Three Seasons of Cultivating Stone Artefacts with Farming Implements in Northwest NSW

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Abstract

Many recorded Aboriginal sites in Australia are surface scatters of stone artefacts. Some of these surface sites are situated on land that has been and still is cultivated. Archaeologists carrying out surveys prior to commercial development or as area surveys for Aboriginal groups, are often asked to provide some interpretation of these scatters. Archaeological assessment can cover such aspects as size of original site, knapping techniques, or density of artefacts. The research detailed in this paper has used genuine farming equipment and modern stone artefacts made from a variety of raw materials, the same rock types as used by Australian Aborigines to obtain some unbiased data on individual artefact appearances, spatial displacement and breakages of artefacts. **The results show that artefacts were scattered between 2.2 and 26.8 metres from their original placement on the surface in only three seasons of normal farming cultivations with disc and tyned agricultural implements.**

Introduction

As more intensive development moves into many old cultivation paddocks that are situated close to towns in either the current or former broadacre cereal growing areas in Southeastern Australia, many scatters of Aboriginal stone artefacts are encountered in archaeological surveys associated with preparations for these developments. A few survey reports written in the past have described Aboriginal stone artefact scatters spread over many metres in former or current cultivation paddocks, as large Aboriginal sites (e.g. Gaynor and Wilson 1995). My 15 years experience in carrying out archaeological surveys and experience coming from 47 years of farming practices, led me to reconsider what was actually being recorded. Using my farming knowledge of past cultivation methods combined with my knowledge of taphonomic processes and archaeological procedures, I formulated a single experiment to test a number of specific questions. These being :

1. What distances can stone artefacts placed on the surface, be displaced in three seasons of normal cultivation practices?
2. What are the percentages of stone artefacts that appear on the surface after each cultivation episode?
3. How many stone artefacts can be recovered by excavation after three seasons of cultivation?
4. What angles does a one-way plough throw material (stone artefacts in this case) to the right from their original position?
5. Has the the size of the stone artefact an influence on the distance displaced from their original position?
6. What is the spread (linear and non-linear wise) of stone artefacts after three seasons of cultivation?
7. Do stone artefacts generally tend to end up on the bottom of the plough-zone?

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Past experiments and observations

A number of archaeological papers concerning plough zone artefacts have been written. Some of these papers give details of experiments conducted with artefacts specially made for the project (e.g. Ammerman 1985, Odell and Cowan 1987, Wandsnider and Camilli 1992) while others observe the distribution of genuine stone artefacts (Roper 1975, Ammerman and Feldman 1978, Frink 1984). All these papers have been written about research conducted in either Europe or the USA, and most concentrated on archaeological procedures with only a few giving information on the farming implements used in the particular paddocks in which the sites were located. However, a number of these researchers made statements as to what percentage of the original artefacts could be found on the surface at any one time. Rober (1975:272) found that in a paddock that had been farmed for at least 20 years, co-joins were up to 9 metres apart. Lewarch and O'Brien (1981:45) predicted that artefacts on the surface were only likely to represent 10% of the total number in the "plowzone" area. Reynolds (1982 :316), from experiments predicted 16% were always on the surface. Frink (1984:357) predicted that all artefacts have the probability of appearing once every six or seven years. Ammerman (1985:37) carried out experiments over 4 years in an olive grove in Italy. He concluded that that over the 4 years, only 6% was ever on the surface at any one time, and the furthest any artefact had moved was 15 meters. Cultivation, however, was being carried out in three different directions. The numbers appearing on the surface were nearly twice as many after rain than in the worse conditions (not classified but presumed to be dry dusty conditions). Odell and Cowan (1987:457-480) carried out experiments with 1000 buried artefacts. They suggested only 5-6% would be on the surface at any one time. They found that over 12 ploughing episodes the site area had doubled from 234 to 471 square metres. However, none of these observations, I found were applicable to conditions found on the western slopes of Southeastern Australia where the circular type cultivation with disc and tyned implements is practised, and not cultivation with moulboard ploughs as was the case in many of the overseas experiments and observations.

In order then, to obtain some data on the displacements of artefacts in Australia, I decided in early 1998, to carry out my own research on land for which I had some control over, and as I own the type of cereal farming implements that were used between 1955 and 1970 on the western slopes of NSW, I decided to use this equipment for my research. As all past experiments with stone artefact displacement in cultivated paddocks have been carried out overseas, the data presented may be different from that presented in this research. Certainly farming practices on the western slopes of NSW are different from farming practices in other countries, largely due to the larger sized paddocks that are cultivated in Australia and the short length of time these paddocks have been cultivated when compared with many in Europe and the USA where fields may have been cultivated for hundreds of years.

Materials and method

In February 1998, two one metre square sites on previously cultivated land, were selected to carry out this research (designated FXP 1 and FXP 2). The land is on a 50 acre (20 ha) farm known as "Fermanagh", which is situated on the Southwestern outskirts of Gunnedah in Northwestern NSW. This small property is owned by myself and one of my sons and so I had a reasonable amount of control over the research areas. Control, I thought was necessary, to avoid as much as possible, interference either knowingly or unknowingly by people walking, driving or riding through the selected sites. The two sites are situated on a gentle hill slope about 500 metres apart. However, the soils are of a different type, as one is a heavy red clay type while the other is a very loose grey decaying basalt soil that sits very close to the original basalt rock beneath it .

Between 1930 and 1970, it was the practice in many farms growing winter cereals in Australia, that paddocks were only cultivated in one direction, that is, starting at the outside near the fence line and travelling around the paddock in an anticlockwise direction with the uncultivated land progressively getting smaller and smaller until the centre was reached. The uncultivated land on the corners or headlands was then cultivated from the centre outwards. For a typical view of this circular method of cultivation and the position of the sites see Figure 1. The land on which FXP 1 and FXP 2 are situated was cultivated in a similar fashion for this research. As can be observed in Figure 1, site FXP 1 was cultivated in a downhill fashion while site FXP 2 was in a uphill fashion.

Figure 1 The property "Fermanagh" showing circular type cultivation

Materials

Materials used in this experiment can be divided into two sections.

1. Stone artefacts
2. Farming plant.

1. Stone artefacts.

The raw materials for the stone artefacts utilised in this experiment were gathered over a number of years from various localities throughout Southeast Australia (Table 1). In all, 200 artefacts were used for this research. Some were made especially for the experiment, while others were scavenged from leftovers from other research projects.

Some researchers conducting plough-zone experiments have used non-stone artefact material (e.g. Wandsnider & Camilli 1992 - nails and washers), or painted their stone artefacts all one colour (Odell and Cowan 1987 - all artefacts painted a bright colonial blue colour), and so their results were not conducted under genuine conditions that are applicable to Australian stone artefacts. The raw materials selected for this research covered a variety of materials, colours and sizes to represent a lifelike range of colours and raw materials found in Southeast Australia (Table 2 & 3).

MATERIAL	**SOURCE**	**FXP 1**	**FXP 2**
greywacke	Tamworth (Northwest NSW)	6	4
chert	Tamworth/Gunnedah (Northwest NSW)	22	4
tuff	Currabubula (Northwest NSW)	5	15
quartz (pebble) and quartz (reef)	Coonabarabran (Northwest NSW), Bendemeer (Northwest NSW)	5	20
quartzite	Coonabarabran (Northwest NSW)	2	2
cherty argillite	Tamworth (Northwest NSW)	14	7
hornfels	Tamworth (Northwest NSW)	15	18
silcrete	Hunter Valley (NSW)	2	2
aplite	Tamworth (Northwest NSW)	1	0
petrified wood	Gunnedah (NSW)	0	2
indurated mudstone	Hunter Valley (NSW)	0	2
flint	South Australia	1	8
TOTAL		100	100

Table 1 Numbers and sources of raw material

FXP 1

MATERIAL	FLAKES	CORES	AXE BLANKS	HAMMERSTONES
greywacke	6	0	0	0
chert	22	0	0	0
tuff	5	0	0	0
quartz	5	0	0	0
quartzite	0	0	0	2
cherty argillite	14	0	0	0
hornfels	15	0	0	0
silcrete	0	0	0	0
aplite	1	0	0	0
petrified wood	0	0	0	0
mudstone	29	0	0	0
flint	1	0	0	0
TOTAL	98	0	0	2

FXP 2

MATERIAL	FLAKES	CORES	AXE BLANKS	HAMMERSTONES
greywacke	3	0	1	0
chert	3	1	0	0
tuff	15	0	0	0
quartz	15	6	0	0
quartzite	0	0	0	2
cherty argillite	6	1	0	0
hornfels	18	0	0	0
silcrete	2	0	0	0

aplite	0	0	0	0
petrified wood	2	0	0	0
mudstone	18	0	0	0
flint	7	0	0	0
TOTAL	89	8	1	2

Table 2 artefact type/raw material

COLOUR	FXP 1	FXP 2
white/clear	7	20
grey	11	5
dark red	19	2
red	0	1
brown	6	18
yellow/brown	29	18
green	4	0
black	24	36
TOTAL	100	100

Table 3 artefact colour

Range of maximum dimensions of artefacts (in mm)

SITE	FXP 1	FXP 2
LENGTH	14 - 117	16 - 114
WIDTH	7 - 66	10 - 74
THICKNESS	2 - 43	2 - 38

Table 4 range of artefact sizes

Figure 2 A sample of artefacts in FXP 1

Figure 3 A sample of artefacts used in FXP 2

Farming Plant

The farming plant selected for this research was of a type used during the 1950s and 1960s for cultivating winter cereal crops on the western slopes of NSW. The farming plant included :Tractors, plough (one-way) for the initial cultivation of the land from a heavily vegetated state, disc harrows (two-way plough) for cultivating moderately thick vegetation, scarifyer for subsequently cultivating the land after the initial ploughing operation(s), this has ridged tynes that can be described as a heavy metal tyne affixed to a large spring to give it the tension to keep it in the ground, combine seeder for sowing and cultivating land at the same time, this has springtynes which have no spring attached but the spring steel it is made of, keeps it in the ground), harvester for removing grain from the mature crop (Figures 4-10, Table 4).

MACHINE	MAKE & MODEL	FEATURES
tractor	Oliver 1850 (1967)	75 drawbar horsepower, water weighted rear tyres, running at 16 lbs/inch pressure, front tyres air filled running at 28lb/inch. manufacturer's stated weight of tractor 10, 500 lb.
tractor	Chamberlain C6100 (1969)	75 drawbar horsepower, water weighted rear tyres, running at 16 lbs/inch pressure, front tyres air filled running at 28lb/inch. manufacturer's stated weight of tractor 12,000 lb.
plough	Chamberlain (1960)	one way operation, 1 separate 18 inch discs - width of cut 12 ft. 7.50 by 18 inch tyres running at 25 lb pressure.
disc harrows	Conner-Shea (1969)	two way operation, 32 scollop discs running 16 (offset) discs in front running at an angle to the following 16 discs at the rear. Wide of cut 12 foot.
Scarifyer	Horwood Bagshaw (1963)	19 solid tynes connected to individual heavy springs on a 5 bar frame. 9 inch duckfoot type share or point connected to each tyne. Width of cut 9 foot 6 inch. 750 by 16 inch tyres (2) running at 25 lb/sq. inch pressure. Heavy trailing drag harrows connected to rear of scarifyer.
Combine Seeder	Massey Ferguson (1958)	32 spring tynes mounted on a 4 bar frame. Width of cut 12 feet. Supported by by 6.50 by 40 inch tyres (2) running at 18 lb/sq. inch pressure. Heavy trailing drag harrows connected to rear of seeder.
Harvester	Massey Ferguson -585 model (1958)	tyres front - 13 by 26 inch, back - 600 by 16 inch, all running at 30 lb/sq. inch. Width of cut 12 feet. Weight empty 8800 lb

Table 5 Details of farming plant used in the research

 

Figure 4 Oliver tractor ---------------------Figure 5 Chamberlain tractor

Figure 6 Chamberlain plough -----------Figure 7 Connor-Shea offset disc harrows

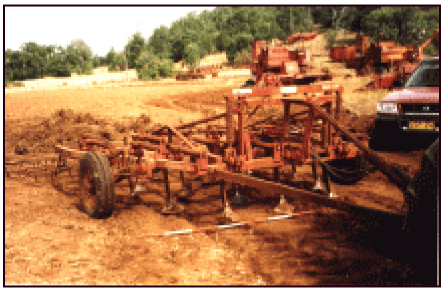

Figure 8 Horwood scarifier ----------------Figure 9 Massey combine seeder

Figure 10 1958 Massey Harvester (model 585)

Setting up the experiment

Prior to being distributed on the experiment sites, the stone artefacts selected, were analysed with nine attributes being recorded. These were :

1. an identification number which reflected the co-ordinates of their position (each was marked with marking pen with their site designation and individual ID (e.g. 2 A1 i.e. Site 2 artefact A1)
2. type of artefacts (flake, core etc.)
3. raw material
4. colour
5. maximum length, maximum width and maximum thickness
6. presence or absence of cortex
7. percentage of cortex (if present).

The artefacts were then photographed in groups of 25 as they were to be placed in a square metre frame in each site (e.g. A1-A25, B1-B25, C1-C25, D1-D25).

The square metre frame enclosing the artefacts was placed a number of metres away from the boundary fence in each site with additional metal pegs placed between the fence and the cultivation. This setup accurately positioning the square metre frame again after each cultivation so as to calculate distances travelled initially by surface artefacts and then after excavation, all recovered artefacts.

After each cultivation episode, the square metre frame was placed back in its original position and all artefacts sighted on the surface were recorded as to their position and distance from their original starting position (i.e. the centre of each 10 cm square). The site was also inspected before the next cultivation to ascertain if rain had revealed any other artefacts. If it had, then these artefacts were also recorded. Cultivations took place in the normal fashion on a farm, that is after rain which allows weeds to grow, or after harvest in preparation for the next season's crop. No tillage implement was pulled at speeds of more than 5 mph (8 km) per hour by either tractor. This was generally the speed limit for tractors constructed and used on the western slopes of NSW between 1930 and 1960.

Both sites were planted with either wheat or barley in June or July for two seasons. Due to a small mob of kangaroos that live just off farm, both sites were grazed in each season and the sites also periodically traversed by kangaroos travelling to and from the lucerne crop growing in the centre of the paddock. Although both areas around each site, did not produce a lot of grain, nevertheless in keeping with normal farming practice, the harvester (see Figure 10) travelled over each site at the end of the first and second season, as if there had been a good crop on it. No crop was planted in season three as the initial excavation started just after scheduled seeding time.

After the initial ploughing in the first season, the position of those artefacts sighted, was recorded and plotted on graph paper, with a straight line being drawn from their original position to their new position. The angles of movement were then calculated (see Figures 12 and 13). This was the only time that these angles were recorded due insufficient artefacts being recorded on the surface before the other three occasions the plough was used.

Every time the sites were cultivated, the position of each sighted artefact on the surface was recorded on graph paper so as to register its distance from its individual starting position. The artefacts sighted in the plot after each cultivation were graphed on separate graph paper to give an individual record of each sighted artefact after each cultivation. At the end of the third cultivation season in 2000, the areas were carefully excavated using a spade down to the bottom of the plough zone. The areas were gridded into one metre squares, and excavated beginning at the original position of the artefacts in 1998. The path of the excavation then followed the general line where artefacts had been recorded over the three seasons (see Figures 22 and 23). The area excavated expanded laterally in each site to ensure artefacts had not travelled outside the expected areas. All squares were excavated in two spits (surface to 10 cm deep and 10 cms to approximately 20 cm (the bottom of the plough-zone). The bottom of the plough zone in all cases, was hard and devoid of decaying vegetable matter and was easily distinguished from the overlaying cultivated soil. Each section was initially dry sieved using plastic 5 mm sieves. Only for a few days after heavy rain did the deposit in site FXP 1 need wet sieving as the soil in this site was very loose and tended not to cling to stone. The soil in site FXP 2, however, was a heavy red clay type and soil stuck to all stone, making it imperative that all residues in the 5 mm sieves in this site, were wet sieved using a pressurised water supply.

Results

This experiment, conducted over three cultivation seasons, generated several strands of data that can be categorised as follows :

1. the maximum and minimum distances that the stone artefacts travelled over the three seasons.
2. the percentages/number of artefacts that were recorded on the surface after each cultivation episode.
3. The number of appearances of individual artefacts throughout the three seasons and the number of artefacts that were unaccounted for after excavation.
4. the angles that the one-way plough moved artefacts (this has special implications for the first pass around a paddock near a fence, or those parts of the paddock that are close to objects such as trees or roads).
5. artefact damage.
6. Artefact capture by a clod or soil ped.
7. The maximum distance any one artefact had travelled in any one cultivation pass.
8. The dispersal of artefacts in a non-linear direction in each site and the greatest concentration of artefacts in each site.
9. the number and distribution of artefacts recovered from the excavation.

The maximum and minimum distances travelled by artefacts

SITE	1ST SEASON	2ND SEASON	3RD SEASON	AFTER EXCAVATION
FXP 1	4.2	12.5	23.8	23.8
FXP 2	5.5	18.4	26.8	26.8

the minimum distance travelled by any artefact (after excavation) was 1.75 metres in FXP 1 and 2.2 metres in FXP 2 (note that FXP 2 had an extra ploughing in season 2).

Table 6 Distances artefact travelled in FXP 1 and FXP 2

These results indicate that for the first season, the maximum distance travelled by any artefact sighted was in the uphill site (FXP 2) not in the downhill site (FXP 1). Artefacts in FXP 1 were moving downhill but they did not travel any further than those in FXP 2 (which were moving uphill). This would indicate that in this research, slope of the cultivated land had only a minor affect on the movement of artefacts during cultivation.

The maximum distance recorded that any artefact travelled in any one cultivation episode, was 11 metres on the 23/5/99. This occurred in the second season in FXP 2 when the springtyned seeder was used to cultivate the soil when there was still a quantity of loose straw present on and in the soil. The straw partially blocked up some parts of the undercarriage of the machine forcing the blockage (soil and straw) to carry the artefact further than would have normally been possible if there were no material present capable of blocking up the machine. When I noticed the blockage, I stopped the tractor and the blockage was removed by hand. Similar conditions occasionally occur on cereal type farms and could be responsible for carrying ‘genuine’ artefacts further than would normally be possible in one pass with any farming implement.

The number of artefacts that could be seen on the surface after each cultivation in each site.

Both sites had 100 artefacts in them, so the numbers recorded on the surface, can also be taken as percentages) (see table 7).

FXP 1
1st season (1998) - 5, 5, 5, 11 **Average - 6.5%**
2nd season (1999) - 18, 18, 11, 11, 14, 15 **Average - 14.5%**
3rd season (2000) - 4, 10, 6, 6, 4,5, 9, 13 **Average - 7%**
Overall Average - 9.39%
FXP 2
1st season (1998) - 14, 18, 14, 18 **Average - 16%**
2nd season (1999) - 12, 13, 15, 12, 13, 18, 12 **Average - 13.57%**
3rd season (2000) - 3, 7, 13, 12, 6, 8, 9, 5 **Average - 7.88%**
Overall Average - 11.68%

Table 7 sighted artefact numbers per cultivated episode per season

These results in Table 8 show that even though the two sites were cultivated on the same day for each cultivation episode over the three seasons, the results were very different in the two sites in the first season (average 6.5% in FXP 1 to 16% in FXP 2), but the averages were very close to each other in the third season (7%, 7.88%). Individual numbers per cultivation episode were never the same. These averages of around 7% are above those recorded by Ammerman (6%) (1985: 37), Odell and Cowan (5-6%) (1987:456), but below those recorded by Lewarch and O'Brien (10%) (1981:45) and Reynolds (16%) (1982 :316).

The number of appearances of artefacts throughout the three seasons

- The percentage of artefacts visible after each cultivation was plotted against the number of times the artefacts appeared on the surface during the experiment.(Figure 11).

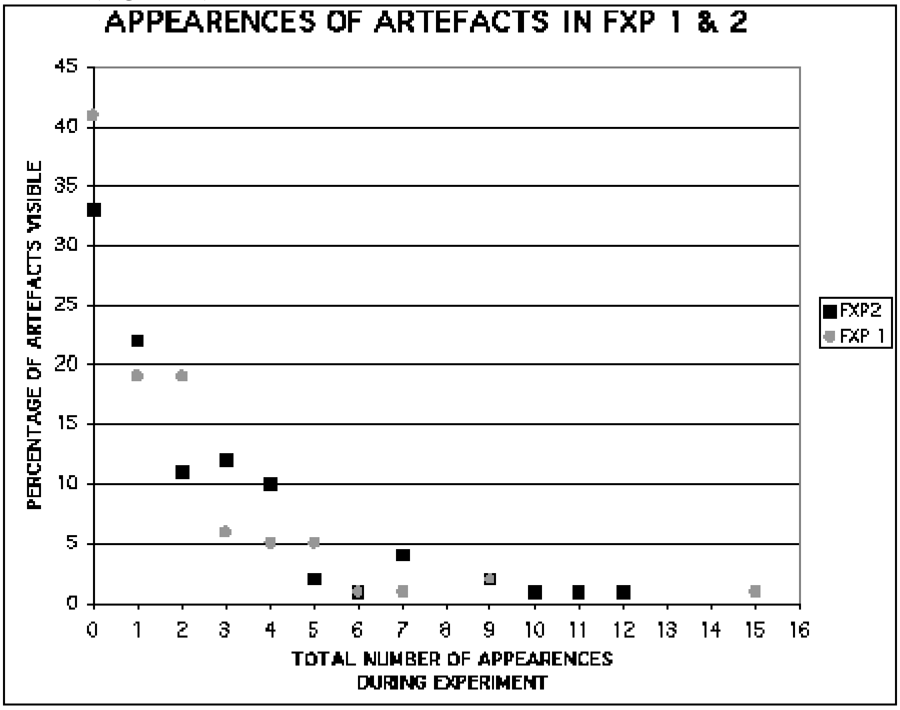

Figure 11 Appearances of artefacts in FXP 1 and FXP 2

Figure 11 shows that 41% and 33% of individual artefacts were never sighted in FXP 1 and FXP 2 respectively over the three seasons. Nineteen percent of artefacts only made one appearance in FXP 1, but slightly more in FXP 2 at 22%. The most appearances was 15 times for one large artefact in FXP 1. As can be seen in Figure 11, most of the appearances were between zero and 5. Only 15 artefacts collectively (7.5%) appeared between 6 and 15 times in the two sites.

There were a number of artefacts that were unaccounted for after excavation. There were eight unaccounted for in FXP 1 (see Table 8) and 20 unaccounted for in FXP 2 (see Table 9).

ID	MATERIAL	COLOUR	LENGTH	WIDTH	THICKNESS	TYPE
A22	mudstone	brown	17	15	2	flake
A24	hornfels	black	26	11	3	flake
B25	hornfels	black	18	10	91	flake
C14	chert	black	32	15	6	flake
D15	chert	dark red	25	16	5	flake
D17	chert	dark red	24	15	3	flake
D20	mudstone	brown	43	12	7	flake
D22	chert	grey	22	13	9	flake

Table 8 Artefacts unaccounted for after excavation n FXP 1

ID	MATERIAL	COLOUR	LENGTH	WIDTH	THICKNESS	TYPE
A5	chert	grey	63	41	11	flake
A7	chert	dark red	40	32	11	flake
A10	quartz	white	30	26	11	flake
A12	horfels	black	35	22	6	flake
A16	mudstone	brown	27	19	7	flake
A24	flint	black	55	46	15	flake
B1	greywacke	black	114	74	30	axe blank
B3	quartz	white	54	27	8	flake
B10	quartz	white	54	27	8	flake
B15	tuff	brown	42	30	5	flake
B20	tuff	brown	34	20	8	flake
B25	hornfels	black	20	12	4	flake
C4	flint	black	55	46	22	flake
C13	tuff	brown	22	18	3	flake
C14	hornfels	black	29	20	6	flake
C23	quartz	glassy	21	10	6	flake
C25	quartz	white	21	17	7	flake
D15	tuff	brown	37	16	5	flake
D20	cherty argillite	black	25	13	3	flake
D25	cherty argillite	black	17	12	2	flake

Table 9 Artefacts unaccounted for after excavation in FXP 2

The results from Table 8 and 9 would seem to indicate that black artefacts or portions of them if they were broken, may be harder to identify than other colours as 39% of those not recovered, were black in colour (however 59% of all artefacts in the total assemblage were black in colour). In contrast only 5 out of 27 white artefacts were unrecovered - 18%.
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The angles that a one way plough can move artefacts to the side of the cultivation

The one-way disc plough only travels in one direction, that is in an anticlockwise direction. Because of the construction of the plough, the plough moves soil and any stone in it, forward as well as to the right (when looking from the rear of the machine). Data taken from the original ploughing in each site, indicates that the angle that the plough moves stone to the right from its original position is not consistent. This is documented in the following diagrams which show the original position of the artefact and the position in which they were found after the first pass in each site.

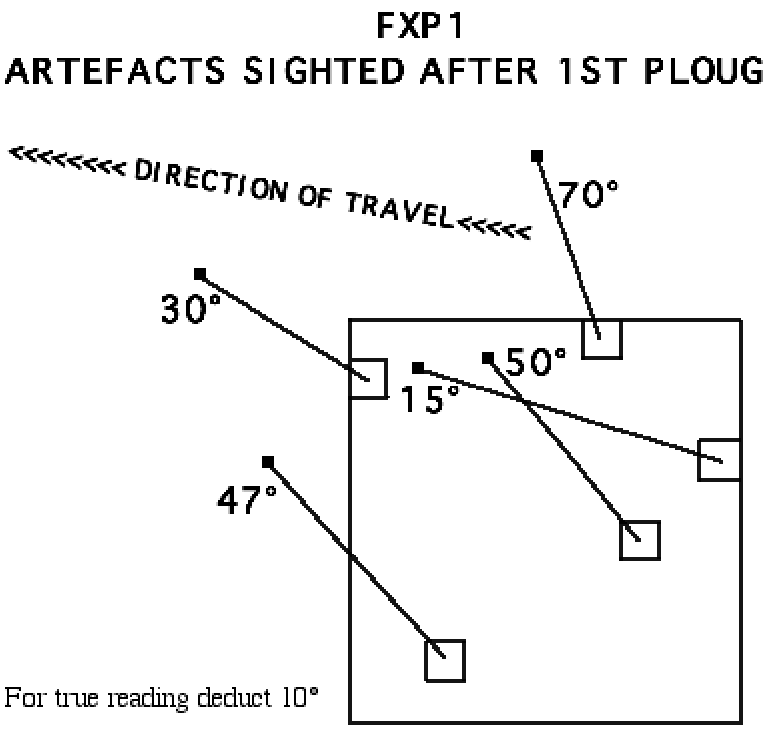

Figure 12 Artefacts sighted and the angle of travel after the first ploughing in FXP 1

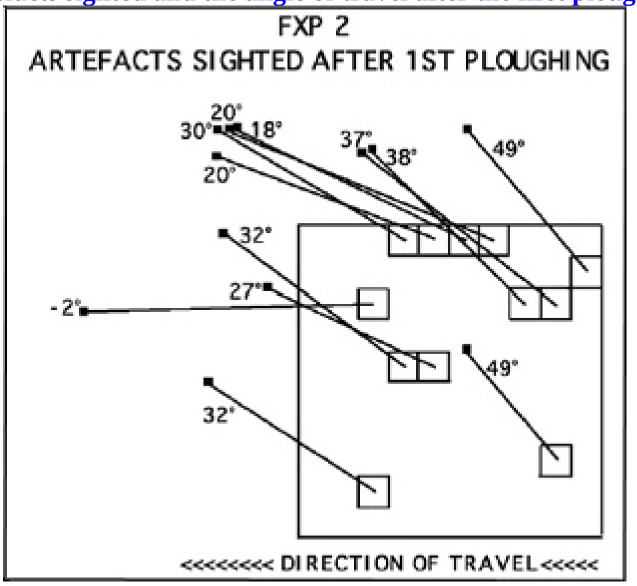

Figure 13 Artefacts sighted and the angle of travel after the first ploughing in FXP 2

The diagram in Figure 13, depicting the position of the artefacts after the first pass of he one-way plough, indicates that groups of artefacts that start from similar areas, can end up in similar areas after the first pass with the one-way plough. The angles varied from 18° to 49° except for one artefact that moved more or less in a straight line (- 2°). This was probably caused by the artefact getting caught in front of one the plough's bearing boxes. These bearing boxes carry the discs - one to each of the 18 discs.

Artefact damage

Damage to artefacts was observed on a number of occasions during the three seasons and after excavation when a number of conjoins were made. There appeared to be two types of damage based on the shape of the break in the artefact. They were :

1. Shear damage by a sharp object , most likely a plough disc (see Figure 14 and 15)
2. Pressure breakage by weight, most probably by a tyre passing over the artefact (see Fig. 14 &15)


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Figure 14 Shear breakage type in chert --------------------Figure 15 Shear breakage type in cherty argillite

Small parts of the some artefacts appear to have been sheared off (Figures 14 and 15) and have much straighter and sharper edges than other broken artefacts (see Figures 16, 17). It is most likely the sharp cutting edge of a disc on a plough caused these shear type of breaks.

The other artefacts illustrated (Figures 16, 17) appear to have had pressure applied to them causing them to break. The broken edges appear to be concave or convex in shape unlike the straight sharp edge profile as depicted in Figures 14 and 15.

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Figure 16 pressure breakage type in mudstone -------------------Figure 17 pressure breakage type in tuff

These broken pieces of artefacts are also of value in determining the distance separating individual pieces at the time of the excavation and for some, in determining the actual distance travelled since fragmentation as some artefacts were recorded intact after preceding cultivations. Distances were recorded for the conjoins in Figures 16 and 17 (see Table 14) as well as other artefacts, but these two artefacts are an example of distances that can be travelled (regardless of size) in 15 cultivation episodes since their separation. This information is more of value than that recorded by Roper (1975:272) who found that co-joins were up to 9 metres apart, in a paddock, but she only knew that the paddock had been cultivated for at least 20 and maybe 30 years, and although the paddock had been ploughed only in one direction, did not know when the conjoins were separated.

Material distance apart cultivation episodes recorded recorded on excavation since separation

Mudstone

2C2 and X2 - 1.7 metres - at least 15 cultivations 2C2 and X1 - 6.4 metres - at least 15 cultivations
X1 and X2 - 7.9 metres - at least 15 cultivations

Tuff

2C5 (1) and 2C5 (2) - 13 metres - at least 13 cultivations

Table 10 distances measured at excavation between parts of artefacts

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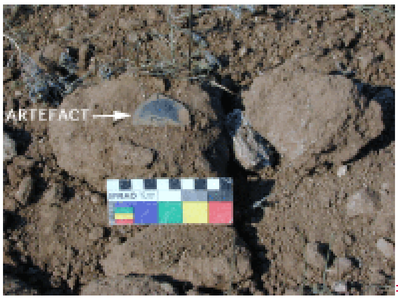
Artefact capture

Size of conjoins in some cases (See Table 14 and Figure 16) does not seem to have a great influence on where the parts of the artefacts end up, as some of the smaller parts in this case have travelled further than the larger part. Actual size can be distorted by the artefact being caught up or lodged in a clod of dirt, thus making the size of the material carried forward larger than the size of the artefact. In fact the the clod can be many times larger than the trapped artefact (see Figures 19, 20, and 21)



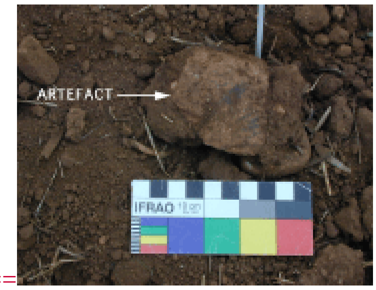


Figure 18 hornfels artefact in clod -----Figure 19 chert artefact in clod ----Figure 20 hornfels artefact in clod

Clay or other soils that easily form large clods or peds in cultivation paddocks, have the capacity to carry artefacts a much greater distance than those that are not incline to clod.

The dispersal of artefacts in a non-linear direction in each site and the greatest concentration of artefacts in each site

The final excavated recorded position of artefacts that were recovered after the three seasons of cultivation, seems to indicate that there were some concentrations of artefacts within the final spread. In Figures 22 and 23, 'S' represents the square metre where all the artefacts were originally placed on the surface before any cultivation. The numbers in each square are the artefacts recovered on excavation.

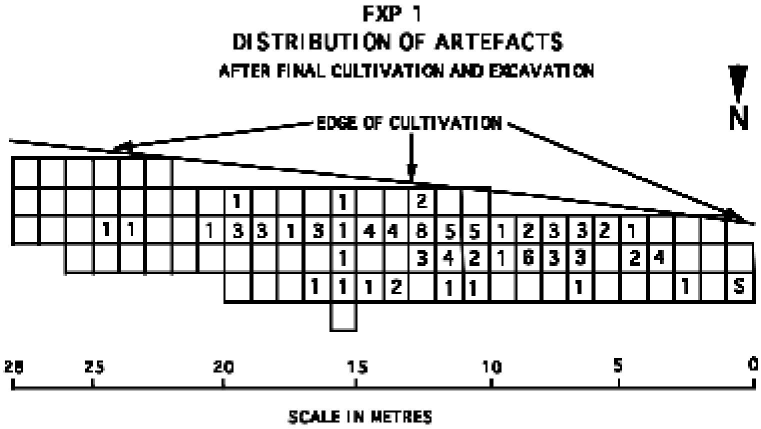


Figure 21 Distribution of artefacts after the final cultivation episode and consequent excavation FXP 1

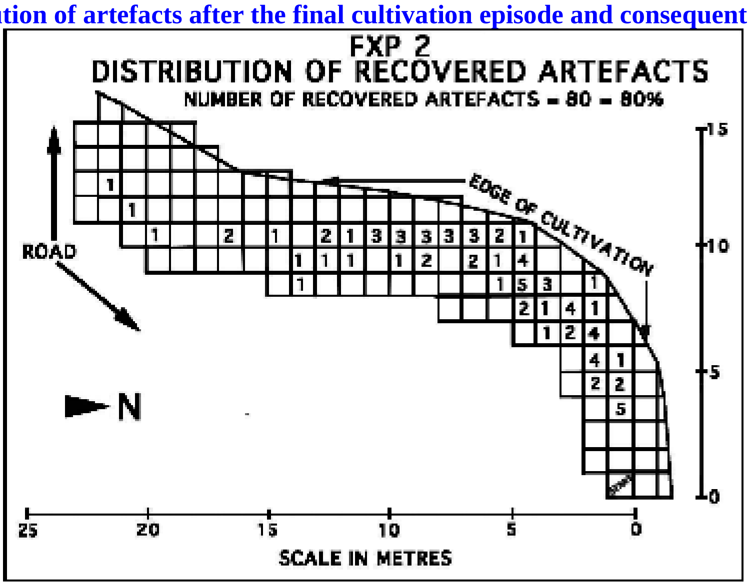


Figure 22 Distribution of artefacts after the final cultivation episode and consequent excavation in FXP 2

The concentration of artefacts recovered from both sites is reasonably similar. In FXP 1 the concentration occurs between the 6 and 13 metre mark from the starting baseline (S in the diagram) where 51% of the assemblage was recovered. In FXP 2, the artefacts are concentrated between the first square where artefacts were recovered (4th square from the base line - (S in the diagram)) and the following 10 metres (where 54% of the assemblage was concentrated). It is of interest to note that artefacts are being spread laterally over a 3 metres width in many instances and in one instance in FXP 1 to a four metre width (4 times the width of the square where they were originally placed before any cultivation). This spreading of artefacts is probably the direct result of the many passes of tyned implements with their duckfoot shaped shares (or points) in the soil. These shares located at the bottom of each tyne, move soil and thus artefacts to the left and right of each tyne as it passes through the soil (Figure 23).

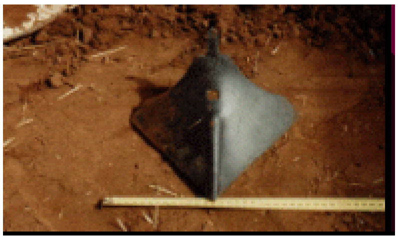


Figure 23 New 9 inch (23 cm) scarifier share or point

Vertical displacement patterns

Excavations in each individual square was carried out by spade in two spits of approximately the same depth. Excavations in each square proceeded to the depth of the hard bottom of the plough zone (between 15- 20 cm in all cases). This method was used to ascertain if artefacts tend to migrate to the bottom of the plough zone. The results in each site over the three seasons tend not to support this contention (see Table 11).

SITE	FXP 1	FXP 2
TOP LAYER (SPIT 1)	54	53
BOTTOM LAYER (SPIT 2)	38	27
TOTAL	92	80

Table 11 Number of artefacts recovered in spits 1 and 2 in each site

The size of artefacts and the length of time the paddock is cultivated, may influence where the artefacts tend to end up. More research may be needed in this area, but these results show that more artefacts at the end of the three seasons ended up in the top half of the plough zone than in the bottom half.

Discussion

The most important data, I believe, to come out of this research were the maximum and minimum distances that artefacts travelled in the three seasons. In FXP 1, the artefacts were scattered between 1.75 and 23.8 metres from point of origin. In FXP 2, the artefacts were scattered between 2.2 metres and 26.8 metres (however, FXP 2 had one more cultivation pass than FXP 1, and this could account for some of the extra distance). If a paddock was cultivated for 10 years with the type of farming implements used in this research, then (using the data from FXP 1) the artefacts could be scattered linear wise from 5.83 to 79.33 metres. Expanding this still further, if the paddock had been subjected to 30 years of cultivation (as many paddocks in the cereal growing areas of NSW have been), the artefacts would be scattered from 17.5 to 238 metres. Using the FXP 2 data, the artefacts would be scattered from 22 to 268 metres in 30 years. This has important implications for interpreting scatters of Aboriginal stone artefacts found in old cultivation paddocks that were first cultivated around the time of the introduction of tractors (late 1920s and early 1930s).

The data detailing the number of artefacts appearing on the surface at any one time is also important. **At no period in the three seasons, were there any more than 18% of the artefacts recorded on the surface in either sites.** Over the three seasons, the average number of artefacts on the surface was 9.39% for FXP 1 and 11.68% in FXP 2. This information also has implications for the interpretation of scatters of Aboriginal stone artefacts found in old cultivation paddocks. An archaeologist conducting a surface survey of a cultivation paddock, would be likely to record less than 20% of the stone artefacts originally discarded in that cultivation paddock. As most cultural heritage assessment in NSW (and indeed throughout out Australia) depend upon an initial surface survey, my results suggest that surveys in cultivated land may underestimated site data by up to 80%.

The wide variation of the numbers of artefacts appearing on the surface in each of the two sites, may be related to the different soil types in each site. The soil of FXP 1 is a very loose grey decaying basalt soil that sits very close to the original basalt rock underneath it, but it can always be cultivated to 20 cm in depth. The soil of FXP 2, on the other hand, is a heavy red clay soil. It requires a lot of effort to get any worthwhile depth in the initial cultivation. In FXP 1, it is likely that the artefacts were buried more deeply in the first season because of the looseness of the soil, whereas the cultivations on the red clay type, did not reach the same depth in the first season as in FXP 1. Consequently the artefacts in FXP 2 were more inclined to stay on the surface in the first season. In the following two seasons there were many more cultivations passes (6/7 in 1999, and 8 in 2000), so the depth of cultivations were similar. The average number of surface sightings of artefacts in the 2nd and 3rd seasons were more similar at each site. However, the number of artefacts appearing in individual cultivations passes was, in many instances, widely different. Soil type therefore, is likely to have a significant influence on how many artefacts appear on the surface after individual passes, but in the long term these differences average out (FXP 1/FXP 2 data :14.5/14 in 1999 and 7/7.88 in 2000).

The non-appearance of many individual artefacts on the surface over the three seasons (42% in FXP 1 and 33% in FXP 2), suggests that over a 30 years period of cultivation, many artefacts once buried, remain so. The extent of excavations required to recover 92% of the artefacts in FXP 1 (106 square metres) and to recover 80% of the artefacts in FXP 2 (118 square metres) from their original square metre, suggests that any excavation to locate and retrieve the majority of Aboriginal stone artefacts in a cultivation paddock would be a major undertaking.

There are a myriad of possibilities to account for the missing artefacts in this research but the most likely being that :
1. The artefacts were moved by the farming implements outside the excavated area.
2. The artefacts were broken up into small pieces and were not recognised in the sieve.
3. The artefacts were picked up by people walking through the farm who were not aware of the experiment (this is particularly likely to explain the disappearance of the large bifacially flaked greywacke axe).
4. The artefacts fell down cracks in the ground and ended up below the plough zone. The ground in both sites is subject to cracking in dry times and the ground did crack on several occasions.
5. The surface of the artefacts changed colour and were not recognised in the sieve. One of the recovered black artefact's surface took on an off-white appearance and was difficult to recognise in the sieve.

The angles and distances that the one-way plough moved artefacts in the first cultivation from FXP 2 shows that groups of artefacts that were originally together can end up in close proximity to each other after the first cultivation with a one-way plough. The action of the one-way plough in cultivating a paddock the first time would cause stone artefacts (if present) near a fence, to be thrown towards or against the fence. If thrown far enough, the artefacts would then be protected from further cultivation as farm implements could not reach them with tyne or disc. When artefacts are found during cultivation, they could be within a couple of metres of their original position. Other artefacts (if present) would be moved on with further cultivation with tyned implements. Disc type cultivators in NSW are usually only used for the initial cultivation in each season and/or if the trash on the ground would block up a tyned implement. It follows then, from this discussion, that Aboriginal stone artefacts found along a fence line or on the boundary of cultivated and uncultivated areas may have initially been left in close proximity to each other by the Aboriginal knappers in the past and within a metre or two of their original position if the fence was there when the original cultivation took place.

Those artefacts that had been broken into at least two pieces during the cultivations and had been recovered in the excavation, suggest two types of damage was occurring. These were the shearing type which appears to have been caused by the discs and the stress breakage type. There are a number of stress breakage types displayed in the artefacts recovered in the experiment. All appear to have been subject to some sort of pressure that has broken the artefact instead of shearing parts off it. This suggests that it was probably the pressure of the tractor or implement tyre(s) that caused the breakages rather than a plough disc. The similarity between the break in the tuff artefact (down the centre) and a cone fracture caused from too much force being applied when knapping, is striking. This would suggest that caution should be exercised if a number of apparent cone fractures are found in artefacts recovered from cultivated fields.
If we use the distance recorded between fragmented parts of one artefact (C5) in FXP 2 of 13 metres in only 13 cultivations as one possibility in a paddock, then the individual broken sections of Aboriginal stone artefacts in cultivation paddocks could be separated by a distance of 1 metre, multiplied by the number of cultivations that a paddock has had in the one direction. The maximum average distance that any parts of a broken artefact achieved in the research was 1.4 metres in FXP 2. This was slightly more than the 1 metre averaged by parts of C5 after separation, but it still shows what distances can separate artefacts that started within a metre of each other. If other factors come into play, such as the partial blocking of any implement by vegetation or straw, then artefacts can be carried much further as was the case with the partial blocking of the seeder in 1999 when an artefact was carried 11 metres in one cultivation.

Importantly, encasement of an artefact in a clod of dirt has a large influence on the distance an artefact can travel in each cultivation. Only three artefacts were sighted in clods but others were probably also affected and this could have extended the distance they travelled. This capture of artefacts by clods or peds, would distort any statistics involving the relationship between the size of the artefacts and the distance travelled. This potential distortion has also been pointed out by Dunnell (1990:593) who stated that the unit of transport may be the artefact in coarse grained soils that have very little clay and organic matter (such as those that are predominately sand) but in heavy soils that have substantial amounts of clay and/or organic matter, objects such as artefacts, move according to the size of the peds, not the size of the artefact. In that case ped size and not artefact size would determine how far the artefact travelled.

The dispersal of artefacts from a one metre width to a much wider band during the research (3 to 4 metres), also points to not only the potential linear displacement but also to scattering of the artefacts to a much wider band. This distance, I suggest, could be increased to a much wider band than the maximum of four metres that was achieved in this research if a paddock were to be cultivated in one direction for a much longer period.

The excavating of each square into two spits of equal proportions, has given some indication that many more artefacts occur in the upper portion of the plough zone. This may be related to the size of the artefacts. Alternately the small number of cultivation episodes that occurred in this research may have biased the result. However, the very action of tyned cultivators such as the scarifyer and springtyned seeder, tends to bring stones and rocks to the surface as opposed to discing which tends to bury material. If a paddock has been subjected to many more cultivations with tyned implements than with disc implements, then there should be more artefacts residing in the top layer than in the bottom layer of the soil. Considering that many more cultivations were carried out with tyned implements than disc type in this research, the result achieved is not surprising.

Conclusion

The results from this research should enable those archaeologists, who have no other options but to analyse stone artefacts in cultivated paddocks, to base their conclusions on some solid data. It is, however, imperative that the cultivation history of a paddock be considered as this can help in the interpretation of the scatters of artefacts. It is also important to assess whether a site is situated in a cultivation corner or headland, as these headlands are worked at right angles to the general cultivation path. This would spread artefacts into a much wider band than with straight linear cultivation. The fact that a change of surface colour was recorded on one black artefact in only three years in the soil suggests that change of surface colour of artefacts is not a prerequisite for the age of the artefact but rather it reflects the type of raw material and soil type that the artefact was in contact with. It should also give archaeologists more data to compare the work carried out overseas on plough-zone displacement of artefacts by various researchers over the past 30 or so years.

Acknowledgements

This paper arose out of a "research in progress" PowerPoint presentation, given at the 2000 Australian Archaeological Association Annual Conference at Beechworth, Victoria. My thanks since then go to Associate Professor Wendy Beck of the University of New England, Armidale, NSW, Dr. Anne Ross of the University of Queensland, and Ken Mulvaney of the Aboriginal Areas Protection Authority of NT, who read drafts of this paper and offered valuable advice on its contents and form and I thank them for their interest and encouragement. I am, however, responsible for the text and any inconsistencies.

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