, but had reached almost every part of the island by 1957. While the spread of *miti* and *kangibi* was observed without much concern, the spread of *ngei* was soon discovered to carry serious implications, especially as it usually invades good soils. Brushing (*sasau*) of homesteads was earlier considered a light job, but the expansion of *ngei* made it more time-consuming.

To check information concerning weeds it was decided to make a series of plant counts in fallow areas up to about five years of age. This would provide a fuller knowledge of the fallow plants, and possibly reveal differential development on different soil types. Ten-metre squares were chosen at random in places where all stages of the fallow evolutional cycle could be found. Edges of fallow areas (i.e. areas within a distance of less than two m. from the boundary) were ignored. The material collected is too limited for a thorough statistical treatment. It is presented in appendix C and records a variety of plants found in young fallows. Most frequently found are *ghangaapuli* (Acalypha grandis Benth.), *hau* (Hibiscus tiliaceus L.) and *ngaupata* (Maccaranga tanarius (L.) Muell. Arg.), all fast-growing trees. On poor soils *ghangaapuli* and *hau* very often take over and dominate the whole area; better soils also carry *ghangaapuli*, but combined with the fern *bangitia*. The older fallow areas, and among them particularly those with good soil, tend to carry a most diversified array of fallow plants with trees dominating the area. Richer fallows have a number of vines and herbs, not only the fern *bangitia*, of differing species. The oldest fallow areas surveyed were dominated by unusual trees, but this should not lead one to draw any rash conclusions: these fallow areas are rare, and often quite limited in extent. Special reasons may have influenced their survival (those with *nguna* are perhaps saved because of the presence of these trees, which have edible fruits).

Statements from the Bellonese that fallow fertility is better judged from the volume of vegetation than from the invasion of special indicator plants, seem to be tenable. At least variation in the composition of vegetation on a given soil type regardless of fallow age is slight, while the height and volume of vegetative cover varies conspicuously. Normally the dominant trees grow about 1.5 m. on a rough average during each of the first five years and trunk diameters increase about the same amount in centimetres per year. This observation is of special interest, as the height of vegetation can be estimated from aerial photographs, at least by comparison, using the proper apparatus. The fallow areas investigated and counted could be used together with others of known age for assessment of fallows of unknown age.

Old utilized plants like *soi*, *mangaghai*, and *aka* develop very well in the fallow areas, as mentioned elsewhere. The search for food in fallow areas during times of scarcity is understandable when it is realized that not only left-over garden plants but also other edible plants are found there.

Finally the fallow areas were analysed to gauge whether any effect of growing sweet potatoes in yam fallows could be seen. The material is too meagre to allow firm conclusions (e.g. sample 7 and 11), but a delay in the development of fallow growth did seem apparent. On poor soils the early invading ferns remain dominant for long, retarding development of the woody regrowth, facilitating cultivation of popular crops as bananas or yams.

It was intended to investigate more fallow areas, especially larger and older ones, but this proved to be impossible. It is to be particularly regretted that so little is recorded about secondary forest vegetation. For comparative purposes the virgin forest should also have been sampled. This was not done because primary forests on Bellona are generally only found in special circumstances and on special soils (see chapter 0.5), this may preclude the making of significant comparisons.

2.1.6 Calendar of gardening

The temporal aspect of gardening activities is important for several reasons. First the inputs in gardening must be geared to activities; areas must be available for cultivation according to the re-

TABLE 7.

Calendar of gardening and

Months of the tropic year		April	May	June	July	August	September
'Moons', synodic months		ngima (5)	ono (6)	hitu (7)	bangu (8)	iba (9)	angahungu (10)
Indicator stars or constellations	hetu'u ghapu	++++++++ ascending Southern Cross, Kaukupenga	++++++++	++++++++	++++ ------ descending Southern Cross	------	------
	hetu'u kangakanga		++++++++	++++++++ ascending The Altar?, Tetoki	++++++++	++++++++	------ descending
Seasons		harvest, ghapu			lean season, kangakanga planting, lauanga 'eha		
Weather regime		rain and sun; trade wind dominating					
Crops:	'uhingaba 1)	harvest 1)					
	'uhi 2)		harvest 2)			planting 2)	
	suinamo 3)			harvest 3)			
	abubu 4)	harvest (tubers) 4)			plant (tubers) 4)		
	iaro	planted any month, harvest 3-6 months after					
	bananas 5)						
	breadfruit, coconuts 6)				main harvest 6)		
Fishing							

Note to the calendar

Time of the year was traditionally found by counting the moons (synodic months), and by counting the days from each new moon. As one tropic year*) has about eleven days more than the normal twelve synodic months together (365.24 days against 12×29.53 days $= 354.36$ days), the calendar had to be regulated at intervals of about three years. On Rennell this was done by inserting an extra month, *haa* (lit., the fourth); on Bellona no special name for the extra month seems to have been used.

To achieve a correction, coincidence of given positions of certain stars and constellations to time of harvest (*ghapu*) and to the lean period (*kangakanga*) was observed, and possibly also the beginning of the flying fish season (*ta'u ika*).

The stars and constellations of the lean period were: Bulibuli, Kaukupenga (lit., net-handle=Southern Cross), Ma'ukoma'a, Tetoki (lit., the adze=possibly the Southern Triangle), Tungaangupe (lit., flock of doves), Baisakunga, Kaabei.

The stars and constellations of the harvest period were: Matangiki (lit., small eyes=Pleiades), Tongunga Maaui (lit., Three Maaui's (brothers)=Orion's

quirements of crops at the proper seasons and the necessary labour force must be reserved for the cultivation work. Secondly, proper timing of harvests is necessary to avoid food shortages. As there are few technical possibilities of storing food on Bellona the latter point means that harvests ideally should be taken at equally spaced intervals throughout the year.

Information on the gardening calendar was obtained by interviewing and by registration of actual events. The interviews were planned to yield information on general features of the calendar. It other subsistence activities.

October	November	December	January	February	March	
ango mataki-taki tu'a ngi-ki penga (11)	ango i ngoto (12)	ango haka'oti (1)	langighi matakitaki (2)	langighi ngoto (3)	langighi haka'oti (4)	*)

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ascending Pleiades, Matangiki — descending Pleiades

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The Altar — ascending Orion's Belt, Tongunga Maaui — descending Orion's Belt

fishing for flying fish, ta'uika

season of the crab, ango — season of bananas and fish, langighi

doldrum weather dominating — occasional hurricanes

planting 1)

planting 3)

harvest (bulbils), plant (bulbils)

harvest (some kinds) 5) — harvest (some kinds) 5)

flying fish, sasabe — sharks, mangoo — surgeonfish, pongo

*) To overcome difference of 11 days, an extra month is inserted occasionally.

Belt), Tango (lit., taro=possibly Sirius), Ngekee (lit., net=possibly Gemini, Te Ngaa o Matangiki (lit., the 'sail' of Pleiades), Tupu'a Tetinomanu (lit., the bird body), Kingikaa, Tangapongu, Tupa.

The experts keenly watched to note whether stars were ascending or descending in the early morning.

The time for the yam planting seems to have been indicated when the harvest stars, especially the Pleiades, appeared in the early morning. This happens in June to September. In the same way the lean period seems to have begun when the first hunger stars appeared in October, and to have lasted until the last of the succession of hunger stars stopped to ascend in the eastern horizon in the last hours of darkness; this was possibly at the end of January.

*) A tropic year is the period (365.2422 average days) between two successive passages of the Earth of a point in its orbit from which the sun is sighted in identical positions between the stars. The tropic year is slightly shorter than the time for a full orbital revolution of the Earth, a sidereal year, which is 365.2564 average days.

proved practical to relate all events to the traditional moon calendar. By the registration method it was intended to check the information previously collected. As direct observations by the author could only be made during the field work periods, registrations were additionally made by Bellonese assistants. For every village a diary was kept for as long as two years in which daily activities of every adult female and male inhabitant present were recorded. Through the diary method the actual cultivation during the period became well known, but whether events were recurrent could of course only be guessed upon. Diary-keeping involved several problems. A detailed recording of any activity implied too much supervision. Hence only main activity during the two normal daily periods of work were of only 3 to maximum 4 hours duration each, interrupted by a siesta period. Registration of only one activity per period involves sometimes a gross inaccuracy, but usually activities including transport actually extend to full half-day periods; much work implies an amount of walking, probably included in a planned use of time by the Bellonese. After some advising the reporters in the villages quickly caught the idea of recording the most time-consuming activity per period. Later the 'village diaries' were collected, the entries translated and analysed and finally classed into broad categories; see appendix J. In the 'activity charts' the amount of work exerted per category of work is expressed in per cent of total normal working hours by the female or male persons present. There were two reasons to enter weekly averages instead of daily ones: the generally rough nature of data (not truly quantitative, but rather qualified estimates) and also the problem of sabbaths. From the charts it is impossible to read off total amounts of workhours per category directly, because the number of active persons varies during recorded periods. Bellonese migrate considerably: they visit other villages, sometimes Rennell Island and other Solomon Islands. The charts show 'intensities' of working in the different classes of work, intended to yield a basis for a calendar. (The charts can, however, easily be translated into 'amounts' of work, because the inhabitants present were recorded.)

The calendar based on interviews is shown in table 7. Traditionally garden activities were related to the now obsolete lunar calendar. As no simple relation can be given between the Gregorian and the traditional calendar, the columns of the table only give an occasional coincidence of lunar and solar months.

The usual problem with moon calendars – that of making them fit into a solar year – was also solved on Bellona. Apparently certain constellations were observable within definite lunar months; if this did not happen, an extra month, called *haa* on Rennell, was inserted. Details on the Bellona calendar shall not be referred here; only it might be added that seasonal change of weather pattern is a gradual one, hence 'ecological timing' is inaccurate, even compared with that of the traditional calendar. Ecological observations, as of the seasonal arrival of the Golden Pacific Plover, were used for making crude corrections to the calendar.

From two years' observations (see appendix H) seasonality of weather changes cannot be described with any acuracy, but there is good evidence for dividing the year roughly into two seasons, one of trade winds (*tonga tu'u*) and one of monsoon or rather doldrum-like weather. Sometime in April the trade usually begins to dominate, bringing a change of weather with more sun and a little less rain. The trades blow until September, at which time they become very unsteady. In October, November, and December there are many calm days. At the end of this doldrum period, high winds often occur. In January, February, and even in March hurricanes with truly devastating force may strike the island.

The weather governs most Bellonese' activities; the garden work is largely determined by humidity. The yam of all crops is the most seasonally fixed. It must be planted in a burnt field, hence cultivation is best started in the last part of the tradewind season. By this procedure it will usually grow under convenient conditions with changing rain and sun during the monsoon-like period and be harvested when the trades start blowing again. Bananas are usually planted in the calm period when humidity is higher; the harvest after up to two years' growth takes place a little later in the year. Taro is different: it may be planted any month and harvested 3 to 6 months later, but the yield depends very much on the weather. Fishing also depend on the weather. There is a peak season in the calm period when flying fish (*sasabe*) are caught (October and November mainly). Reef fish like surgeon fish (*pongo*) are mainly caught in February and March. Sharks were traditionally caught mainly in November. Information on these food supplies is combined in fig. 40 which, however, is non-quantitative.

The names in the Bellonese calendar reflect some of the important events of a productive year; thus: harvest season (ghapu); season of bananas and fish (*langighi*); season of crabs (*ango*). Several additional names exist for seasons, but most seem less related to the lunar calendar; fishing season (*ta'uika*); lean season (*kangakanga*) usually coinciding with main planting season July to October (*launga'eha*). The months January and February

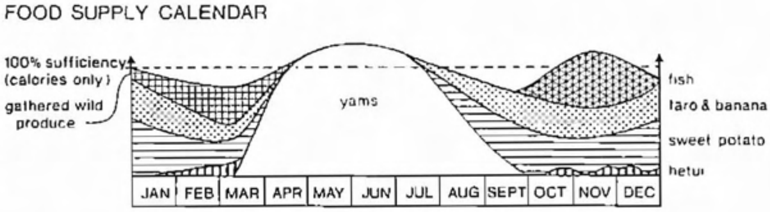


Fig. 40. Food supply calendar. Not quantitatively drawn. The supplies of yams and fish are seasonally very important. Taros and sweet potatoes show less seasonal variation in amounts supplied. Gathering is esp. important just before the yam harvest; collecting of left-over garden products, *hetui*, is made at every time of the year but most eagerly before the new harvest.

especially are often low in food supplies. They are off-seasons for most crops and people have often to start a systematic gathering – better termed collecting – of non-cultivated produce. The off-seasons contrast very much with the happy days of abundance during the yam harvest and also later when taro, bananas and fish may be combined as 'supplementary food' (*kai kiki*), which naturally is appreciated as a healthy diet.

The picture of activities obtained by the diary method does not deviate essentially from that described above. If differs mainly by dissolving the rigidly outlined seasons of cultivation into several smaller periods with changing main activities. From the two years observed it is clear, for instance that yam planting depends more on preceding spells of dry weather than on a definite date or rather lunar period; the same goes for fishing.

No direct observation of variations in food supplies were made; the rough estimate in fig. 40 is given on the basis of distribution of activities. In chapter 4 a further estimate of food supplies and demand of labour for subsistence activities is given.

2.1.7 Yields and labour requirements for some garden types

An assessment of yields and labour for at least the most important types of gardens was included in even the earliest plans for field work on Bellona. The difficulties of such a task were at first greatly underestimated. Two reasons must be mentioned briefly: 1) Any assessment must consider that no fixed relation exists between the work spent in a garden and the resulting yield. The relations between work and yields are ideally described by a function; this is best determined by field experiments or by collecting a large amount of controlled material. Neither method could be used on Bellona. 2) Due to the gardening methods applied, Bellonese gardens show large individual variations in both yields and expenditure of work per ha.

One of the points complicating a generalization from Bellonese garden data is the variation of planting material, to which is related a similar variation in labour requirements.

Though the first gardens observed were almost monocultures regarding species, it was soon discovered that a variety of plants was used in them and in most other gardens. The exact composition of planted material is thus of great concern for assessment of yields. Further great care had to be taken in estimating the areas of gardens, because of their frequent irregular shapes and – even more difficult – indistinct boundaries. Another serious problem remained to be solved: the gardens are usually not harvested within a definite short interval of time; rather, food is taken from them over a period of one, two or even three months, even when they are monocultures. However convenient this may be for the Bellonese, it means for the investigator that the yield is ill-defined; yield of a fully mature garden is of course larger than that of a very young one. The difficulty is hard to surmount because food may be fetched from a garden at almost any hour of the day and hence may be unnoticed. This rule is broken when feasts are given: many gardens are dug simultaneously and the food is piled up for display. It is thus tempting to wait for such an occasion, but this does not give a proper picture of normal garden production. Frequently the gardens providing daily food yield more because only the fully grown roots are removed; the smaller ones are left to develop further (a method observable also in potato gardens in northern Europe). In the following assessment, a correction for post-sampling development of roots has been added to the estimates of yields from harvests that were dug up all at once.

As no feasts were definitely to be held within the period of investigation, a sampling system had

TABLE 8.

Estimated 'ideal' yields per ha. of some crops.
Calculated from average yield per plant x 'ideal number of plants' per ha.

Crop	No. of samples	Yield/plant kg:	Plants/ha.	Yield/ha. tons:
'uhingaba yams (Dioscorea esculenta)				
'u. ango	3	2.906		
'u. Kenga	3	3.310	~ 5,000-5,250	14.5-17.4
'u. mai Laapani	34	3.252		
'u. tautu	2	2.919		
'u. mai Laapani		3.252		16.3-17.1
'uhi yams (Dioscorea alata)				
beetape	23	5.234		
bootebo	3	6.186		
kakenuku	2	2.710		
maingoto	3	4.925	~ 4,500-5,250	12.2-41.6
singasinga	3	2.693		
soosopu	11	4.178		
'uhi a Pana	3	2.725		
'uhi a Panio	1	7.915		
soosopu	11	4.178		18.8-21.9
'uhi yams (D. alata) for comparison after D.G. Coursey 1967				
West Africa				7.5-18.0
South East Asia				12.5-25.0
West Indies				20.0-30.0
taro (Colocasia esculenta)				
tango Sangi	63	0.489	~ 12,000-15,000	(5.9)-7.3
tango sun	3	0.943		11.3-(14.1)
bananas (Musa sp.) various kinds, mainly huti mongi	7	9.283	~ 3,500	32.5
coconuts (Cocos nucifera)	10	(Copra) ~ 15 kilos (from ~ 70 nuts)	~ 150	~ 2.2

to be used. To dig large amounts, even in mature gardens, would have been wasteful because dug food will not keep. We had therefore to use samples as small as possible as a basis for assessment. Normally only about 5 % of the total number of plants were dug in each garden, but these were chosen to represent variations in proportions estimated to resemble those of the total garden. Fortunately the central parts of gardens usually display little variation. The edges of the gardens being of limited influence on the final estimates, the most serious problem remaining was to judge variations in soils and plants material. One limitation of the sampling system is that the area occupied by a single plant is hard to assess. Where possible therefore we sampled whole garden divisions. It is thought that this sampling method is the best available, though it barely achieves results with an error of less than 10 %. Results of sampling of individual kinds are entered into table 8.

When people became aware of our interest in yields and food plants they became most informative. Quite clearly yield was a matter of intense concern. Much additional information was obtained as on counting systems, details of gardening techniques, and on competitiveness. The Bellonese's awareness of the quantities harvested is of fundamental importance in any comparison of Bellonese and Western economic concerns. There is a similar awareness of the quality of the food harvested. Tubers especially are keenly observed: are they nice looking and tasty? How is their size? The usual Melanesian regard for enormous tubers was clearly present. We were presented with several yam tubers of weights exceeding 10, even 20 kg, far more than we could possibly consume. Pride in presenting the giant tubers was prominent. Custom on Bellona luckily permits a further giving away of food received without arousing bad feelings among the original givers – in fact to the contrary.

The outburst of informative zeal was used to ask people of Matahenua village to keep tubers harvested from each plant separate and to let them be weighed. Much material was collected on the tuber yields of the most common crops. From the averaged weights and areas found from the ideal planting patterns, 'ideal yields' were then estimated. Results are shown in table 8. It is seen that yields of Bellonese gardens compare favourably with those of Southeast Asia. As the basic material is too scanty for regular statistical treatment, it must be used accordingly; still it is thought to demonstrate the approximate yields fairly well. For *'uhi* yams the planting densities do not apply factually to the largest and smallest types of tubers. Practical yields may not fall short of the yields of *soosopu,* one of the most commonly planted *'uhi* yams. The same may be remarked of *'uhingaba mai Laapani* within the *'uhingaba* group. A major source of error stems from the ill-defined garden peripheries that make area assessments difficult. Results are shown in table 9. Compared with directly assessed yields those of table 8 are generally high. As the method assumes that all plants yield successfully, it tends to estimate 'maximum obtainable yield' as under conditions resembling those in 1965–66.

Further attempts were made to guarantee sound estimates of yields. In a period of competitive planting (*sanga hetau*)* people carefully counted and remembered how many baskets of food were harvested from individual gardens. The size of gardens could be determined in situ and by analysing aerial photographs with reasonable accuracy.

Later it was discovered that though yields of some competition gardens compared nicely to those of recent gardens, others had quite fantastic yields. Further interviews revealed that some competitors to impress people had diminished their 'basketfuls' to the extent that sometimes a 'basket' was only one single yam. The historical material is therefore left disregarded. With such corrections, an estimate of recent yields could be made, but the problem remained of checking the 'measure': basket (*kete*). We first tried to check the weight equivalent of current baskets of food. Several baskets were weighed, and as expected, weights fluctuated somewhat. The weights of 'nice' baskets, as used in everyday life, fluctuated only slightly, however.

Other ways to assess yields were tried, but nearly all proved useless. Like some ethnologists we planned a 'besieged town' strategy: to guard the trails into the village, try to weigh all food being carried in and ask questions concerning its origin. This procedure seemed ridiculous in the eyes of the Bellonese; it would still have been difficult to assess which areas had been harvested to produce each basketful, and it would have meant constant guarding for at least three months until the yam gardens were totally harvested. As a means of assessing consumption it would have been of interest, but it was judged to be a method far too costly in time for our limited programme.

From the two tables (8 and 9) it is seen that yields of the actual gardens sampled fall within the maximum limit calculated from 'ideal' yields. Sample No. 1 of table 9 has a yield only possible because it combines *'uhingaba* yams with some high yielding *'uhi* yams. Nos. 1 and 2 show clearly

*) *Sanga hetau* (competitive planting) occurred once in 1942–43 and again in about 1954 and is said to have taken place as early as 1925. Individuals, assisted by relatives and friends, tried to win reputation by planting vast gardens. When a *sanga hetau* garden was harvested, crowds of people watched heaps of roots being counted. After display and distribution, most of the harvest was left to rot. Such Melanesian-style competitions inferred future periods of land shortage and have been condemned by missions working on Bellona.

TABLE 9.

Yields and work for some

Crop	1. 'uhingaba and 'uhi yams	2. 'uhingaba and 'uhi yams with kape	3. 'uhingaba and 'uhi yams
District	Ghongau	Ghongau	Sa'aiho
Name of place	Tahamoana ma'anga tu'a	Te Akau, abaaba i Mangokuna	Baingau ma'anga baasia
Planter	Tupuia	Topue Tekiuniu	Michael Tongaka
Type of soil	kenge hingohingo	kenge ngau	malanga 'one
Years of fallow	abt. 10 baomatu'a	> 10 baomatu'a	6
Area of garden m^2	890	485 (7 potu)	1610 (15 potu)
Sampled area	5% stratified	14% stratified	4% stratified
Direct assessment	18.4 t/ha	13.2 t/ha +*) 5 t/ha	10.8 t/ha
Corrected estimate (+ unharvested plants + seed material)	22.4 ± 1.7 t/ha	14.2 ± 0.2 + 5 t/ha = ~ 19.4 t/ha ± 2 t/ha	12.0 ± 0.6 t/ha (harvested all at once)
Yield in tons per ha/yr (fallow area included)	2.0 t/ha/yr	2.2 + 0.4 t/ha/yr = ~ 2.6 t/ha/yr	1.7 t/ha/yr
Clearing, bonga		7 x 3 h = 21 h	16 x 4 h = 64 h
Burning, baakani		2 x 4 x 6 h = 48 h	16 x 5 h = 80 h
Digging, nganga	5 x 3 h	5 x 3 h = 15 h	16 x 4 h = 64 h
Planting, sanga, tanu	not specified	1 x 6 h = 6 h	2 x 8 h = 16 h
Staking, beeghai, sangoi		-	2 x 8 h = 16 h
Weeding, kangaghi		1 x 3 x 3 h = 9 h	2 x 8 + 2 h = 18 h
Harvesting, ghapu		? large	14 x 3 h = 42 h
Total workhours of garden	~ 196 h	99 h+	300 h
Workhours per ha/yr	~ 2200 h	2041 h+	1900 h
Workhours per ha/yr (fallow included)	~ 200 h	165 h+	266 h
Yield per hour	~ 10.2 kg	< 7.1 + 2.4 kg = 8.5 kg	6.3 kg
Work and area combined to produce 1 t/yr (fallow excluded)	0.044 ha/97 h	0.050 ha/105 h+	0.08 ha/161 h
Work and area combined to produce 1 t/yr (fallow included)	0.48 ha/97 h	0.56 ha/105 h+	0.56 ha/161 h

*) Unharvested part of garden. **) Bananas not all bearing. ***) Labour with sweet potato is lower,

higher yields than do Nos. 3 and 4; the difference may be explained by fertility of the soils. Sample No. 3 was said to yield unexpectedly little. Probably this was because of shallow soil, but it may have been less effectively cultivated than was customary because the owner lived far away. *Beetape* yams are said to produce more than *'uhingaba* on *malanga* soils. This seems to be verified by comparing 3 and 4. Yields of bananas seem high, but it should be kept in mind that bananas are difficult because of frequent crop failures.

Taros and sweet potatoes are low-yielding compared with the yams. They are, however, almost non-seasonal and hence necessary for provisions in periods without yam or banana crops. Sweet potatoes, sample 7, were cultivated continously with some occasional fallowing. It was not known whether the yield of 6.5 tons/year could be regularly achieved, but a fallow followed by a yam crop was planned for the future. In 8 a yam/sweet potato rotation is considered; it extends over 8 years. Not even such a rotation seems to important Bellonese crops.

4.	5.	6.	7.	8.
beetape-yams	bananas, buti mongi	taro, tango ngeka, tango sua	Sweet potato, patito (as solitary crop)	Sweet potato, patito (combined with yams)
Sa'aiho	Ghongau	Sa'aiho	Ghongau	
Baingau, Temanu ma'anga tu'a	Ngotuma	Kaangua i tu'a	Hangekumi ma'anga	estimate
Heman Haikiu	R. Puia	Matiu Sa'omoana	mission	
malanga 'one	kenge ngau	malanga hingohingo	kenge ngau	
6	> 10	3	no fallow (after	
	baomatu'a	tangumooto	'uhi, 'uhingaba)	
2660 (20 x 2 potu)	840 (14 potu)	~ 300	2400	
5% stratified	different method	10%	5%	
12.4 t/ha	15.5 t/ha	~ 8 t/ha	6.2 t/ha	14 + 6.5 t/ha
13.3 ± 0.5 t/ha	max. estimate **)	~ 10 ± 1 t/ha *)	6.5 ± 0.3 t/ha	20.5 t/ha
(harvested all at once)				
1.9 t/ha/yr	2.2 t/yr	~ 2.0 t/ha/yr	6.5 t/ha (after yam) (continuous possibly 2.2 t/ha/yr)	2.5 t/ha
18 x 3 h = 64 h	7 x 2 h = 14 h	2 x 2 x 3 h = 12 h	10 x 4 h = 40 h	
22 x 8 h = 176 h	7 x 2 h = 14 h	1 x 1 x 8 h = 8 h	40 x 2 h = 80 h	
2 x 8 h = 16 h				
14 x 2 h = 28 h	7 x 2 h = 14 h	1 x 4 x 3 h = 12 h	50 x 4 h = 200 h	
2 x 4 h = 8 h	2 x 4 h = 8 h		10 x 4 h = 40 h	
1 x 4 x 5 h = 20 h				
1 x 3 x 9 h = 27 h	1 x 3 x 3 h = 9 h	1 x 3 x 3 h = 9 h	40 x 1 x 2 h = 80 h	
22 x 3 h = 66 h	? large	? large	40 x 2 h = 80 h	
405 h	59 h+	41 h+	520 h	2000 (yams) + 1000 -
1525 h	702 h+	1365 h+	2166 h	2200 (sweet potato)
218 h	64 h+	342 h+	4300 with yam ***)	
			722 h (continuously)	450-600 h
8.7 kg	< 22.1 kg	< 7.3 kg	~ 3.0 kg (continuously)	~ 5.0 - 6.8 kg
0.075 kg/115 h	0.045 ha/42 h+	0.100 ha/137 h+	0.154 ha/334 h	0.39 ha/46-210 h
0.53 ha/115 h	0.50 ha/42 h+	0.40 ha/137 h+		

in practice hardly more than 3000.

be able to yield unvaryingly. At least it was said that the size of yams was on the decline.

It is regretted that enough samples were not collected to make an estimate of the influence of soil types, fallow lengths, and crop types, but this proved impossible. The time required to establish samples on a sound basis was considerable. The difficulties to make sure that all tubers of a certain area were dug were amazing. Often small tubers (*taaghubi*) are deliberately left in the ground as spare provisions and for use as seed tubers.

It is also difficult to know if 1965–66 was a typical year. Much evidence indicates that the Bellonese expect large variations in yields; in fact the harvest varies enough to make it a question of good or bad life every year. Locally it was said to be a fairly good year for yams. Taros did less well; their yields vary much with the seasons and are said to be best around November. On Bellona banana yields are hard to assess, especially with bananas cultivated in gardens. Those grown near villages are higher yielders, but their number is small and they were hence left without assessing yields.

Labour requirements

The assessed garden yields, described in table 9, were also analysed in terms of the amount of work invested in their cultivation. For the entries of one of the *'uhingaba* yam gardens of the table (in Tahamoana), no specified data could be obtained for the labour used; for the banana and taro gardens it was necessary to reconstruct data to some extent. Generally it is difficult to assess labour inputs in detail, because many individual variations occur from garden to garden and from planter to planter. The burning of an enormous tree in one of the taro gardens sampled was unusually time-consuming; the labour involved in harvesting a banana garden may be difficult to estimate because the period of ripening is indeterminate. These two examples should be taken as a warning against treating the ciphers too seriously. From various sources it is still possible to arrive at a number of rather rough assessments of working hours for different crops. Data taken from work journals that were kept locally for nearly two years, give reason to believe that the gardens described had work inputs within 'normal' variations.

Working hours for yam gardens, be they *'uhingaba-'uhi* gardens or planted with a mixture including taro (both normal and *kape*) are similar to those for sweet potato gardens. Large sweet potato gardens – the easiest to analyse – like the one described, have comparatively high work inputs. The garden sampled was a mission garden, in which most of the planters were young people who work less efficiently than mature workers. The normal amount of work for such a garden is probably between half and three quarters of the amount used here. However, the hours of work per ha. is similar for both yam and sweet potato gardens. The more uniform the area to be planted and the greater the homogeneity of the crop, the faster the work is. If only a few big trees are to be killed or cleared, the work is less. Although the fertility of virgin forest is good, the Bellonese prefer secondary growth for planting. As long as the areas look 'strong', even young fallows are sometimes preferred to old ones, particularly if there is labour shortage. Yields per hour of labour input are highest for bananas because the labour input is especially low, but this only holds if the banana cultivation is successful.

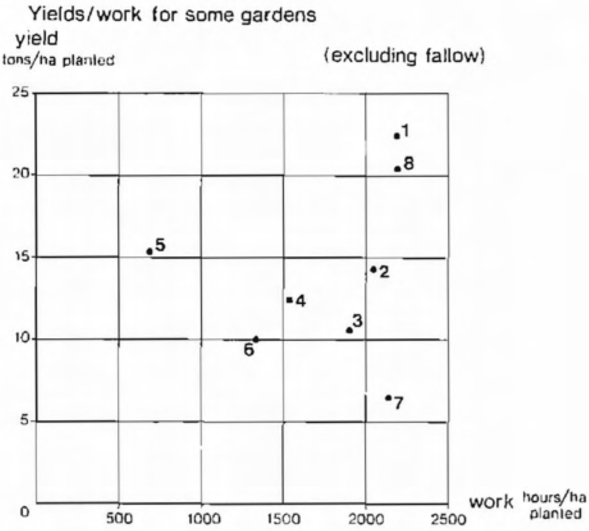
Frequently failures occur for both bananas and taros. Next come the yam gardens, which in the samples have a greater variation in yield than is usual. This is largely due to the low yields of the mixed yam garden sampled.

A more humid weather pattern would have resulted in higher yields of the taro-*kape* part of the garden, but possibly a lower yield of the yam part. The strategy behind the mixed Bellonese gardens is to ensure a yield of some size regardless of normal changes in weather pattern. This strategy is similar to that formerly used in Scandinavia where fields sometimes were sown with a mixture of barley and oats: in drier weather barley has the advantage, in wetter the oats. It has been demonstrated repeatedly that a combination of single-crop fields of the two cereals yields better than a mixture of the two on a single area. In Bellonese gardening this drawback is of little importance compared with the advantage of extending the period in which food may be had from the garden.

Another factor interfering with gardening efficiency per hectare is the size of the garden area cultivated. The usual benefits of large-scale operation are observable in Bellonese gardening; large gardens demand less labour per ha. than do small ones. Unless its area exceeds about 200 m^2., an isolated garden is usually not cleared if in an old fallow area. Felled trees tend to be kept standing by surrounding ones, making clearing an arduous job; for yams the climate of a tiny garden tends to be too damp and shady. The soil is said to improve when clearings are large enough to let air and sun in. On the other hand, the advantages with larger areas soon diminish. High winds tend to become more dangerous for the crops. An optimal size of garden area is difficult to assess without prolonged observations, but in practice areas of gardens were usually within an area of 200–1000 m^2. though extremely large gardens are reported to have ocurred.

The various operations of the gardening procedure require varying amounts of labour, briefly considered below.

Clearing the land usually involves 10–20 % of the total work of a garden, – the older the fallow the greater the work. Sometimes the planter works alone, but usually a group (*tau*) assists. Competitiveness often results in the group working faster



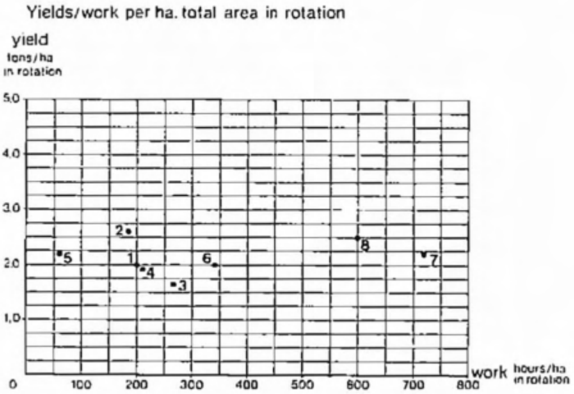


Fig. 41. Yield and work figures for the gardens of table 9. To the left is shown figures disregarding fallows; these are included in the diagrams to the right.

The numbers in the diagrams refer to the samples of table 9. 1 = *'uhingaba* and *'uhi* yams; 2 = same with taro and *kape*; 3 = 1; 4 = *beetape* yams; 5 = bananas; 6 = taro; 7 = batates, sweet potato; 8 = batates, sweet potato combined with yams.

than would usually be expected, except when the group is large as in mission school's gardens. On the same type of fallow the preparation for the same kind of garden takes an almost fixed amount of work, regardless of the size of the working group.

Burning operations take as much as double the amount of labour used in clearing. As this is a women's job, the Bellonese men claim it is naturally a somewhat slow phase of the work.

Splitting the firewood for killing trees is a hard, but necessary task. Skill plays an enormous role in the expenditure of labour used in burning. Experienced people use similar labour hours in burning, claiming that rushing endangers the quality of burning, so decisive for good results.

Digging and planting must be assessed together. They are often undertaken the same day and are carried out in largely similar ways. Strong, experienced people are capable of digging twice as fast as others. Usually the composition of groups is rather similar. Labour spent on digging and planting therefore varies only little per ha. Planting must take place before rain washes away any of the valuable ashes left from the burning. This point is very important as a background to understanding why the total work force must be large when planting. As the success of a yam garden depends on the speed of work when planting, a large working capacity is decisive for the final results.

Staking and trailing vines on stakes, are always done for certain crops. Failure to do this seriously effects a yam harvest (yields are said to be halved). Staking and trailing involve aesthetic considerations which are important enough to induce extra efforts. Undoubtedly weeding represents the greatest variable in labour input. The weeding of the taro gardens sampled (see table 9 column 6) was in excess of normal. Even the planter himself admitted that the extra work would probably not pay off in a larger yield, but he correctly added that his chances to remedy damages as by insect attacks were better. The young generation is weeding less than more mature gardeners.

All reservations considered, a few features may be summed up concerning labour requirements: 1) Yam gardens require from 1500 to more than 2000 hours of work per ha.; a relative high demand for work. 2) Taro possibly requires less work per ha. and 3) Bananas require very little work per ha. 4) With sweet potatoes it may look as if work requirements are very low, namely if they are cultivated immediately after yams. If cultivated 'alone', sweet potatoes demand as much work as do yams. From these observations it is seen how tempting it is to cultivate sweet potatoes in the yam fallows.

To ease interpretations, the data have been presented graphically (figs. 41 a and b). In fig. 41 a fallow areas are not considered, whereas they are included in fig. 41 b. As yields of the different

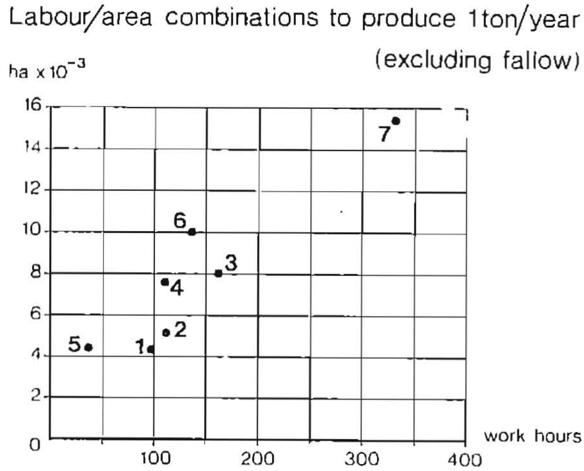
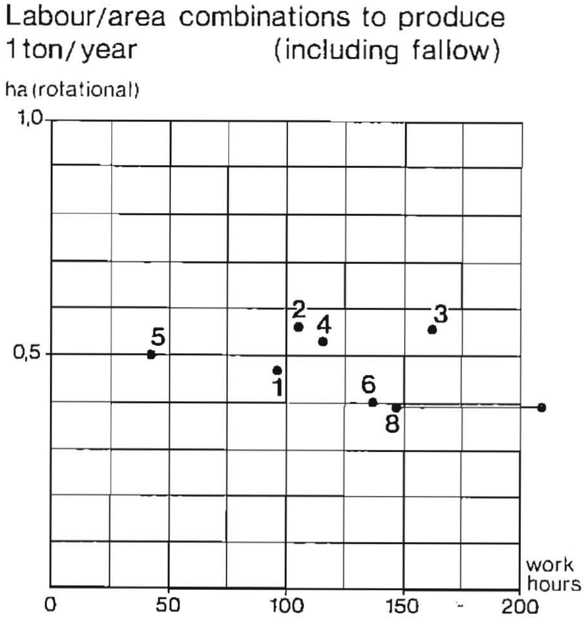


Fig. 42. Input-combination figures for the gardens of table 9. Diagram to the left shows figures disregarding fallows, these are included in the diagram to the right. The numbers in the diagrams refer to the samples of table 9. See also text to fig. 41.



garden vary, data are hard to compare for further analysis based on the graphs.

Areas and work inputs combined to produce a ton per year are shown in fig. 42 a and b. As composition of the different crops is similar, it is permissible to compare raw weights, at least if they are regarded solely as calorific sources. Assuming no land shortage occurs it may be adequate to consider fig. 42 a. Banana seems the most economical crop under this assumption, taro and sweet potato the least economical ones. The differences between the yams in the gardens analysed are only small.

In fig. 42 b fallow areas have also been considered. From the figure it seems that differences in total land requirements are small. Most demanding are bananas and some yam gardens, least so sweet potatoes. Variations in work inputs are more conspicuous with sweet potatoes as the most intensive cultivation and bananas as the most extensive. Yams are most rewarding on good soils, even better than taros; on less fertile soils the opposite may occur. Sweet potatoes are found to be choice if land shortage is pronounced. Combined with yams they are very labour intensive.

It is interesting that bananas, taros, yams, and sweet potatoes historically have been introduced into Bellonese gardening in that sequence (see appendix D). This may be interpreted as representing a development in gardening towards greater labour intensity and more continuous land use.

The trend in fig. 42 b is even more evident if it is remembered that the area requirements of bananas possibly are underestimated, and that sample 3 was considered aberrant. On the other hand, the scanty material does not allow for safe conclusions. A comparison between different crops is difficult to make because the soil factor has to be kept constant, as well as other environmental factors. Such demands can hardly be satisfied on Bellona, because a given type of soil usually is planted with a predetermined type of crop. Controlled field experiments are probably the only way to solve the question.

2.2 Gathering, collecting, and hunting

It was not included in the early plans to investigate the extraction of wild food on Bellona. Soon after the field work was started, it became evident, however, that wild food could not be left unconsidered as it contributed significantly to the total supply of food. There were two reasons for this: 1) Gathering, collecting, and hunting fill temporal gaps in food supplies; occasionally they have an important function as part of a survival technique that is vital on an isolated island. 2) Even with other supplies available, some amounts of wild food are procured because they are appreciated and easily at hand at certain times.

There are some serious obstacles when wild foods are surveyed. To identify the kinds of plants and animals of interest has its problems. Far from all Bellonese are experts in this branch of food production. Especially with the plants and animals used in extreme food shortages, the number who really know is very limited. Bellona had not experienced a prolonged scarcity since the 1930s, so the young generation had felt no strong incentive to learn as had the old one. With the help of some skilled informants lists were, however, soon established together with specimens of a large number of wild foods.

Another problem was to assess the volume of food gathered and collected. This proved very difficult. Estimates were based on reported number of days that wild foods were eaten and with normal consumption.

If the investigation is followed by 'participant observation' great care is necessary. Wild foods are sometimes obtained from difficult terrains, and in some cases it is difficult to distinguish edible plants from inedible ones. Local assistance is especially important because many poisonous plants may be mistaken for similar-looking food plants, as *hutu* for *banga hutu,* and *soi* for *abubu* yams.

A few words may be added on the terms describing 'extraction of wild food'. The Bellonese use the general word *haiba* for gathering, collecting, hunting, and fishing; these are sharply distinguished from cultivation and harvesting food. The prolific vocabulary specifying various forms of extraction of wild food includes words for snaring of flying foxes (*kamo*), netting of lobsters (*unga-unga*), of fruit doves (*senge*), of Pacific doves (*seu*).

In Western science interest concerns descriptions of other aspects of 'extraction'; but the vocabulary is (at present?) much less developed. There are terms for animal extraction (hunting and fishing), for non-systematic extraction (gathering) against systematic (collecting). The latter distinction, introduced by Braidwood (1960) is not of general use, neither is 'foraging' for extraction for immediate consumption.

2.2.1 Gathering and collecting of food

Gathering is according to Braidwood understood as an irregular use of nature's diverse edible materials, whereas collecting is more developed, involving a recurring regular use of natural food resources following a planned, seasonal pattern. Both gathering and collecting are practised on Bellona. Apart from theoretical interest, gathering and collecting deserve to be mentioned here, because almost every year for a month or more these activities provide the bulk of available food. Even in the months when the yam harvest is reasonably good some wild produce is used either together with yams or separately. Acquiring this produce often has the characteristics of gathering since it simply consists in picking fruit, as papaya (*mami-apu*), Morinda (*nguna*), and Spondias fruits (*bii*). Usually the fruit is picked haphazardly when it appears to be ripe by anyone passing by.

Many edible fruits are gathered in this way. Immediately before and after the yam-harvesting season one may refer to the utilization of wild produce as collecting. Several months after a yam garden has been harvested the germinated tubers or bulbils (*hetui*) left over from the harvest are collected. Because the Bellonese tend to leave small tubers unharvested, the quantities collected from such a garden can be quite large. No specific counts of yams thus collected were made because of the difficulties of surveying a stream of supplies of such an intermittant character, but on one occasion it was noted that children collected four baskets of small tubers (about 80 kg) from a recently fallowed garden of 12 *potu* (approx. 720 m^2). Experience from surveying yields of gardens was similar in that large amounts of tubers were normally left undug.

The activities just mentioned continue through the fishing season and are very much appreciated then, since the demand for mixed 'supplementary' food (*kai kiki*) is great.

When the garden supplies run low, and especially when a real scarcity (*kangakanga*) begins, the search (*nguki* or *haiba*) for wild supplies again changes character. Some supplies are still collected, such as *ghape* vines that may yield a major part of the food consumed for several weeks; also the left-over cultivated food plants are still collected. But the search grows more intense. Gardens which have lain fallow a long time, are now revisited for self-regenerated food plants which may have developed new tubers. As the period of scarcity lengthens more and more of the supplies are taken from the forest. See appendix B for the names of most exploited plants during scarcity times. Normally many of these are not eaten because they are less palatable, or more ofte because they require special treatment to remove toxic contents. Bellonese activities may be said to become increasingly archaic as a famine develops. Almost forgotten plants have to be brought to mind, and cooking techniques have to be re-learned. For example the use of bulbils of Dioscorea bulbifera L. (bulbil-bearing yams) has not been practiced since the 1930s but is still remembered.

The extraction of wild food becomes more and more improvised during scarcities, in contrast to the regular seasonal collecting. Even when sufficient garden produce is available, the collecting of food is seasonally sustained. Possibly this is due to the high nutritional value of the collected food. The change of diet means probably an extra supply of minerals, vitamins and proteins with different amino-acid patterns. From the extended list of collected plants this explanation may find support, but quantitative analyses are still unavailable in the area.

For many of the scarcity/gathering activities there is a very specific, traditional terminology. For instance picking *kala* nuts is called *'uinga kala,* and cutting *ngeemungi* branches in order to pick the fruits is *hati ngeemungi.* The young, edible vines of the *ghasigho* plant are called by the special name *pulo,* and the edible stage of the *mango* plant is *beeghini.* The vocabulary has its origin in an earlier culture stratum where emphasis on gathering was greater. Possibly the existence of a specialized terminology helps to fix elements of the gathering techniques in the minds of the Bellonese and helps to make the knowledge ready at hand during scarcities.

2.2.2 Hunting

Animals also are important on the Bellonese list of food supplies. Both terrestrial and marine animals are gathered/collected. See appendix B 4 for a survey of major utilized species.

The terrestrial fauna is poor as to number of species, hence both gathering/collecting and hunting of land animals are much less inviting than similar activities preying on marine animals.

The largest land animals gathered and eaten are various crustaceae. Both the Coconut Crab (*akui*), the Great Land-crab (*ango*), and the Hermit Crab (*'unga*), were eaten on Bellona traditionally; nowadays they are tabooed by one of the missions on the island. Especially the Coconut Crab is, however, still eaten by many people and considered a delicacy. Besides the gathering of crabs, only that of insect larvae was of some importance traditionally. Still the longicorn larvae (*ahato*) are eaten by some Bellonese, but apparently the number of suitable old trees for the wood-boring insect larvae is rather small nowadays. Such trees were climbed with climbers, and thoroughly inspected by tapping (*lapa*).

The number of land animals hunted is almost as modest as that of those gathered. Flying foxes (*peka* and *puli*) were occasionally hunted, and *peka* still are. Simple but efficient hunting methods were used. An implement (*kama*) was described by Birket-Smith (1956 p. 80). It resembles a giant brush with a 3–4 m long handle, and *ue* brambles at its end to entangle the prey. Flying foxes are now hunted very little even though they take a heavy toll of the papayas of Bellona, as the SDA mission does not permit them to be eaten. Also some birds are hunted: doves and pigeons, lories (*sibingi*) together with some marine birds. Most important were and are doves. They were netted with large hand nets (*seu*) from platforms (*hata*) made in strategically placed trees. Great prestige was attached to netting; the fortunate netter often secured himself some doves for his perches (*sakanga*). Doves were a food reserve and a symbol of status. Traditions of large catches generally relate to remote ancestors (Canoes T66). Nowadays birds are more often hunted with shotguns or catapults. No land mammals and reptiles are hunted, and the importance of hunting is quite insignificant in total food provisions and almost nil as to both doves and flying foxes. At least during about one year's reported activities, hunting was not reported in a single case as 'main activity during half-a-day'.

Marine fishing is as difficult to distinguish from gathering/collecting as is terrestrial gathering from hunting. The main difference is that fishing rests heavily on the use of implements developed for that particular use. (For fishing see paragraph 2.3.)

Marine gathering activities are almost all properly termed collecting, because they involve a planned search, often in a routine pattern, of the reefs usually at low tide. The main yield is molluscs, crustacea, and a few kinds of echinoderms. A long list was easily made encompassing these animals, but their identification has proved to be difficult since no accompanying species collection was made simultaneously. The lists in appendix B-4 mention only some of the most remarkable species.

Collecting by patrolling the reef (*haangota*) is especially performed by women. Before the advent of the SDA mission, some of the most appreciated animals collected were crustacea, as Spiny Lobster (*tapatapa*), and molluscs as Turbo Shell (*angingi*), and Horseshoe Clam (*haasua*). Also octopuses and squids (*heke* and *nguuheke*) were taken when possible. Many shells were gathered for later use for utensils as scrapers.

On present-day Bellona marine collecting has lost some of its importance. There is certainly a rather large potential: a couple of men were able to collect a bag of crayfish weighing more than 10 kg in about five hours night work on about two kilometres of reef length. If distribution of crayfish is even, total yearly catch may attain between 5 and 10 tons per year for Bellona, assuming 2–4 hours a night for catching. If the stock of crayfish is stable under such heavy taxing is, however, questionable. It is presently a question of academic interest only, as catches are much lower because of the religious taboos already mentioned.

To evaluate the economy of gathering/collecting only little material is available. The work-diaries contain an approximate record of the time spent in such activities. Estimates are based on records of work and information on yields of a few collecting trips. No great accuracy may be achieved in this way; but as the total output of collecting is quite limited, the errors of the estimate cannot influence essentially the estimates of total food production.

With the more haphazard gathering – as picking and eating on the spot of any available fruit – data are totally absent. Even though some Bellonese are seen eating a lot of gathered fruit during a day's work, the total amounts are believed to be small. At least the extra time spent with such gathering is apparently quite insignificant. An exception is the contribution to food supplies by the highly esteemed *ngeemungi* trees (various kinds: Santiria, Haplolobus, Canarium?). Such yields have not been estimated because they are infrequent and nonseasonal: in fact no observations of harvests were made during the two field work periods. Still, the total output is small compared with that of other sources, aside from the fact that only about two hundred mature *ngeemungi* trees were noted. (Total amount of fruit trees in 1965 was about one thousand, excluding coconut palms.)

2.3 Fishing:

(*tautai, haangota*)

2.3.1 Scope of the investigation of fishing

No evaluation of the fishery resources available for exploitation by the Bellonese is at hand. Calculations can be made for the area accessible for Bellonese fishing by analogy with the productivity of similar ocean areas. The area to be considered is limited to a maximum of about 4,500 km^2, since canoes are paddled to the fishing places and back, and the duration of a single expedition rarely exceeds 12 hours.

Even if an assessment of fishery resources were available, it would probably be of limited value unless it were very specific. Many of the important species in Bellonese catches are migrant species of which it is hard to assess potential catches. Further it would be interesting to know the potential catches of those specific kinds of fish that Bellonese fishermen may actually catch. From the occurring potential and actual catches fishing efficiency could be evaluated; this, however, would be possible only where intensive fishery research had been carried out through long periods. Presently only modest information has been obtained on fishing in places similar to Bellona.

On Bellona information has been collected concerning kinds of fish caught and fishing techniques applied. It has further been attempted to assess the amounts of fish caught in a few sample periods. Combined with the time spent with fishing, an estimate may be made of total catches.

2.3.2 Kinds of fishes caught

In 'Natural History of Rennell Island', vol. 1, T. Wolff (1958) gave a list of systematic and vernacular names of some Rennellese fishes. In 1965–66 it was attempted to ascertain that the list was usable also on Bellona, and possibly to extend it. Unfortunately, we had to realize from the start that safe identifications could only be made if collected specimens could be brought back for further examination by experts. As that was impossible, we had to rely on another, less satisfactory method: identifications on the spot from printed sources. To that end, Titcomb and Pukui's 'Native Use of Fish in Hawaii' (Titcomb & Pukui, 1953) was used. Some species were identified when caught, but others had to be identified from illustrations by local people. The illustrations were without colours, but they were apparently not missed by the Bellonese assistants. (R. Kuschel & T. Monberg, 1974, have shown that colour in fact is rather unimportant locally for characterizing objects.) Later R. Kuschel, using a far more encompassing book on the fishes of the Great Barrier Reef, did the matter over again and added many identifications and gave corrections to others. In appendix B-5 the resulting list is given.

2.3.3 Fishing techniques

Bellonese distinguish between day and night fishing according to the implements used and further according to the mode of transport used as canoe, walking on reef, or swimming. As usual on Bellona it is hard to find general classifications, but the specific terms concerning fishing methods, make possible a high degree of accuracy in the description of individual methods. Although many of the implements used are relatively simple, the great variety of techniques suggest a long period of differentiation. Several similarities with other Polynesian fishing techniques can be pointed out (see B. Anell 1955), but it is evident that Bellonese fishing methods lack some of the refinements of nearby Melanesian and Polynesian islands (Ruvettus hooks, kite fishing, etc.) However, Bellonese fishing techniques include some of those classed as the oldest in Ocenia, for example shark-snaring. Seen from a phylogenetic point of view, Bellonese fishing may be characterized as comprising a great variety of techniques, but in old forms with little specialization.

The distinction between day fishing (*tautai 'ao*) and night fishing (*tautai poo*) is used in the following brief outline with a further sub-classification based on the equipment used.

Day fishing (*tautai 'ao*)

On Bellona fishing from the reef is mainly done when the sea is calm; the slightly developed reef has few fish itself, but they can usually be spotted along the outer edge of the reef when the surf is not too strong.

A person picking up molluscs on the reef (*haangota*) can sometimes catch a few small fish with his or her hands (*ngangao*). This type of fishing can be combined with the use of poison. However, fishing with poison (*punu*) is usually carried out with a net, which is put over holes in the coral, where leaves of Derris (*luba*) have been placed. When – as is often seen – the hand net (*kupenga*) and other nets are used for fishing on the reef with poison, the activity is termed *sunaghi*. As the reef flat is very irregular and limited, the large seine nets (bugho) are not used on them. A popular piece of fishing gear is the multi-pronged fishing spear (*tao muungui*), or the wooden spear without barbs (*tao hua*). When the Bellonese go spear fishing (*bengobengo*), goggles (*ghaasi*) are often used advantageously because many fish hide beneath the overhanging reef edge. Sometimes hook and line are used from the reef, as from a canoe in the fishing technique called *aho 'angunga*, in which the hook is jiggled up and down. Fishing while walking on the reef is called *hakamatinga*. Very often reef-walking is interrupted by long intervals of swimming. Nowadays a common equipment while swimming consists of rather cheap and primitive goggles. Spear fishing with goggles and swimming (*ghaasi hanahana*) can go on for hours without interruption; the Bellonese have been trained since early childhood in swimming expertise.

Now and then they get sunburnt from exposure to the strong sun, and they can get very serious cuts from the coral. The traditional sandals (*taka ba'e*) used for reef-walking, and the old sunshields are now rarely seen.

Diving with the *kupenga* hand net also occurs. This operation, *sunaghi* and *ungaunga*, demands extraordinary swimming skill. Fishing with bow and arrow is never used, whereas its use is widespread in the nearby Melanesian islands.

Some types of hook and line fishing (*aho* and *hakamatinga*) are practised from the reef. To make it possible to throw the hook and bait far enough out, a sinker is often attached to the line. An interesting fishing method is *haamoe uka*; by this method a fishing pole is put on the shore, and the baited hook (*uka, ghau*) is taken beyond the reef by a swimmer. The hook is placed in the wanted position attached to the sea bottom, and the swimmer returns to the shore and waits.

Daytime fishing from a canoe may involve a net; the type of net employed is usually the large *bugho* net used in the same way as a seine or ringnet, i.e. as a means of fencing in the fish. It may also be used as a gillnet in which the fish get stuck while trying to pass through the mesh. Very few large nets are used nowadays on Bellona and then mostly for *pongo* fish or for catching flying fish in the daytime (*tangu*). More individualistic types of fishing are preferred, mainly because of the high cost of making and maintaining the *bugho* nets. Diving with swimming goggles is common; the spear is the most popular implement used in such fishing. Above all, the canoe is used for hook fishing (*hai uka*) during the day. Such fishing is termed *maata'u*. In *aho baka* fishing the line and hook are used trolling behind the canoe. The hook used is small in this type of fishing, but normally large hooks are preferred by the Bellonese. In modern times steel hooks are used. Traditionally sharks were caught with large wooden hooks (*ghau nga'akau*). This fishing type was called *a'ango*; shark fishing has now totally ceased because SDA does not permit shark meat to be consumed. The reason why hook and line is so popular is no doubt the possibility of catching large fish such as sailfish (*ika langi*), Barracuda (*angu*), Bonito (*bangukango*), Horse Mackerel (*hu'aaika*), Small Bonito (*'atu*), and others. Formerly the line used was always sennit (*kaha*), but now nylonline is almost the only type seen. To prevent losing the line, and to keep it orderly, it is wound on a piece of log. Even though the lines are handled with great care, when large fish are hooked, the hands of the fishermen often get desperately cut by the line.

When a short line and small hook are used, as is often the case, the fishing is termed *siisii*; it is performed both from the reef or from canoe and day or night. Most refined is *hatuangi* fishing, in which the hook has a special wrapping (*ngaukei*) to protect the baits until it has reached its position. Usually this type of fishing is done from canoes. The leaves used for the wrapping unfold slowly, and the baits are released when on the bottom. Only one of the baits is attached to the hook, the others serve to attract large bottom fish such as bonito and trevallies.

Night fishing (*tautai poo*)

This way of fishing is considered most effective on moonless nights when the sea is calm. Very often during the season (*ta'uika*), fishing continues night after night usually with the aid of torches (*ngaama*). Often fishing is done by walking on the reef, using a *kupenga* net for catching small fish as *nga'ea*; such fishing is called *baaloaghi*. Crustacea are also caught in this way, a fishing technique called *ungaunga*. Also hook and line fishing (*siisii*) is practised from the reefs, though usually from canoes (*siisii baka*). The largest catches on Bellona are obtained from torch-light fishing from canoes for flying fish. On nights of suitable wind direction, or better of quite calm weather, relative high temperatures and no moon, many torches may be seen flaring over the pitch-dark water. Around the torch-carrying canoes of the large *baka 'eha* type there is usually a company of three smaller canoes (*hua*). This arrangement (see fig. 43) utilizes the expensive torches to the full. A set of special rules regulates the behaviour of the canoe men to avoid quarrels; for example the area in front of the *baka 'eha* canoe is taboo for the *hua* canoes. With hand nets, two *kupenga hangahanga* nets at the ends, and one shorter *kupenga kaumatu'a* net at the middle, the three members of the crew of the big canoe shovel flying fish into the canoe. A fourth member of the crew is fully engaged in firing the torches. The small canoes are manned by crews of one or two men and cannot accomodate torches.

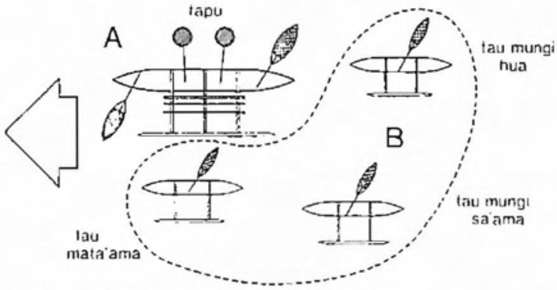


Fig. 43. A fleet of canoes, *kaubaka*, for catching flying fish. The large canoe A carries the torches; only A is allowed to catch to its starboard side and its fore. Three small canoes B utilize the torch light behind and to the outrigger side (port) of A.

Several other variations of the methods mentioned above exist, but the types described are those of greatest importance. Individual catches are intermittent, although sometimes comprising spectacular weights, but on the whole the cooperative flying fish catches are great enough to change the normal pattern of village life, usually for an interval of a week or more.

2.3.4 Importance of fishing

From the preceding paragraph and from work diaries it can be seen that the Bellonese devote a conspicuous part of their working hours to fishing. Still it appears that the amount of fish caught is quite small, especially if the seasonal catches of flying fish are disregarded. Undoubtedly the return in weight of food from fishing compares unfavourably with that from work in horticulture. The interest in fishing must then be explained by the fun and sport of fishing and the chance to gain prestige. Also the special nutritive value of fish with its high protein content (including many different amino acids) immediately comes to mind as a special incitement to go fishing. Further, fish is considered delicious food. It must be added that in fishing the basic costs of manufacturing equipment and its upkeep (foremost canoes) diminish returns further.

2.4 Food processing

From remarks added to the list of food plants (see appendix B-3 on utilized plants arranged after uses) it may be inferred that food (*utunga*) generally is cooked before being eaten. Exceptions from this rule are mainly the many kinds of fruits from trees, but they form only a fraction of the total food supply. The predominance of cooked food may partly be explained by the fact that much Bellonese raw food material contains throat-irritating or toxic elements. Often the poisonous contents are easily destroyed by heating; also a technique learnt from the *hiti* is used. By this the food is soaked for a period up to a month, sometimes after initial and nearly always with a final thorough baking. Apart from its use as a detoxicant, baking naturally makes food more palatable. Even sweet fruits such as papaya are often cooked to be tender (*moso*), a much desired quality. In contrast to elsewhere in Polynesia, fish are never eaten raw.

The importance of kitchen work is obvious from the fact that it occupies more than 25 % of the Bellonese women's total working hours. Part of the preparation is easy. Most of the root crops are not peeled, but merely cleaned by wiping or by slight scraping with the scraper (*tuai*, see Birket-Smith, 1956, fig. 41). Some of the seldom used, emergency foods must not only be peeled but also sliced, placed in baskets, and soaked (usually in the sea) for one to ten days before they are ready for cooking. Some fruits receive pre-treatment before baking; with some of them the kernels are cracked, but as a rule preparing food for cooking means little work.

Cooking takes place in a separate hut called *paito*. It involves three different types of 'ovens'; *'umu tanu*, the traditional Polynesian earth oven; *'umu ta'ota'o*, a variety of the earth oven i which the earth cover is replaced by other material, nowadays often a sack, and *'umu tini* which is the modern European type of boiling meals in cooking pots, or using frying pans. Other methods of long tradition are a way of roasting on a controlled fire (*tunu*), and smoking (*nganga*).

The earth oven is made by heating suitable coral chips on a fire and placing them in a pit by means of primitive tongs. Food wrapped in large often fragrant leaves is then placed on the stones, some sea water poured on, and the whole covered up with earth. After steaming for up to 6 hours, some food parcels (*'ahii*) are unwrapped and tested to make sure the food is properly cooked. Normally it is, for long experience has taught the Bellonese women to start at the right time, just after midday, to have food ready for everybody an hour or two after sunset.

Some of the most common Bellonese dishes

Pota, a traditional dish of cooked leaves especially taro leaves (*ngau tango*), hibiscus leaves (*kookona*), leaves of a wild vine (*ghape*), or *manongi* leaves (young shoots of the *ghaapoli*-type of Ficus), again wrapped in banana or *tii*-leaves. Some *pota* types are especially delicious, as one made of young, tender taro shoots (*ungi*); it is an expensive dish. Nowadays *pota* is made with coconut cream, which adds greatly to the taste. Also other foods are now often mixed into the *pota*. Among the newly introduced plants, sweet potato is one of the few whose leaves are considered good for *pota*.

Lengalenga, a taro dish in which both roots and leaves of taro are used. It was probably introduced from Malaita after World War II and is very popular.

Tokonaki, a kind of pudding, made from raw, grated taro (see *songo*) mixed with coconut cream, and when baked, wrapped in large banana leaves.

Apart from these dishes, the earth oven is used for cooking almost any type of food: fish (*kaui*), poultry (*paulo*), and even foods like papaya and bananas which can also be eaten raw.

The *'umu ta'ota'o* is seen most frequently. It is said to produce somewhat drier meals, and to be especially suitable for cooking oily fish, probably because the light cover allows vapours to escape.

'Umu tini, food cooked in aluminium pots and frying pans, is considered inferior to that from the traditional ovens, but much easier to make, and the method is especially good for boiling corn cobs.

Some traditional food recipes do not require the use of an oven. All foods to be roasted in a small fire or on the glowing charcoals belong to this group. Flying fish and other fat animals, including the Coconut Crab, are preferred roasted, since this method retains more of their fats. Such foods are considered especially delicious by the Bellonese (and by some Euro-Americans too).

Songo (pudding) is one of the few traditional dishes made without heating; it is almost an essential ingredient of communal feasts, as at the New Year. Raw materials are pre-cooked taro- or yam-roots and coconut cream. The taro is grated and mixed in a great wooden bowl (*kumete*, see Birket-Smith, fig. 45). The grating of the coconut endosperm, and the subsequent wringing out in bundles of *hau* fibres or coconut cloth must have been an arduous task before iron graters were introduced, although shell graters (*tuai hasi*), are said to have been quite efficient. Previously taro was almost solely used for the traditional puddings, now not only the recently introduced manioc (*lioka*), but also old tubers including the various yam types are accepted as ingredients.

For preparation of *ngeemungi* oil a special technique is used. The drupes are placed in a bowl of boiling water heated by the immersion of hot stones, a process called *tio*. The extracted oil can be decanted after some time into the usual coconut containers in which it will keep for several years. Afterwards the skin can be removed from the stones, pounded into a pudding and eaten, and even the kernels can be utilized after cracking the hard shells.

Apart from making *ngeemungi* oil, no preserved foods are made on present-day Bellona. An ancient preservational technique, the preparation of sour taro paste (*puke masi*) is now obsolete. Only few living Bellonese have ever tasted it. Pits, about one metre in diameter, were dug in the ground, furnished with a lining of banana leaves, and a paste of cooked taro was placed within. Afterwards coconut cream was poured upon it, and the pit sealed with leaves.

Losses during food preparation

Losses during the preparation of yam or taro tubers are normally less than a few per cent. These losses were determined in a few cases, but only from the scraping process, since only changes in water content seem to occur during cooking. An attempt was made to weigh the remnants left after eating the same food stuffs. Almost everything was eaten, the exception being when the skin had been baked too hard or was blackened by direct contact with the hot stones. Such leftover pieces were thrown to the chickens. Still it seems clear that usually less than 5 % of the raw weight of edible tubers was lost!

Losses for other food stuffs were definitely greater. This is especially true for fish and chickens, the unedible remains of which were estimated to be about 20 %. Internationally 20 % is a low cipher; the general percentage of losses on Bellona of round 10 % is therefore modest.

Food-processing work

One of the hallmarks of an independent household is that it eats from its own oven. When a household, even temporarily, is without housewife or husband, it often stops to make ovens. Also aged people eat from others' ovens. Thus the number of ovens made per day is usually much less than the number of households.

Also the making of an earth oven usually involves cooperation among a number of households. The working groups appear to consist of two to four women, wives and grown-up girls of the same village, but others may join in, for example the bands of young girls wandering between the villages. In a few observed cases the preparation of an oven took about four hours for four women, occasionally assisted by conversating visitors. The work included the heavy task of providing an adequate supply of firewood, which is usually a hard job, even though men supplied fuel. The preparation of the oven itself took about an hour's cooperative labour, the least part being the ignition, the arrangement of the food parcels in the oven and the covering up. Heating the stones took less than half an hour, but it required constant attention. Usually people only eat hot food once a day, most often in the evening. In the morning only cold food is taken, and there is no lunch.

From the diaries the hours spent in food preparation seem to be greater than when estimated from the number of ovens likely to be made in the villages concerned. Over-estimation is highly probable for major tasks, like making ovens, because the reporters tend to concentrate on 'important works'. However, the numerous tasks involved in, but not directly classed as oven making, should at least partially make up for this tendency towards overestimation. A more accurate determination of the time spent in food preparation will require a better classification of the work involved, which was beyond the scope of the simplified method used in the 'work-diaries'. The average Bellonese housewoman seems to use about two hours per day to prepare food, which is considerably less than the housework hours found from the diaries.

To conclude this brief survey of food preparation it should be pointed out that the whole cooking process seems to be remarkably well planned. The cooperation between households economizes on the heat required, and just as important as this, it economizes on the hard labour and the fuel involved in making an earth oven. Since losses in food preparation are so small, it seems rational to carry the food to the homestead for preparation. The greatest transport problem is the carrying of firewood, which might be lessened, although at the expense of the benefit of having a good supply of ashes for the bananas and other plants growing around the homesteads.

2.5 Production of technical accessories to subsistence

At the outset of chapter 2.0 'technical accessories to subsistence' were described as non-food material necessities of the Bellonese society. Of course the scope of the concept 'necessity' is somewhat arbitrary; it depends on acceptable standard of living, which is difficult to define. In the present work 'necessity' is taken as similar to what the Bellonese generally live by and accept. In a relatively primitive society few luxuries occur, and they may be disinguished from necessities without too much difficulty. The making of climatic shelter of accepted standard and of the implements necessary to produce food at the accepted level of work inputs are considered to substantiate 'technical accessories to subsistence'.

It goes almost without saying that only the most important items of Bellonese material culture have been mentioned in the following.

2.5.1 'Climatic shelter'

Previously firemaking was achieved by means of the fireplow *(nganiabi)*. Although the art is still widely known and leads to the desired results within a few minutes, matches are greatly preferred; though infrequently used because fire usually may be borrowed from a neighbour. Lighting of fires for bodily comfort is still done on Bellona, possibly les frequently than before the introduction of better clothing and houses. As fires are often of multiple uses, their making is here disregarded.

Before World War II clothing was of the usual Oceanic *tapa* (bark cloth) type: a loin cloth *(kongoa)* and little more, except for a turban occasionally worn by the men. The last man to use *tapa* regularly on Bellona, Tango'eha, died about 1963, and since then *tapa* has rarely been made. Manufacturing methods are still known, however, so it was easy to collect details about it and about the raw materials used (see appendix B-3). Nowadays the materials for the scanty clothing worn by the Bellonese, shorts and shirts by the men, dresses by the women, and very little by the children, are always imported. One informant claimed that the import of cloth was one of the most labour-saving innovations in modern time, almost as important as the introduction of steel axes and knives. Before, he said, the strokes of the tapa beaters were heard almost all the time, and people were always on the search for trees from which to take bark for *tapa*. The reason was that *tapa* could not be washed; it was thrown away when dirty. Now, usually only dresses are sewn on Bellona, since men's clothing is bought ready-to-wear abroad, most frequently in the Chinese stores in Honiara. To cut and sew a dress is a quick affair, completed by two women in between a half to one day's work, using calico worth about 5 $. Clothes are very rarely repaired, and are literally worn to threads before being thrown away.

Other 'climatic shelters' are used at night, which are locally considered rather cold (sometimes 17

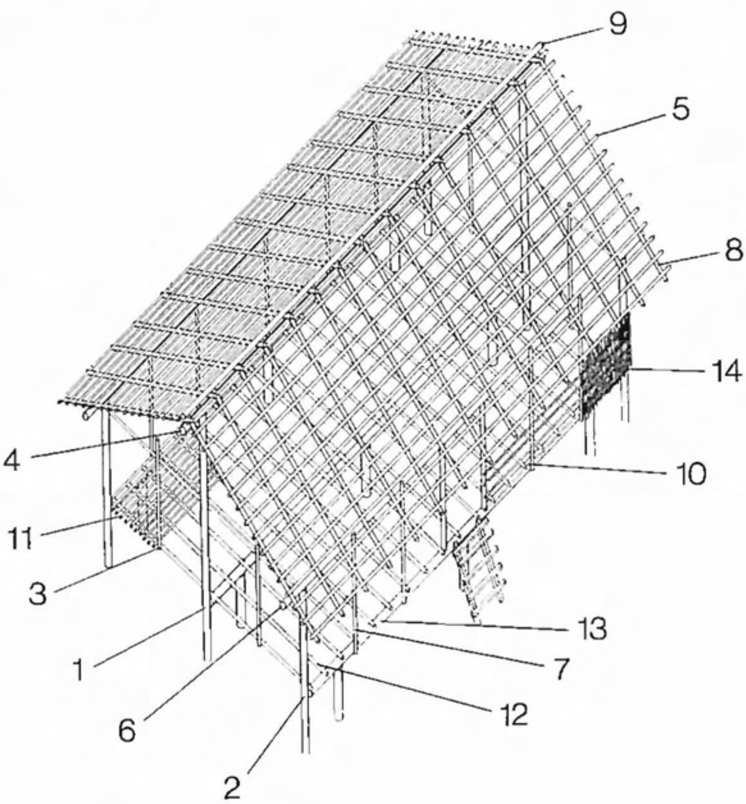


Fig. 44. The different parts of a living house: 1) Main pole, *pou tu'u*, 2) Corner pole, *pou taha*, 3) Gable pole, *pou tanga*, 4) Ridge pole or purlin, *ta'ohuhu*, 5) Roof beam, *kaukaui*, 6) Head beam, *kaukaui ngango* or *sasanga*, 7) Wall pole, *kaso*, 8) Spar, *huaa kaso*, 9) Upper ridge pole, *ta'opatu*, 10) Wall stringer, *kaukaui*, 11) Floor, *sangiki*, often made of rattan cane, *'ue*, 12) Floor beam, *kau poloa*, 13) Sill beam, *kau a papa*, 14) Thatch panel, *mata-angau*.

to 19°C). Although the use of 'European bedding' is well known to the Bellonese, sheets and 'boy's blankets' have far from displaced traditional sleeping mats on the island. As a mattress almost all Bellonese use a pandanus leaf mat (*baghu*) sewn together. It is cheap to use, takes only a few hours to make, and is decidedly comfortable since it offers some insulation from the occasionally damp and draughty floors of the houses. Every Bellonese owns at least one *baghu*, which is kept dry by sunning and sometimes by heating over a fire. While sleeping the Bellonese like to wrap themselves (*tubi*) in soft mats (*malikope*). These mats are plaited and like the *baghu* type (discussed in Birket-Smith, 1956 p. 98 ff) made from the leaves of the small pandanus palm (*kie*) fig. 52. People of status sleep under large *malikope* mats (always at least a full fathom (*ngoha tasi*) long and a half fathom (*toghi hatahata*) wide, sometimes with elaborate designs of in-woven black strips of *tai* banana fibres. A normal-size mat takes about a full week for at trained woman to make: collecting leaves (*saasanga ngau kie*) drying them over a fire (*baalui kie*), and plaiting them (*ngangańga malikope*). Fortunately *malikope* mats last for several years. Many Bellonese have such mats; possibly about 200 mats are used throughout the island. Bellonese abroad often use European bed clothes, which are also more and more common on the island. The mats last about 10 years, much longer than imported bed clothes.

Housing

In principle all Bellonese houses are constructed in a similar way the basic element being a roof supported by a set of poles. Two large poles (*pou*) are dug into the ground, after the house site (*'atinga*) has been measured off. The poles are concave at their upper ends to form a solid base for the ridgepole (*ta'ohuhu*). The foundations for the two long walls of the house are made from two set of poles carrying the beams. This stage (*hakaekeeke*) is illustrated in fig. 45 a. A number of spars (*kaso*) are then placed on the ridgepole resting on each of the beams (*sasanga*), and finally a layer of laths (*kaukaui*) is securely tied to this construction (fig. 45 b). Traditionally ridgepole and beams are fixed in position without the use

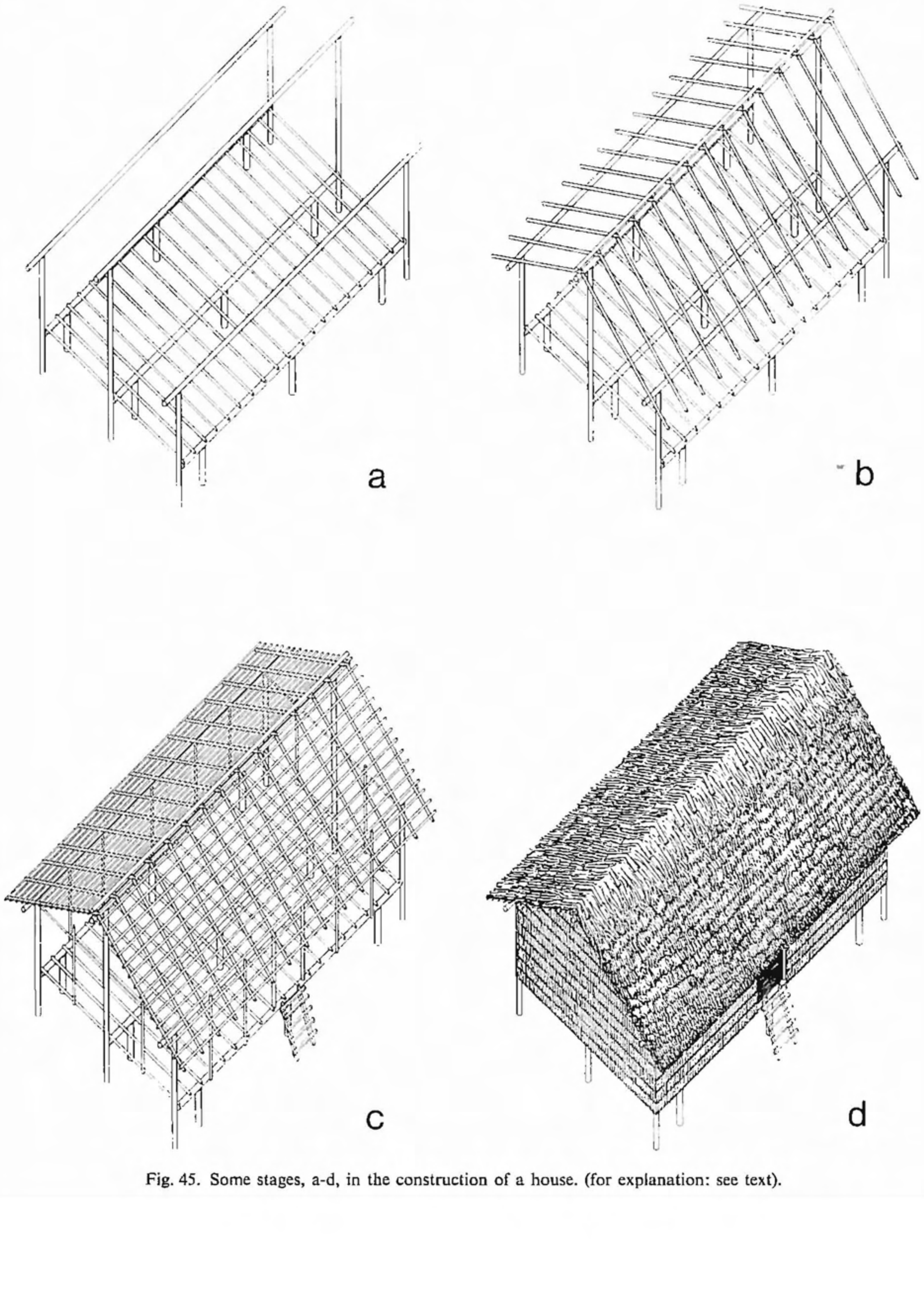


Fig. 45. Some stages, a-d, in the construction of a house. (for explanation: see text).

Fig. 46. Taupongi's house in Matahenua of a construction similar to the house in fig. 45. Note the kitchen house, *paito*, behind and the *usi* bush in front. This small bush conveniently growing below the window has fragrant leaves used for rubbing hands after eating fish.

of nails; elaborate lashings of sennit or rattan cane connected the elements in a strong, yet flexible way. Nowadays nails are commonly used. If a floor platform is included, as it usually is, it is installed at this stage. (Sometimes it is independently built initially.) The finished house frame is often left for a long period. The roof is thatched with numerous sticks of pandanus leaf thatch panels (*mataangau*) tied to the laths row by row beginning at the eaves and going up to the top (fig. 47). Roof ridges are secured by special thatch, usually held in place by half-cut-through coconut leaf stalks (*ta'ota'o*) placed athwart the ridge, or by small piercing sticks. Sometimes coconut fronds are put on top of the normal thatch as a reinforcement or as a semi-permanent repair. The house ridge is difficult to make both lasting and leak-proof. An extra small ridgepole (*ta'opatu*) over the main one protects this and helps to fix thatch.

Up to this point all Bellonese houses are made in similar ways. The traditional house (*hata*) had no side walls (*paangaba*), but was in principle just a roof (*tu'aa hange*) with closed gables placed on a slightly elevated platform (*'atinga*). Inside the *hata* had a ceiling on which the owner sometimes slept. Part of the owner's few possessions were put on the shelf, part hung on strings and part simply stuck into the thatch of the roof. Only a few *hata* are left now (fig. 48 and 49) and new ones are very rarely built (one in 1972). More elements have been added to the Bellonese house, especially since 1938. First walls came into use. These were easily fitted into the traditional building methods by making the sides of the house higher. This simple type of house is now used almost commonly for kitchen houses (*paito,* fig. 48 c). Once walls were made, doors naturally had to follow, and later windows. After World War II it became fashionable to build houses 'on poles'. The traditional construction has been modified by erecting a raised floor platform (*sangiki*) inside as seen from fig. 48. Often this is still an independent element unconnected to the rest of the house. The floor is usually made from imported rattan canes

Fig. 47. A thatch panel, *mataangau,* is made by folding pandanus leaves over a stick. The leaves are firmly secured by being pierced with a midrib from a coconut palm leaf.

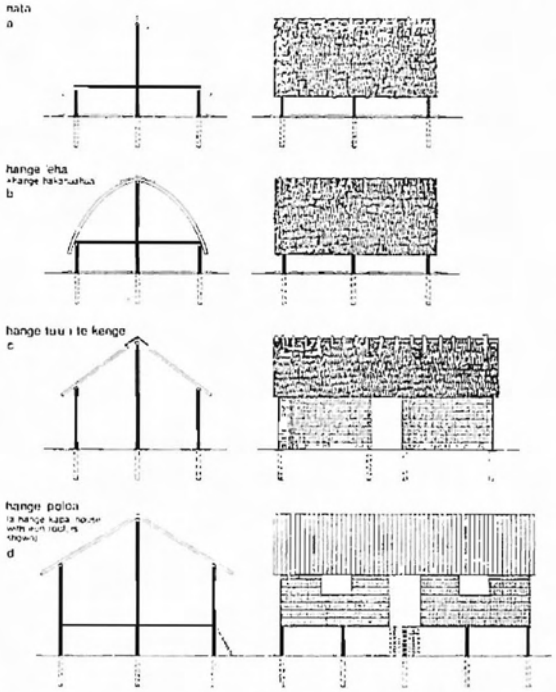


Fig. 48. House types from Bellona. a: A traditional house, *hata*, about 2 m high. The interior shelf was used for sleeping. b: A chief's house, *hange 'eha*; its curved rafters were a sign of high status. c: A house type similar to modern Bellonese kitchens, *paito*, with high walls. Temporarily families may live in a kitchen house. d: *Hange poloa* (*poloa* = floor, from English). Such houses have often iron roofs.

(*ue*), tied to the floor beams. Although the houses become rather rickety through the elongation of the poles, few attempts have been made to reinforce the construction by integrating the floor construction or by the addition of oblique braces. On the contrary, the construction has been widely accepted with all its drawbacks. Recent building innovations include the use of corrugated iron for the roof. These also have been accepted although their complete lack of insulation make the houses less comfortable to live in.

Apart from the types of houses mentioned above, some variations must be mentioned. Even before Christianity prestige houses were built. A large house indicated many inhabitants or supporters and was thus respected. Normally nobody would enlarge his house beyond what was strictly necessary because of the big expense of upkeep. An alternative way of expressing or establishing superior status was by owning a *hange hakahuahua* house, which had curved rafters (see fig.48 and 50). Since the rafters had to acquire the curved shape by natural growth, they had to be carefully selected. Often they were presented as gifts by the builder's kinsmen. The prestige house had additional comfort, since its single room had better head room thus allowing people to walk upright for nearly the whole floor. Further its cost and upkeep were only slightly more than for a common house, always provided that the builder's enterprise was matched by sufficient observant people to supply the proper rafters.

Another type of house, of ancient origin, but still much used, is the small leaf house (*hange ngau niu* or *hange kaunga*) with thatch of coconut leaves or *baghu* pandanus respectively. As reported by Birket-Smith, this is a temporary structure

Fig. 49. A traditional settlement 1966: a *hata* seen from the main trail along the coconut palm-flanked side trail, *anga singa*.

Fig. 50. A stately *hange hakahuahua* 1966; Polo Sa'engeika's house in Kapata standing in a most impressive coconut grove.

often reduced to a simple lean-to made of coconut fronds. The leaf houses are often built for sick people and burnt after their use, a very sanitary procedure.

The changes from the *hata* type of house to the usual modern Bellonese house are multiple. Modern houses are larger, they have higher walls, doors, windows, and usally a raised floor platform and iron roof (fig. 51). All these innovations were introduced very fast, most of them from about 1947 to 1960. It is still uncertain what motivated the rapid changes in housing, although not in the basic principles of construction. The explanation offered by the Bellonese themselves suggests that the introduction of kerosene lamps was an important element. They created a possibility for indoor life in the evenings never thought of previously, and this again created the demand for dwellings in which it was easy to walk erect. Further the peaceful and more permanent settlement pattern which evolved after Christianity is part of the explanation. But the soil-floored, high-walled houses first introduced had very obvious drawbacks as living areas. In periods of moist weather these houses were damp, and the newly introduced tuberculosis found easy prey in such conditions. Houses built on poles are much better in this respect. In fact they are as good as the old *hata*, but they are very much more expensive to build and keep up. Their early success was partly due to their value as status symbols. They were soon associated with high rank, because the alien missionaries recommended them. Now almost all Bellonese live in houses built on poles (*hange*

Fig. 51. Modern house 1966; it has an iron roof and is built on poles. Shutters and door are made from plywood.

6

TABLE 10.

Work expenditure in making a house.

	No. of men	Time spent (day units)	Total no. of workdays
Making house frame, hange ngungu:			
Felling (taa) and preliminary preparation of poles (pou tu'u)	1	1	1
Carrying of poles	6	½	3
Digging holes for poles and their insertion	6	½	3
Putting up ridgepole (ta'o huhu), rafters (kaso), and laths	2	1	2
Thatching roof:			
Preparing thatch panels (mataangau)	12	1	12
Thatching ('ato hange)	12	1	12
Tying small sticks to roof and cover (tubi) and (tubi hange)	1	1	1
Cutting off thatch at eaves (toghi)	-	-	-
Making floor:			
Erecting the floor platform, cutting vines in proper lengths	2	2	44
Tying floor (samu sangiki)	2	1	2
Putting up wall thatch:			
Making thatch panels	12	1	12
Putting up vertical supports (nguumutu)	2	2	4
and horizontal supports (ngungu)	2	2	4
Thatching walls (ato)	12	1	12
Tying small sticks to thatch	1	1	1
		total workdays	69
(The adding of a ladder, doors, windows, etc. was done over a long period.)			

pou), even though many are of modest dimensions.

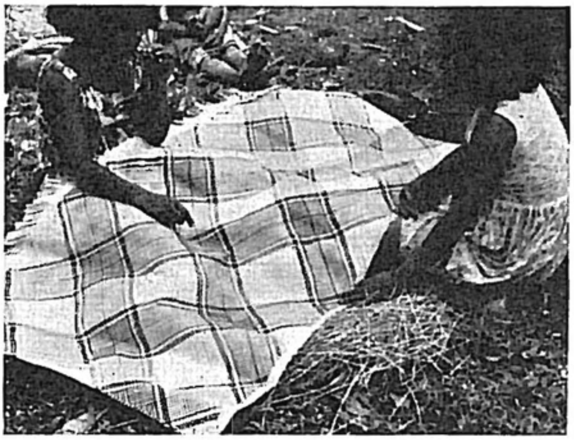
The higher standard of housing has resulted in a sharp rise in housing costs for the Bellonese. The amount of materials used in house construction has increased, and the best types of trees for poles, as *ghaimenga* and *tabai*, are in short supply. Even the pandanus leaves used for thatch can be a little difficult to get, as the areas for its cultivation are often needed for food production.

On almost every area near the villages suitable for pandanus growing, but too stony for food-cropping, thatchbearing palms are now planted. As thatch is heavy to carry, areas close to settlement are always preferred for its cultivation. Naturally, the islanders are eager to rationalize house construction. The use of corrugated iron reduces upkeep by about one fourth, as far as the replacement of roof thatch is concerned, but has the severe drawbacks mentioned before. It may be added that iron roofs make any inhabitant fully aware of even a few drops of rain falling on his roof, not to mention high winds!

The various changes in Bellonese housing have greatly influenced the cost of houses. Still they are, however, relatively cheap if materials and work for a 'normal' house are considered.

The sample construction was a 4-fathom (*ngaho ngima*) house in Matahenua, the labour figures for which are roughly given in table 10. Half days were used as time units, since work is often limited to that time span. Other samples closely resemble the one shown; a similar house built at Hatagua, on Rennell, took 66 workdays. It is interesting to note that making thatch sticks takes roughly a fifth of all the work invested, and the thatching operation another fifth. If the life of the house frame is approx. ten years, at least two roof re-thatching operations can be avoided if corrugated iron is used (fixing the sheets takes only a trifle

Fig. 52. a) Plaiting of a coarse floor mat from a coconut palm leaf.



b) Plaiting of a modern, fine sleeping mat, *malikope*, from Pandanus leaves with some banana leaf strips.

of time compared with the thatching). An iron roof can thus save approximately 30–40 workdays on a house that lasts ten years, and this from a total of less than 100 workdays spent on it. Corrugated iron is thus worth at least 50–100 workdays, as it can be re-used on other frames, since the iron lasts for more than twenty years on Bellona. From this it may be inferred that the use of iron roofs cuts expenditure of housing by more than one third. To this saving of work must be added the saving of land space used for growing, carrying, and preparation of the pandanus leaves. Further iron roofs are often used as catchment areas for watertanks, which adds to their usefulness. No doubt an iron roof also adds to the owner's prestige. The disadvantage of iron roofs is the price, about 50 $ per house. As the normal income a Bellonese could earn by working copra locally was (1966) about a dollar or less a day, the values of work saved and the cost of the iron roof were almost equal. Possibly the use of iron roofs was economically of little advantage, except as a means for accumulating wealth, and most people agree that leaf roofs are more comfortable.

In fact most iron roofs are bought with money earned by working in plantations abroad. In addition to the drawbacks mentioned above, another seems to follow the introduction of iron roofs: the need for 'sawn' timber. The sawing of timber would help to utilize forest resources better, but since sawing is not done yet, sawn timber is imitated by planing full timber, which leads to enormous losses of valuable hardwood. This occurs on an island where greater economy in exploiting vanishing timber resources is highly desirable (see note on *ghaimenga* timber in appendix B-1).

2.5.2 Means for production: implements and canoes

Implements for gardening

Implements used in horticulture are nowadays mostly of foreign make. From their introduction in the 1890s steel axes (*'aakisi*) especially the *'sainama'*-make of axes ('Chinaman'?) and bush knives (*kiba*) have, since World War II totally replaced the former stone or shell adzes (*toki 'ungi* and *toki susungu*). This resulted in a great saving of labour according to local information, parallel to that demonstrated in New Guinea by Salisbury (1962). Also in firemaking, imported matches have almost totally replaced the traditional firemaking tool, the fireplow. However, the most characteristic implement in horticulture, the digging stick (*koso*) has withstood all attempts at replacement. As previously mentioned, the digging stick functions well in the present type of horticulture. E. Boserup (1965) draws a connection between intensity in agricultural practices and simplicity of implements used; this finds support in Bellonese experience. Probably the invading grasses will put an end to the use of the digging stick, but such an occurrence seems to lie in the more remote future. The *koso* and its manufacture are discussed under horticulture. Because the work involved in making a *koso* is negligible, it is only occasionally reused. Of other manufactures used in horticulture, the making of leaf baskets (*pongaponga*, see fig. 52)

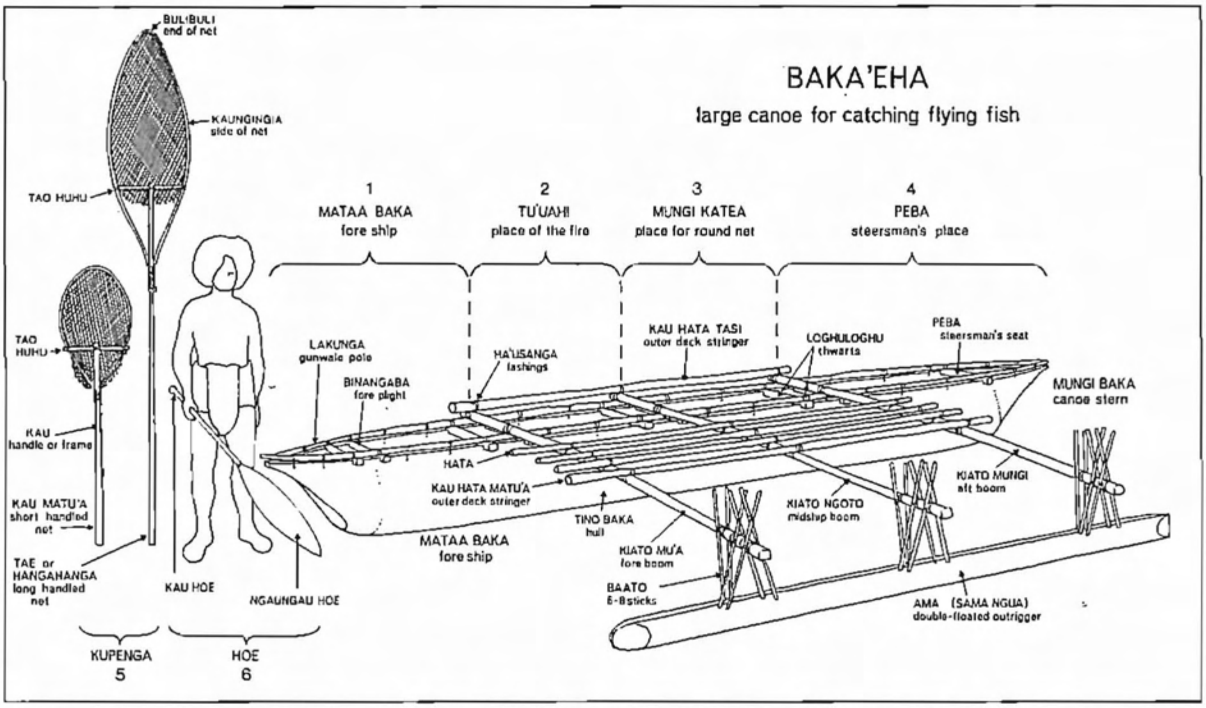


Fig. 53. A *baka 'eha* canoe; it is indispensable for catching flying fish because it is large enough to carry the necessary torches. To prevent cracking the hull is covered with coconut palm leaves. Two *kupenga* hand nets are also shown.

deserves mentioning, but since they too take so little effort to make (5–10 minutes) and their manufacture may more aptly be included with the relevant horticultural process, they shall not be discussed here.

Implements for fishing

As in horticulture, the post-war period has witnessed great changes in the use of fishing gear. Birket-Smith, during his stay on Rennell in 1952 was one of the last to see almost all the traditional gear still in use (Birket-Smith 1956). As mentioned previously the great wooden shark hooks are now obsolete as also the traditional small hooks (*ghau ngoku*) which have been replaced by the more effective barbed steel hook. Sennit fishing lines (*kaka*) and common lines (*uka*) have all been replaced by nylon lines, no doubt because of the outstanding amount of work involved in the manufacture of sennit. Spears (*tao*) for fishing are still made locally, but usually with iron prongs. The large seine nets (*bugho*) are now seldom seen; they are still widely used on the reefs at Rennell, there being about one per village. Those observed in 1965–66 were in a state of disrepair and no opportunity occurred to see the manufacture of such nets. In contrast the racket-like, smaller nets (*kupenga*) are still widely used. Hand nets are of three types: long-handled (*hangahanga*), short-handled (*kau matu'a*), and without handle (*kupenga ungaunga,* fig. 53). These nets are often seen being repaired. From the repair work observed, it is estimated that it would take at least three working days to make a new net. Nets need continued repair when in constant use, and it appeared that a complete replacement occurred every second year. Upkeep of a single net will thus amount to 1½ workday per annum. There are about 80 *kupenga* nets on Bellona, which involve a total annual upkeep of 120 workdays.

The torches (*ngama*) used for catching flying fish must not be forgotten, since they are indispensable in this important fishery. For the sake of economy they are made to burn intensively only in intermittant short periods, to give 'flares' (see fig. 54). A night's fishing will require about five torches per team of canoes, each representing half a day's work for one adult man, this including other preparations.

On any potentially good night up to twenty fishing expeditions will be operating. If about 20 nights a year are fully exploited, the work expenditure on torches amounts to about $20 \times 5 \times 20 \times 1/2$ = about 1000 workdays annually for the whole fleet. Understandably high-pressure kerosene lanterns are in vogue, but they are still too expensive to operate for most Bellonese, especially since their mantles are fragile and must be frequently replaced.

Canoe building

Canoes are indispensable for all the more economic Bellonese fishing methods. It is therefore not surprising that canoe construction is one of the subjects much planned and discussed on Bellona.

The two types of canoes built on Bellona differ more in size than in general principles of construction. The 'flagship' for catching flying fish (*baka 'eha*) requires much work to build (fig. 53 and 54).

The building of a new *baka 'eha* in 1966 for Sengeika Tepuke is described in detail. It does not deviate much from similar descriptions of Tesuatai's and Temasi's canoes and field observations (among others of Sanga'eha's new *hua* built in 1966). It took seven days to build the three-and-three quarters fathom (*ngoha tongu hatutungi*) canoe. Often building takes longer, but the fishing season was approaching, so the work pace was a bit forced. Many men were employed in the construction. How such large work forces can be enlisted is explained in paragraph 5.3. The commander (*te hakahua o te baka*) of that canoe, Sengeika Tepuke, has illustrated the various stages of the construction in fig. 54.

First day (1). A great *ghaimenga* tree near the Manakau trail in Ghongau had been selected for the canoe (Sa'aiho district had few suitable *ghaimenga* trees at that time, and the consent of the land owner to fell it, Paul Sa'engeika, had been acquired.) *Ghaimenga* trees have enormous plank buttresses, making them difficult to fell (*tua*). The cut was placed almost a fathom above ground. Ten men assisted in the felling, which occurred just after sunrise. Once the tree had fallen (*too*), it was partially barked and outlined (*titi*), and some preliminary hollowing (*ali*) was done. Already at 6.30 a.m. this part of the work was completed, and the work party was served food (*'oso hekau*). Drinking nuts (*polo*) were also given to the thirsty men.

Same day (2). A preliminary shaping of the exterior was made at the stern and great masses of

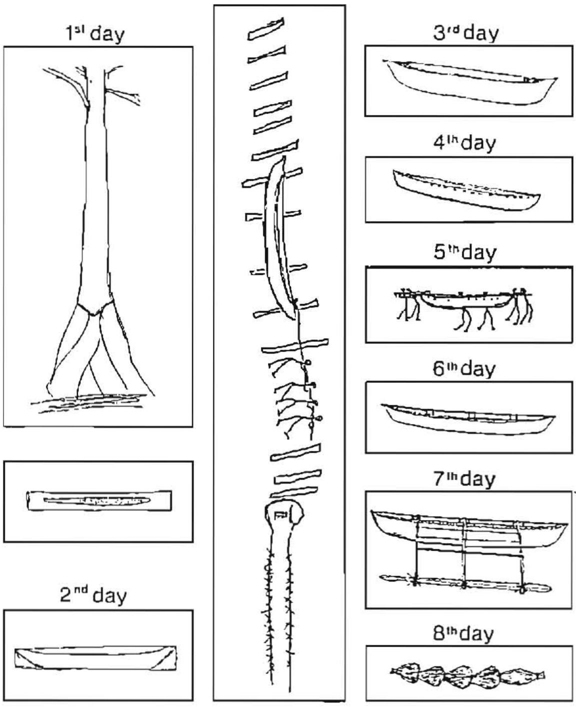


Fig. 54. Sketch by Sengeika Tepuke to show the making of a large canoe. In the middle is illustrated how rollers, *toso*, were used to transport the dug out to a settlement. On the 8th day the maiden voyage was made; several torches (as shown below, right) were used to attract flying fish.

the tree were removed to make the hull acquire the desired length (*potoi*) and to shape the ends finely (*sema*). Together with the preliminary hollowing made the same morning, this serves to ease the transport of the heavy hull. The early morning work force of ten was increased to thirteen, a convenient number for dragging the trunk on rollers (*toso*) from the forest down to Kapata (Sa'engeika's principal settlement). The half-days work ended with a food gift of 100 drinking nuts.

Second day. The first shaping of the hull (*tino baka*) took place. Adzes (*toki* and *sou*) were used almost exclusively to form the interior; the fine grained wood gives rise to a remarkably smooth finish. The two ends (*ngu potu*) of the canoe demand great care in shaping. At the ends the hull is only sparingly hollowed to give needed strength at these potentially weak points in a dugout canoe. Two seat-like platforms (*manu*) are thus formed. The sides of the hull are then made even, an operation called *tu'uti*. Seven people participated in the full day's work. As is usual, at least one old

Fig 55. *Baka 'eha* canoe on its landing place. The hull is protected against sun by a coconut leaf cover. Notice the strong, yet flexible fastening of the outrigger float to the booms by means of sticks. A short- and a long-handled *kupenga*-net is also seen.

man with acknowledged expertise participated in this important phase of the construction.

Third day. The last details of the hull were worked out: lashing holes (*ha'o*) for the gunwale poles were cut, and the hull was given a final going over. Eight men participated and received a rewarding meal (3 bags of *'uhingaba* yams, and 1 bag of taro).

Fourth day. The finished hull was partly hauled on rollers (*toso*) sometimes on coasters, partly carried by means of attached poles to the sea. Eleven men took part in this back-breaking work. The weight of the hull was so great that the men almost staggered beneath it, but they went on and on, almost running all of the two km. to the coast at Ahanga, the first destination of the canoe, and they only stopped a few times to gain breath. One of the worst parts of the job was to lower the canoe down to the beach from the cliff; many ropes were used for this task. Such a feat of strength was not ignored by the islanders. Loud shouts of pride and joy abounded, and everybody started for the trail to admire the new canoe. According to custom a new food gift was served, this time with fish and *'uhingaba* yams. No more work was performed that day by the carriers!

Fifth day. This was the day for lashing the gunwale (*toto'o*) and fixing the thwarts (*loghuloghu*). This is a time consuming task but is not regarded as hard work. Much skill goes into making the lashings strong enough, yet flexible. Nine men participated for about half a day (Sengeika, Kaitu'u, Sau'eha, Momoka, Temasu'u, Baiabe, Saobaa, 'Uku'uku, and Taupongi). No food present is served on such an occasion.

Sixth day. This day was spent attaching the outrigger to the hull (*hakaama*). The three outrigger booms (*kiato*) are indirectly fastened tö the hull through the gunwalepoles; if this were not done the great forces exerted on the float would easily break either hull or booms. Fastening the outrigger float (*ama*) to the booms is also indirect through a set of connective sticks (*baato*) hammered into the float and lashed to the booms. On top of the booms a platform (*hata*) is made from a set of sticks (*kau hata*). Finally the gunwale lashings are protected by the application of a brim of coconut leaves (*hakatapia*). At every stage great care is taken to avoid damaging the canoe through the continual change from wet to dry states. Sengeika alone took care of the final details on the canoe, which was completed at the end of this, the sixth day.

Seventh day. The day of the first trip. Sengeika, the commander of the canoe, prepared everything for this maiden voyage (*bengo*), particularly the torches. Before the start of the first fishing expedition a special meal (*hakaanga*) was served by Sengeika (a basket of *'uhingaba* yams and a basket of *'uhi* yams). At night the canoe went to sea with a crew of four. 1) Sengeika: *mataabaka* (in the fore with a *hangahanga* net), 2) Kaitu'u: *peba* (steersman, aft), 3) Sa'obaa: *mungikatea* (fisherman with round net), and 4) Kaipua: *tu'uahi* (carrier of the torches). They sat in the canoe in this sequence 1), 4), 3), 2) as always in a *baka'eha* with a crew of four.

The total expenditure of work on this particular canoe was 43 workdays, a total which deviates less than 10 % from two other estimates of work for the same type of canoe (*baka 'eha*). Smaller canoes (*hua*) require less work; sometimes a single person makes the canoe except for the carrying. Only fragmentary records of the construction of a *hua* canoe have been compiled; it is estimated that about 25 workdays are required to build one. Possibly small canoes generally only 'cost' from 50–60 % of the work input for a large canoe.

One may wonder why with this background the large canoes are built. Their advantages are better seaworthiness and capacity. The last aspect is important because it enables the canoe to fish flying fish by torch light, accomodating one person to tend the torches. With most other fishing operations the chances of a good catch are about the same for the two types of canoes. This may explain why only a minimum number of *baka 'eha* canoes are built.

The amount of labour involved to make a canoe is remarkably low. Compared with other Polynesian craft the Bellonese canoe seems rough and clumsy and without decorations; it is a boat of utility with little non-functional adornment. Probably this has to do with the short life span of Bellonese canoes. Ageing, through cracking, causes early destruction. Few attempts are made to protect the canoes. No paint is used and they are only shaded from the sun by placing a few coconut fronds over them. Hurricanes do away with many canoes; often the efforts to pull them beyond the reach of storm waves are in vain. Canoes rarely remain in use for more than a couple of years.

3. A survey of total Bellonese material production 1955-66

3.0 The subdivisions of material production

In the following survey only some characteristics of Bellonese material production are treated, mainly inputs as land materials and work, outputs as harvest, catch of fish, implements, and canoes. First subsistence production is surveyed (3.1–3.5), then production for export, i.e. market production (3.6). To find a common denominator by which values can be described of both inputs and outputs and subsistence as well as market sector of the economy is difficult. Monetary units are only partly applicable because of the severe limitations for exchange and substitution of factors of production and consumption. The export production is viewed on a background of terms of trade and finally an attempt is made to estimate the subsistence production in terms of energy. The subsistence production is analysed in sections similar to those used in the preceding chapter; numbers of paragraphs of the two chapters correspond to facilitate comparisons: the paragraph describing gardening in general is found in 2.1, and the estimate of gardening inputs and outputs in 1965–66 is in 3.1.

3.1–3.5 Subsistence production 1965–66

3.1 Gardening production:

The essential inputs in this are land, seed materials, and work; necessary implements are treated in 3.5.

3.1.1 Assessment of land utilization 1965–66

Methods of the survey

Bellona was photographed from the air and a chain and compass traverse was made in connection with a geological field campaign and a phosphate survey (T. A. Adams 1961). This resulted in a scale-determined outline map presently kept in the BSIP Geological Survey Department. In 1965 we resurveyed the traverse, which resulted in negligible corrections to the map scale. Some of the verified distances on the ground were later used for the determination of scale of air photographs taken in 1962. These were kindly set at our disposal and were used to produce a map (Pl. 1 accompanying this volume). The map was prepared by the Danish Geodetic Institute using stereophotogrammetry; topographical names were added by Taupongi of Matahenua. Naturally the map was of much assistance in the field work and also to scale later maps produced from photographs taken in 1943, 1947, and 1966. The last photography was taken by the kind assistance of British authorities and the Megapode Airways. It has been used for a base in estimating areas of various types of use on Bellona.

Total area, excluding dry parts of the reef, was first found by square counting and later by plotting outlines on an electronic plotting board feeding a computer programme. The last device quite overshot the limits of accuracy set by scale determination, but did away with the accumulation of errors by adding up tiny areas. Bellona's area was found to be 16.97 km² (equalling 6.6 sq.miles), the error probably less than 2 %. Considering the difficulties in defining the outline of the area, it is reasonably given as 17.0 km².

To identify major land uses a field survey was conducted March-April 1965. It was attempted to inspect all areas and village areas at least to the extent of making possible identification from air photographs of those non-inspected. Further interviews were made concerning all utilized areas to assure that no areas would be omitted in the survey, and to furnish data on inputs of work. A fairly good coverage was attained (about 90 % of all gardens) but it proved difficult to estimate areas with adequate accuracy; also it proved necessary to give the survey a greater time depth. Bellonese gardening relied heavily but not exclusively on yams, and the taro, banana, and sweet potato areas utilized in a full year could hardly be assessed in March-April. Another problem was that the scale on the photomaps prepared for the field work was far too small (about 1:20,000) for the diminutive Bellonese garden plots.

The second field work period, September–October 1966, utilized a first rate airphotographic coverage of the total area, helping to keep surveying proper at a minimum. Photographs were taken on the 22nd of August, in time to let us have the pictures available in the field, but too early to let them depict all yam gardens planted for the 1966 harvest. These had to be sketched for later addition to a map of land utilization.

For the final analyses of land utilization a photographic map was prepared from the 1966 air photographs at a scale of approximately 1:2,500. The camera type (Wild Aviogon) and flying height applied had resulted in a negative scale of about 1:11,000, and this together with a normal black-and-white film easily allowed the desired enlargements to be adequately detailed.

The gardens found by the ground survey were identified or plotted on the photographic map. Missing ones discovered on the photographs were classed to type by comparison with those already known. Following characteristics proved instrumental in identifying area types: grey-tone, 'texture' of area, and height of vegetation together with more special features as contours of garden areas. The features resemble closely those recommended by P. Koch (1970) in a survey of African land usage.

Recognition of garden types proved fairly easy from the photographs; the permanent crops were easiest to identify. An estimate of fallow areas is important in ascertaining whether land use is stable or not. Some efforts were made to identify fallow areas of different age on the basis of field mapping of sample areas in both 1965 and 1966.

Some of the characteristics of various areas are given below in table 11. The 'key' gives only a coarse description and will probably require adaptation for use in milieus other than the Bellonese. It has been applied to other Bellonese airphotographs (see chapter 7) with fairly few complications, but application of this key or similar ones depends greatly on seasonal development of areas for success. It must be admitted that a number of gardens could not have been identified solely by using the key. Safer evaluation requires the use of at least two yearly photographs: one to show yam gardens (to be taken about March) and another to show non-yam gardens (possibly to be taken about October).

Generally assessing of permanently cultivated areas were without problems. Coconut palm and pandanus groves were easily distinguished, except when very young. Bellonese coconuts yield at an age of about five years; before that they are of little productive interest, which tends to diminish the importance of errors. Pandanus groves yield quickly and are interpreted from the photos with few sources of error. Only one category of permanent crops implies serious difficulty for interpretation: the tree crops of the village areas. The reason is that the functional connection between tree crop and area is hard to define. Is it an area of the village green or do the trees really occupy an area equalling that of their crowns? Conventionally tree crop areas have been defined as the crown areas.

The fallow areas are always difficult to assess: old ones are sometimes similar to virgin forest and the difference between ages of regrowth is the harder to determine the older the stage. The young stages (1–6 years fallows) were distinguished by a grey-tone strip compiled from the photograph analysed from various well-identified sample areas. Comparing samples it was possible to distinguish young/mature fallows (younger than 6 years age less than about 12–15 years) and mature fallows/secondary growth. The last distinction is slightly arbitrary, as mature fallows are considered fallow areas recently involved in the rotation of garden areas whereas secondary forest has not been so. Possibly secondary forests are of limited interest as garden areas. Virgin forests in the proper sense of the word are probably non-existent on Bellona, some trees have been cut almost everywhere. The concept of virgin forest is here restricted to areas from which the forest has never been cleared. Because even very ancient clearings can be traced, there are probably few chances for mistakes. Functionally a forest mistakenly considered virgin may resemble a true virgin forest very much (i.e. by delivering a diversity of timber trees).

Reef areas (*ngoto*) were also evaluated together with coastal terraces. These have been divided into unusable land (*apata*), and 'coastal places' (*abatai*). The latter are partly cultivable, often planted with coconut palms and usually important as landing places for canoes.

The maps resulting from the interpretation described above are found as plates 2–5 (land utilization 1966), accompanying this volume.

When the interpretation of the photographic map was completed the areas of the different land use types were determined. As with the total area of Bellona, a plotting machine (a Coradograph coordinatographer) automatically punched coordinate-codes on a tape which in turn was fed to a preprogrammed computer. The areas were determined within tens of m² at the given map scale

TABLE 11.

	Main characteristics used for interpretation	
Type of area	Grey tones	Texture
Village area (manaha)	Very light, uniform-blotched	Fine, uniform
Pandanus groves (maalu)	Very dark	Coarse, individual tree-crowns distinguishable, small leaf rosettes (diameter few m.)
Coconut groves (kiu)	Medium light, speckled	Coarse, individual tree-crowns distinguishable, large leaf rosettes (diameter > 5 m.)
Yam gardens ('umanga 'uhi)	Dark, speckled	Coarse
Banana gardens ('ungu huti)	Medium dark, speckled	Coarse
Taro gardens ('umanga tango)	Medium light	Medium
Sweet-potato gardens ('umanga patito)	Light, uniform	Fine, uniform
Fallows (ma'anga)	Light dark	Increasingly coarse, finally 'cauliflore-like'. Uniform - heterogeneous
Secondary growth (bao matu'a)	Medium, speckled	Coarse
Virgin forest (mouku)	Light, medium speckled	Coarse, often 'terrazzo-like'
Coastal terrace (aapata ma abatai)	Varying	Varying

(1:2,880), easily yielding an accuracy within ± 1 %, by far smaller than the errors caused by ill-defined boundaries of areas. In fact the method was extremely accurate, but the apparatus proved rather vulnerable. The areas of single parts of area types were therefore determined otherwise. From a map replica on plastic foil the areas to be determined were cut out and weighed. This method yielded an accuracy of about ± 2 %. To achieve this accuracy control weighing of samples had to be performed. (The reason seems to be that humidity is adsorbed to the foil surfaces.) Adding nearly thousand part-areas could lead to an undesirable loss of accuracy. To prevent this, the total area of Bellona was divided into 'strips' orientated orthogonally to a straight line found as 'best fit' to the main trail (sum of squares of distances was minimized by calculation). In this way very few boundary lines between garden areas were found to be cut by the strip boundaries. Naturally, the strip areas were used to control sums of their included part areas and, later, also for comparisons between 1965–66 areas and previous owners.

The garden areas assessed are not, however, similar to those actually planted. From the sample previously discussed (Matiu Sa'omoana's garden figs. 27, 28, and 29) it can be seen that prepared garden areas are kept as a reserve. As much as 15 % of gardens are sometimes left unplanted. It is therefore often of little consequence to aim at too high accuracies in area determinations.

The general results obtained are shown in table 12, and fig. 56. Perhaps the most remarkable findings are that the areas regularly exploited (village areas and cultivated land including fallows) of area types from airphotographs (scale 1:2,500)

Stereoscopic height	Other characters
0-0.5 m.	Trails, houses, single trees. Detached settlements: 'key-hole' shaped
3-5 m.	Sub-rectangular configuration of plots
> 10 m.	Solitary; irregular or sub-rectangular plots
1-4 m., varying within plot	Usually with large dead trees, stakes, visible individual plants
1-2 m., varying within plot	Usually with large dear trees, individual plants with large, shiny leaves
0.5 m.	Usually with small dead trees, individual plants hardly distinguishable
0.5 m., very uniform	Resemble village greens
Increasing from about 1.5-10 m.	A grey-tone scale of considerable assistance in central parts of photography, combined with stereoscopic height assessments. Fallows gradually emerging into forest
About 10 m. and more	Individual trees distinguishable, few kinds, often traces of clearings
High, varying	Individual tree crowns distinguishable especially of 'emergent' trees. Many kinds, some very characteristic (e.g. Ficus sp.). No traces of clearings
Varying	

add up to less than 37 % of the total land area. If the *bao matu'a* fallow areas are regarded as a sort of area reserved rather than as an exploited area, less than 27 % of the total land area is productive with food crops. Of the food crop land about one third is in perennial crops; thus barely one fifth (18 %) of the total area is utilized as garden land, including the necessary fallow areas.

For further analysis the garden areas of the preceding years were assessed. They were identified by their later fallows. Results are given in table 13. In 1966 planting of the yam gardens was hardly begun, hence the area is not comparable with that of the preceding years. The older fallow areas (stemming from preceding garden areas) are larger. Of course the figures are influenced by errors, but these are estimated to be less than 10 %. For a control, the 1962 fallow areas deduced from the 1966 photographs were compared with garden areas found on a photographic map from 1962; the coincidence was remarkably good – only about 5 % of the fallows dated from 1962 could not be referred to their relevant gardens, identified by local people (especially Taupongi of Matahenua). Another interesting finding was that areas classed as 'old fallows' on the 1966 map in fact seem to stem from only two years' garden areas. This supports the idea that old fallows – of the *bao matu'a* stage – really are reserves rather than parts of normal rotation. The development is illustrated in fig. 57.

The decrease of garden areas during the period considered can easily be explained from the fact that large areas were subsequently planted with coconut palms. Garden areas have been reduced at varying rates in the three districts. In Ghongau

TABLE 12.

Land utilization, Bellona 1965-1966.

Areas in ha. Figures in parentheses: percentages of total land area (of district or total).

	SA'AIHO	GHONGAU	MATANGI	BELLONA
Reef areas	21.4	36.0	28.9	86.3
Coastal terrace	10.1 (4.0)	19.7 (1.9)	11.5 (3.4)	41.2 (2.5)
cultivated, abatai	0.7	1.7	0.5	2.9
Wild growth land	148.3 (58.8)	748.2 (72.0)	255.5 (75.4)	1152.0 (70.7)
Primary forest	89.4 (35.4)	405.2 (39.0)	180.4 (53.2)	674.9 (41.4)
Secondary forest	13.8 (5.5)	254.3 (24.5)	46.6 (13.8)	314.8 (19.3)
(in tino henua)	8.2 (3.3)	254.3 (24.5)	37.0 (11.0)	299.5
Old fallows	45.1 (17.9)	88.7 (8.5)	28.5 (8.4)	162.4 (10.0)
(in tino henua)	41.3 (16.1)	79.3 (7.6)	24.0 (7.1)	144.6 (8.9)
Horticultural land	68.9 (27.3)	179.8 (17.3)	44.6 (13.2)	293.3 (17.9)
(in tino henua)	63.7 (25.3)	175.8 (16.9)	42.4 (12.5)	281.9 (17.3)
Cultivated 1962	14.3	54.5	12.6	81.4 (5.0)
(in tino henua)	13.2	54.4	12.5	80.0 (4.9)
Cultivated 1963	18.1	51.6	10.6	80.3 (4.9)
(in tino henua)	16.4	50.1	10.5	76.9 (4.7)
Cultivated 1964	17.1	37.6	9.9	64.6 (4.0)
(in tino henua)	15.8	36.6	9.5	61.8 (3.8)
Cultivated 1965	13.6	28.4	10.4	52.4 (3.2)
(in tino henua)	13.1	27.3	8.9	49.3 (3.0)
Cultivated 1966	5.9	7.7	1.0	14.6 (0.8)
(in tino henua)	5.3	7.5	1.0	13.8 (0.8)
Perennial crop land	21.3 (8.5)	77.8 (7.5)	24.8 (7.3)	123.9 (7.6)
Coconuts total	20.2	75.6	23.8	119.6 (7.4)
- bearing	17.1	73.1	21.3	111.5 (6.9)
(in tino henua)	16.0	73.0	21.3	110.3 (6.8)
Coconuts, not bearing	3.0	2.5	2.6	8.1 (0.5)
Pandanus	0.7	0.7	0.1	1.4 (0.1)
Other fruittrees	0.4	1.5	0.9	2.9 (0.2)
Agricultural land	90.2 (36.0)	257.6 (24.8)	69.4 (20.5)	417.2 (25.5)
Village area	3.4 (1.4)	13.8 (1.3)	2.5 (0.7)	19.7 (1.2)
Land area	252.0 (100.0)	1039.9 (100.0)	338.8 (100.0)	1630.1 (100.0)
Total area	273.4	1075.2	367.8	1716.4

the decrease has been largest but this district has still the most available land per inhabitant and has planted most coconuts. (Differences between districts are treated in chapter 7.)

Reduction of area does not necessarily imply a similar reduction of cropped areas. From records of gardens planted it appears that two crops per rotation instead of one have with increasing frequency been taken, at least from yam garden land (see table 14). The additional areas cropped per annum have been estimated from recorded re-planting rates of yam gardens. For the estimate it has been assumed that the yam area percentage of the annual garden area was constant during the period analysed. The assumption is only partly valid; with more double cropping less taro-banana areas are necessary, because the 'fallow crop' replaces them. Hence the yam percentage of garden land increases slightly if 'fallow cropping' increases. This means that the maximum total 'cropped' areas of table 13 should be slightly larger for the most recent years (about 4.5 % for 1965). Still, a considerable reduction of the garden plus fallow areas has taken place. The reduction has been largely offset by a reduction of the duration of fallow periods. The duration seems now to approach the minimum length of fallowing required according to traditions to obtain 'sustained yields'.

Areas fallowed more than 5–6 years are becoming increasingly rare except on poor or inaccessible soils.

For the last year with fully recorded garden areas, 1965–66, the inputs were found from the photographic map to be about 52.4 ha. To find the area harvested during that year (from the yam harvest 1965 until the beginning of harvest 1966) about 15 ha. must be added. The total area was thus about 67.5 ha.

It now remains to find with which crops this area was planted. About 60 % of the yam area may be estimated from observation as planted with sweet potatoes; the sweet potato area was measured from the photographic map. Normally annual taro/banana and yam areas are of about same size; this also has been verified from observations. The areas found are shown in table 15.

More detailed distribution data in areas have been found from analyses of the field work records for 1965; they are roughly in accordance with those above – in fact they convey little extra accuracy because the crop composition of gardens widely varies.

The areas annually cultivated are modest, at least if compared with total land area. However, it must be borne in mind that if stable yields are aimed at, the necessary fallow areas must be added. If the annually cultivated yam area is A, the total necessary area for yam including fallows is 6 A. Similarly taro requires 4 B, bananas 7 C, and sweet potatoes 3 D, when the annual area for each of the crops are B, C, and D relatively. Sweet potatoes are assumed as planted in yam fallows, using it for one year and prolonging the fallow period for at least two years.

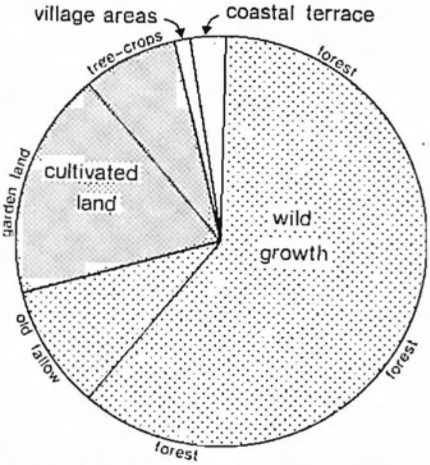


Fig. 56. Land utilization 1966. Including necessary fallows, about one fourth of the area is cultivated. Old fallows are often in marginal lands; they represent a reserve for cultivation. Most of the forest and the coastal terrace are uncultivable.

If the minimum fallowing periods are observed, it is seen that the present garden land (27.9 % of the land area) does permit stability to be maintained; but the possibilities of acquiring old fallows for cultivation are restricted within normal garden land.

TABLE 13.

Garden areas 1966, and fallow areas 1966 arranged after age.

	Garden area 1966	1st year fallow (= gardens 1965)	2nd year fallow (= gardens 1964)	3rd year fallow (= gardens 1963)	4th year fallow (= gardens 1962)	5th year fallow and older	total
Percentage of total land area	0.9% *)	3.2%	4.0%	4.9%	5.0%	10.0%	27.9%
in ha.	14.6 *)	52.4	64.6	80.3	81.4	162.4	455.7
total area cropped twice in rotation	-	0.9%	1.1%	1.3%	1.3%	?	-
max. total cropped areas in % of total area	-	4.1%	5.1%	6.2%	6.2%	?	-

*) As from photograph taken August 22nd, 1966;
only gardens planted after the yam harvest (March-May) have been included.
Total planted area 1966 was said to be similar to that of 1965.

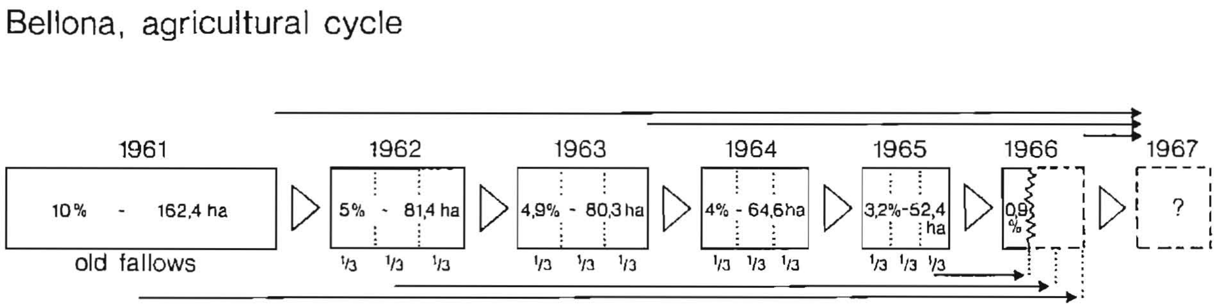


Fig. 57. Diagram showing the reduction of garden land on Bellona. Most of the areas lost for gardening are planted with coconut palms. In 1966 observations encompass the first eight months.

3.1.2 Inputs of garden work

The total amount of labour necessary to cultivate the areas found above can be estimated from the figures of labour expenditure for the various crops (see paragraph 2.1.7). Rounded figures for total estimated work in gardens are shown in table 15.

It takes more than land and labour to produce a garden. Seed tubers for yam gardens are important and very valuable whereas the other gardens are propagated with less valuable material, as taro tops, banana cuttings or suckers, and sweet potato cuttings. Seed tubers for one hectare of yam garden amount to as much as from 200 to 500 kg per ha., varying with the seed weight of the tuber or the part of tuber used (bulbils are rarely used). The weight of seed tubers has been subtracted from yields. In all, seed tubers represent an input of from about 5 to 13 t. for the total garden area per annum, most probably is a cipher from the lower end of the range. From preceding paragraphs (2.1.4–2.1.7) it is seen that very little equipment is used for production. Most of this stems from the monetary part of the economy (see 3.6).

The total yields have been estimated from the area data previously referred to and from the yield per ha. shown previously in table 9. From questionnaire data concerning all 1965–66 gardens it has been found that half of the yam gardens are of the *'uhingaba/'uhi* type; the remaining half is represented by a variety of yam combinations. Hence it has been assumed that half of the yam garden area yielded about 20.7 t. per ha. and the other half about 12.7 t. per ha. The average yields are thought to represent yields resulting from different types of soils. The last cipher has been taken as an average from available ciphers; taros and sweet potato averages have been taken also. Total outputs are given in table 15.

The accuracy of the different estimates referred to is highly varying. Areas may safely be assessed within 2–3 % of error through analyses of aerial

TABLE 14.

No. of yam gardens replanted with sweet potatoes.

	1966		1965		1964		1963		1962	
	Total	Repl.	Total	Repl.	Total	Repl.	Total	Repl.	Total	Repl.
Matahenua	15	9	18	11	24	17	5	3	12	8
Ngotokanaba	13	8	14	7	21	10	8	3	12	3
Sa'aiho:	28	17	32	18	45	27	13*)	6	24	11
Pauta	15	14	13	8	14	7	20	17	16	10
Ngongona	18	8	44	27	49	28	44	24	39	24
Tahakingoto	5	5	14	11	14	6	13	11	9	7
Ghongau:	38	27	71	46	77	41	77	52	64	41
Ahea + Matangi	26	8	43	21	36	17	30	14	26	10
Bellona:	72	42	146	85	180	96	137	75	131	65

*) Of 41 persons 18 were absent to work in plantations.

TABLE 15.

Estimated inputs and outputs of Bellonese subsistence production 1965-1966.

FOOD PRODUCTION	Inputs							Outputs		
Gardening	land areas (% of total area)				work:					
	excl. fallow		incl. fallow							
Annual crops:	ha.		ha.		ha.	workhours per ha.	total workhours	ha.	tons per ha.	total tons
yam gardens	26	(1.6%)	156	(9.6%)	26	1,925	50,050	26	16.7	635
taro gardens	13	(0.8%)	52	(3.2%)	13	1,365	23,745	13	10	130
banana gardens	13	(0.8%)	91	(5.6%)	13	725	9,425	13	15.5	202
sweet potato (replanting)	15	(0.9%)	45	(2.7%)	15	2,200	33,000	15	6.5	98
	Σ 52	(3.2%)	299	(18.4%)	67		116,220			1,065
other crops, leaves and cabbages										25
										1,090
Perennial crops:										
coconuts*) bearing			100	(6.2%)	100	100	10,000	100	1	100
coconuts*) non-bearing			8	(0.5%)						
pandanus			1.4	(0.1%)	1.4	70	100			
miscellaneous fruit trees			2.9	(0.2%)	2.9	100	300		5	15
*) excl. coconuts for copra export			112.3	(7.0%)			10,400			115
Foraging (gathering, collecting)										
terrestrial	total land - village areas		1,610 ha.		150 persons in 30 days/3 hrs		13,500	rough estimate		40
marine	reef		86.3 ha.							
Fishing	landing areas (abatai); implements, see below; canoes, see below				60 men on 45 occasions/8 hrs		21,600	fish, other marine animals		about 60
Food preparation	forest and fallow areas for firewood: 45 fires per day of about 10 kg; ~ 165 tons of firewood; ~ 15 ha. of forest				90 women in 300 days/3 hrs		81,000	detoxication and increased palatability of food		
Total food production	'all of Bellona incl. reef'						243,000	prepared food from: 1,090 t of garden produce; 115 t of cocos; 40 t of wild food; 60 t of fish		

continued

photographs. Difficulties arise, however, when distribution of kinds of crops is considered. It is possible to identify main types of crops from photographs, but the problem must be parallelled with that of assessing yields per ha. of the same crop combinations. In some gardens the crop combination may even change during the period of cultivation. The sources of error from the two assessments last mentioned greatly exceed those stemming from measurements of areas; together the errors can hardly be kept below ± 10 %. It must be noted that the influence of variations in type of soil was included in the assessed yields, but also that they refer to a single year; variations stem-

TABLE 15 continued

ACCESSORY SUBSISTENCE PRODUCTION

			total workhours	
Plaiting of mats	leaves from various pandanus trees and some bananas	about 500 baghu = - 200 malikope =	= 1,000 = 1,000	replacement of mats
Housing	thatch: 1.3 ha. of pandanus per year timber from 6 ha. of forest (50% usable timber)	about 150 living houses = - 150 kitchens = - 13 public houses =	15,000 6,000 3,200	replacement of houses
Canoes	wood for replacement: 7 baka'eha = 28 m^3 17 hua = 39 m^3 62 m^3 = 4.5 ha. of selected forest	work for construction of 7 baka'eha = 14 hua =	 2,410 3,360 5,770	replacement of canoes
Implements nets, spears, berches, repairs	negligible	about 600 workdays =	4,800	
Total accessory subsistence production	about 12 ha.		37,000	replacement of mats, houses canoes and implements
Total subsistence production	All of Bellona at varying intensities	food accessories	243,000 37,000 280,000	food for subsistence + surplus replacement of subsistence goods

ming from climatic differences have been left unconsidered. Together this means that only an elaborate sampling system may significantly improve the accuracy of production data. Another way to assess yields that was considered was to ask every household or some selected ones to weigh food for daily consumption, but the plan was thought too difficult to accomplish especially as yields could not safely be referred to definite gardens.

For perennial crops 1965–66 inputs of land and labour are more easily found. The land used for coconuts, the most important perennial crop, was found to be about 110 ha. of bearing palms with additional 8.1 ha. of palms coming into bearing within the next five years. It must be noted that the land planted with coconuts not only forms a large share of cultivable land (almost 21 %) but that it is of the best quality found on the island.

It is more difficult to assess the yields of coconuts. Bellonese coconuts are often irregularly spaced; a spacing of about 8 m. or less is often seen on Bellona – against 9 to 10 m. in commercial plantations. Calculation of number of palms from the area planted and normal Bellonese spacing gives a total of about 16,500 palms. In fact a conservative count came to more than 22,000 palms actually grown. This gives roughly 200 palms per ha. against only 150 on commercial plantations.

Of great interest is usually also the age of the stock of palms. Fortunately most palms were planted after 1947 and are within the stage of full-bearing. Some reduction of potential must be ascribed to the fact that some palms grow on poor soil (especially on the coastal terrace). Also ill-tending of the coconut groves is widespread, a theme of many reports from agricultural extension officers. In 1965 more than half of the coconut groves in the central part of the island were all but totally neglected except for incidental harvesting.

However, Bellonese palms do apparently not yield less than commercially grown ones; rather the contrary. About 50 to 80 nuts are harvested per palm per annum on Bellona, approximately the same yield as in the Solomons, but the average weight of Bellonese nuts is greater than normal, namely about 0.8 kg per husked nut.

Perennial crops other than coconuts include pandanus and miscellaneous fruit trees. Pandanus groves (*maalu*) cover an acreage of about 1.4 ha. The yield of nutritive material from pandanus is insignificant, since currently the palms are mainly used for thatch material, and hence discussed later.

Other trees producing edible fruits cover only about 2.9 ha. of land (the estimate includes only trees properly identified.) Among the most valuable trees are *ngeemungi* (Santiria, Haplolobus, and Canarium spp.), but many other deserve mentioning. (See appendix B-3.) The total input of land for perennial crops is shown in table 15.

Inputs of labour with perennial crops are generally very low, mainly because the initial work of planting is an investment of utility lasting more than sixty years. It is estimated that the planting of one ha. with coconuts requires about 600 working hours if the seed nuts are available and – as usually seen – a young fallow with little clearing work is used for planting. Planting of a pandanus grove takes a similar amount of work, but the investment lasts only about 10 years.

A coconut grove may function according to at least two different strategies. It may deliver food and drink for local use, that is work on a subsistence basis, and it may be used for the production of copra. Bellonese groves served both functions. From the copra export amounting to 18 t. 1965–66, it is estimated that only roughly 10 ha. of coco pâlm land were used. The labour required for export production was about 3,500 workhours. (See paragraph 3.5.)

For the approximate 100 ha. of coconut palms labour inputs are estimated to be about 100 hours per ha. – the same as for semicultivated tree crops – resulting in a total input of about 7,000 workhours per annum.

The other tree crops mentioned require from about 70 hours per ha. for pandanus to about 100 hours for semicultivated tree crops; the extra hours encompass the difficult occasional picking of fruit.

The yields of coconut groves have been estimated from the areas planted with bearing palms, the average planting density (about 150 palms per ha.), average harvest of nuts (about 70 per palm per annum), and average weight per nut. To reduce the weight to dry copra basis, corresponding data on Strait-Settlement nuts have been used; these resemble Bellonese nuts as to size. This calculation gives a maximum yield of 2.2 t. of copra per ha. Probably the estimate thus arrived at must be regarded as a potential yield never actually harvested*); the estimate is interesting because slight improvements of transport and processing arrangements may rapidly increase Bellonese copra production, especially if prices remain at the present level or rise.

Non-edible materials stemming from coconut palms have been disregarded as outputs here, also the small amounts of edible material produced by pandanus groves have been disregarded; their use is very restricted anyway.

For trees, annual production of edible fruits has been estimated at about 50 kg. of fruit per tree, assuming about 100 trees per ha. Undoubtedly some trees, as *ngeemungi*, are capable of spectacular yields, exceeding 100 kg. per tree, but the harvests are irregular. Possibly the harvest is slightly overestimated, but it deserves mentioning because of the high-calorie and vitamin-rich contents.

3.2 Gathering/collecting, and hunting

The area inputs in gathering/collecting and hunting are hardly assessable in detail. For the terrestral part of these activities almost every area may be used, possibly except village areas (totally about 1610 ha.). Even garden areas may occasionally be included, namely when self-propagated, edible plants appear. Marine collecting is on the contrary quite sharply confined to the fringing reef (86.3 ha.); the reef area of Bellona is quite small compared to that of most Pacific islands of comparable land area, and it is further reduced as to utility because of prevailing religious taboos.

In paragraphs 2.2.1 and 2.2.2 the foraging activities were estimated to be the main food production for about one month of the year. This seems to correspond fairly well to the data of the 'diary survey', although the latter records a shorter amount of time. Possibly this stems from the difficulties of distinguishing marine collecting from fishing, often carried out on the same occasions. Roughly estimated every grown-up Bellonese spends 3 hours a day during one month for gathering/collecting.

*) In 1965–66 according to official records a total of only 18 t. of copra was exported; se table 24.

Outputs have been estimated roughly from the food quantities necessary to supply the population for approximately one month. The scant existing information on results of reef-collecting expeditions seems to indicate that sufficient food is gained for sustenance, but that work requirements are high. The relatively small output is acceptable because of the difficulties of gaining food in other ways.

Hunting has here been completely disregarded (see paragraph 2.2.1). The estimates for 'foraging' activities are entered in table 15.

3.3 Fishing

Since each village uses its own beaches as fishing bases, and its crews and catches are transported to and from the sea via special trails (*anga ki tai*) belonging to people of the village, the inputs and outputs are easiest to record per village. An attempt was made in 1966 to evaluate fishing by observing crews participating and resulting catches in Matahenua village. During September and October the fishing season was at its highest. Nine to ten men were on the sea every possible night, that is until to about one week before new moons. The intervening pauses were used for rest. The fishing methods were constantly changing. When only few flying fish were caught, they were normally used for bait to catch larger fish.

The main input in fishing is work. In the peak season about a fifth of the male population from the age of about fifteen was observed fishing regularly except sabbaths, but during a full year the average Bellonese man is estimated to fish only about 45 times, using up to 8 hours on each occasion. This may include smaller trips, but does not consider the hours used for rest when fishing is over. (These were classed as 'no work' in the diaries.) In some villages people fish a lot more than the average here estimated, in others considerably less apparently related to access to the sea and the land areas available for cultivation.

The inputs of vessels and gear are considered in a later paragraph concerning accessories to subsistence production.

Outputs were greatly changing, especially with hook and line fisheries. The estimate is very hazardeous; it is founded on quite few recorded catches, although from different seasons. Per event about 20 kg were landed per fisherman in Matahenua in 1966, but the results varied from nothing to more than 70 kg, the last because of catching of three extremely large fish. Still the total annual catches on Bellona are believed not to be less than about 60 t.

3.4 Production of technical accessories to subsistence

(fire, clothing, houses, canoes, and implements)

It proved impossible to assess the scope of using fire for comfort because fires often are lit for multiple purposes. As mentioned previously, clothing is nowadays of imported materials, the time used to sew them is almost negligible when considered over a period because most clothes are worn to the last shred. Locally made mats, both *baghu* and *malikope* mats, are still widely used, although the *malikope* is increasingly used for export. The materials for the mats stem both from the cultivated pandanus patches and from wild material. Women spend considerable amounts of work sewing and plaiting mats. *Baghu* mats will last for about two years; there seem to be about 500 on the island, and it takes from four to five hours to make one. As previously mentioned, *malikope* mats will keep for up to 10 years; these is a stock of about 200 on the island and they take up to 50 hours to plait. From these ciphers the total yearly cost of mats has been estimated. The ciphers include work with normal drying and maintenance.

Housing

To assess the annual cost of housing the houses had to be classed and counted; also an idea on general durability had to be developed.

On Bellona there were in 1966 about 150 dwelling houses, about the same number of kitchen houses (*paito*), and 13 houses for public purposes (council houses, churches, schools, and houses for the sick). The distribution is given in table 16.

The average lifespan/durability of Bellonese houses was difficult to estimate because of the 150 living houses listed, some were quite new due to the recent formation of two villages (Tahakingoto and Ahenoa) which had split off from their original villages. To calculate the average age of 'normal dwellings' of normal durability, houses of the new villages should be ignored, and also special types of houses. The average age of the re-

TABLE 16.

Houses on Bellona 1965-1966.

District	Living houses	(Disused houses)	Kitchen houses	Public houses
Sa'aiho	30	(1)	29	2
Ghongau	98 *)	(17)	78	8
Matangi	22	(3)	19	(3)
Bellona	150	(21)	126	13

*) including schoolhouses used as living houses.

TABLE 17

Distribution of houses according to age classes.

Age in years	Sa'aiho	Ngongona	Total
0-1	6	12	18
1-2	4	18	22
2-3	3	10	13
3-4	1	16	17
4-5	2	3	5
5-6	2	1	3
6-7	6	-	6
7-8	3	-	3
8-9	-	-	-
9-10	1	-	
10-11	1	-	1
11-12	3	1	4
12-13	-	1	1
13-14	-	-	-
14-15	-	1	1
Total	32	63	95

Mean age Sa'aiho 5 1/2 years
Mean age Ngongona 3 years
Overall average 3 3/4 years

maining 95 houses was determined by interviewing owners, and by inspection (table 17).

The oldest house of the sample was a *hata* owned by one of the elderly men on Bellona. This *hata* was the only one used as a dwelling in 1966. Great age is evidently exceptional for Bellonese houses, and it is only possible if extensive repairs are done regularly. In Sa'aiho information was also gathered concerning large-scale repairs that had been carried out.

The generally held Bellonese ideas about houses are reflected in table 18 showing re-thatching; only small repairs are necessary in the first 3 years of a house's lifespan, but after that repairs become more and more frequent, since thatchwork will only last for about 3 years. After 3–4 years, damage to the frame work of the house becomes more frequent, due mainly to rot, which apparently depends on the type of soil into which the poles are dug. Final abandonment of a house usually occurs because the heavy supporting poles are falling to pieces, whereas the thatch can be rejuvenated up to four times. (Extra repairs may occur if a house has been disused for some time and is afterwards reoccupied.) Obviously, corrugated iron does away with a lot of repair work. (Any further prolongation of the lifespan of Bellonese houses must await the introduction of some means of preserving the poles.)

When the number of houses necessary to sustain living standard on Bellona and their durability were found, the total annual cost of housing could be estimated from the expenditure of work on the 'normal' house described in paragraph 2.5.3. The average-sized Bellonese home is slightly smaller than the sample house described; it costs about the same amount of work as for the sample if window shutters, door, stairs, and other details are included. A house of normal lifespan (10 years) will require a total of about 140 working days, an average of 14 days per annum.

Work expenditure for a kitchen house (*paito*) was estimated roughly on the same lines; deductions were made for size, and absence of elevated floor and reduced length of valuable poles. Usually kitchens last a litle longer than ordinary houses,

TABLE 18.

Number of complete re-thatchings in Sa'aiho, distributed according to age of house.

Age in years	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12
No. of houses considered	6	4	3	1	2	2	6	3	0	1	1	3
No. of complete repairs on above houses	0	0	0	1	3 *)	2	6 *)	4 *)	0	3 *)	2 *)	6 *)

*) Some houses rethatched more than once.

TABLE 19.

Type of canoe		baka 'eha	hua
Sa'aiho	Matahenua	1	6
	Ngotokanaba	3	5
		4	11
Ghongau	Pauta etc.	2	4
	Ngongona	6	13
	Ghongau	0	2
		8	19
Matangi	Matangi + Ahea	2	4
Total Bellona		14	34

possibly because of the preserving effect of the smoke. It was estimated that a kitchen costs between 25 and 35 workdays to build. The yearly upkeep was estimated to be about 5 days per house, assumed the frame lasts about 10 years with two renewals of thatch during that period. Each home has normally an attached kitchen house, but in some cases – as when a house is inhabited by a single, male person – no kitchen is built.

Each of the few public buildings was estimated as requiring about three times the amount of work to build as a common house and about the same amount to keep up as living houses. That is, about 30 working days per unit per annum. The reason for this was that public houses were about double the size of living houses. On the other hand the figure takes no account of the elaborate furniture often found in these, but not in private houses. An estimate of the work used to furnish churches was almost impossible; it was probably better classed with social work than with materially productive labour. Given the assumptions previously outlined, the yearly expenditure on housing can be estimated for the 150 living houses, 126 kitchens and 13 public buildings.

A special category of buildings, the copra dryers (*hange kapala* or *hange baalui kapala*) has not been discussed here since it belongs under copra production.

For all Bellonese houses an additional requirement must be considered, the need for land on which to grow the necessary pandanus leaves for thatch. The sample house described above required about 500 thatch panels. Twelve leaves are necessary for one panel. Sixty leaves form a bunch (*kapita*), and a fully grown pandanus may produce 2 bunches or 10 panels a year. Thus the thatch for a 5-fathom house will take the harvest of 50 pandanus palms. Normally the thatch will keep for about 3 years, which means that a normal house will need the output of 66 m² of pandanus grove for upkeep. The total sum of a Bellonese house will thus require an area of approximately 1.3 ha. of pandanus for its upkeep (which compares favourably with the 1.4 ha. of pandanus calculated from aerial photographs.) It was also attempted to estimate the amount of wood used for timber. The sample house took about 2 m³ of round wood for its frame, but if the logs are dressed as to look like sawn timber much more is used. From the amount of wood a corresponding area of productive forest was estimated; this is shown in table 15.

Canoes are some of the valuable assets owned by the Bellonese. The cost to maintain the fleet was estimated in much the same way as the cost of housing: the size of the fleet was found and the average lifespan per canoe, and the data were combined with the figures of expenditure in building a standard canoe of each type.

The total stock of canoes October 1966 was found from inspection and by interviews (table 19); some canoes were found on almost inaccessible landing places only because we had been told where to find them.

The keeping qualities of canoes are low: of the 48 seaworthy canoes on Bellona in 1965 only one was more than two years old; of the rest roughly 50 % were less than one year and 50 % between one and two years old. Very few had drifted away in the recent past, so it seems that ageing (usually through cracking) causes early destruction. No attempt is made to protect them, such as with paint. The only care given these crafts is some protection from the sun by placing a few coconut fronds over them, and attempts to pull them high enough on the beaches to be beyond the reach of storm waves.

The total expenditure to build canoes and keep them in a fairly good state of repair was then estimated on the basis of a labour cost of 43 workdays for a *baka 'eha* canoe and 25 workdays for the smaller *hua* canoes, and assuming a lifespan of two years.

Consumption of wood for canoe construction is very great, mainly because less than one third of a canoe tree can be utilized with the building

TABLE 20.

'Capital': accumulated work invested in the subsistence sector.

		Workhours
Housing		
150 living houses	wood from 60 ha. of forest	83,000
150 kitchens	thatch from 4 ha. pandanus grove	36,000
13 public houses		21,500
		140,000
Canoes		
14 *baka 'eha*	wood from 14 ha. of forest	4,800
34 *hua*		6,800
		11,600
Mats		
200 *malikope*	unassessed	10,000
500 *baghu*		2,500
		12,500
Nets and implements		5,000
Total investment:	selected wood from 78 ha. of forest	~ 170,000

method employed. A *baka 'eha* consumes easily a tree of about 4 m^3 of selected wood, whereas a *hua* may use only about 2 m^3. It is interesting to observe that *hua* canoes take much more work to construct, but waste considerably less wood. This is possibly the strategy behind the hesitation to build more *baka 'eha* than absolutely necessary.

Nets, torches, and other utensils in fishing were estimated to consume about 300 workdays per annum, the same amount was believed used for repair of various implements. The estimate is only founded upon the impression that about every day the equivalent of two Bellonese on an average are employed to repair implements. Before the introduction of modern material the amount of work spent is reported to have been much larger.

3.5 Subsistence service

The field investigation was concentrated on material production. It would be unjust, however, not to mention the non-salaried service works, because they actually occupy the Bellonese for a considerable part of their time.

Normal household work others than food preparation seems to occupy at least one woman per household at least for about four hours a day, totalling about 22,500 workhours per annum. Such work encompasses laundry work, cleaning and tidying the house and settlement, repairing of clothes, and nursing of children. The estimate is a low one, but most of the activities mentioned require much less time in the Bellonese society compared with a Western one: children take care of other children and the few clothes and furniture make most household work relatively simple, though modern household machinery is totally lacking except sewing machines.

Teaching children takes a lot of time, but as instruction normally is by demonstrating work procedures during normal work, the time used for the purpose has not been assessed separately. It is felt that teaching taken in the widest sense is by far the largest single non-material investment in the Bellonese society. A remarkably large part of the life of a Bellonese is spent learning the crafts of subsistence production.

Time expenditure tending sick people and other social activities has likewise not been assessed. From the diary investigation it is evidently very important, possibly occupying the Bellonese in up to one third of total working time. A further analysis of the social activities has not been aimed at in this work.

3.6 'Capital': accumulated work invested in subsistence

It was mentioned previously that there is little of equivalence to 'capital' in the non-monetarian aspects of Bellonese economic life. The accumulated work in existing 'capital' goods has been estimated for various items; see table 20.

Invested work amounted to only about 60 % of yearly work in the subsistence sector, with housing as the largest single asset. Work accumulation in housing was about 3½ times the annual upkeep.

TABLE 21.

Approximate number of Bellonese employed outside Bellona 1944-1965.

	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Sa'aiho				1				$2\frac{1}{2}$	1	2	2	2	5	$4\frac{1}{2}$
Ghongau	1				1		1	3	$2\frac{1}{2}$	$8\frac{1}{2}$	$9\frac{1}{2}$	$5\frac{1}{2}$	$7\frac{1}{2}$	3
Matangi										1	1	22	3	6
Total	1			1	1		1	$5\frac{1}{2}$	$3\frac{1}{2}$	$11\frac{1}{2}$	$12\frac{1}{2}$	$9\frac{1}{2}$	$15\frac{1}{2}$	$13\frac{1}{2}$
Estimated total earnings	100			100	100		100	600	360	1250	1350	1050	1560	1620

(converted into Aus. Dollars)

	1958	1959	1960	1961	1962	1963	1964	part of 1965	
Sa'aiho	10	2	1	$2\frac{1}{2}$	5	$11\frac{1}{2}$	9	3	
Ghongau	$11\frac{1}{2}$	2	$4\frac{1}{2}$	$8\frac{1}{2}$	8	$17\frac{1}{2}$	$5\frac{1}{2}$	2	total 70
Matangi	4	4	6	3	4	$4\frac{1}{2}$	12	3	
Total	$25\frac{1}{2}$	8	$11\frac{1}{2}$	14	17	$23\frac{1}{2}$	$26\frac{1}{2}$	?	
Estimated total earnings	7350	1150	1660	2020	3675	5075	5725		

(market prices)

The high rate of depreciation in housing, or the short life of houses, was one of the problems in Bellonese subsistence. There was a marked tendency in 1965–66 to improve the quality of houses with resulting increased investment of work, but decreasing yearly expenses of work. Another remarkable feature was the low investment in canoes. As mentioned previously, the rational background was possibly the low life-expectancy of canoes. The large investment in mats was less definitely assessed, but the magnitude is believed to be correct. *Malikope* mats were, however, used more and more for trading only, as 'Western' bedding substituted for them. There seemed to be a tendency to make *malikope* mats in idle seasons with the purpose of selling them, but the resulting income was low. The mats were used intra-island for some exchanges and functioned occasionally as a sort of money, having an almost fixed price (Aus. $ 2 each).

3.7 Inputs and outputs of the monetary sector of Bellonese economy 1965–66

The monetary sector of the Bellonese economy was only weakly developed in 1965–66. In daily life on the island money played an insignificant part; most elementary needs were not valued in or paid with money; food and housing were never paid for. But for a few things only payment in money was accepted. Tithes demanded by the churches, taxes, school fees and all imported Western goods. The Bellonese had a growing demand to acquire money for all this, but in 1966 it could hardly be said that money was integrated in daily Bellonese life. The monetary and the subsistence sectors co-existed, but few transfers between the sectors took place or even could take place.

Roughly there were two ways to earn money in 1966: by the export of labour or locally produced copra. Apart from that a few other sources of income were found: a headman and dresser (local medical assistant), a radiooperator and a few other official servants were paid modest wages (from Aus. $ 10–$ 50 a year) from 'abroad'. There had also been attempts to export other goods than copra: carvings and plaitings were occasionally sold, but such sales remained unimportant in 1966.

Export of labour was largely directed to plantations, but also some Bellonese worked in Honiara. Most Bellonese employed abroad had started to work on plantations of which those at Tenaru and Yandina were especially preferred because families could be taken along and management was considered fair. Almost all Bellonese working on plantations were unskilled workers, but a few had been trained there to acquire skilled or semi-skilled jobs as carpenters, bricklayers, and plumbers. Some trained as craftsmen remained on plantations, but most took jobs later in Honiara, the capital of the Solomon Islands. Plantation work was generally considered to add to experience by the Bellonese (travelling is highly esteemed), it meant a way to acquire skills, and it gave an opportunity to raise a small fund of money or goods. Possibly only the plantations offered a chance to survive for those Bellonese who had little opportunity to acquire gardenland on their own island. At least the standard of living (housing and food) was lower on Bellona.

All Bellonese who had worked abroad in the period 1950–66 were interviewed concerning their place of work, working period, incomes and goods/cash transferred to Bellona. In table 21 the total number working abroad is shown. Salaries were usually from Aus. $ 12 to 20 per month, plus the value of board and lodging. In Bellonese opinion the wages were reasonable, especially as they were increased in the last part of the period (as were prices). Usually there was a possibility for saving in the plantation jobs; in this context the main interest is to estimate the resulting returns to Bellona from the export of labour.

Some Bellonese labourers sent money back to Bellona during their working period abroad, but often the only gain for the island community was the things they brought back when returning. Typically the returning labourer had with him the clothes he wore plus a 'boy's box' with contents. Often the clothes were impressive, being brand new with gay colours and exotic patterns, but they seldom included more than a pair of shorts and a shirt, sometimes plastic sandals. The labourer often brought back a good bush knife and an axe. In his box he had about three yards of calico for gifts, pencils and exercise books as a token of newly acquired education, some matches, a few fancy things, and the accumulated capital; all of this was safely kept under a heavy padlock. About 1963 the fashion was to acquire small kerosene lamps with a four gallon drum of kerosene and, for married men: a hand-sewing machine (locally: *te singa*) for his wife. The machines were bought at an average price of Aus. $ 20–$ 30; about the same was paid for a bicycle. Bicycles were more and more frequently brought back as were house building materials, notably corrugated iron for roofs, and watertanks. Some even had saved to buy a radio and a watch.

TABLE 22.

Most frequent imports by plantation workers, distributed after value.

	%	
Personal gear:		
trousers	10.4	
shirts	7.1	
towels	0.9	
powder	0.5	
bed sheets	0.9	
	19.8	
bicycles	5.2	
watches	8.6	
	33.6	
Foods:		
rice	11.7	
biscuits	1.7	
	13.4	
Implements:		
bush knives	4.3	
axes	2.6	
fish line	1.9	
	8.8	
Other items:		
soap	7.0	
calico	24.1	(gifts)
kerosene	10.6	
matches	1.3	
tobacco	1.3	
	44.3	

Values of the clothes, calico and hygiene make 50.9% of total value of goods brought with labour.

From a sample of about 50 returns from plantations the items most frequently taken back were the following during the period 1950–66:

Money (90 %), bar soap (80 %), calico (70 %), extra trousers (60 %), extra shirt (55 %), bush knives (50 %), fishing line (45 %), one or more bags of rice (35 %), matches (30 %), kerosene (25 %), towels, baby powder, axes, exercise books (20 % each), tobacco (15 %), watches (15 %), biscuits and tinned fish (10 %), underwear and bed sheets (10 %), lamps, fish hooks, ink, sugar, bicycles (about 5 % each). In table 22 the approximate distribution after value is given.

It may be noted that most items imported meet rational needs; there is little background for the

TABLE 23.

	Persons returned	Persons bringing no goods
Sa'aiho	49	16
Ghongau	96	15
Matangi	50	2
Bellona total	195	33

often heard statement that 'natives fritter away their money'. This is underscored by the remaining of the import-list items. Among these there are found extremely valuable longterm investments as corrugated iron for two houses and two watertanks. The ready money brought back rarely exceeded Aus. $ 10 per person; useful things were greatly preferred to money, which is no wonder when the difficult conditions for trading on Bellona are considered, together with the saving in freight.

From the sample of fifty returns previously mentioned, it was estimated that the average value imported into Bellona by returning labourers per annum around 1965–66 was about Aus. $ 30 per individual. The amount has been found from an estimate of value of the usual imported items from a price evaluation made on Bellona – necessary because some of the things were second-hand.

The yearly amount gained from Bellona was increased during the period 1950–65, during which the total number of people returning from abroad can be seen in table 23.

From the number of labourers returned during 1950–65 it seems probable that the total amount transferred to Bellona is about Aus. $ 6000, or on an annual average of Aus. $ 400.

During 1965–66 about fifty persons returned from abroad bringing money and goods back with them. The total value of the import was thus approximately Aus. $ 1,500.

Among labourers returned from plantations the idea of making copra from their own palms on Bellona naturally emerged. A cooperative society was formed to promote copra production and organize its transport, along with other intentions. Data on copra exported from Bellona by the cooperative society are available from 1961 onwards (see table 24). Since generally very little was sold otherwise, the data give a fairly accurate estimate of the total copra export. Shipments of copra were generally very small and showed no tendency to increase before 1965. The tonnages were so small that they could possibly be produced in the time between the advertisement of a ship's arrival over the radio and its actual appearance.

TABLE 24.

Copra export from Bellona (approx. figures).

		tonnage	value Aus. dollars
1961	1. quarter	2.5	
	2. "	2.9	
	3. "	5.0	
	4. "	2.5	
	total	12.9	$ 1,238.75
1962	1. "	7.4	
	2. "	7.0	
	3. "	0.4	
	4. "	4.8	
	total	21.6	$ 1,812.30
1963	1. "	1.4	
	2. "	0.6	
	3. "	0.7	
	4. "	2.7	
	total	5.4	$ 544.75
1964	1. "	-	
	2. "	7.5	
	3. "	7.0	
	4. "	9.0	
	total	23.5	$ 2,749.50
1965	1. "	-	
	2. "	10.0	
	3. "	4.0	
	4. "	4.0	
	total	18.0	$ 2,160.00
1966	1. "	-	
	2. "	24.0	
	3. "	14.5	
	4. "	12.0	
	total	50.5	$ 6,565.00

(Figures have kindly been reported from Copra Board and District Office, Honiara).

T. Monberg (1965) has given a detailed analysis of the bankruptcy of the Bellonese Cooperative Society; some causes were of a social kind, others more technical. Social causes prevented real cooperation and frustrated all planned production, and technical problems made attempts to export even after the bankruptcy of the society a very difficult affair. In 1965 to 66 the presumptive individual exporter faced at least the following problems: 1) lack of storage facilities, 2) unpredictable shipping opportunities, 3) uncertain prices. The three link together: because of missing storehouses copra could not be kept dry and free of mould; it had often to be re-dried. This again involved much transport as drying only could be made at a few driers placed inland. Changing shipping schedules were very discouraging as they hindered real planning of production. 'Profits' changed not only because of changing prices but also because of the varying amounts of work resulting from eventual re-drying and extra transport. Some of the problems connect with the smallness of Bellonese production and the island's inaccessibility and location remote from a major port (fig. 3), others relate to a general lack of communication between the British authorities and the islanders for which it is hard to hold anybody responsible. There were signs of improvement in 1966; ships could from then on be requested if a reasonable amount of copra was ready for transport. A pre-announced price paid on the beach would have meant a further incitement to increase production, but was considered too risky by the administration.

If the normal Bellonese year from about March to March is considered, the production 1965–66 was only about 18 t. of copra, worth about Aus. $ 2,160. (The production was tripled during the following year.) The income during the year observed was little higher than that gained from the export of labour. But for such a comparison inputs also must be considered.

TABLE 25.

Labour expenditure per annum in producing copra from 1 ha.

	workhours
3-4 weedings or brushings	96
husking of 4,000 nuts	32
splitting of nuts	8
drying in hot-air drier (100-200 nuts a day)	160
collecting firewood, repair of drier	80
transport of unhusked nuts and copra	56
	432

To estimate inputs, copra production was observed in two areas, each about one ha. in area. The harvest in each area was about 4,000 nuts per ha., and the labour expenditure about 430 workhours. Work distribution was approximately as seen from table 25.

From the samples labour used in production of the exported 18 t. of copra is found to be from about 3,550 hours (at 2.2 t. per ha.) to about 7,500 hours (at 1 t. per ha.).

A few comments on the labour expenditure figures should be given: 1) Weeding was sorely neglected in the coconut groves on Bellona, causing losses through germination of nuts and through pest attacks. The high figure of weeding would be decreased if management of the groves was continuous. 2) Husking is done at twice this speed on plantations where better instruments are available (fig. 58). On Bellona husking is done with a pointed, hard-wood pole (*manguka* wood) stuck

Fig. 58. Husking of coconuts by means of a pointed hardwood pole. Both husks and the hard inner shells of the "nuts" are used for fuel when dry.

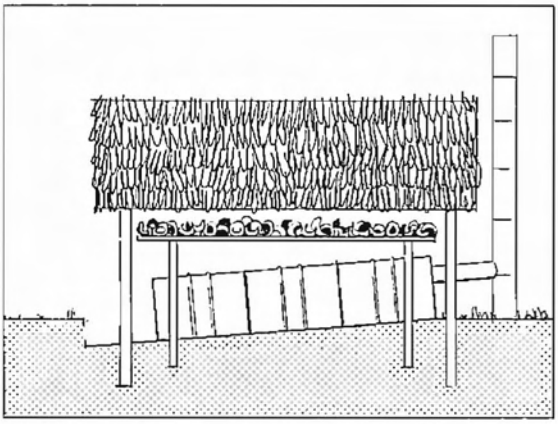


Fig. 59. A local coconut drier. The modified Kukum-drier was made after instructions from government extension officers. It is built from cheap materials, available from Honiara. a: Longitudinal section to show the construction.

b: The whole arrangement is contained in a house of local type.

into the ground. (A steel tripod is used on plantations). 3) Splitting is amazingly fast; one strong quick hit with a bush knife on the equator of a husked nut is sufficient. 4) The primitive drier, made of scrapped oil drums (see fig. 59 a and b) demands most of the work in copra production. The drier's capacity is limited, its fuel economy bad, and much work is necessary to gather enough firewood. A larger drier of improved type would be more economical to run, although the question of access to sufficient firewood would be aggravated. Depletion of nearby fallows is to be avoided; this may involve long transport of wood, even though empty coconut shells are usually used as fuel. 5) Carrying is a serious problem. A form of wheeled transport could ease the health-threatening carrying very much.

The 110 ha. reserved for copra production were evidently underutilized. The copra production potential estimated from the 22,000 bearing palms is ideally about 250 to 260 t. per annum. Another probably more realistic estimate may be had from the 110 ha. planted. According to R. Child (1964) 1.45 t. per ha. is a reasonable yield for unfertilized palms; this gives a 'practical potential' of about 160 t. of copra per annum. Even the record-like 1966 yield of 50.5 t. can therefore possibly be tripled.

To produce the actual export harvest only slightly more than 8 ha. would be necessary. One advantage with the very extensive Bellonese copra production is obvious: little labour is wasted on the idle areas lying as a reserve for future's production; an increase can be made almost instantly. Probably the labour expenditure in total copra production only slightly exceeded the hours required to produce the 18 t. of copra exported. As mentioned in the paragraphs on subsistence production, by far the largest part of the coconut groves were to be regarded as subsistence production areas in 1965–66. The inputs and outputs of the monetary sector are shown in table 26.

It is tempting, but almost impossible, to compare export of labour and export of locally made copra as ways to acquire a monetary income. Plantation labour was salaried at about Aus. 10 cents per hour, excluding value of food and housing. The latter may be estimated at about the same amount, raising total salary to about 20 cents per hour. On Bellona, helpers in copra production were salaried at only 10 cents per hour. For a landowner, local copra production rewarded him about Aus. $ 120 per t. or about Aus. $ 240 per ha. if efficiently worked. The profit may be estimated as approaching $ 200 after deduction of salary for 430 workhours at 10 cents. Normally the profit was probably only half as much because yields per ha. were lower and more transport involved. Still, amounts from $ 100 to $ 200 per ha. per annum were incredibly large to the Bellonese. Assuming a Bellonese had surplus land to produce copra from, he could apparently earn money very advantageously, compared with the plantation labourer. With shortage of land, things are different.

In 1966, 26 % of all men over 15 years of age and 18 % of the women were working abroad; in all, 210 persons were away, meaning 210 persons less to provide for. If they had all returned to the island, an additional 150 ha. of coconut groves would have had to be cultivated, assuming they would require proportionally the same amounts of land as the residing population. Such an area would have been difficult, if not impossible, to find. For this reason it seems possible that people without land on which to base a local copra production would be forced to or would prefer to work on plantations abroad instead of accepting the lower local wages.

The advantages of local copra production seem so obvious that one may raise the question why the production potential was inefficiently utilized, at least for most landed Bellonese. Some of the drawbacks were touched upon earlier, but another may be added: the difficult terms of trade. If the Bellonese want an imported article for which no local equivalent exists, the price will be accepted and hence the necessity to gain the equivalent value in money by export. With an existing Bellonese substitute for imported goods the price in terms of required work is worth considering. An example may demonstrate this: A traditional *tapa* loincloth (*kongoa*) required about two days' work to produce locally. A pair of trousers cost approximately the income of two days' plantation work, but as trousers are more comfortable to wear and last longer, can be washed and mended, they are preferred to loincloths. In fact loincloths have now totally disappeared. Other examples of imported goods which have substituted locally produced ones are easy to find; it may suffice to mention corrugated iron replacing pandanus thatching and nylon line replacing sennit. With most foodstuffs the decision is more difficult: locally an hour's work may produce from 3 kg (sweet potatoes) to 22 kg (bananas) of food; reduced to dry matter weights they shrink to about 1 and 7 kg. If imported food should be purchased in labour via wages for copra production, one hour's work would only buy about ½ kg of rice on dry matter basis. (Rice has been taken as a relatively cheap imported foodstuff.) From this it may be indicated if not proven that imported foods must possess properties not found in local foods, if they should be attractive to import (keeping qualities is an example).

TABLE 26.

Monetary sector: estimated inputs and outputs 1965-1966.

Export of labour	Work	Resulting income
210 persons	about 50,000 w.h.	about 1,500 Aus. $
Export of copra		
18 tons (8.2 to 18 ha.)	about 3,550 w.h. to 7,500 w.h.	about 2,160 Aus. $
	Σ about 54-57,500 w.h.	Σ about 3,700 Aus. $

The expenditure of monetary income seems to support the ideas presented above. Money is generally not spent on traditional articles. Money is spent on 'replacement-articles': imports replacing traditional goods, but only when advantageous. Finally money is spent on 'innovative articles' goods with no traditional counterparts, when they are deemed attractive. No traditional articles were said to have been traded among the local Bellonese except on rare occasions. 'Replacement articles' found in every household included knives and axes (estimated at a total island outlay of Aus. $ 650). 'Innovative articles' were also frequently met: most common were kerosene lamps (making a total outlay of about Aus. $ 390, but annually consuming kerosene for about Aus. $ 120). More and more frequently seen were watertanks, bi,-cycles, sewing machines, and radios.

During the survey it was obviously easy to find in what articles money has been invested, but how much of the actual annual income invested was not known. In fact it must have been a small amount, as much of the money for copra exported 1965–66 had not been paid the producers at the end of the period. Until the beginning of 1965 about Aus. $ 6,350 had been paid to the Bellonese from the Copra Board since it was started 1960. The income of plantation labourers had possibly amounted to about Aus. $ 17,500 during the same period. Of an estimated total monetary income of about $ 13,850, about 40 % of the income had thus been invested.

An unsolved problem is what the remaining income has been used for. It must first be remembered that the expenditure per person is quite low. No enquiries were made, but it is felt that a prominent part was paid in taxes, tithes and school fees.

To conclude this brief sketch of the monetary sector of the Bellonese economy, its connection

TABLE 27.

Monetary sector. Total invested capital *) 1965-1966. (Estimated in Aus. $).

	Matahenua	Ngotokanaba	Pauta	Ngongona	Ghongau	Matangi	Total	% of total
Iron roofs and water tanks	38	62	179	708	52	100	1139	20.2
Lamps	22	8	5	45	18	28	126	2.2
Cutlery, pots, knives, axes, bedding	105	36	32	245	20	56	494	8.8
Sewing machines	338	112	112	1010	88	112	1772	31.5
Bicycles	196	38	110	852	38	100	1334	23.7
Radios	254	54	34	380	-	46	768	13.6
Total	953	310	472	3240	216	442	5633	100.0

*) Four operating copra driers are not included in the table. Approximate value 200 $.

with subsistence must be stressed; money and subsistence are not to be seen as competitors, but as supporting each other. On the other hand it seems advisable that the monetary sector should be developed only to form a basis for 'necessary' imports, unless the island's carrying capacity shall be unnecessarily decreased, assumed the existing terms of trade.

Capital invested, monetary sector, 1965–66

During house to house interviews lists of capital goods possessed by the islanders were made. Information was freely given and usually the objects were even demonstrated. The number of objects are therefore believed to be nearly accurate, although the evaluation is not. The prices paid were no doubt given correctly by the Bellonese – informations are very rarely intentionally falsified – but it was impossible to assess the value of the objects after wear and tear. It may be very much less than the price paid for some objects. The estimated values are given in table 27. Bicycles especially (24 % of total investment) last a few years, mainly because of lack of repairs; also radios (14 % of total) have a short life under the tropical conditions of the island. On the other hand iron roofs and watertanks keep well (about 20 % of the total investment). Sewing machines – productive investments – make even more, namely about 32 % of the total. The sewing capacity seems to be too large for material needs. No doubt possession of a sewing machine conveys some status too.

The total monetary investment, only about one half time the annual income, appears low. The high depreciation is part of the cause, but it should be remembered that the income from preceding years was lower because of lower wages; in monetary terms Bellona was a poor island! Also it should be kept in mind that the monetary investment represents the equivalent of 56,000 work-hours at the normal salary of 10 cent an hour; it is almost equivalent to the annual total work in the monetary economy.

3.8 A crude survey of the Bellonese economy

In many respects the Bellonese economy is a typical 'subsistence plus cash' economy: basically a subsistence economy but extended by a hardly integrated monetary one. From the preceding paragraphs the inputs and outputs of the various sectors may be found. It is evident that Bellona is involved in an extreme 'dual economy': the subsistence part located on the island using most of its area and about two thirds of its work force; the monetary economy partly on the island but utilizing only a fraction of its area and work force and partly located abroad occupying about one third of the effective work force, but none of the island's areas.

A crude survey of the main flows in the economy is attempted in the diagram below (fig. 60); inputs of work are used as a common basis for comparisons. The total work force of all adult Bellonese is estimated to about 835,000 work-hours annually. Of these about three fourths or 600,000 w.h. are available on the island, the remaining fourth or 235,000 w.h. are exported, both for plantation work or to schools abroad. About half of the labour force on Bellona is utilized for subsistence activities. The other half is partly idle, perhaps underutilized partly used for social activi-

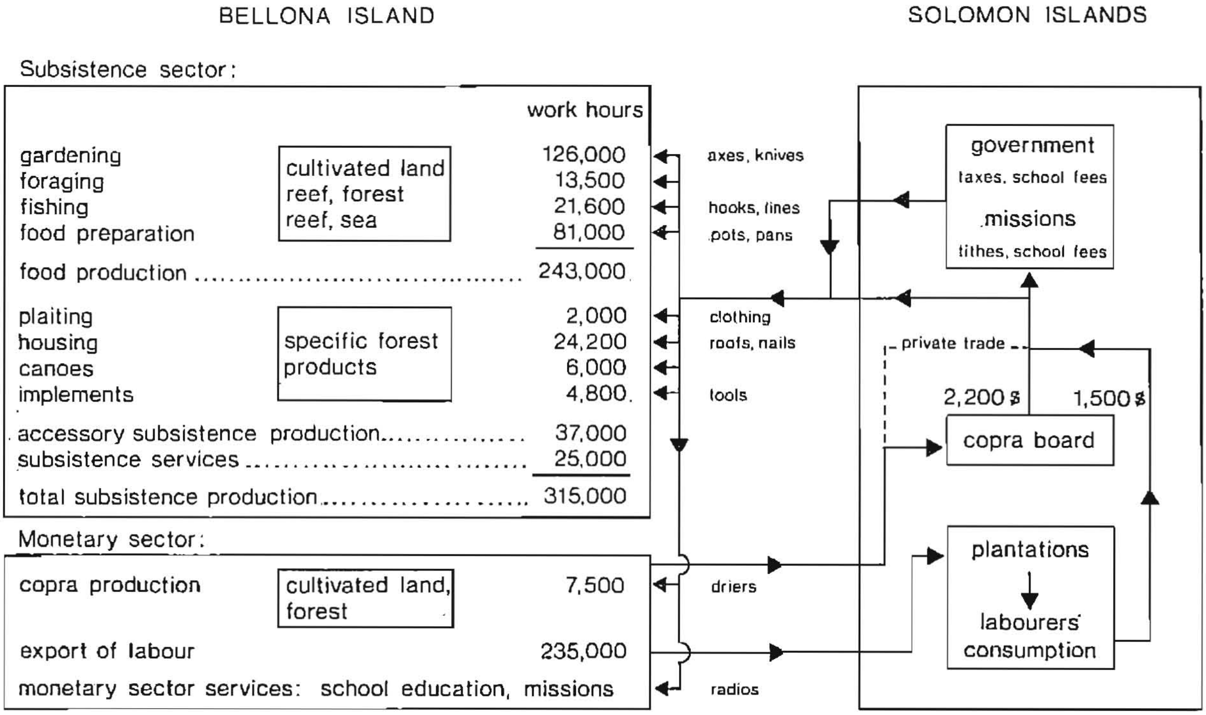


Fig. 60. Diagram showing economic flows between Bellona and the Solomon Islands. The subsistence sector is strengthened by import of tools and a few other items. By exporting labour and copra the monetary sector supplies the means to pay taxes and imports.

ties. This results in no material production, but it would be very unwise to regard it as wasted.

The newly acquired monetary income seems to be utilized to a large part for substitutes in the subsistence sector. To a great extent the money is advantageously invested in goods; this results in decreasing future work inputs or increasing subsistence outputs.

One of the great questions to be solved in the future is whether the present development can go on. It seems tempting to develop a money economy via local copra production in preference to export of labour. However, the local copra requires areas that must be taken from the cultivated (or cultivable land). A future conflict between the subsistence demands of a growing population and the demands for greater monetary incomes locally gained seems unavoidable.

4. The Bellonese in the subsistence context

4.0 Demand for food versus food production

In the introductory chapter it was mentioned that one of the important linkages between population and the subsistence system evidently was the relation between food demand and supply or in other terms, the stress on 'carrying capacity'. This concept mainly following W. Allan (1958), is understood as the long-term ability of a food-producing system to feed a population. It is assumed that the work required in food production is within the working capacity of the population.

To assess the food requirements of the population, the size of population must be known, together with its minimum requirements on a standard basis.

4.1 The census, 1966

As no census with the relevant data existed, a new census was planned. T. Monberg compiled a census almost simultaneously but with other uses in mind. However, the two counts – although made during the same period of time and both by interviews – differed markedly in principle. Monberg's count was made on the basis of recognized kinship; the author's was organized as a household survey. When they were finished on the last day of September 1966, there was an excellent opportunity to make a final check of the results. After corrections had been made, the counts differed only by one person: a baby born either on the day of the census or the day after. Counting on a kinship basis by means of interviewing key persons as heads of families proved a rapid method to determine the total or *de jure* Bellonese population. The household count involved difficulties in assessing the number of Bellonese abroad, but it gave a reliable result for the population then present on the island, the *de facto* population. It appears that in a population which has such keen interest in recognition of kinship as have the Bellonese, a census on a kinship basis is the most economic one to produce complete results. In principle the household count is the most appropriate for the present purpose, but two problems made it less productive on Bellona than expected: many Bellonese were not always established in the same homestead, and neither the inhabitants nor the homesteads were readily identified by name.

The three sources of error were overcome by the friendly cooperation of the Bellonese. Possibly the name problem is the reason why previous official estimates of population varied too much from the 1966 census – to be accounted for by actual population increase. The difficulties stem from the fact that every Bellonese has many names, and their use varies with the person calling them. Only one name, the *ingoa hakama'u,* is fixed throughout lifetime; often it is not used at all. Usually the baptismal name, *ingoa paputasi* or *ingoa baptaisi,* or additional names such as pet-names, nicknames, and honorific names are employed. With the 1966 censuses all names, lineages, villages and homesteads were asked, and a census number applied to each Bellonese for future use. In table 28 some figures of the 1966 population are given.

The population present on Bellona included a total of 17 'aliens', among whom the Melanesians were considered by the Bellonese to be definitely 'non-Bellonese', although much respected because they were missionaires.

The difference between Rennellese and Bellonese is so slight that no objections whatever were given to listing Rennellese in the census, whereas inclusion of Melanesians was strongly resisted. An explanation is that intermarriage between the Rennellese and the Bellonese people is commonplace, while marrying Melanesians is generally not accepted by either Rennellese or Bellonese. Rennellese women with Bellonese husbands are naturally considered Bellonese, but it is more difficult to decide if a Rennellese man through marriage becomes a Bellonese 'citizen'. If Rennellese men had acquired land, they were listed here as Bellonese (2 cases). A similar problem occurs with Bellonese living abroad. They have been listed as Bellonese if still recognized as such by the population of the island (such as unmarried women, children, and all males) even if they definitely do not want to return to their home island. No Bellonese man was in 1966 known to have given up inherited land; thus nearly all Bellonese men remain attached to their island throughout their lifetime.

The basic information sought from each indivi-

TABLE 28.

Population of Bellona counted on households, September 1966 *)

	Sa'aiho	Ghongau	Matangi	Bellona total
Number of households on Bellona **)	27	72	19	128
Total Bellonese present (de facto population)	132	344 *) + 1	94	570 *) 571
Bellonese abroad	39	140	31	210
Total Bellonese (de jure population)	171	484 + 1	125	780 781

*) Excluding 6 Melanesians and 4 temporary Rennellese residents (teacher's families).

**) Households understood as one or more families occupying the same house. There were 36 unoccupied living houses.

dual for the census was: 1) names (especially the fixed name [*ingoa hakama'u*] and the name most frequently used), 2) lineage, 3) age, 4) marital status or status within a household, and 5) 'address'. A few comments are necessary on these points. The personal name as a means of identification (1) was treated above; information on lineage (2) also serves as a means of identification and is further of great importance since kinship is the most commonly used frame of reference for persons on Bellona. Assessment of age (3) was not an easy task among people who care very little about numerical age, but apparently prefer terms referring to physical or social 'stages of development'.

As determination of age is of importance in assessing basic components in the description of a population, the method in determining age will shortly be referred.

In table 29 the local terms which proved useful in assessing objective age are given. They can only give the approximate age, and with varying accuracy at different ages. For age determination the table was used in combination with the list of 'reference years' (see appendix E). The 'reference years' have been objectively checked, since most of them have been recorded in literary sources. Unfortunately there are long periods without any safe record in the list. It has therefore often been used for checking a person's age in such a way that more than one calendar reference point has been applied. ('How old were you at the time of the great hurricane [1910]?' 'How old were you when Dr. Lambert first visited Bellona [1930]?'). In some exceptional cases it was impossible to make an independent determination of a person's age; then it was found by comparison to other person's age in the same age group (*'atu haahine* for women, *'atu taangata* for men), or to the number in the sequence of brothers and sisters. With six very old persons almost everything failed and only an 'older than' determination could be made. Usually accuracy was satisfactory. For people born after 1930, the age could usually be determined within a margin of one or two years (except probably for some women), but for the few old people mentioned the error was probably not less than ± five years. For the following analyses the margins of error in the data are insignificant.

With the margins of error in these approximations, the sex/age composition of the population is illustrated by the conventional 'population pyramid', showing number and percentage of people according to sex in 5-year age classes, see fig. 61 and 62. Both *de facto* and *de jure* populations are shown; *de facto* population in this case excludes resident Rennellese and Melanesians.

No attempt has been made to analyse population dynamics thoroughly. There is no ready knowledge of birth and death rates locally and it proved very hard to collect raw data extending more than a few years back. Possibly the eminent memories of the Bellonese could be used for a reconstruction of data that would be extremely interesting; there is scant available information on pre- and early post-contact population development. Only a few conspicuous features observed from composition of recent population shall be mentioned here. The pyramid looks like a prototype for developing countries; obviously both a high rate of birth and of death are operating. One of the 'cuts' in the pyramid, in the 1936–41 group, is

TABLE 29.

Relative age terms on Bellona.

Vernacular name	Approximate age	Approximate English term
tama meamea	1 month	newborn; lit., red child
huahua tahanga	1-6 months	baby; lit., naked child
kapakapa totongo or ngapangapa totongo	6-9 -	baby crawling with difficulty
sehu totongo	1 year	infant, crawling
ngaka too	9-18 months	small child, learning to walk, but sometimes falling
sehu (or tama sehu)	1½-2 years	child able to walk
hua hetengetengehaki	2-3 -	child able to run fast
bangokaa tama	10-14 -	child young
bangokaa matu'a	about 19 -	adolescent
uu hakahatu	13-20 -	teenagers; girls developing breasts
ngutu kengekenge		boys, beard starting to grow lit., with dirty mouth
matu'a	over 20 -	grown up
'atu'atu matu'a	about 40 -	middle-aged, still strong
ponga tama		approaching middle age
ponga matu'a		late middle age
sosoka	over 50 -	old, but still working
taumango ti'aki	60-70 -	old, slightly senile
nenebe	80 -	very old, senile
matu'a punge o te henua	100 -	exceedingly old, able to talk, but not to walk

Notice:

Some of the terms, especially for advanced age, are overlapping.

Generally terms refer to a person's individual development, they vary slightly with the individual speaking.

locally explained as a dramatic decrease in fertility: 'The old gods denied us children because we broke off our relations with them'. At least the lack of people in the 25–29 age bracket was not, according to local informants, caused by direct losses from introduced diseases as has been the case in other parts of Oceania. This gap in the middle range of the reproductive class has not prevented the population from being generally a very young one. 50 % of the population is 16 or younger.

Mortality seems to be greater for the young age classes than for the old ones: from 30 years and older survival is better. A considerable change in sex-ratio is observed above the age group 40–49 years. The age class over 50 shows a 3:1 ratio of women to men, whereas the one below displays a 1:2 ratio. Possibly part of the change is only apparent; age determination of women over forty is difficult on Bellona because they traditionally are extremely shy. Many 'did not remember anything'. Their birth years were therefore concentrated unrealistically near the memorable years of 'the great hurricane' or other years of disaster.

The population absent from Bellona amounted to about 25 %, remarkably evenly distributed in sex and age classes. Evidently Bellonese prefer to take their families with them abroad. Married couples migrate to work on plantations, which is remarkable as workers on most plantations in the Western Pacific normally are single males. Proportionally, old people migrate almost as much

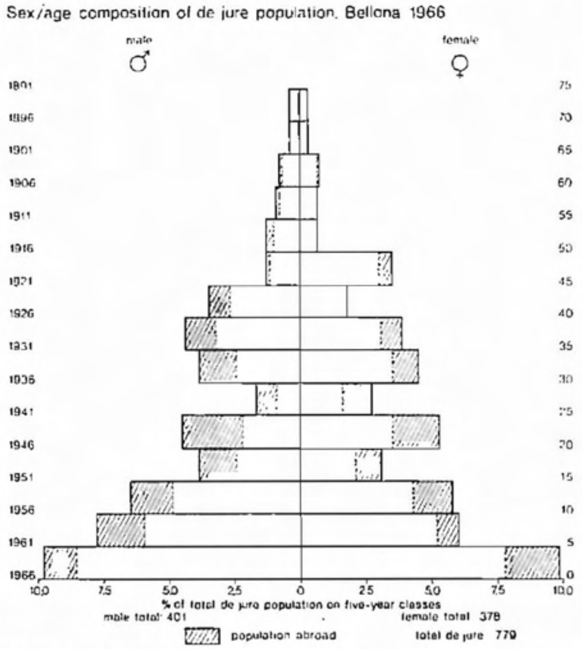


Fig. 61. Population pyramid showing de jure population 1966. It may be noted that emigration encompasses people of both sexes and all age classes.

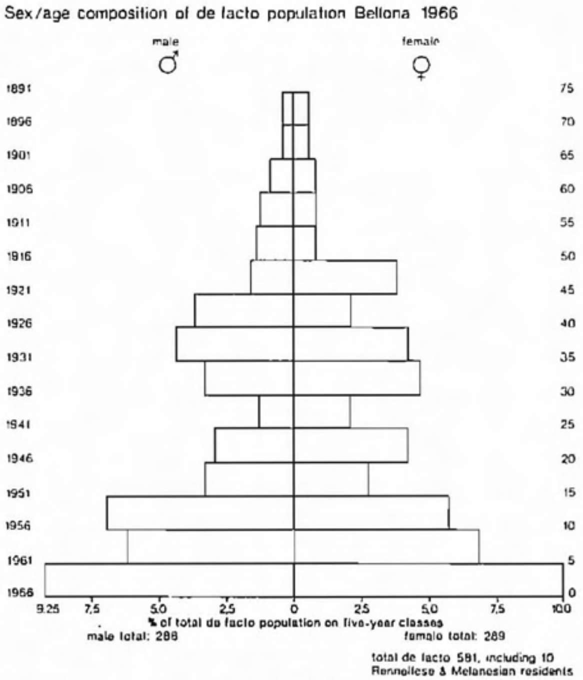


Fig. 62. Population pyramid showing de facto population 1966. From 1938 a sharp decline in size of year classes is seen; after 1950 an increase started.

as others, but their purposes are different. Some are simply in Honiara to be treated in the hospital or to see a dentist; others have been taken along with young relatives. An amazingly high proportion of people of less than 20 stay abroad to receive an education. Of the 20–24 year class, one third of the women and half of the men seek some kind of education, mostly in Honiara, and often successfully.

The percentage away from Bellona changes considerably from time to time. Fluctuations may be due to changes in employment; they are often sudden changes as working contracts usually are annual or bi-annual. Bellonese like to travel and to visit their people at home or abroad. An interesting material on migrations collected by T. Monberg and L. Christensen has not yet been analysed, but it shows a great amount of migrating. Also travels on Bellona itself are frequent. Children and young unmarried people often wander about, and occasions for visits are easily found for everybody. In the diary survey a remarkable high percentage of time was found to be used on 'social contacts' and leisure.

4.2 Food requirements on a standard basis

The population present on the island at the time of the census is illustrated in fig. 62; 6 Melanesians and 4 Rennellese might have been included in *'de facto'* population together with 7 Rennellese visitors. 1966 was a year of few migrations, and it seems safe to assume that the number of people residing throughout the year was of approximately the same size as at the date of census. Disregarding deaths and births, the census population has accordingly been taken as the number of people living on island produce and working on the island. (Deaths and births represent definitely smaller changes in the number of residents than do migrations).

No attempt was made to assess consumption of the Bellonese population directly. Local assistants were unable to cope with the problems of weighing operations and bookkeeping. A nutritional survey might yield interesting results, especially if combined with an investigation of health, but it must await future research. Here only general food requirements in calories and protein are considered.

To obtain a satisfactory degree of accuracy (± 10 %) in assessing requirements, a detailed approach is necessary. FAO's Nutritional Studies No. 15 (1951 and later edition) recommends that one starts with a 'Reference Man and Woman'. These reference persons are defined as being 25 years of age, healthy, physically capable of active work and weighing 65 and 55 kilograms respectively. Further they should live in an environment of an average temperature of 10°C, have stable body weights on balanced diets and perform specified activities. From these reference persons the requirements of a total population can be determined (FAO 1957, 11–12) after correcting for variations in body weight, age, and different environmental conditions. Having made these corrections and others for lactation and pregnancy, it is evident that the main source of error arises from the assessment of the level of activity. Another, though less significant error stems from differencies in the digestive process, which differs according to the type of food taken.

The energy required for work changes greatly. Direct metabolic measurements could not be taken during the field work. Instead some comparisons with the FAO descriptions of typical work and its corresponding energy expenditures and some typical work on Bellona were made. It was felt that the FAO reference figures 13,400 kJ/3,200 kcal for men and 9,600 kJ/2,300 kcal for women per day) reflect the Bellonese activity level, except that they should possibly be slightly higher for women. It must be admitted, however, that the estimate is rather weakly founded. Seasonal and individualistic working patterns dominate; uniformity in daily activities is the exception rather than the rule even when a number of people are engaged in for instance 'digging a garden'. There seems to be a tendency towards hard engagement in hard physical work for short intervals of time only, followed by long periods of rest and leisure; in fact work and leisure are often very hard to distinguish. 'Sprinter'-type activities seem to be preferred; this results in an endless putting off of tasks that involve prolonged hard work. The FAO tables available lack relevant descriptions and figures of energy expenditure for types of work other than those of the Western world, which is regrettable since the need for such material is much greater outside the industrial world than inside where measurements easily can be made. However the figures on requirements already cited are thought to be reliable within about ± 5 %, because more than half the amount of the requirements are due to non-activity dependent metabolism.

For the application of the FAO figures for reference woman and man the prescribed procedure has been followed: the population was divided into convenient age groups, and corrections for body weights and environmental temperature were made*).

Determination of the weight/age curves for Bellonese females and males proved to be difficult as people were most reluctant to be weighed on the swing-furnished spring scale employed. Only 69 people volunteered, but of these few were adolescents. Although the sample obtained contained a wide spread of ages and some of the more numerous classes in the population were also well represented in the sample, the resulting curves are only satisfactory as approximations because of the under-representation mentioned.

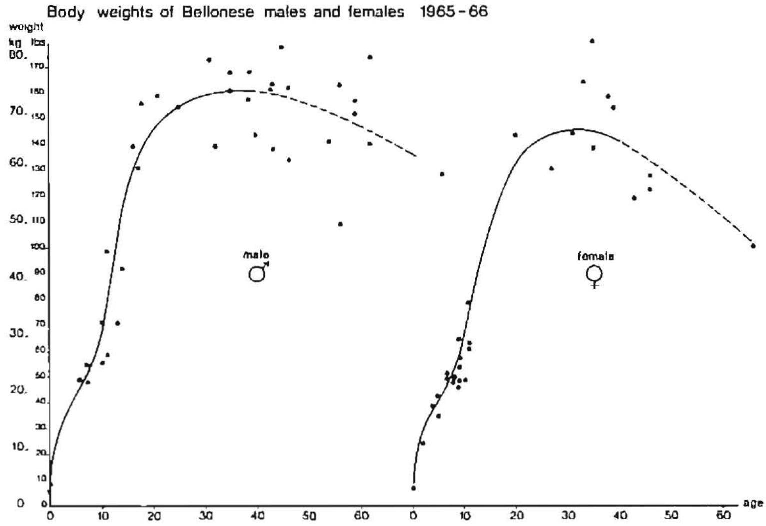
The curves (fig. 63) show a considerable decrease in weight for advanced ages, which is in accordance with other observations. Also the high body weights of both females and males at the 'reference age' (25 years) were in keeping with our impressions, though they are high compared with most European people. Here it might be added that weighings were made in May 1965, at a time of the year when food supplies are sumptuous.

The errors introduced through inaccuracies in age determinations are definitely much less than those stemming from estimating level of activity. 25°C was chosen as representing environmental temperature. Air temperatures are certainly higher at the times when Bellonese are at work outdoors. At night temperatures are mostly less than 25°C, but not indoors.

To the daily and yearly calorific requirements calculated from the population number and weights an allowance has been added for the 11 aliens present on the island (at 9,200 kJ/2,200 kcal per individual per day). Allowances have not been made for the Bellonese visitors from abroad during the yam harvest season; these requirements are not only modest but also occur in a period of con-

*) FAO/WHO 1973 recommend a simpler procedure. The new tables have reduced requirements somewhat.

Fig. 63. Weight curves for Bellonese males and females. Because of the few samples, the curves are not very definite; especially the rate of decline in weight after about 30 years of age is not firmly established.



siderable surplus. Possibly visitors may consume up to 4.2×10^3 MJ/1×10^3 Mcal per annum. If so the total yearly calorific requirement of the Bellonese staying on Bellona is about 1996×10^3 MJ or 477×10^3 Mcal (see table 30). Figures are given non-rounded.

In addition to calorific requirements also the intakes of protein need consideration. According to different doctors who have visited the island over a long period, starting with Lambert's visit to Rennell in 1930 (Lambert 1936), there seem to be no signs of any specific malnutrition on Bellona, except for kwasiorkor-like symptoms among children. If FAO's instructions for the estimation of protein requirements (FAO Nutritional Study No. 16, 1957) are followed and body weights are assumed to fit the curves presented, the daily and yearly protein requirement is as in table 31.

The requirements for protein thus arrived at are measured in 'reference protein'. To allow for the different percentages of amino-acids present in other types of protein, the weights of these have to be enlarged to ensure sufficient supply of any kind of amino-acid necessary for humans. FAO has tabularized coefficients for important types of proteins: coefficients are for example for fish protein 1.45, for sweet potato protein 1.25. With reference to the relevant coefficients the annual requirements of protein are calculated to about 8.9–9.5 t. for the resident population.

Assuming people gain their calories mainly from roots (sweet potatoes, taros, and yams) adults will get the proteins required with such food. For people with low caloric intakes, roots are insufficient as protein sources. Especially among the 4–6 year group there is a great chance of protein malnutrition since their diet tends to consist of food less rich in protein than roots, as for example bananas and papayas. The same tendency is found for babies, especially for weaned children; fortunately there is also a custom of feeding them with pre-chewed fish foods. These have high protein coefficients protein-rich enough to assure a fair supply of reference protein, because the fish are combined with protein of quite different amino-acid patterns. This is in accordance with findings in New Guinea (Hipsley and Langby 1953), but a further discussion is beyond the scope of this survey.

The Bellonese must for their sustenance provide food containing 1996×10^3MJ and about 9.5 t. of protein according to estimates based on FAO prescriptions. Approximately 50 % of the amounts goes to the children and adolescents who are not involved in production. At an average content of 25 % carbohydrates, about 566 tons net of root crops must be produced to feed everyone. (According to Coursey, 1967, and Ayenuga, 1955, both yams, taro, and sweet potatoes contain about 25 % of carbohydrates).

The necessary gross production of root crops is found by adding inevitable wastages: seed tubers (about 5 % of the yam crop) and food processing (about 10 % of the total crop). From this, necessary gross production is calculated to a minimum of from 445–526 t., or 495 t. ± 50 t., depending

TABLE 30.

Estimate of daily and yearly requirements of food energy for

	Males					
Age-group	Average weight	Daily req. for FAO 'Ref. Man'	÷ corr. for age	÷ corr. for temp.	Number on Be.	Total result. daily req.
		kcal (kJ)	kcal (kJ)	kcal (kJ)		kcal (kJ)
0-1	-	1,120 (4,686)	-	1,036 (4,335)	12	12,432 (52,015)
1-3	-	1,300 (5,439)	-	1,203 (5,033)	32	38,496 (161.067)
4-6	-	1,700 (7,113)	-	1,572 (6,577)	31	48,732 (203,895)
7-9	-	2,100 (8,786)	-	1,942 (8,125)	26	50,492 (211,259)
10-12	-	2,500 (10,460)	-	2,312 (9,673)	28	64,736 (270,855)
13-15	-	3,100 (12,970)	-	2,867 (11,995)	10	28,670 (119,955)
16-19	-	3,801 (15,903)	-	3,516 (14,711)	19	66,804 (279,508)
20-29	70,0 kg	3,379 (14,138)	0	3,126 (13,079)	24	75,024 (313,900)
30-39	72.5 kg	3,466 (14,502)	3,362 (14,067)	3,110 (13,012)	44	136,840 (572,539)
40-49	72.5 kg	3,466 (14,502	3,258 (13,631)	3,014 (12,611)	30	90,420 (378,317)
50-59	69.0 kg	3,237 (13,544)	2,800 (11,715)	2,590 (10,837)	14	36,260 (151,712)
60-69	65.0 kg	3,201 (13,393)	2,529 (10,581)	2,339 (9,786)	9	21,051 (88,077)
70					0	0
Total daily requirements					males: Σ 289	669,957 (2,803,100)
Average daily requirements					males:	2,318 (9,699)
Total yearly requirements Bellonese					males:	244,534,305 (1,023,131,500)

on the varying water contents of the crops. To the minimum amount must be added a surplus (see W. Allan 1958) large enough to ensure necessary provisions in years of small harvest, or even allowances for extreme natural hazards.

Even 526 t. of root crops are not sufficient for a minimum supply of protein, because of the low protein contents of these crops (1.12–2.78 %, normally about 1.5 %). About 2 t. of extra 'complete' protein is necessary. Normally fisheries ensure ample protein for the population, but it is interesting that selection of root crops towards protein-rich types might make a root crop diet sufficient also with proteins.

4.3 Comparison between food supply and requirements

Total supply estimated from the survey of land utilization and the selected assessment of per hectare yields (chapter 3.1), and requirements as estimated in the foregoing section of this chapter are given in table 32.

The supply to be expected from the acreage planted will, assuming normal yields, ensure the Bellonese an overwhelming surplus on an annual basis. Even when deductions are made for a possible overestimate of cultivated areas, there is a large surplus. It is, however, unequally distributed on the island.

Bellonese 'de facto' population 1966 (based on FAO-instructions)

Females						Both sexes
Average weight	Daily req. for FAO 'Ref. Woman'	- corr. for age	- corr. for temp.	Number on Be.	Total result. daily req.	Total result. daily req.
	kcal (kJ)	kcal (kJ)	kcal (kJ)		kcal (kJ)	kcal (kJ)
-	1,120 (4,686)	-	1,036 (4,335)	13	13,468 (56,350)	25,900 (108,366)
-	1,300 (5,439)	-	1,203 (5,033)	33	39,699 (166,100)	78,195 (327,168)
-	1,700 (7,113)	-	1,572 (6,577)	30	47,160 (197,317)	95,892 (401,212)
-	2,100 (8,786)	-	1,942 (8,125)	25	48,550 (203,133)	99,042 (414,392)
-	2,500 (10,460)	-	2,312 (9,673)	25	57,800 (241,835)	122,536 (512,691)
-	2,600 (10,878)	-	2,405 (10,063)	11	26,455 (110,688)	55,125 (230,643)
-	2,703 (11,309)	-	2,500 (10,460)	13	32,500 (135,980)	99,304 (415,488)
65.0 kg	2,599 (10,874)	0	2,404 (10,058)	39	93,756 (392,275)	168,780 (706,176)
67.5 kg	2,676 (11,196)	2,596 (10,862)	2,401 (10,046)	51	122,451 (512,335)	259,291 (1,084,874)
65.0 kg	2,599 (10,874)	2,443 (10,222)	2,260 (9,456)	36	81,360 (340,410)	171,780 (718,728)
57.5 kg	2,375 (10,355)	2,055 (8,598)	1,900 (7,950)	10 1	19,000 (79,496)	55,260 (231,208)
52.5 kg	2,223 (9,301)	1,756 (7,347)	1,624 (6,795)	10	16,240 (67,948)	37,291 (156,026)
-				0	0	0
			females: Σ 296		598,439 (2,503,869)	1,268,396 (5,306,969)
			females: $\bar{x}$		2,022 (8,460)	$\bar{x}$ 2,168 (9,071)
			females:		218,430,235 (913,912,185)	462,964,540 (1,937,043,685)

Total daily requirements Bellonese both sexes	1,268,396	(5,306,969)
Total daily requirements strangers both sexes (17 x 2200)	37,400	(156,482)
	1,305,796	(5,463,451)

Total yearly requirements Bellonese both sexes	462,964,540	(1,937,043,685)
Total yearly requirements strangers both sexes (17 x 2200 x 365)	13,651,000	(57,115,930)
Estimate on requirements for 1966 de facto population	476,615,540	(1,994,159,615)
	~ 0.48×10^6 Mcal	~ 1.99×10^6 MJ

From the horticultural calendar it is clear, however, that the abundance is unevenly distributed over time. In the 5–7 months of yam harvest provisions are plentiful: on an average 336×10^3 MJ or 82×10^3 Mcal per month are available against only 165×10^3 MJ or 40×10^3 Mcal required. Even half of the yam harvest is sufficient for the supply. The problem is the traditional period of scarcity. The perishable yams long harvested are of little help in this; the crops depended on traditionally were taro and bananas, but they yield little during the period. Gathering even if concentrated in these months yield insufficiently alone. Obviously supplies have to be taken from many unreliable sources. Sweet potatoes have been found a useful crop for the period. They have a

TABLE 31.

Estimate of daily and yearly requirements of food protein for Bellonese

Males						
Age-group	Average weight	Req. per kg weight	Req. per individual	+ 50%	Number of individuals	Group total daily req.
0-1	10 kg	1.3 g	13.0 g	19.5 g	12	234 g
1-3	13 kg	1.2 g	15.6 g	23.4 g	32	749 g
4-6	19 kg	0.8 g	16.2 g	24.3 g	31	753 g
7-9	27 kg	0.7 g	18.9 g	28.4 g	26	738 g
10-12	35 kg	0.7 g	24.5 g	36.8 g	28	1,026 g
13-15	52 kg	0.8 g	41.6 g	62.4 g	10	624 g
16-19	65 kg	0.6 g	39.0 g	58.5 g	19	1,012 g
20-24	70 kg	0.35 g	24.5 g	36.8 g	17	625 g
25-29	72 kg	"	25.2 g	37.8 g	7	265 g
30-39	73 kg	"	25.3 g	37.9 g	44	1,668 g
40-49	72 kg	"	25.6 g	38.4 g	30	1,134 g
50-59	70 kg	"	24.5 g	36.8 g	14	515 g
60-69	65 kg	"	22.8 g	34.2 g	9	308 g
						.. 9,651 g
			Sum of daily requirement males:			
			+ corr. (x 'protein coefficient' = 1.45)			13,994 g
			yearly requirement males:			5,107.8 kg

larger potential for vegetative propagation than taro. A single cutting may yield several tubers, whereas taro (top) cuttings only yield one corm each. With such a modern crop combination scarcities should be swiftly vanishing.

Normally a food surplus is observable during the yam period, and undersupply is rare. The normal surplus seems thus to be evident, as is usually the case with populations living on a subsistence basis (W. Allan 1958). In other words the insurance against natural hazards amounts to about half of the normal food production. Another random influence is probably considered too by the Bellonese: the 'risk' that most kinsmen might return. They could be supplied during a normal year, but hardly during for example a year with severe droughts.

4.4 Time expenditure necessary for subsistence activities

In chapter 3.1 to 3.5 the inputs of labour to perform the subsistence activities of Bellonese economy were estimated.

On Bellona in 1965–66 there were about 270 persons (121 Bellonese men, 146 women + aliens) present in the age classes (according to Bellonese concepts) obliged to work (20 years and over). After 19 old people have been deducted, the total number of people present to work the necessary hours was about 250. About 300 days a year are workdays, which means that the 250 persons were obliged to work effectively for at little less than 3½ hour each day for strict subsistence purposes. If transport is included, this means working about half the day, which coincides happily with Bellonese ideas of normal life, and is practical if one wants to avoid work during the middle part of the day with its intense heat. Clearly, however, an even distribution of work is not possible. Heavy, continuous work is essential during the planting season for yams and at the peak of the fishing season. Even if the work spent in monetary production is added (table 26) there is plenty of time left for social enterprises and leisure.

In appendix J the expenditure of time for female and male adults of two villages is shown. Matahenua village is located with easy access to the sea, Pauta farther inland and with a little more difficult trail to the coast. Time expenditure has been found from diaries kept by local assistants. As only major tasks before and after noon are recorded, the diaries give only a crude picture of activities performed during each half-day. In the 'de facto' population 1966 (based on FAO instructions for estimating).

Females						
Age-group	Average weight	Req. per kg weight	Req. per individual	+ 50%	Number of individuals	Group total daily req.
0-1	9.5 kg	1.3 g	12.4 g	18.6 g	13	242 g
1-3	12.5 kg	1.2 g	15.0 g	22.5 g	33	743 g
4-6	18.0 kg	0.8 g	14.4 g	21.6 g	30	648 g
7-9	26.0 kg	0.7 g	18.2 g	27.3 g	25	683 g
10-12	34.0 kg	0.9 g	33.6 g	50.4 g	25	1,148 g
13-15	45.0 kg	0.6 g	27.0 g	40.5 g	11	446 g
16-19	57.5 kg	0.35 g	20.1 g	30.2 g	13	393 g
20-24	63.0 kg	"	22.1 g	33.1 g	27	894 g
25-29	67.0 kg	"	23.4 g	35.1 g	12	421 g
30-39	67.0 kg	"	23.4 g	35.1 g	51	1,790 g
40-49	62.0 kg	"	21.7 g	32.6 g	36	1,174 g
50-59	55.0 kg	"	19.3 g	28.9 g	10	289 g
60-69	50.0 kg	"	17.5 g	26.2 g	10	262 g
						9,133 g
			Sum of daily requirement females:			
			+ corr. (x 'protein coefficient' = 1.45)			13,243 g
			yearly requirement females:			4,833.6 kg

Sum of daily requirement both sexes:	18,784 g
+ corr. (x 'protein coefficient' = 1.45)	27,237 g
Yearly requirement both sexes	9,941.4 kg
+ allowance for strangers (17 x 36.8 x 365)	228.3 kg
	10,169.7 kg

diagrams work within the major groups of activities is shown on a weekly percentage basis. Surprisingly enough subsistence activities occupy only about one third of the active time, and social enterprises and leisure more than half. One of the main tasks of the diary survey was to find seasonal distribution of work. From the diagram this may be seen; the scarcity period with collecting/gathering, the main fishing period, and the yam season are conspicuous. All activities seem to depend heavily on the weather which can be seen by comparison with the diagrams in appendix H.

4.5 Some comments on the 'carrying capacity' concept

A definition of carrying capacity has been given by W. Allan (1958) as the number of people able to live from a given area assuming natural conditions and food production techniques as unchanged. Allan also included the production of a normal subsistence surplus in his assumptions. It seems that the carrying capacity concept has been scientifically useful resulting in progress especially for the research on African subsistence agriculture. Still, the concept invites further discussion of some aspects, for providing a sharper definition of its individual elements.

The essence of the 'subsistence law' (W. Allan 1958) is that local production equals consumption plus 'normal surplus' for a given food-production system.

In notions slightly differing from Allan's this can be expressed $a \cdot y = p\,(c + n)$, where *a* is the area on which the system is based, *y* is yield per area unit, *p* the population, and $(c + n)$ the consumption including 'normal surplus' per head. Maximum population density, or 'carrying capacity' is thus $p : a = y : (c + n)$.

Discussion of the single elements may take two leads. The whole concept of 'carrying capacity' can be intimately linked with a given food production system (ad modum W. Allan) or the concept can be connected with the assumption of a

TABLE 32.

Estimate of total annual food supply 1965-1966.

	gross yield tons	seed material etc. tons	preparation losses tons	raw edible supply tons	dry matter of ingestible material tons	total amount of energy 10^3 Mcal	contents of protein (reference protein) tons
yams	635	32	64	539	145	575	
taro/bananas	190	0	19	171	43	176	
sweet-potatoes	104	0	10.4	94	24	96	13.3
collected food	40	0	4	36	9	37	
fishing catches	60	0	6	54	11	44	2.2
totals	1035	32	103.4	894	232	928	15.5

maximum biological production for a given area regardless of exploitation.

Following Allan, population *p* must be counted in standard units. This idea is evidently sound but instead of 'Oxford units', it might be preferable to use reference women and men according to FAO standards. Allan, curiously enough, does not include the energy for cultivation in 'consumption'.

Allan takes for the element *a* the total area on which the population group *p* is living. He has consequently to introduce the expressions 'cultivable percentage' for reducing the total to the exploitable area by the given agricultural technique. Further he uses the 'land use factor' for the proportion of total cultivable area to cultivated area per annum.

Yield per area unit, *y*, is understood as the long-term stable yield, and c + n is as previously mentioned the average consumption per head including 'normal surplus'. Allan in fact defines consumption more implicitly: 'acreage necessary to feed one person' (= 'cultivation factor' = acreage per capita).

If the 'carrying capacity' concept is used in its universal sense it is advantageous to distinguish between properties of the environment and of the cultivative system.

With population, *p*, the distinction makes no difference as to the two definitions: it can be given in any of the standard units. The area variable, *a*, must be assessed with regard to its biological production potential. If so, it is assigned a productive potential independent of the system of exploitation.

The yield per area unit, *y*, assessed for the total area at hand is thus conceived as an expression for the efficiency of the food production system – within the limits of the environmental potential. By 'universalizing' the expressions for area and yields combined, a measure of productive efficiency may be achieved.

There is little need to alter the expression for consumption, so long as consumption is understood as a minimum consumption including the 'normal surplus' and possibly also the amounts of energy for the normal productive work. Probably the assessment of consumption is a most difficult task because of its ill-defined nature; consumption is heavily influenced by the aspiration level of the population in normal life. To avoid unnecessary difficulties a standard consumption must be defined, but this does not do away with the problem connected with consumption caused by the work necessary to produce the agricultural output (which is again depending on capital investments and other variables). In fig. 64 a curve for production is shown under the assumption that production is determined by inputs of labour and area alone. Costs of labour in energy are depicted by a straight line. As the distance between the line and the curve shows the output available to feed the population, 'carrying capacity' is marked by the point x in the diagram, which corresponds to the maximum surplus available.

According to Allan's concepts it is fairly easy to find the 'carrying capacity' of Bellona. The present population must be reduced to standard units: about 457 'reference people' could live on the presently cultivated land. To this number must be added the 'carrying capacity' of cultivable areas presently used for non-subsistence purposes: the coconut groves and the old fallows. If old fallows

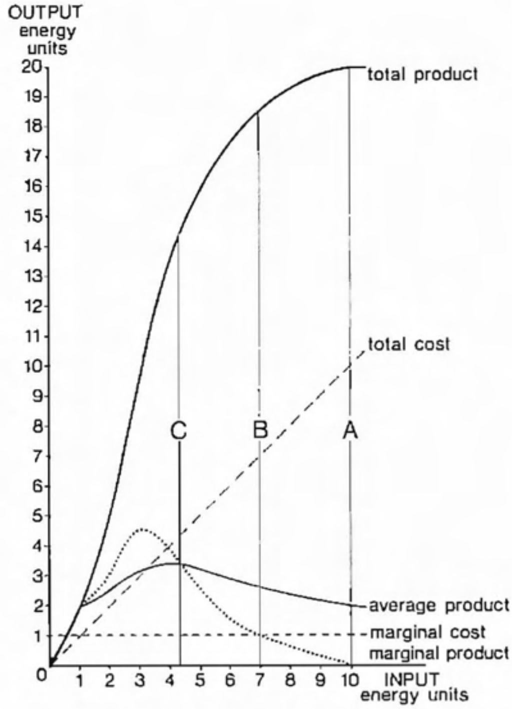
Fig. 64. Production curves (fully drawn) and cost curves (dashed) under subsistence conditions. Output and input are both given in energy units (as food calories).

The shape of the total production curve is thought to be realistic though idealized. The total cost curve is here assumed linear; this assumption seems realistic under normal cultivation practices.

Production is normally confined to the input interval between the lines A and B. At A maximum production is attained; added inputs decrease the total output. From origo to the line B there is a strong incentive to increase input as every unit added increases average output.

At C distance between the total product curve and the total cost curve is at maximum (marginal product and marginal cost curves intersect).

Net production is hence maximized at C. Maximum carrying capacity is advantageously defined as the number of people that can be nourished by the production attained at C.



are estimated to be of only half capacity, these two groups of areas add 190 and about 130 'reference people' respectively. 'Carrying capacity' amounts thus to 457 + 190 + 130 = 777 or about 800 'persons'. In fact about 1000 persons might be able to live off the island in a population of composition similar to the present one. Those people would live at a lower standard than that of the present Bellonese; especially the scarcity periods would mean a serious frustration.

For the assessment of the 'carrying capacity' on a basis of potential biological production information on climate and soil factors are necessary. Our knowledge on these matters does not yet allow an exact calculation of potential production; an approximation is described in chapter 6.

5. The social nexus to subsistence production

5.0 Production system – social system

Obviously subsistence production is regulated in different ways by society, and by the same token subsistence production sets conditions which society cannot ignore.

In chapter 4 one of the major limitations imposed upon a society was discussed that is, the carrying capacity of the land base. Additional aspects of the nexus between subsistence production and society will briefly be analysed here: 1) land tenure as an institution regulating the availability of land, 2) distribution of produce, the means through which individuals share the supplies, 3) distribution of work, the problems of organizing and distributing labour, and finally 4) regulation of production (see fig. 65). It is greatly to be hoped that the sociological material already collected by other scientists will be analysed further and thus deal in greater depth with the topics briefly outlined here.

5.1 Land tenure

In relation to subsistence production one of the significant aspects of land tenure is the question of how the necessary land areas for production are acquired. The mainstay of Bellonese land tenure is that land is individual property. There

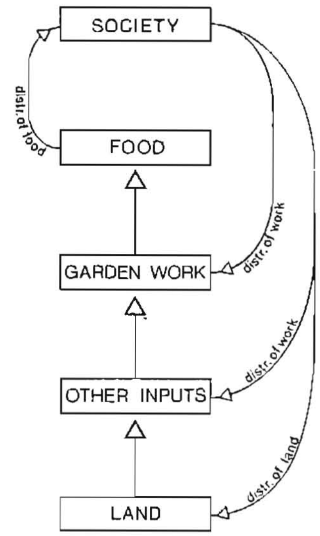


Fig. 65. Diagram showing the connection between subsistence production and society.

are very few signs of 'the communal rights of the primitive societies' (E. Terray 1970); but this could hardly be expected as the Bellonese society is possibly derived from more differentiated central Polynesian societies (Bellonese 'Ubea and Hutuna = Wallis and Futuna?). Also a Melanesian influence is possible, but can hardly be distinguished from the Polynesian one because of the great similarities in systems of land tenure.

The individual rights to land are more or less rigidly applied. Generally rights are most specific for permanent use. Planting of coconuts is only permitted on one's own land: such planting is often used to demarcate a transfer of rights or a claim. Consequently coconut groves have boundaries that are very well defined, often within centimetres. The rights to a planted garden are also definite: crops belong to those who grew them. But garden land may be used for planting by many more than the owner himself. After permission, which is readily given, most of the owner's lineage can use his areas for annual crops. In the remote parts of the cultivable areas even more people may be allowed to plant crops, and in the forest areas the areas themselves are ascribed little value. Trees may be individual property, but access to timber resources are given to all friends once they have asked for it. Specific rules govern who may use beach areas, landing places, and the trails leading to them. Within a lineage the rules allow all members to use lands for their subsistence; the individual owner gets as his special tribute little except the honour of having the powers to give rights to his kinsmen. From this should not be implied that land property is of no importance; rather on the contrary it is a central interest for any Bellonese because recognition and acquisition of status rank very high. The rules for acquiring land are therefore important.

No 'foreigners' could obtain land on Bellona in 1966 because special laws of the Protectorate expressly forbade outsiders to buy land on Rennell and Bellona. For Bellonese there were three ways for acquiring land: 1) by starting cultivation of unclaimed land (*toghinga*), 2) by inheritance (*hesuinga*), or 3) by gift (*tukunga*). *Toghinga* is similar for instance to 'landnam' in Scandinavian history. Nowadays no unclaimed areas exist on Bellona, so

TABLE 33.

Corresponding kinship - and land divisions.

Kinship divisions			Land divisions	
English term	definition	Bellonese term	English term	Bellonese term
clan	patrilineal descendants from an original immigrant	sa'a	'district' as: Western district Ghongau and Matangi districts combined	Sa'aiho or Ngango district sometimes together Sa'a Kaitu'u, but usually the two districts are mentioned separately: Ghongau and Matangi
'lineage'	patrilineal descent group from a less remote ancestor	manaha o te hanahano or manaha	lineage land, land of an original independent homestead	manaha 'onga = manaha soko (tasi) (independent homesteads) also manaha hakanohonga
family	(part of) lineage, extended family, or nuclear family	manaha	homestead/settlement usually with attached land	manaha

the *toghinga* rules can only be applied in a more restricted sense, as when a man starts cultivating a patch of soil in the forest of his own lineage. The rules were applied in 1938 when former taboo areas were desacralized. For instance, the former highly sacred area Ngabenga in Sa'aiho district was partly claimed by and cultivated by a resident of Ghongau district. This could only be done because Ngabenga was an all-island taboo area and not a temple area belonging to an individual lineage.

The normal way to obtain land is and was by inheritance. Only patrilineal kin is entitled to inherit. Although primogeniture included rights to inherit the largest amounts and the best land, this was certainly not without exception. Testators are in principle free to give away land while they are still alive and thus disinherit their sons; testators can also decide the distribution of their land between their inheritors. Some cases come readily to mind where the eldest son's share was diminished for the benefit of another. The Bellonese public has an intense interest in such cases. If a son has been misbehaving, as by neglecting his duties to his father, public opinion seems always to back up the father's decisions. Decisions about inheritance are usually officially declared by the testator. It can be done through apparently casual remarks, as for instance on a Saturday when people are assembled outside the church for service. The testator may be sound and healthy, but decisions about inheritance are usually made and discussed when one feels death approaching. Often a large part of a man's land has, however, been given away to inheritors during the testator's life; he may just keep one or two homesteads and some useless tracts for himself when aged. Canoes, T 122, discusses a case in which land is given away. Such discussions are quite common on Bellona. The system of inheritance has some important consequences. One of the most evident is that the map of land tenure mainly becomes a graphical expression of kinship; se plates 6 to 9. Although redistribution of land has taken place as a result of feuds, traces of the ancient distribution of land from the first immigrants may be discerned. In principle the land of an independent lineage (*manaha soko tasi*) seems as a minimum always to have been a strip from the central path to the coast, which encompasses all types of land forming the base of Bellonese subsistence. By later subdividing, the strips were gradually narrowed, and nowadays many Bellonese men do not own a full strip but just one or more smaller patches of land. As a consequence of the correspondance between kinship and rights to land, there is also a close relation between kinship divisions and land units (see table 33).

Another important consequence of the inheritance system is that inequalities in distribution of

TABLE 34.

Land areas per capita, on districts.

Districts	Sa'aiho	Ghongau	Matangi
average land area per capita 'de facto'	1.94 ha	2.88 ha	3.60 ha
average cultivated land per capita 'de facto'	1.12 -	1.68 -	1.54 -
average garden land per capita 'de facto'	0.98 -	1.47 -	1.24 -
estimated production from garden land available per capita 'de facto'	1.2×10^3 Mcal	1.7×10^3 Mcal	1.5×10^3 Mcal
average land area per capita 'de jure'	1.47 ha	2.14 ha	2.71 ha
average cultivated land per capita 'de jure'	0.86 -	1.24 -	1.15 -
average garden land per capita 'de jure'	0.74 -	1.08 -	0.94 -
estimated production from garden land available per capita 'de jure'	0.8×10^3 Mcal	1.3×10^3 Mcal	1.1×10^3 Mcal
	average per capita requirement $\sim 0.84 \times 10^3$ Mcal		

land often are increased over generations through fragmentation. In 1966 the land areas per capita differed much from district to district, see table 34. Figures are given both for the *de facto* population and the *de jure* population. It is seen that available per capita area is from 25 % to more than 41 % larger in Matangi and Ghongau than in Sa'aiho, which again implies that Sa'aiho even in good years – as 1966 – operates at a level of provisons too low to be sufficient if all its inhabitants return. The differences between available land per inhabitant are even larger on lineages (table 35).

The giving away of land is one of the remedies against too large differences in available land; it operates largely within lineages. Most often donator and the donated are closely related; in fact the people receiving land are usually presumptive heirs. But it is not always so. Also a close friend or ally may be given land, and land is sometimes given just for pity.

Traditionally great differences in population pressure were the background for tensions that often resulted in long wars. Characteristically the last wars on Bellona, in 1938, had as background a long chain of land strifes. The simple mechanism was probably that if a lineage grew numerous and its land hunger intensified, it might be tempted to conquer extra areas from another, weaker lineage. 'Stealing land' was founded on the same principle of force, but in such a case the side bereft of land recognized its inferiority in power and refrained from defence. This system is still operative on a reduced scale and the reason why some Bellonese have a strong desire for land registration.

Still another system for regulating the land population ratio was and is operative. It was discovered by T. Monberg who wondered why so many people in his first census in 1962 were declared to belong to two lineages. The reason was found to be that they had been adopted as children into a new lineage. There seems to be a close relationship between the number of adopted children and the amount of family land that may be inherited and naturally also between children given in adoption (*tama tuku* or *tama pusi*), and land poverty. No doubt this system is an important safety mechanism for relieving tensions stemming from differences in population pressure. In fact one can almost speak of a redistribution of children, as more than two thirds of all Bellonese children were given out for adoption. Perhaps the expression giving children out for adoption leads to a false idea of heartless strategy. In all reality children are accepted out of love as heirs of an additional family.

The adoption system combined with the usufructus rights to land within lineages are most important principles for giving people access to cultivable land. Certainly there are still differences between districts, but also on that level several cases of borrowing land have been observed.

TABLE 35.

Land area per capita, on lineages.

(all figures approximate: areas are estimated from schematic, uncorrected maps: Land Tenure 1965-1966, pl. 5-9).

	total area in ha.	cultivable area *) in ha.	cultivable area in ha. per de jure pers.
SA'AIHO district			
Matabaingei lineage	72	51	0.8
Sauhakapoi -	127	70	2.8
Tongomainge -	52	32	1.3
	252 **)	153 **)	average 1.5 **)
GHONGAU district			
'Angohi -	17	12	1.5
Baitanga -	43	39	0.8
Ghongau -	120	51	1.2
Hangekumi -	97	60	1.7
Mata'ubea I -	51	27	2.7
- - II -	11	11	0.4
Ngikobaka -	114	57	1.0
Nukuangoha -	226	131	1.1
Patonu -	37	23	7.6
Sa'apai -	92	57	1.3
Tangakitonga -	78	41	0.7
Tongaba -	132	93	2.2
'Ubea -	18	9	1.0
Henuangoto (Council quarters)	1	-	-
	1039 **)	613 **)	average 1.2 **)
MATANGI district			
Ahenoa lineage	55	17	0.5
Pangangiu -	68	25	3.1
Te'atubai -	20	12	0.7
Tehakapaia -	190	90	1.5
	339 **)	147 **)	average 1.2 **)

*) garden land, all fallows, and land with perennial crops.

**) incl. areas of alien lineages.

When the Bellonese system for maintaining a balance between population and land is analysed, it seems much more crude than similar systems from related Polynesian islands. Tikopia had its famous '*fakatau ki te kai*' system, according to which the size of population was controlled so as not to exceed the feeding capacity of the garden-lands (described in R. Firth's famous book in 1936). Possibly Bellona and Rennell were 'backward' in this respect, because their resources were still less exploited or exploited with less predictable results than Tikopia. (This island had for instance irrigated taro patches with almost constant yields.)

5.2 Distribution of produce

It may be convenient to distinguish between the distribution of a) foods, b) some of the non-food goods closely bound to subsistence, and c) 'wealth' in general.

5.2.1 Distribution of food

There is reason to believe that distribution of garden produce played a much larger part in Bel-

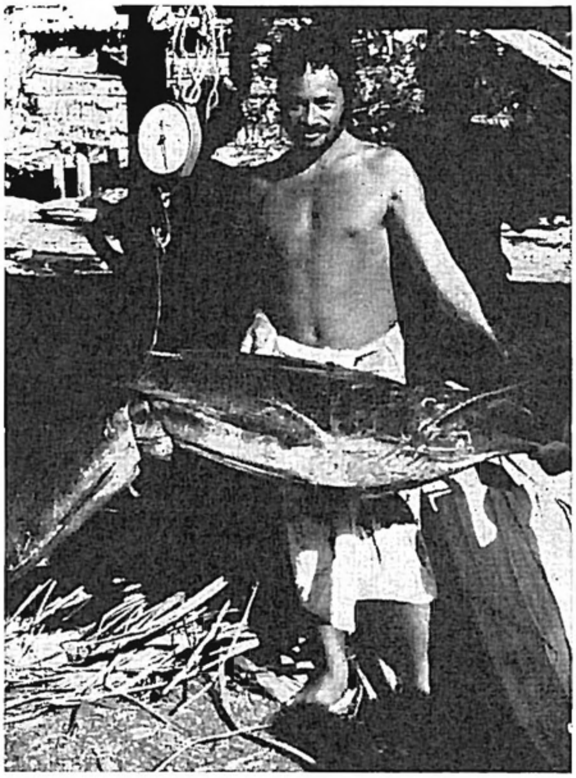


Fig. 66. A large sailfish, *ika langi*, caught by Temasu'u May 1965.

lonese life before the advent of Christianity. Some of the great distributional feasts connected with the major rituals may have been useful for securing a share in the food offerings (*'inati*) for even the poorest of men on Bellona. Some limitations on the distributions were evident, however. Only a few of the rituals involving food offerings resulted in general distributions. Most rituals were dedicated to district or lineage deities, meaning that distributions were mainly within the usual sometimes narrow circles delimited by close kinship and encompassed by the rules of land borrowing. Another restriction was that in ritual distributions status was taken into consideration, which usually meant that high-status people – frequently also the great landowners – received the most. Apparently distributions taking place at religious and other feasts did not aim at an equalization of food provisions. Still, if judged from the experience of modern feasts involving distribution, everybody receives enough, provided sufficient amounts are available. The reason is that all people of high rank are anxious to pass things to their dependents. 'Big men' acquire status by receiving food first and tend to increase their status by being generous. As is the case in many Polynesian societies, status is acquired by being recognized as productive and generous, whereas no status is gained by the accumulation of wealth – rather to the contrary. At feasts both on Bellona and Rennell it has been observed repeatedly that everybody kept very little and was anxious to see that all had enough.

A parallel of what is observed at feasts often occurs in daily life, only the number of people involved is generally smaller. Close kin are never left without food if some is available. Catches of fish as well as garden foods are distributed. It cannot be claimed that this is a principle necessary for the viability of Bellonese society, but the practical value of distribution especially for large catches is evident among a people with little mastery of the techniques of preservation. When, for example, Temasu'u of Matahenua village landed a large sailfish (17th May 1965), it was brought to his house where it was greatly admired by the public because of its size (exceeding 110 kg). (See fig. 66.) Within an hour it had been divided up so that all the households in the village had a large piece of meat, even the visitors from the neighbour village Ngotokanaba received some. Temasu'u evidently took great pleasure in giving away his fish and kept just the head, tail, and some smaller parts for himself. Most gift pieces he did not hand over in person. The people who delivered the fine pieces of fish to a house were usually asked the following sort of question: 'Who is the expert fisherman giving away this fine piece of *ika langi* to us who have caught nothing?' Decay usually sets in so fast that fish has to be prepared within half a day, and it was! Temasu'u was the name of that day, but he knew that somebody else would be honoured another day from whom he would expect to receive a share. The principle of mutual help and mutual recognition of prestige in return, resembles the reciprocal principle found behind the religous practices as analysed by T. Monberg (1966). Although the principle cannot be considered to have developed directly from necessity, it is certainly of importance in terms of efficiency in the subsistence syndrome.

When travellers, whether from overseas (*pengea hongau*) or just inland parties (*malanga*) are visiting a village, they are fed, a principle which held throughout 'ancient' Polynesia. It has the advantage of enabling travellers carry very little in the way of provisions. Of course the continuity of the principle lies in reciprocity, which is clearly recognized by the Bellonese. Sometimes the principle is violated, but usually the very slightest of hints of annoyance are enough to make the no longer wanted visitor leave. If this does not work, there are other means. Nobody would dream of denying food to even the most tiresome visitor. But he runs the risk of being offered one day a not quite cooked yam in which the remains of the toxic contents are not completely destroyed. Usually he discovers this before getting sick, and leaves, otherwise he may start vomiting much to the amusement of the spectators.

It is very difficult to judge the extent to which food supplies were equally distributed on Bellona. In the old society provisions were probably evenly distributed within lineages at the clan/subclan level, and thus fluctuations in supplies must have been levelled.

This picture has changed only slightly up to the present day except that coconuts are gradually excluded from the food exchange sphere.

5.2.2 Distribution of non-food subsistence materials

Regarding the distribution of accessories to subsistence technology, these may logically be treated with the distribution of work, because such items are usually made by one individual or group for the specific use of a single person or group. In consequence most houses, canoes, and implements have specific owners. Still such products are often distributed by being given to others, when the owner has had new ones made.

A special case of redistribution is seen in the *hemasi'inga* relationship between two friends who freely use each others goods rather unrestricted.

5.2.3 Distribution of monetary goods

The redistributional rules outlined above seem to be valid with regard to money too, but they are much less rigidly followed. In a paper on the breakdown of the Bellonese Cooperative Society, T. Monberg (1965) described some aspects of the rules for distribution, including monetary income. At least in the first period of money-earning, money was distributed almost like food. Consequently the Bellonese had great difficulties in accumulating capital. But there is a growing tendency, mostly in the younger generation, to exclude money and 'Western' goods from the distribution rules. Possibly the exception of alien goods is related to certain ideas about their dangerousness. Initially, for example, iron tools are said to have been considered harmful to yams, and even to cause failure in the harvest.

In 1966 the exception of money from distributional rules was already a threat to the viability of the subsistence system. Sons often planted a good part of their father's land with coconuts to gain a monetary income solely for themselves. At the same time less and poorer land was left for the growing of crops for the sustenance of the family. Evidently a development where obligations to redistribute income are reduced can lead to an increased independency for the cultivators. Perhaps this increases the incentives to produce more, but the consequent loss of social obligations may be fatal in a system of cultivation where natural hazards mean a constant threat for the population, and a system of mutual assistance is one of the few ways to reduce dangers.

5.3 Distribution of subsistence work

Most types of work on Bellona are initiated by an individual, or the decisions to work are, though a large part of all enterprises imply cooperation of more people. The definite leader of any job, the *hakahua*, must generally make reasonable decisions; otherwise he may soon find himself unable to assemble a faithful cooperating group. In fact, even people of highest status experience severe limitations to any exertion of power. The checking mechanism is simple: wrong decisions waste work and result in less produce for distribution in the working group and loss of prestige.

There are several possible explanations for the dominance of cooperative over individual work. A few ecological indications may be mentioned. One has already been pointed at: in planting of gardens it is important to inter the seed yams, taro or banana cuttings within short time to avoid damage to the planting material or to the soil. Heavy rains are a constant threat as they may remove the fertile ashes almost completely (see 3.2). Similar 'bottlenecks' in operations are found with many other types of work. When catching flying fish it is advantageous to cooperate for utilizing torch light effectively. Thatching of houses is easiest when made almost at once, lest the in-

Fig. 67. Group of persons helping to thatch a new kitchen for Kaipua 1965.

complete thatch may be damaged by wind (fig. 67). In canoe building many people are necessary for carrying the log; it is extremely difficult to make a canoe single handedly. To prevent the finished hull from changing form and cracking all reinforcements must be rapidly installed. These examples must suffice to illustrate that large working parties are advantageously applied in several tasks of Bellonese subsistence production. The total output is increased when identical amounts of working hours are delivered within a short interval of time instead of a long one: output depends on effect (work per unit of time), as well as on amount of work alone.

Aside from the above consideration, cooperation seems to have other positive effects on production. Work in groups involves competition between the members. Cooperative work tends especially to stimulate efforts when all the members of the group perform exactly the same job, as making thatch panels. Group work is also important for teaching the young some of the elementary parts of subsistence production. They can observe the operations repetitively, and are at the same time highly motivated to follow the group. In for instance canoe building there is much less repetition in operations and the group is more rigidly organized as assistants under the direction and strict supervision of an expert, the *mataisau,* who is at the same time an efficient teacher in canoe building.

Of course combined work also has drawbacks. It may cause quarrels, and the loss of time in social interactions involved in group work may seem considerable. (Possibly the consideration 'loss of time in social interactions' is completely un-Bellonese. It cannot be precluded that the social side of work is regarded just as important as that of production.) Nevertheless from an economic point of view there is no doubt that some subsistence works are advantageously performed in groups.

Of course the necessity of cooperation for the successful completion of a job does not presume any special type of organization within the groups. On Bellona the groups vary in composition according to the task to be performed, and for whom, and are thus of little permanency; also the leaders change constantly. This was observed in garden mainly, but also in more casual observations of fishing and house and canoe construction. A few principles are distinguishable in the composition of work groups. They are organized following the lines of recognized kinship. They imply reciprocity or a rotation of jobs.

Usually work groups consist of a nucleus encompassing men of equal status and mostly of the same lineage; each of these are followed by a fringe of members of their nuclear families and representatives of in-laws, friends, or dependents. The principle of reciprocity obliges the 'nucleus' to assist in similar works; hence there is a certain constancy in work groups for gardening, whereas the 'fringe' varies considerably both in numbers and consistency. When a big leader (*hakahua*) starts work, more than fifty may join willingly when they hear rumours about where and when (fig. 68). In garden work the reciprocity obligation must usually be fulfilled soon; grown-up men and family fathers usually plant at least one garden cooperatively per year. With canoe and house building fulfilment may take several years. Large canoes for catching flying fish (*baka 'eha*) are often built by a closed circle of men of each village, each in turn (see paragraph 2.5.2).

As already mentioned, the amount of work performed by each participant is by no means necessarily equally as large as that of others. Status is acquired by working long and hard. To ensure a proper judgement of the amounts of work to be done and possibly also to establish a measure for the performance of each, the garden divisions of cooperatively planted gardens (*potu 'umanga*) are


Fig. 68. Group of persons assisting R. Puia in weeding a coconut grove before planting sweet potatoes.

useful. Generally one *potu* is a grown-up man's share of the work, which means a limitation to the struggle for status. A strong man may work his division faster than others, which is usually noticed with favour, but a slower man may have produced a more neatly arranged division that is noticed with equal favour. It appears from this that the combined effect of competition and limitation of work obligation is just that the work to be done is swiftly finished and standardized, but severe frustrations for the less effective workers are avoided. After all, digging of a garden is done in few hours, so people may enjoy their rewarding meal almost simultaneously. In passing it may be noticed that there is no direct connection between material rewards and work performed in cooperative gardening. On the other hand everybody is forced to participate effectively; otherwise a loss of prestige, so vital for any Bellonese, may occur. To stress the last point, a reference may be made to the local custom of applying honorific names; these refer often to the bearer's cultivative abilities, as Ngima'usi (lit., green hand), Haikiutango (lit., maker of thousand taros). Also a number of common names refer to skills in production as Sanga'eha (lit., great planter), Haikiu (lit., maker of coconut groves).

5.4 Regulation of subsistence production

Too little is yet known of the problem of how subsistence production is regulated in quantity and time, the 'cybernetics' of production. Some crude features for timing of food production have been described with the agricultural calendar (chapter 2.6). But how are quantities to be produced decided upon?

A large surplus of food is usually produced during the yam harvest period. (See chapter 4.3.) Of course the production target is planned to be sufficient in subnormal years. In gardens with divisions the size of the cultivated area is normally decided upon from the start and it remains constant. A family head usually makes one or two divisions for each person of his household. Undivided gardens seem to be determined as to size in a similar way, but their area is often changed as work procedes. Sometimes a part is left unplanted, sometimes extra area is cleared and added to the garden area. Other types of gardens are planted according to less fixed schemes than yams; often two taro gardens are planted annually per family but extra ones may be added. Similar arrangements are found with sweet potatoes. Bananas and *kape* are following a cultivation model more like that of yam with fairly rigid areas and seasons. Summing up, it seems that a thorough planning is difficult. Some universal approximate rules are used to decide upon areas of crops like yams, bananas and *kape*, but the system has many possibilities for regulations over time. This is advantageous, since it may save labour and areas, but it compensates only partly for the weak point in Bellonese food production: the high variability of yields stemming mainly from changing weather conditions.

The main problem in the planning of Bellonese fishing is naturally to have large enough catches.

During the flying fish season the problem is less than usual: the fleet is large enough to occupy all hands, and extra canoes are hence not needed. Further the catches are at times almost too large to be consumed; higher efficiency is therefore only in demand when catches are small. Increased efficiency is difficult to acquire. Better equipment like better lanterns is expensive, as is an increased radius of action for the fleet. Instead another strategy is used, namely to apply a variety of other fishing methods for a variety of kinds of fish. It is tempting to view the array of fishing methods as a means of obtaining a certain amount of fish during a long period although the cost of catching is much larger than with application of few specialized methods during advantageous periods: a strategy tending to maximize the smallest outputs. Possibly this is the explanation behind the apparent conservatism regarding Oceanic fishing methods (see B. Anell 1955). If so, the 'conservatism' should be most prominent on small islands and more so with less varying resources.

For other parts of subsistence production regulation presents less of a problem. It is foreseeable how many houses and canoes have to be built during a year. The rules for building large canoes have been touched upon previously, and every grown man has normally his own small canoe. So far canoe building presents no planning problems as the lifespan of a canoe is fairly fixed, but two remaining points present difficulties. One is the resource problem of accessible canoe logs, the other the unpredictable losses at sea or on the beach, mainly caused by high winds.

With housing one of the problems is that people move from village to village. Within every district there are at least two churches of different confessions operating. Religious affiliation is somewhat unstable; at least social tensions often have the consequence that a family moves quite abruptly and becomes members of the church of the new village. From this reason more than twenty houses were empty on Bellona in 1966, and new houses had to be built suddenly.

Summing up, it seems that production is regulated to meet the demands as accurately as possible. One of the general problems is the high variability for the outcome of the production. This has possibly lead to an application of less advantageous methods. Two ways to improve these conditions come easily to mind: to improve storage possibilities and to increase productivity. The first point means that new probably untraditional techniques must be introduced. The second one has no easy solution: water for irrigation is almost unaccessible; fertilization is too expensive, and so on.

From the above is seen that a strict regulation of population to make it fit available resources is not easily perceivable for the islanders, as it would have been if production were more predictable. Perhaps this explains why a population planning policy has not been practised on Bellona as it has for example on Tikopia. In traditional Bellona there were few ways to do away with surplus population; wars and emigrations are those best remembered.

Perhaps Bellonese regulations exemplify Wissler's explanation: 'the tribal group expands until it reaches the limits of its food supply. Then, if it does not succumb or remain static, it evolves a new mechanism for feeding itself, only to repeat the phenomenon over once more!' (Wissler, 1923.) In chapter 7, the development on Bellona is analysed to see if other phenomena are involved or not.

6. Subsistence in environmental context

6.0 Limits to production. Efficiency, stability

The connection between societal man and physical environment has always been an important subject matter of geography. In early thinking it was assumed that human activities were largely determined by the physical environment. This 'environmental determinism' was during the first two decades of this century gradually transformed into less rigid concepts of the milieu as opening certain possibilities for human life; in other words, that activities could be explained only with certain probabilities. H. H. Barrows (1922) stressed the importance of studies concerning the ecology of societies, but had few followers. The explanation is possibly that his period was one of great optimism: the inventiveness of technological man was thought to have broken the bonds of natural conditions. At least it was almost impossible to quantify most of the connections between environment and society beyond the most trivial as 'agriculture is mainly in the lowlands' and the like. Daryll Forde (1934) stated: 'The study of the relations between cultural patterns and physical conditions is of the greatest importance for an understanding of human society, but it cannot be undertaken in terms of simple geographical controls to be identifiable on sight . . .'. After the 'quantitative revolution' in geography the significance of environmental influence is still a major subject of many geographical studies; the importance of environmental limitations of societies, especially for primitive economies, has been admitted by several modern geographers (P. Haggett, 1966).

The environmental influences may occur more or less predictably and cause prohibiting or limiting effects on one or more phenomena in societal life. The effects on society are either direct, as for instance the influence of climate on thermal comfort, or indirect, as production of food on health.

Although the importance of direct environmental influences must be admitted, they are not to be dealt with here. A study of bodily thermal comfort along the lines of P. O. Fanger (1970) would be of great concern, as, for instance when assessing the hours of the day utilizable for heavy work. The Bellonese idea that it is dangerous to work hard in gardens around noon seems to be scientifically sustainable because of the combined effect of heat and humidity.

The influences on the productive apparatus shall be dealt with in more detail. Most environmental effects on society are transmitted through biological production, as this is a basis both for production of food and of accessories to subsistence. The environmental factors of concern here are therefore primarily those on which photosynthesis is based. Light, temperature, carbon dioxide, water, and mineral nutrients are all necessary. From some plants, enough is presently known about the effects of production factors on photosynthesis to allow a rather detailed calculation of the net production of dry matter with given conditions. This is not to say that calculation is easy, nor that it is applicable for any crop under real-world conditions. De Wit (1968) advocated simulations of crop growth on the basis of hourly photosynthesis, accumulated through the period of growth, taking into account respiration, translocation, and the growth of leaf, stem, and root as conditioned by environment; such a state of refinement in calculations has not yet been achieved. Jen-hu Chang (1968) states more modestly that it might be possible to estimate 'potential photosynthesis' as determined by radiation and temperature alone, all other factors optimal. Some of his results were published in 1971. The approach is interesting because it can result in estimates of the maximum obtainable yield under ideal management that usually encompasses regulation of water and fertilization. Hence the only factors left to nature's control are radiation, temperature, and carbon dioxide pressure; control of these growth factors is too uneconomic in normal agriculture (and carbon dioxide pressure generally varies little in nature). 'Potential photosynthesis' calculated on radiation and temperature may therefore be applicable as a measure of the agricultural possibilities of a region, these are of great concern in agricultural geography. The most important plant growth factors are separately treated in the following to trace their influence as constraints to the Bellonese system of exploitation.

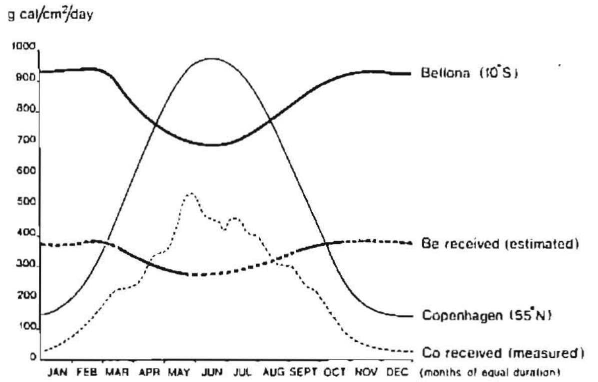


Fig. 69. Insolation curves for Bellona. The top curve is drawn according to figures from Smithsonian tables. The curve below is partly observed, partly estimated. For comparison, curves for Copenhagen are shown.

6.1 Radiation and temperature factors

Both radiation and the carbon dioxide pressure as ultimately limiting climatic factors in plant growth are normally beyond the power of influence of agriculturists. Gross photosynthetic production is directly related to intensity of the visible (photosynthetically active) part of solar radiation received at the earth's surface; an estimate based on this factor was therefore desirable. Unfortunately radiation is difficult to observe. Because of this no regular series of observation have been made on Bellona or on any nearby locality. Other methods for acquiring the desired estimate were therefore considered.

J. N. Black (1955, 1956) used observations of duration of sunshine or of cloudiness. But even such observations were unavailable on Bellona; also convenient instruments were not at hand. An attempt was therefore made to correlate observed precipitation with the readings of a Robitsch actinographer used during two periods (15/3–25/5, 1965 and 12/9–23/10, 1966). The correlation was significant at the 1 % level, but explained only less than 20 % of the variations of radiation. No doubt correlation could have been improved if precipitation had been measured hourly; but this was not possible. The method was therefore abandoned. Originally it was planned to keep the self-registrating Robitsch actinographers operating throughout a year, but they proved to be too difficult for local surveillance and had hence to be withdrawn. The lack of a self-registrating, robust yet accurate photometre for measuring photosynthetically active radiation is still strongly felt. The actinographer tried has a further drawback in its need for corrections since it actually registrates the thermal-active part of radiation alone, and has to be calibrated for an estimate of total radiation.

Clearly it is possible without appropriate measurements to arrive at even a crude estimate of primary gross production. The procedure used here must be revised; still it may be useful to consider the transition from solar light to harvested yield briefly.

Solar light annually received 'at the outer atmosphere' amounts to 129.1×10^6 MJ/ha or 30.9×10^6 Mcal/ha, as can be found from Angot's theoretical values in Smithsonian tables. During 113 days only about 40.5 % of the theoretical figure was received at the earth's surface on Bellona. If this figure is taken as representative for the year, a total of 52.3×10^6 MJ/ha or 12.5×10^6 Mcal/ha is received per annum (fig. 69). The low figure can be explained by cloudiness; it is supported by published estimated figures (Landsberg 1961: 120–140 kcal/m²/year).

For calculation of gross photosynthesis incident radiation at surface is less suitable; it is preferable to use photosynthetically active radiation, which is usually about 25 % of incident radiation (D. Gates, 1962). On Bellona, this means that about 13.1 $\times 10^6$ MJ or 3.13×10^6 Mcal. of radiation is convertible into primary photosynthesis roughly estimated.

According to the literature, the efficiency of radiation utilization by green plants varies. Often no reference is made in the literature as to on which basis the conversion 'efficiency' is calculated. 'Efficiency may be either gross photosynthate or net photosynthate in percent of either incident radiation or visible light (almost: photosynthetically active radiation). Usually net photosynthesis amounts to 3–5 % of energy contents of incident radiation or from 7–14 % of the energy received through visible light. At an 8 % efficiency at the conversion of photosynthetically active light into net photosyntate, Bellonese production may achieve about 61 t. of carbohydrates per ha. With a crop such as yams the maximum edible harvest is thus about 15 t. of dry matter per ha. since the top/root ratio is about 4 to 1. If the water contents of yams are considered, the maximum harvest obtainable may amount to 60 t. of roots – that is about three times the present level.

TABLE 36.

Estimates of maximum photosynthesis.

Solar light received at limit of outer atmosphere (Angot's values)	30.9×10^6 Mcal/ha/yr
(loss 59.5%)	
Solar light received at earth's surface (estimate)	12.5×10^6 Mcal/ha/yr
(loss about 7.5%)	
Photosynthetically active light ~ visible light	3.1×10^6 Mcal/ha/yr
(loss min. 92%)	
Net photosynthesis ~ resulting biomass	0.25×10^6 Mcal/ha/yr

The total process with the maximum figures are shown in table 36.

Total conversion ratio sunlight to net photosynthesis is thus $0.405 \times 0.25 \times 0.08 \times 0.0081$; that is only 0.8 % of the light is utilized at best.

The widely varying figures for net production reveal clearly that the basis for using 'efficiency rates' is weakly defined. Many reasons account for the wide range of the figures. Firstly, it would be preferable to observe the appropriate plants on location. Secondly, if a calculation has to be used, it must be divided into well-defined stages. Hourly figures must be calculated for gross primary production from which must be deduced loss from respiration, both figures obtained from well-defined functions showing how production depends on radiation and how respiration follows temperature. Foliage must be defined throughout the period, and assumptions made on biomass (respiration follows accumulation of biomass). On Bellona respiration losses are probably of the magnitude of 60–75 % (see e.g. D. Müller, 1965). In the high temperatures of the Bellonese nights most of the modest amount of energy captured through the photosynthesis of the cultivated plants is lost through respiration.

6.2 The water factor

Precipitation (and temperature) was measured on Bellona for about two years (fig. 70); apart from this few observations were made relevant to water (see appendix H). Observations on evaporation from a free surface were started, but had to be given up because of a period of severe drought.

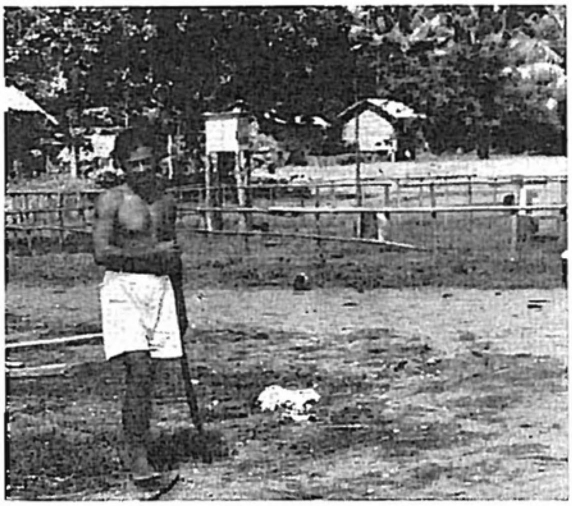


Fig. 70. The meteorological station, Bellona 1965–66. The Stevenson screen is seen to the left, then a pole for an anemometer and, to the right, the Robitsch actinographer. In front one of the observers, Sengeika Tepuke.

(Animals and humans alike were too strongly attracted by the water!). Still, a few conclusions may be drawn concerning water as a limit for crop growth.

From raw data on precipitation it is tempting but erroneous to assume that water is available in adequate amounts throughout the year: the annual amount of precipitation was in excess of 2½ m. of water. The distribution is remarkable, however, see fig. 71 and appendix H. Several heavy rains exceeding 100 mm per day occur annually, as do periods of drought. The latter were sometimes considered very harmful in spite of relatively short durations. Water retention capacity of Bellonese soils varies, but is generally amazingly low, often in the vicinity of 100 mm of water.

During a period of dryness, the beginning of withering in some crops was observed. Just eight

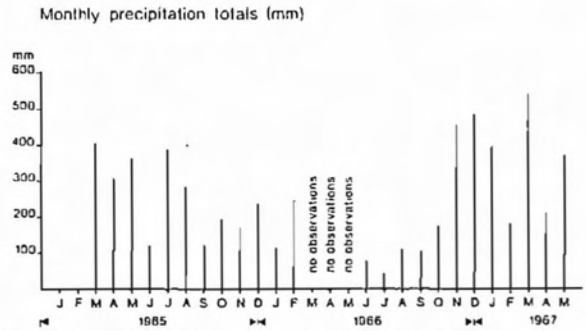


Fig. 71. Two years' observations of precipitation.

TABLE 37.

Occurrences of 1, 2, 3 ..... consecutive days of wet/dry weather in two years' observations on Bellona.

	'Wet periods':											'Dry periods':										
	> 10	10	9	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	9	10	> 10
January	.16				.10				.04	.15	.13	.16	.03	.09	.06		.09					
February					.13		.19			.19	.13	.19	.04	.06	.07							
March			.29					.13	.10	.06	.08	.16	.10			.08						
April		.17			.12				.15	.14	.03	.07	.10	.05	.07		.10					
May					.25	.21		.14	.05		.04	.09	.07		.14							
June					.13			.08	.06	.08	.02	.08	.04	.06						.17		.28
July		.15				.09			.04	.03	.10	.07	.06	.04			.09			.13		.18
August				.12				.06		.06	.08	.08	.03	.09								.47
September			.17					.07	.15	.13	.13	.13	.13				.10					
October				.17			.10		.12		.08	.06	.04	.12	.17		.12					
November							.17	.07	.05	.07	.08	.05	.07	.05	.07	.08	.10			.15		
December						.12	.10			.08	.06	.10		.18	.08	.10				.18		
%	1.57	2.86	3.85	2.27	6.0	3.4	4.3	4.6	6.4	8.3	8.3	10.4	6.0	6.0	5.1	2.0	5.1			5.1		8.2
cum. %	1.6	4.5	8.4	10.7	16.7	20.1	24.4	29.0	35.4	43.7	52.0	62.4	68.4	74.4	79.5	81.5	86.6			91.7		99.9

days of drought damaged taro, and a few days later bananas were harmed. It was said, but not observed, that 14–20 days will ruin yams. In accordance with what one would expect from their texture, *malanga* (silty) types of soil offered least, and *kenge* (loamy) types most resistence to drought (see Dalsgaard 1970). Long before withering, reduction in production was indicated; for example taro is said to 'sleep' after a few days without rain.

To estimate the loss of productive days a 'frequency table' of consecutive days of dry or wet weather was compiled (table 37). Taro may be liable to damage for about 8 % of the year especially during the 'dry' months of June to August. Possibly about 20 % of production time of taros is lost annually, not including the almost daily hours after noon with too little available water. Normally yams appear to be a very reliable crop, but even here the losses during noon periods are no doubt experienced. Seventeen days of continuous sunny, dry weather were reported to have been disastrous to young yam gardens on porous, light *malanga* soils. The reason why greater damage is not done to yams is no doubt the fact that yams are not cultivated during the driest period of the year. On the contrary this period is utilized for clearing and burning new gardens and is thus indispensable in the total process of yam cultivation. Yam seems to be a risk-minimizing crop to grow but requires a slightly higher input of work than some alternative crops. Nevertheless yams are a crop well adapted to the climate; approximately 10 % of the growing season is lost for production because of dryness (six- to nine-day periods of droughts). Being a crop cultivated in fixed yearly periods, yams lose probably half of the year as potential growing period, because the growing period can only be extended to about 10 months. To estimate losses through damage by droughts available data are too incomplete. Even with detailed data there is presently hardly a theoretical basis for a detailed estimate of losses caused by insufficiently available water, though there has been much progress in recent years, especially for the crops of industrialized agriculture.

To reduce the danger of the soil drying out, the Bellonese employ some traditional practices. Gardens are kept at a moderate size, thus increasing shade and improving wind shelter, but sometimes more direct measures are taken to prevent drying. On several occasions in 1966 it was observed that coarse mats of coconut leaves were spread in young gardens (fig. 72), and cut off branches of other trees were employed similarly. Normally mulching has not been observed on Bellona.

Taro is usually grown beneath 3–4 m high shelter trees killed by burning. The effect of such shelter trees may be seen in the humidity profiles

Fig. 72. During a period of excessive drought the soil of some taro gardens were covered with coarse coconut leaf mats.

(figs. 73). Such areas suffer least from fluctuations in humidity, but still the profile reveals a reversal after midday because of the heating of the soil. It seems that the humidity conditions in gardens are greatly influenced by the reduced movement of the surrounding air. At least the conditions cannot be explained solely by a shading effect, because the highest temperatures develop in the layers of air next to the soil surface resulting in low air humidity. Anyway the shading effect is limited as the trees have no leaves. The early loss of our soil thermometres limited the chances of documenting this characteristic phenomenon better. Probably temperature and humidity conditions of the two main types of gardens, the shaded and the the sun-open types, are the most important man-made environmental changes employed in Bellonese horticulture. There is evidence that taro is vulnerable to excessive soil temperatures. Stanhill (1965) found that soil temperature over 33°C can be inhibitive to germination. Possibly the extensive use of shade for taro, except on swampy soil, is explained by this vulnerability. (For comparison the cultivator inflicts only small changes in soil properties; see chapter 3.) Humidity conditions are known to interfere markedly with plant growth both on Bellona and Rennell. Consequently the better drought resisting yams are grown on drier ground and always in much more open gardens. If yam is cultivated on 'cold' soil, the area is often totally cleared; not even trees to support the yam vines are left. Instead the tripod-like type of supports is used. This type of garden is much

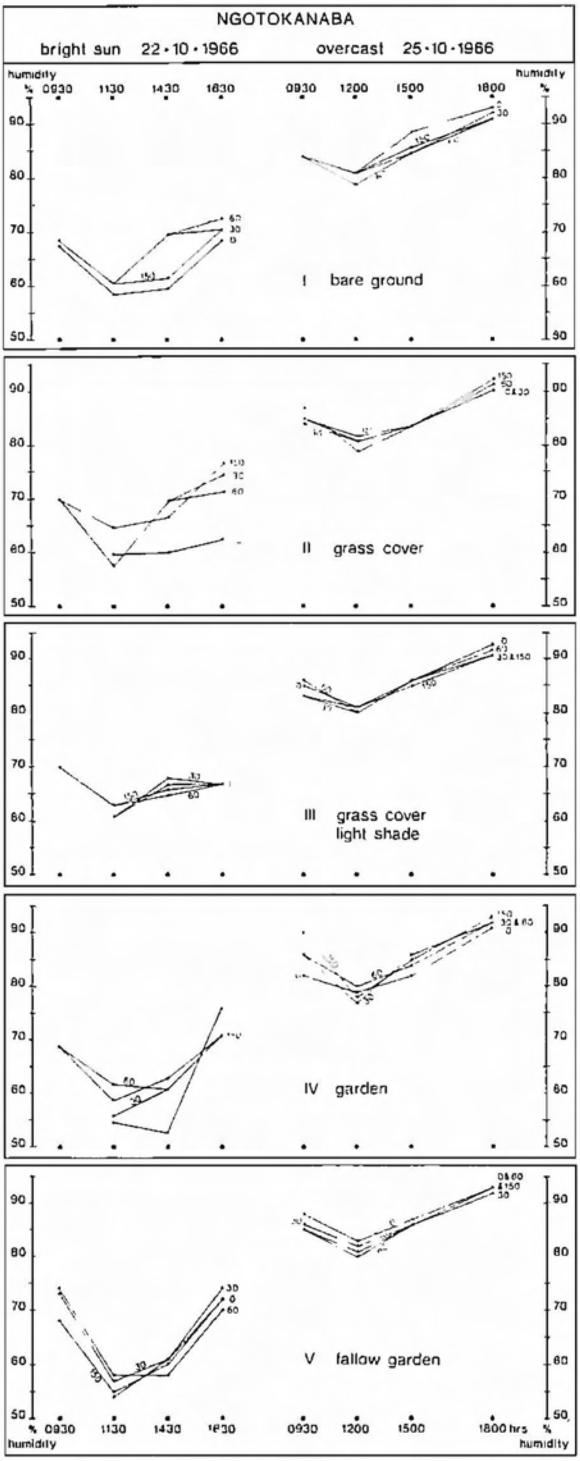


Fig. 73. Humidity profiles over various types of ground in Ngotokanaba. The low humidity of the sunny day 22 Oct., and the high one of the cloudy day 25 Oct. are noticed.

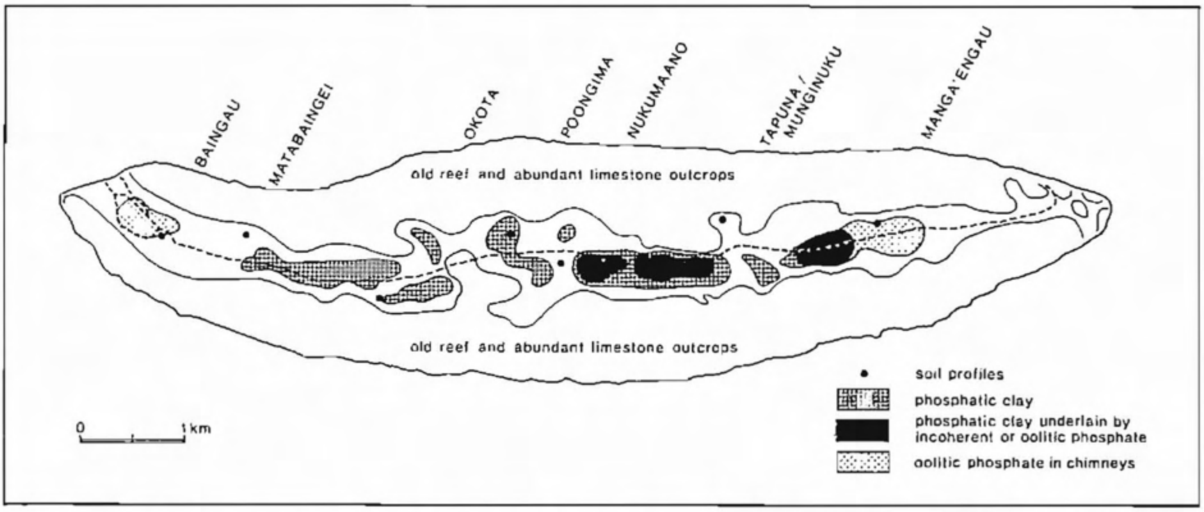


Fig. 74. Map showing occurrences of phosphatic soils and sites for the sampling described in appendix G and in text. Map partly after White and Warin, and K. Dalsgaard.

more used on Rennell than on Bellona. Rennell has generally more wet soils, including swamps (*husi*) used for the cultivation of taro.

To conclude about humidity conditions: there is no doubt that potential yields on Bellona are reduced by excess or lack of water. Though irrigation and draining are not employed by the Bellonese, several measures are taken tending to decrease wastages caused by the unsuitability of the humidity factor.

6.3 The soil factor

Only some properties of Bellonese soils related to crop production will be briefly treated here. For a general description of Bellonese soils see K. Dalsgaard (1970). The indirect influence of soils on plant growth via the water factor has been mentioned above; the soils as providers of important nutrient elements will be considered in the following.

At the outset of field work Nye and Greenland's fundamental book (1960) was fortunately available as a background. Very little was found, however, on soil-crop relations, especially in respect to crops such as yams, taro, and bananas, so important on Bellona. Our main interest was to elucidate the changes in soil during the normal cultivation-fallowing cycle. One of the pertinent questions was to discover if normal cultivation practices avoid a reduction of soil fertility, and another concerned the general level of 'fertility' of soils.

During the field work period more than 200 soil samples were collected with the energetic assistance of K. Dalsgaard. The samples were air-dried and packed for later analysis in Denmark. This procedure was necessary because of the difficulties in carrying out laboratory work in the field. Unfortunately the method made it impossible to investigate the role of nitrogen in the soil; the nitrogen content is subject to changes during the procedure. As deficits most likely would develop in macro nutrients because of the burning technique, an analysis of these was of great concern.

Samples of about 150 g were taken to a depth of 20 cm from selected places where gardens were surrounded by fallows representing different stages of regrowth; see fig. 74. An attempt was made to sample each of the major types of soil in places where 'complete cycles' were found. The purpose was to obtain information on fallow recovery without introducing errors from local soil variation and to discover how soil type influenced recovery after cultivation. Samples were further taken from within a single garden to assess the variations of soil properties within a small area. These samples showed later that variations within limited areas were so great that much of the collected material was too scanty to produce statistically significant results. Of course observations on a given area during a full garden cycle exceeding six years would have been more advantageous.

To find out whether variations in samples could be explained by the action of individual

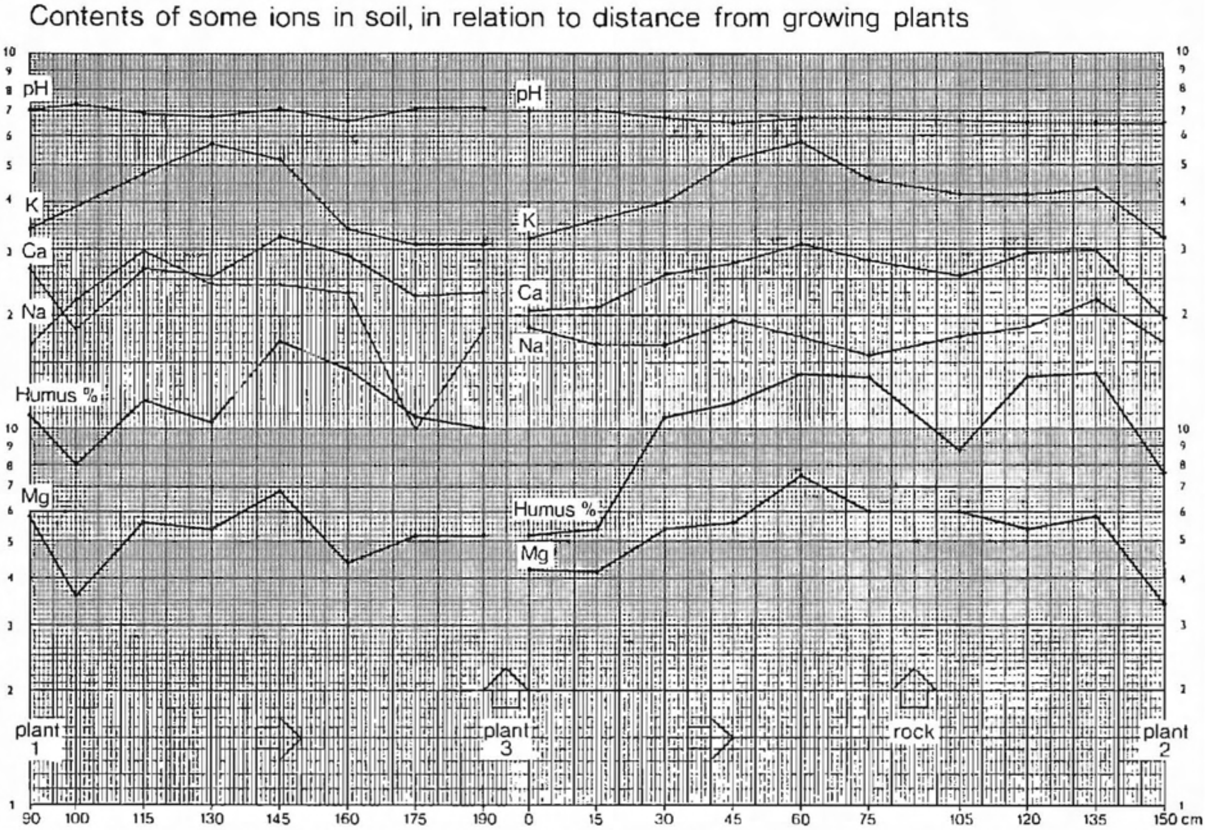


Fig. 75. Variation in soil contents of K, Ca, Na, Mg, humus, and pH. Contents show significant increase with distance from plants.

plants, an additional set of soil samples was taken in lines between yam hills. The pattern used was triangular to allow for a check on the analyses, the results of which are shown in fig. 75. Except for pH and sodium, there appears to be an increase in plant nutrients at almost an equal rate as one moves away from the planting sites, reaching a peak almost exactly midway between the plants. This indicates an extraction of ions by the roots, but it may also be partially explained by the horticultural technique of digging up and mixing the top soil layers with material from beneath; this is done only where the plants will be placed. This digging, however, encompasses only a fraction (about 25 cm) of the area under consideration and is thus not likely to cause the degree of variations found. The variations within a plant bed are still large enough to make a careful sampling necessary before any conclusions can be justified.

With generous assistance from the Institute of Botanical Ecology at the University of Copenhagen, which has developed routine procedures for large quantities of soil samples, both the samples mentioned above and the 200 samples from the gardening cycle were analysed. The analyses encompassed most of the more prominent elements for plant nutrition: Magnesium (Mg), Calcium (Ca), Sodium (Na), and Potassium (K), (ad modum Kolterman 1952, modified; Truog 1930; Jeffries and Thomas 1960). Simultaneously acidity pH (Reed and Cummings 1945) and content of organic matter were determined (oxidizable organic content after Walkley and Black 1934, and Walkley 1947).

Averaged results from the analyses are shown in appendix J, and some further examples of coarse-textured *malanga* type of soils in fig. 76. The figure shows how decreases occur in the immediate root zone of the growing plants. Development from the garden stage to the following fallow reveals a significant decrease in both K, Na, and Mg-contents in the soil (a t-test shows it to be significant at the 0.001 level.) Since this drop also occurs in the humus content it must be ascribed to

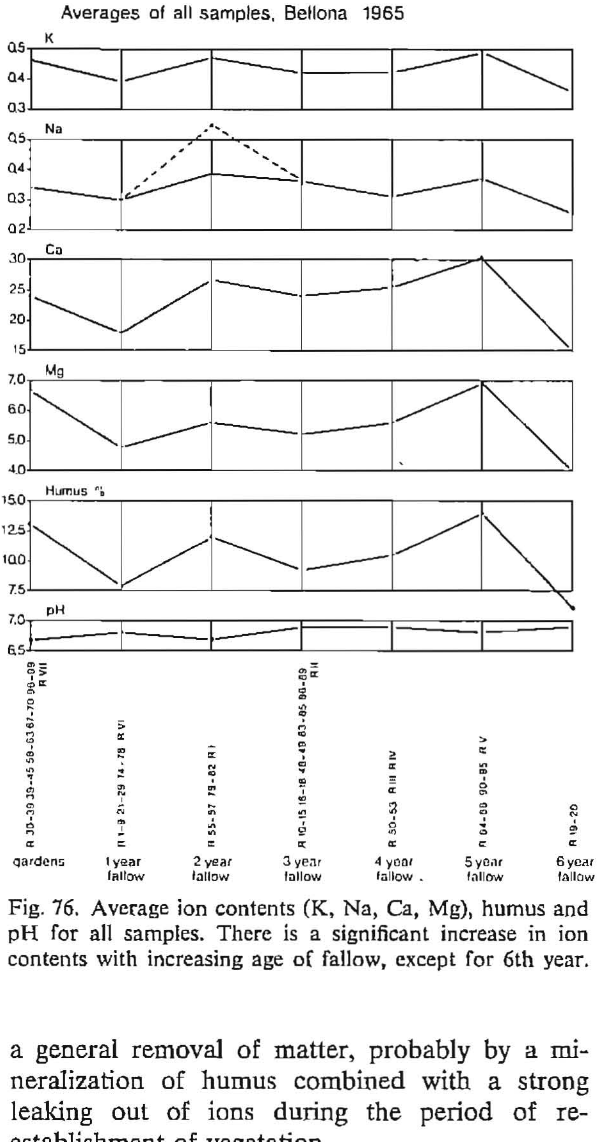


Fig. 76. Average ion contents (K, Na, Ca, Mg), humus and pH for all samples. There is a significant increase in ion contents with increasing age of fallow, except for 6th year.

a general removal of matter, probably by a mineralization of humus combined with a strong leaking out of ions during the period of re-establishment of vegetation.

The most important effect of fallow vegetation seems to be its capability of 'pumping' most of the nutrient elements back into the top soil from deeper layers. Most of the preferred fallow plants develop deep-going roots – which supports this hypothesis. The development during the fallow years reveals an increase in the soil's content of ions; however 'old fallow' samples are too few to support firm conclusions. For example the first three years' development in organic matter and K ions is generally significant at the 0.01 level. A few of these 'old fallow' samples show a decrease in the soil's ion-content. If the total soil vegetation system is considered this may be explained by the fact that the storage of ions in the vegetation at that stage is reaching a maximum in the normal fallow cycle. When this stage is reached, the lower store of the fallow has usually disappeared, killed by competition from the dominant fallow trees. This fast changing of fallow regrowth may also partially explain why soil conditions in young fallows vary so much; they vary more than garden soils under crops and more than soils in old fallows.

From the analyses it can further be deduced that there is a significant difference between *malanga* and *kenge* types of soils (sandy loams and silty clays); see figs. 77 and 78. Contents of any element are greater in the fine textured *kenge* than in the *malanga*, which is in accordance with the Bellonese ideas of the inherent fertility of these soil types. The development from garden to fallow does generally not reveal, even with regard to organic matter and K, a significant decrease in 'fertility' (even at a 0.5 level of significance). This was to be expected because the removal of ions by crops from the soil is almost impossible to demonstrate even in the much better known soils of the temperate zone.

Only few references to soil analyses under a shifting cultivation system have been found in the literature. One of the first and most thorough is probably Cowgill's analyses of Maya agriculture (1962). Everywhere she found lower nutrient ion content than is present in Bellonese soils except for K. She claimed that differences in Ca and Mg during the agricultural cycle are of low significance, while differences in pH, organic matter, total N, and K are more highly significant. These findings are in agreement with the results from Bellona, except that pH in the Bellonese 'rendzina' type of soil developed on limestone in the tropics hardly changes during the agricultural cycle. Organic matter in Bellonese soils compares roughly with Cowgill's scheme in which nitrogen was not analysed. In all it may be said that Cowgill's results are consistent with findings from Bellona except for the higher fertility of Bellonese soils. The importance of the vegetation as a 'bank' for nutrient ions is underscored by the low content of the nutrient contents of the soil, even when more fertile types are considered. As will be shown later for K, the fallow vegetation accumulates on an average double the amount usually found in normal Bellonese soil. Even on the fertile Bello-

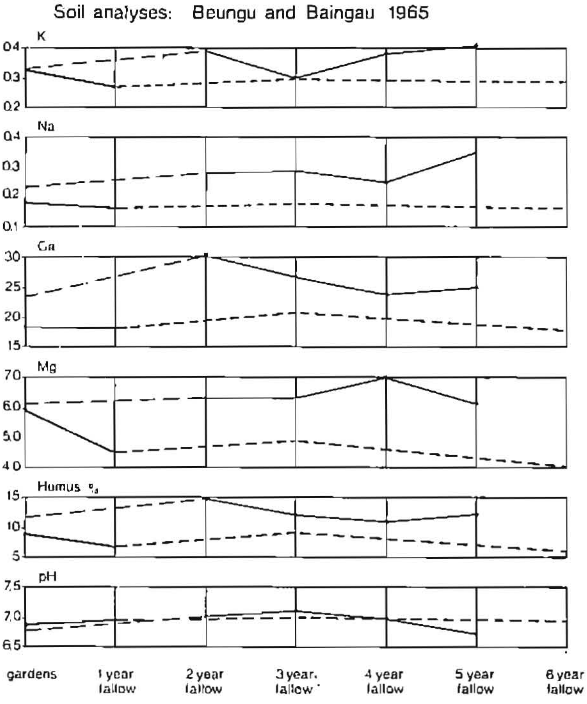


Fig. 77. Soil analysis from the sampling sites Beungu and Baingau, both with *malanga* type of soils. Such soils seem generally to be poor; compare with fig. 78.

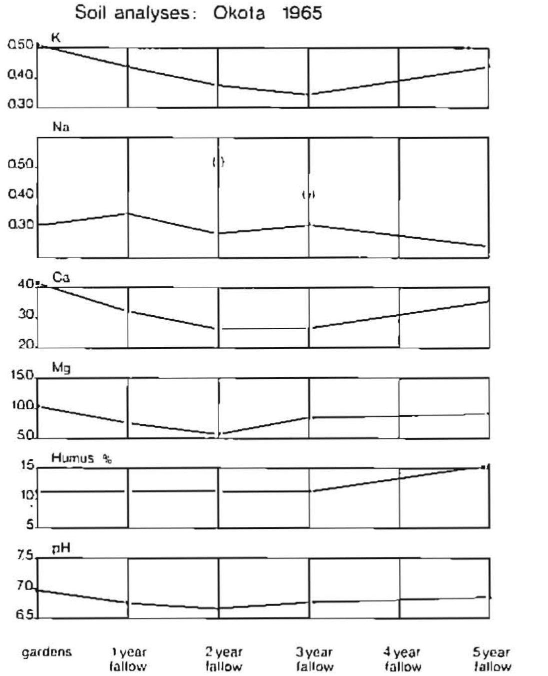


Fig. 78. Soil analyses from the sampling site Okota with *kenge* soil. It has generally higher contents of plant nutrition ions and shows fast recoverage during the agricultural cycle.

nese soils, vegetation's share of nutrients are much more important than soil contents.

The sufficiency for crops of the macro nutrients available in soils is difficult to estimate because so little is known about the requirements of Bellonese crops. (There is scarcely any knowledge available about yams, see Coursey 1967, and almost nothing about taro. But good data are available for banana requirements, especially cultivation in plantations; see Simmonds 1966).

In table 38 some approximate figures have been collated, mostly from the sources mentioned above; for yams most figures are estimated from comparisons with other crops of similar composition, which obviously involves a certain risk. It appears from the results that a deficiency of P, Mg, and Ca is unlikely to occur in Bellonese gardening re-

TABLE 38.

The removal of macro nutrients from Bellonese soils by yams and bananas, at a production of 5 tons of dry matter per ha.

	amount available	removal by average yam crop (5 tons dry matter)	removal by banana crop (5 tons dry matter)
N	not known	app. 100 kg/ha.*) ?	app. 50-120 kg
P	2-7 t/ha., 3 t/ha. average	app. 7 kg/ha.*)	app. 1-10 kg
S	not known	app. 2 kg/ha.*)	app. 3 kg/ha.
K	80-550 kg/ha., 220 kg/ha. average	app. 110 kg/ha.*)	250-425 kg 1)
Mg	1.6 t/ha.	app. 110 kg/ha.*)	9-15 kg/ha.
Ca	8-32 t/ha., 14 t/ha. average	app. 1.5 kg/ha.*)	3-11 kg/ha.

1) von Loeschke 1950.

*) estimate.

TABLE 39.

Potassium contents in ashes of burnt fallow vegetation.

Age in years of fallow samples	Weight of ash fraction	Weight of charcoal	Soluble*) K of K per g of sample ashes:	charcoal:	Total kg/ha soluble K	Accessible**) g K/g of sample ashes:	charcoal:	Total kg/ha accessible K	Total K kg/ha: soluble + 'accessible fraction'
1	1690 g	1080 g	13.88	1.98	15.96	19.27	2.64	21.91	37.87
2	770 g ***)	535 g	15.66	1.57	17.23	18.95	3.14	22.07	39.30
3	750 g	920 g	25.03	5.40	29.43	56.91	11.99	68.90	98.33

*) 'soluble' means here soluble in water of about 20°C.

**) 'accessible' refers here to a standard laboratory procedure, here used to extract the ions previously not dissolved in water to similar extent as done by living plants.

***) as less litter was burned with this than with the other two samples, the figures are probably too small.

gardless of the crop cultivated. Some caution, however, must still be exercised. Although enormous amounts of P are available (as may be seen from a previous investigation of Bellona as a presumptuous phosphate mining area (White and Warin, 1965), P may be largely inaccessible to the plants. However, in the analyses cited only accessible elements are given. With respect to the remaining nutrient elements S is usually considered to be available in sufficient quantities because of the marine location of Bellona. However, it seems very likely that low amounts of K and N may limit the yields of Bellonese crops. Both N and S can be stored in fallow vegetation, but they are largely removed as gases when this is burnt and can thus be transferred to the crops only to a very limited extent. With N which is so important for any crop, this raises the question of how the necessary amounts can be acquired at all. No doubt some N compounds are carried down with precipitation; the amounts of N contained in rainwater in the tropics is probably greater than found in measurements from temperate regions. Still, the amounts necessary for crop growth would be sufficient only if accumulated in vegetation or soil. Of these two possibilities, vegetation must be dismissed, because of the burning. The storage of N in soil is most likely via an organic mechanism. To explain how sustained yields have occurred over the centuries on Bellona, one must probably look for a hitherto undescribed way of N fixation utilizing inactive N_2 from the atmosphere. No plants were found with the usual nitrogen-fixing root nodules.

To investigate the role of fallow vegetation in the cycling of K, three trial spots each of 10 m^2 and with vegetation of different stages of regrowth were cleared of over-ground vegetation. Afterwards the vegetation was burnt on an iron plate, and the ashes were collected for analysis. The burning of young fallow growth was especially difficult, but with the help of local assistants it was finally accomplished. In the Laboratory for Agricultural Chemistry of the Royal Danish Agricultural College, the ashes were analysed for K following standard procedures (see B. Kjær, 1969). Before flame photometry could be carried out, the ash samples were homogenized. Charcoal was removed by sieving, and after pulverization was burnt to ashes. K contents were determined both as a water-soluble fraction and as 'extra' exchangeable potassium. The results are shown in table 39.

Overall a large increase in K content of the vegetation is evident. The increase from the garden stage exceeds 60 kg K per ha. but as the storage in 'weeds' of a garden is very low the total increase is probably near 100 kg, which is the total amount of K accumulated. It is interesting that the magnitude of this storage capacity is about that required by a normal crop. Among the macro nutrients, K is the only one (except for N) likely to be insufficient for and thus limiting crop growth. The importance of the vegetation store is thus evident, as is the importance of a proper administration of the fallowing system. The normal inclination of the Bellonese cultivator to avoid a premature felling of fallows is thus understandable, because it may deprive him of an easy extra yield. It is regrettable that a further investigation of the increase of ion content in older fallows had to be abandoned because of the difficulties inherent in it. The hypothesis is still that the marginal increase is diminishing after five years of fallow, and is almost nil after twelve years. It must be

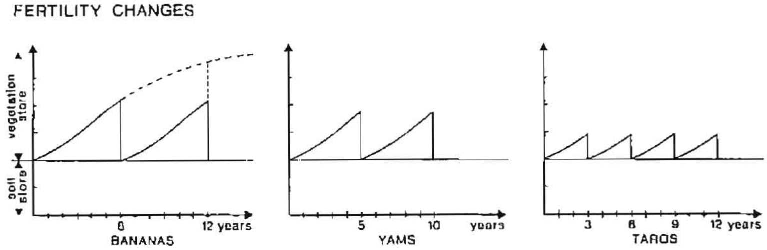


Fig. 79. Theoretical diagrams, describing changes in "fertility" of garden areas during agricultural cycles with some important crops. Bananas have high fertility requirements; taros have low ones. Recovery is proportionately faster to the low fertility levels (but this advantage is offset by relatively high demands of labour).

noticed that the Bellonese are aware of the fertilizing effect of ashes, cf. the use of ashes to promote growth of bananas and pandanus near kitchens.

To check if some of the macro nutrients under discussion were actually limiting crop growth, a small fertilizer trial was run. In two gardens three types of commercial fertilizers were applied (potassium-sulphate, a triple-phosphate, and ammonium-sulphate) kindly put at our disposal by the Department of Agriculture in Honiara. Divided gardens (*tohitohi*) were used, as these offered an oportunity for a natural arrangement of control beds. The results were later inspected by Bellonese friends and reported by letter (unfortunately making a quantitative determination of increase in yield impossible.) As might be expected, the application of $(NH_4)_2SO_4$ gave strong response, as did K_2SO_4 (the strongest, it was reported), whereas the superphosphate was reported to result in almost no change. From another trial run it was discovered that combined 'NPK' fertilizers and also locally acquired wood ashes gave fine responses.

It seems probable that the effect of ammonium sulphate is due to the content of ammonium mainly; therefore the effect of K_2SO_4 is almost certainly to be ascribed to the K content. Unfortunately no K fertilizer with neither S nor N could be provided except the local ashes that may yield responses from unconcentrated contents, hence no conclusive proof of the importance of potassium could be established. The positive results of both K and N fertilizer under conditions similar to those on Bellona are supported by the experience of others (such as Simmonds, 1970).

To check K relationships more closely, the soil profiles, corresponding to the fallow areas investigated, were analysed to find the distribution of exchangeable K content with depth. Further, an attempt was made to find how the K ions were retained in the soil. The cation retention capacity, the 'T value', (Piper's method, modified) was found, and the humus content were determined to discover whether these or colloidal constituents were responsible for cation absorption.

The results of this investigation which was also carried out with the helpful staff of the Laboratory for Agricultural Chemistry, were as follows: 1) contents of K decrease markedly with depth in profiles; the difference seems largest in newly cultivated soil. 2) 'T values' of a magnitude 35–70 meq.val./100 g of dry soil were high enough to explain values of 'bound' K ions. 3) Values for humus contents – found through losses on ignition after removal of carbonate – varied from about 16 to 27 %, enough to suggest that K ions may be bound to humus. One source of error is that charcoal contents produced by the swidden techniques used in cultivation may have increased the values slightly. But since visible grains of charcoal were removed before ignition, the increase is probably only slight. Summing up, it can be said that nothing is found to contradict the importance of good housekeeping with available K in Bellonese gardening.

Although it has been demonstrated that macro nutrients in all probability are limiting the yields of Bellonese gardens, little is known concerning the quantitative reduction. It is clearly perceived by the Bellonese that a prolongation of fallow up to about twelve years (the *bao matu'a* stage) increases yields. There are two alternative principles to follow for the Bellonese gardener: he may employ horticultural cycles with long fallows and a high level of fertility for a given plot of land, or he may use short term cycles with less fertile conditions (see fig. 79). This is in accordance with findings for African systems by Nye and Greenland (1960). If there is land enough, the Bellonese takes the advantage of long fallows, thus reducing his work for a given yield. Presently it appears that the Bellonese gardener has reduced his fallow periods to a length for each crop at which the fer-

TABLE 40.

Connection between soil depth and cultivation.

	deep soil	shallow soil	
cultivated	2765 (82%)	313 (3%)	3078
non-cultivated	603 (18%)	9270 (97%)	9873
	3368 (100%)	9583 (100%)	12951

tility achievement per time unit is near maximum. He is possibly reluctant to reduce fallows further, because he experiences a sensible decrease in yields; most interviews indicate this.

A pertinent question is now whether a further reduction in fallow periods would infer damage to the soil/vegetation system. There are several indications that this is the case. If fallows are shortened, the regrowth has increasing difficulties in establishing itself. Burning clears away most of the humus contents, which again decrease the humidity and cation retension capacity. It seems that the ion contents of the soil are increasingly determined by the storing capacity for cations of the clay mineral fraction of the soil. As this is very small, 'fertility' may be reduced gravely (less than one third of the original). There are striking examples to demonstrate an evolution along these lines on other Pacific islands, where historical evidence proves grass steppes to have developed such as Honiara plains and areas in Fiji. From Bellonese experience it appears that if the soil is misused, the humus will be removed. If this is the case, as it may be under permanent cultivation, the maximum ion retention is reduced to the amount retainable by the clay minerals alone. Old village sites from which weeds have constantly been removed seem to prove that normal fallow vegetation will never invade again. Possibly the same danger will develop although more slowly with the cultivation of sweet potatoes after yams and with the cultivation of tobacco. There is fortunately a growing awareness of these dangers among the Bellonese.

Apart from the problems just mentioned, stability in land use seems to be maintained by normal Bellonese practices. This does not preclude the possibility that specific resources may run low. Canoe trees (*ghaimenga, tabai, suaso*) are now almost unavailable in one district, and threaten to become scarce generally. No doubt growing interest in fishing partly explains the greater exploitation of these trees, but still the shortage of such timber displays an imbalance not observed before. A certain 'rationing' of such timber by placing a taboo on them may help, but further, more stringent steps may be necessary to preserve a sufficient number of these trees. A gross count of available *ghaimenga* trees revealed that the large Bellonese land owners, *hakahua,* still possess an enormous number of trees, although many of them are undersized. Better distribution of timber would be the first way to lessen the shortage and this, in fact, is already occurring since more and more *hakahua* allow people without suitable trees to use their timber.

Soil depth as a limitation for cultivation

Bellonese horticulture is highly dependent on soil depth as demonstrated by the sample showing the planting procedure for a garden (see chapter 2.1.4). Soil with a depth of less than 20–25 cm, *ghinaghina* soils, are seldom cultivated; this is also true for soils with a large fraction of coarse material. It was therefore interesting to find the approximate extent of soil of the limiting depth, and possibly exclude areas with coarse material.

Two of the geologists prospecting phosphate on Bellona, White and Warin, published a map showing areas with a soil thickness exceeding one foot. The map was partly based on interpretation of aerial photographs, partly based on samples taken in regular traverses as in Ghongau district. An attempt was made in 1966 to see whether the areas with deep soil found by the geologists coincided with cultivated areas as interpreted from the aerial photographic map.

'Cultivated land' distinguished from 'non-cultivated' (secondary or primary forest) deduced from the photographs was compared with 'deep soil' and 'shallow soil' on the geologists' map. In Ghongau the connection was (on 1000 m^2 squares) as shown in table 40.

The contingency coefficient is highly significant, even though the Bellonese look for a soil depth of more than 15–20 cm, even if found in small areas, whereas the geologists probably strive to find the maximum extension of a possible mining area. In practice the two areas are almost identical.

From analyses of the different aerial photographs taken of Bellona it is clear that the central part (*tino henua*) has been continuously cultivated, but that the cultivation of the more isolated pockets of soil (*abaaba*) has been much less stable. Possibly the explanation is not only their remoteness but also their shallow soils, requiring a prolonged fallow period to rebuild fertility, or sometimes resulting in abandonment of cultivation after one miserable test. It appears that the only areas where soil thickness is not restraining cultivation are the central areas, totalling about 420 ha.

Even 420 ha. represent a fairly high amount of potential production, namely about 4,200 t. of dry matter annually or, theoretically, enough to feed a population approaching 15,000 persons. With the present system of cultivation the fallow period required reduces harvested area to about one sixth, and the actually acquired yields make only two fifths of the potential. The actual carrying capacity thus arrived at is slightly less than 1,000 individuals.

6.4 Natural hazards and subsistence

Natural hazards interfere strongly with the lives of the Bellonese. It has previously been touched upon that targets for food production must be planned at a 50 % safety margin, also that the whole gardening strategy aims at a minimization of risks inflicted by droughts or excessive rains. In fishing, maximum catches cannot solely be set out for, but a diversity of methods are necessarily applied to increase chances for at least some catches (as similarly described from other societies by P. Gould 1963 and W. Davenport 1960). Cooperation, so prevalent on Bellona, implies also a spread of risks. Although very few or no data exist on the hazards of living on Bellona it might be useful to mention some of them.

In food production there is always the risk of a failing harvest. Usually this stems from droughts. These occur at unperiodic intervals, but much more frequent than should be implied from the near-equatorial location of Bellona. Traditions tell about severe droughts in 1910, of one in the early thirties, and one in 1943. At all these occasions some people died from starvation; in 1943 many fled to Rennell to avoid hunger and thirst. Less fatal droughts, cutting but not annihilating yields, have occurred much more often. Also hurricanes represent a reoccurring threat. They seem to strike on an average of from 3 to 5 years. Often they accompany droughts. Hurricanes destroy gardens and carry off canoes. They also inflict death at sea, but not so often as might be expected. In daily life the risk of high winds are taken lightly as can be seen from the very elementary staking of yam gardens on Bellona. A thorough staking as used on Rennell would require only about 5 % extra work, but this is regarded as a waste of effort. Of course no staking helps if a hurricane hits directly, but now even distant hurricanes cause damage to Bellonese gardens.

The worst threat to Bellonese lives nowadays are probably illnesses, most of which are recent imports. From the collected diaries, it seems that people are suffering from illness in about 10 % of their normal working hours. No data have been collected on infant mortality, still undoubtedly high. During two years of observation 1964–66, tuberculosis and pneumonia accounted for more than 80 % of the deaths. Pneumonia seems to be the main 'occupational disease' which is probably incurred and worsened especially by night fishing and accidents at sea. Tuberculosis seems to hit the less well-fed people exceptionally hard. During the period observed, only a few cases of malaria were diagnosticised. All were people returning from plantations. Prior to European contacts, malaria seem to have been totally absent. In spite of the foregoing, general health appears to be good on Bellona (Lambert, 1934, and later reports from medical assistants). Infectuous diseases were rare on traditional Bellona; they have definitely increased with the breakdown of traditional measures of quarantine. Remedies against cuts and wounds are fortunately much more efficient in modern times.

6.5 Localizations as an adaptation to the environment

The general and controversial question of how the Bellonese adapt their activities to the local situation cannot be answered solely by analysing availability of resources. Also the question of accessibility of resources must be considered because it influences the operational costs of all activities. Localization is here viewed solely with regard to resources for food production and localization of settlements. For subsistence production rational localization is vital, which is not to say that it is not influenced by non-subsistence activities (see chapter 7 for the changes in settlements 1938–66).

Bellonese food production relies on a number of

TABLE 41.

Resource bases for some subsistence activities.

Horticulture	Collection of vegetable produce	Fishing	Collection of marine produce	House and canoe building	Non-subsistence activities Copra production
fertile soil of necessary minimum area = gardenland, 'umanga	fallow gardenland, ma'anga secondary growth, ngaoa'anga forest, mouku	canoe-launching area, abatai and trail, anga ki tai	reef area, ngoto coastal trail, anga ki tai	forest timber stands, mouku and ngaoa'anga light forest, ma'anga pandanus groves, maalu	coconut groves, kiu trails, anga firewood from fallows and forest, ma'anga, mouku

resources: 1) fertile soil covering a certain minimum area for horticulture, 2) a quantity of diverse trees and other wild plants for collecting and gathering, 3) a variety of timber trees for house and canoe building, and finally 4) access to the sea for fishing and collecting of marine produce. Most of these resources are of limited distribution and cannot be treated as resources specific for separate kinds of production; housebuilding involves, for example the use of products from forest (long timber), and from cultivated areas (for thatch).

As could be expected, there is a strong tendency to incorporate the necessary resources within each unit of utilization. With the type of resource localization usual on islands, this gives rise to a 'radial or strip type' of holding each encompassing the diverse area classes necessary for the multi-resource-dependent production. Cases illustrating this can be found in all parts of the world: from the African 'huza' farms (G. Benneh 1971), and the Fijian farms (L. Thompson 1949) to the Old-World Danish farms (V. Hansen 1964). For a good survey of this problem, see A. R. H. Baker 1969. The idea that an independent homestead must command all the necessary classes of land was expressed by J. Brunhes and C. O. Sauer as early as in 1923 and 1925. A similar concept is deeply rooted in Polynesian culture. The word *kainga* from Futuna, for example, means 'property shared by a kindred' and usually consists of all the different area classes from the mountains to the sea (E. Burrows, 1936). Such patterns are found in almost all islands of Western Polynesia.

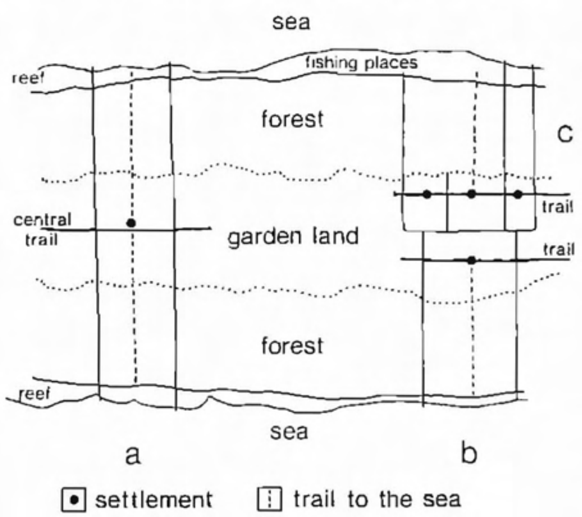


Fig. 80. Hypothetical development of landholdings on Bellona. The original immigrants probably divided the land in coast to coast strips, yielding fine opportunities for fishing (a). Possibly subsequent divisions mainly aimed at giving access to gardening land (b). Recently, only some holdings include forest areas and coastal trails (c).

Once the idea of building up holdings that encompass all the necessary resources has been accepted (on Bellona this is done more on a lineage than on an individual basis), the shape of holdings will depend on the distribution pattern of resources. P. Haggett (1965) sketched some possible resultant patterns; the linear one fits the Bellonese pattern nicely. The central ribbon of good land is no doubt the cause to this, combined with the 'economic sense' of the Bellonese. Since horticulture is the most time consuming subsistence activity, it is not surprising that settlements are located in this central ribbon as pearls on a string. Two parallel lines of settlements would also have been a solution to the problem of 'least effort'. It seems in fact to have been partially used earlier on the two side trails (*anga panga*) north and south of the permanent trail (*angatu'u*).

Initially landholdings were probably strips from coast to coast across the long axis of the island, ('a' in fig. 80).

When land was distributed among heirs, the strips were fragmented during centuries, often in