APPENDIX 4

STONE TO STEEL REVISITED: NEW GUINEA EXPERIMENTS

Before data on labour inputs can be related to the archaeological data of prehistoric irrigation systems, an adjustment must be made for the differences between a pre-steel and steel technology. Salisbury's 'From Stone to Steel', published in 1962, was an early attempt to do just this. Salisbury tells how one day when he was returning from watching and timing gardening operations his most reliable informant 'unexpectedly' stated, 'That would have taken three times as long when we had stone axes' (1962: 219). As he freely admits, that remark was 'the germ for much of the analysis' in his book (ibid). On the basis of this and estimations by other informants Salisbury concluded that work such as cutting bush and fence posts took three times as long before steel axes were introduced. Thus, pre-steel, 2.5 times as long was spent on clan work (gardening) and 1.5 times as long was spent in lineage work (fencing, gardening and housebuilding). His estimates went unchallenged for many years and the revolutionary changes following the adoption of steel which he outlined have become part of the myth of progress through introduced technology. As with much of this progress women's work was not lightened at all by the new introduction as Salisbury noted (ibid: Table 1).

Rappaport (1968: 261) considered the steel bushknife to be a more important introduction than the steel axe to the Maring group he studied, because of its superiority in clearing undergrowth over the traditional method which involved laying a 7-10 cm diameter pole on the ground, bending the weeds over it and then chopping them with an axe.

Townsend (1969) sought to quantify the difference in labour input between clearing forest with stone and steel axes by experiment. Men equally at home with stone and steel axes (the latter had not totally replaced any traditional tools until 1966) were asked to cut down a number of trees with each tool. Townsend concluded (ibid: 204) that the 'ratio of 4.4:1 for the time required for clearing land with a stone adze as opposed to a steel axe should prove reliable for other areas'. Does it however? The Sanio-Hiowe of the Sepik could hardly be described as typical swidden agriculturists. Their staple food was

sago and other food gardens contributed less than 5 per cent to their diet with no attempt being made to burn, fence or weed the garden plots. In the experiment it appears that Townsend himself selected the trees to be cut and was not observing normal garden clearance activities. While the people studied 'do no burning or ringing of trees in clearing' (ibid) it is not clear whether they pollarded or simply left large trees standing in their evidently very small garden areas nor whether these gardens were in mature or secondary forest. Townsend's paper was important in providing the first attempt at quantification on any scale for New Guinea in comparing stone and steel axe use. The nature of the subsistence activities of the group studied and the experimental method used largely invalidate his results however.

Clarke (1971: 175) 'with considerable effort' persuaded some old Bomagai-Angoiang men to take up their discarded stone axes once more and use them for felling and slashing tasks. He gives no details but states that, on average, work took four times as long with stone axes. How many trees were cut in the experiment and how closely conditions replicated those of the pre-steel era is uncertain. He describes the effect of the introduction of steel axes as not only lessening labour requirements but also as increasing:

> if not the size of the area gardened, the size of the area cleared of trees each year. Also Bomagai-Angoiang informants say that now with steel axes they fell large trees that they would have only pollarded with stone axes. Because most of the pollarded trees resprouted, the regeneration of mature forest was more rapid before the introduction of steel axes than it is now. Steel axes also encourage the clearing of primary forest (ibid: 189).

Other figures are given by Godelier (Godelier with Garanger 1973) who concludes that to cut small trees is 1.5 to 2.5 times quicker with steel axes and to cut large trees (above one metre in circumference) is 3.0 to 4.5 times quicker (ibid: 200-210). The experiments which Godelier conducted among the Baruya (Eastern Highlands Province), most of whose food comes from swidden gardens, seem more reliable indicators of pre-steel conditions than previous experiments because of the methods used and the scale on which he operated. Before steel axes were introduced the Baruya never attempted to cut down large forest trees over two metres in circumference. These trees were ringbarked and left to die; some years later the rotted tree could be felled easily with a stone axe. Godelier makes the point that

efficiency of work does not only depend on directly visible parameters such as tree width and hardness, the strength of the woodsman and his motivation, and the quality of axe used. Much effort can be saved by making preparations ahead of time, such as by ringbarking trees on future garden sites some years in advance.

More recently Sillitoe (1979) has published the results of a series of well designed experiments to compare the efficiency of stone and steel tool use among the Wola (Southern Highlands Province). His data are the most comprehensive published so far for the region and his results closely parallel Godelier's, which is even more significant in that he appears not to have heard of Godelier's earlier work which is not referred to in his paper. The trees cut were generally of small circumference and required 2.2 times as long to cut with stone than with steel. Cutting fence stakes took 1.4 times as long, sharpening the stakes 1.9 times, the removal of roots and small tree stumps from a garden area 1.04 times and the lopping of branches to prevent them from shading gardens 1.5 times.

It is difficult to compare directly stone and steel in the performance of some of these tasks because they often require different techniques to achieve the same results. As elsewhere, steel axes are used for work not previously attempted, such as felling large hardwood trees and splitting them up for fence posts. In the past such trees would have been killed by ringbarking, pollarding or lighting fires against them. The techniques used for splitting the trees for fence posts and the parts of the tree used were also different in pre-steel days. The material removed from the garden is now cut into smaller pieces and Sillitoe suggests that burning is thus more complete, producing more wood ash as fertilizer. By removing trees and stumps that previously would have been left in the garden there is an increase in the area of any plot actually planted, a more efficient use of space.

Steensberg (1980: 24-40, 53-65) also takes up the question of stone versus steel, noting several earlier observations on the relative efficiency of the two and also commenting on clearing practices not involving felling by axe, such as ringbarking and firing the base of the tree. He was shown (ibid: 64) a tree in the Duna area (Southern Highlands Province) which had been ringbarked two years previously but which still carried some leaves which would not have died for a

further two or three years. A fire was set at its base to kill it and Steensberg was told that all leaves would disappear within a month.

Traditional practices on Aneityum (see page 33) involved the clearing of larger trees by ringbarking and fire. Steel axes are today not common on the island, the biggest effect on clearing practices being made by the ubiquitous bushknife. In 1980 when large areas of secondary and mature forest were cleared to make an irrigated garden, I observed that fire set at the base of large trees was used to kill and fell them rather than the axes which the Government had provided. Some large trees were left standing within the garden area. Elsewhere on the island ringbarking of trees is common in areas set aside for future gardens. One change not commented on by other observers is that steel axes permit an increased flexibility of response. Formerly, to clear a garden in mature forest required a much greater degree of forward planning. An area earmarked as a future garden site, for use perhaps two or more years hence, would have its trees ringbarked so that they would be dead when clearing took place. Today the possession of a steel axe means that a quicker response is possible to the need to bring new garden areas into production, since they can be prepared and planted almost immediately.

Rappaport noted that bushknives are much more efficient for clearing grassland than the traditional techniques but as Steensberg (1980: 59) points out, in areas with a marked dry season (such as Aneityum) grassland can be burned off and the roots removed by digging sticks. Overall efficiency is thus not necessarily very marked in this task. Metal spades and forks are important in turning the ground in some areas but no experiments have compared their efficiency to those of digging sticks. I suggest that it would be of the same order as of steel axes as compared with stone.

Steensberg (ibid: 90) records that ditch digging with steel spades in swampy ground, which is to some extent comparable to turning the ground in swamps on Aneityum and elsewhere, is 2.7 times more efficient than using wooden spades. This was based on an experiment at the Kuk Swamp but, as he notes (ibid: 89), recent drainage of the swamp had led to the upper layers drying out and losing their cohesiveness. This impaired the efficiency of the technique using wooden spades and so steel tool efficiency was somewhat exaggerated in the experiment.

Using an average of Godelier's and Sillitoe's figures, I calculate that steel axes, bushknives, forks and spades are 2.1 times more efficient than their pre-steel equivalents. On this basis I have recalculated the labour inputs necessary per hectare per year for the various techniques of gardening (Table 5). Some tasks are unaffected, of course: in planting and harvesting wooden digging sticks are still generally used and in certain kinds of complete tillage the hands are more important than spades or forks. In weeding, metal bushknives can be used but this task appears to be as efficiently performed by hand or with small knives of bamboo or other materials, so no adjustment has been made. The adjusted figures vary from 1.1 times longer spent in furrow irrigated gardens before steel tools to 1.8 times longer spent in some pondfield and island bed systems. When labour input figures for agriculture provided by Clarke (1971: 173), Bayliss-Smith (1980) and my own data are examined, the increased gardening labour with a pre-steel technology is between 1.1 and 1.5 times. We can compare these results with Salisbury's estimates (1962: 219) of 1.5 and 2.5 times.

It can be seen that the introduction of steel tools for gardening has brought tangible benefits in reducing male labour, though it has affected women's labour in gardening to a much smaller degree. Earlier assessments based on informant statements and experiments of dubious validity have, however, certainly overstressed the difference steel tools have made.