Proceedings of the Sixth International Permaculture Conference
September-October 1996, Perth, Western Australia

The Use of Earthworms to Convert Hardpan to Arable Soil, Without Mechanical Tillage, Followed by Cycling with Poultry for the Sustainable Production of Food in the Dry Tropics

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[Submitted Paper]

Ladies and gentlemen, my interest in your field of knowledge and enthusiasm was generated by ignorance and fear whilst a Member of Parliament in Western Australia's Legislative Council. I represented the Electorates of Kimberley and Pilbara. After 11 years I resigned from Parliament because I could no longer represent, to the standards I had set, from a Kimberley residential base. To remain in Parliament and represent effectively I would have to abandon our demonstration which became the reason why I am standing before you today.

In 1974 I won a scholarship to study remote area development around the world. I advised each country I would share the information gained during the study. Consequently, I received cooperation at the highest level from governments regardless of their political philosophy.

When I completed the study in March of 1975, I realised the world was in a mess with people demanding more goods and services than they could rightfully expect from their own level of work output. I also realised the World was being poisoned.

I could see the World heading for economic recession so I endeavoured to warn my colleagues. This caused me to lose credibility because they thought I had spent too much time under the tropic sun. Luckily my family believed me. My wife, Judy, agreed to radically change our life style.

In March of 1976 I wrote to my leader, Sir Charles Court, and advised him I was about to give a practical demonstration of those things I had been espousing in Parliament. We would obtain a virgin block of land in the Ord River district and conduct three demonstrations.

They were to:

- Design and build a home, using indigenous materials where possible. It would be built without the use of trades persons or hired labor.
- Develop a commercial orchard using alternative technologies and to reduce reliance on fossil fuels.
- Develop a factory for the production of frozen confections and fruit juices, using the reject fruit from the commercial orchard. The food was to be produced without the addition of preservatives, artificial colouring or artificial flavouring.

We did not have any farming experience, nor experience in the manufacture of frozen confections. I had previously built two homes using sub-contractors but I had never attempted the building of a home whilst doing all trades myself.

The Lands Board thought it was strange that we requested the worst block of land available, with 66% of hardpan. The hardpan was heavy red soil with high clay content and no fibre. It was considered "dead" soil – thus suiting our requirement for demonstration. The land was 22 acres or 8.7 hectares on the west bank of Lake Kununurra, 17 kilometres south of the town site. It also had the highest point of irrigable land in the valley.

Kununurra is located in the east Kimberley, approximately 15º south of the Equator. It has a monsoonal climate with 780mm of rain falling between November and March. It has a winter similar to a Mediterranean summer. Winter minimum mean temperature is around 19ºC. The summer temperatures average forty days per year in excess of 40ºC.

When we obtained the land in April of 1977, we had not heard of names like Mollison or Podolinski. We thought we were alone in our quest. We decided to rejuvenate the soil by using earthworms so we investigated earthworms to find they needed moisture, shade and food. We then sought plants which could offer such an environment. We found a legume which was high-protein, self-mulching, evergreen and would regenerate on only 300mm of rain per year. It was *Verano Stylo*.

Each time we planted a tree, we added a few worms and a few seeds of Verano Stylo. We also placed a flat rock near the tree to give the worms a shaded, moist area. For a few years we thought the politicians and departmental officers could have been correct with their doubts of our endeavour. Then the wonder of natural symbiosis became evident. With the growing evidence we broadcast Verano Stylo seed between the trees during the monsoon.

In the mid 1970's to the early 1980's, solar pumps and solar technology were not readily available, except for water heating, which we had in the homestead. For this reason we designed a low input system using a recycled 20,000 gallon squatter's tank on the block's highest point. It was filled from a single phase 1 HP pump at our lake jetty. A similar, interchangeable 1 HP pump, at the tank, could be used to irrigate the whole property, in rotation, through a five line octopus.

The system was also designed to allow 250 trees to be watered using gravity only. We limited our mango trees to 200 in the orchard and a further 20 around the

homestead. The orchard, with immature trees, was watered for the first six years and then cut off.

The orchard has not been irrigated for the past 10 years. We limited our Mango trees to 220 because we did not wish to become reliant on the hiring of labor.

Now the trees are mature, they are given an annual application of an organic fertiliser, Dynamic Lifter, around the drip line. The application is usually 5 kilos per tree. If the tree needs more mulching than the slashed natural grasses it is given an application of hay or mulch from our mulch pile. Our mulch pile is comprised of prunings, rakings, grass cuttings, paper and ash. In addition to the mulch pile we have always maintained a worm/mulch pit which will be described later.

Figure 1 a shows the red hard pan and the building of our house which was two steel farm sheds surrounded by water-worn cobblestones. The slow progression

a: 1978 b: 1982

Figure 1: *Homestead in 1978 and 1982*

Figure 2: *Homestead in 1990*

of the verano stylo and earthworm activity can be seen from the bare ground in 1978 through 1982 (Figure 1b), until 1990 (Figure 2) which shows it was highly successful.

Note the Golden Shower (Cassia fistula) in Figure 2. We couldn't grow this tree when neighbours were spraying heavily with insecticide. When we developed our own clean island in the sea of poison, the birds returned and consumed all the looper grubs which ate the Golden Shower leaves. The Willy Wag Tails also returned to eat the spiders under our verandah awnings and reduced their webs to an aesthetic level.

Figure 3 shows the commercial result of our endeavour – organically grown Kensington Pride Mangoes.

In 1980, when it appeared our Earthworm and Verano Stylo experiment might work, we had the soil from our worm/mulch pit analysed. It should be noted that we occasionally used water weed from the lake in this early pit.

Table 1 shows the result of the analysis from the Government Chemical Laboratories. Note the comment from the laboratory:

> *The concentrations of this organic soil are very high. The values for both nitrate and zinc are about ten to twenty fold normal soil levels for the Ord River.*

We then decided to conduct another experiment using earthworms in a cycle with poultry. Once again this was to be conducted on non-productive hardpan. This is probably the most successful experiment I have ever been involved with.

Prior to describing that experiment I will show you the result of a trial conducted by the West Australian Department of Agriculture which was done without consultation with us.

In February 1984 we found an officer of the Department in our orchard taking leaf samples. When asked what he was doing, he advised us he was conducting a trial

Figure 3: *Organically grown Kensington Pride Mangoes*

Tropical Farm - Ord River, Kununurra
(W.R. & J.M. Withers)

Analysis by the Government Chemical Laboratories,
125 Hay Street, Perth W.A.

Soil sample taken from the Worm/Mulch pit on May 1980.

Analysis was conducted on the understanding that soil sampling was carried in strict accordance with procedures recommended by the Department of Agriculture.

Lab No. Samples 13787/80 & 17395/80	**pH (1+5)** 8.0	**Reaction** Mildly alkaline
Less than 2mm dry basis		**%**
Total Nitrogen, N		0.463
Organic Carbon, C (Walkly Black)		5.90
Item		**Parts per million**
Nitrate		68
Zinc, Zn (extr in ammonium carbonate/ETDA)		18
Calcium, Ca (extractable in 0.1M HCL)		5400
Magnesium, Mg (extractable in 0.1M HCL)		1440
Phosphorous, P (extractable in 0.5M $NaHCO_3$		300
Potassium, K (extractable in 0.1M HCL)		1020

The concentration of plant nutrients in this organic soil are very high. The values for both the nitrate and zinc are about ten to twenty fold normal soil levels for the Ord River. We suggest you discuss these results with the local office of the Department of Agriculture.

Agricultural Chemical Laboratory.

Copy to O.I.C., Ag Dept, Kununurra.

Table 1: *Soil analysis results*

comparing the nutrient uptakes, through leaf analysis, of mango trees. At this stage I must comment that we were at loggerheads with the department of Agriculture. We had lost our first 500 very expensive mango trees because we followed the advice of the Department. They had given us instructions for the planting and potting of Mango seed which we had followed meticulously. I had hand picked 500 mangoes from selected trees in Broome and arranged nursery care after potting them. After 12 months we arranged special road transport and maintenance to travel the 1,000 kilometres to our property. We had been advised the information given to us by the Department was a result of trials from their Research Station. The Department of Agriculture and the CSIRO had the Kimberley Research Station, on the Ord River, near Kununurra.

After 18 months and two pot changes as directed, our trees began to die. The Department was unable to determine why they were dying and we were frantic. We quarantined the trees in the nursery whilst watering them with the hope of salvaging some. We lost the 500 trees.

Remember we were not farmers. With the thought that it may be some form of Die Back or other disease, we planned to burn the pots and trees and fumigate the soil

prior to disposing of it as directed. As we were removing the trees from the pots we noticed that all trees had a bulging knot about 10cm beneath the soil surface.

Further investigation proved the Department had not done trials with Mangoes at the Kimberley Research Station even though trees were growing there. The information, from trials, had come from their Tropical Research Station which was in Carnarvon. Carnarvon is not in the tropics.

We had followed directions for non-tropical growth and did the pot transfers, without disturbing the root system, at the times recommended. Our growth rate was three times that of Carnarvon so we were transferring a coil of knotted root from the bottom of the first pot into subsequent pots. Eighteen months later the trees choked themselves to death.

Our anger and subsequent comments about the Department of Agriculture did nothing for public relations. It is understandable why they may have endeavoured to prove we were not practical in following the pathway of organic growing which was strange to them.

When we found the Departmental Officer taking leaf samples, and heard his explanation, we asked if the results of the district trials would be available to us. He replied in the affirmative.

After 12 months of pestering the Department, we received the results of the trials which proved to be most interesting. Only three orchards had been tested. One was the Department's trial orchard which had labor inputs with fertilisers and sprays beyond economic realities. The other orchard belonged to Chris Wilford, a very efficient, conscientious farmer who was receiving some assistance from CSIRO. He had optimum fertiliser and irrigation programs including nutrient and trace element additives.

	% Dry Basis					PPM Dry Basis		
Code	**N**	**P**	**K**	**Ca**	**Mg**	**Mn**	**Cu**	**Zn**
Wilford	1.14	0.11	0.64	1.97	0.46	83.8	8.1	13.2
Wilford	1.42	0.10	0.51	2.27	0.42	101.0	7.8	10.6
WA Dept of Ag.	1.45	0.11	0.79	1.31	0.28	83.6	4.9	12.4
Withers	1.43	0.13	0.75	0.91	0.34	31.0	8.6	14.7
Withers	1.56	0.13	0.85	1.06	0.43	50.2	6.8	12.5

Table 2: *Leaf analysis by the West Australian Department of Agriculture*

Table 2 shows the result of the trial conducted by the Department of Agriculture in February 1984. I have a sneaking suspicion the trial results were not what they expected. That is now of historic interest. I must say that our relationship with the Department in 1996 is now amicable.

And now back to the other experiment we conducted in 1980 with the earthworms and poultry.

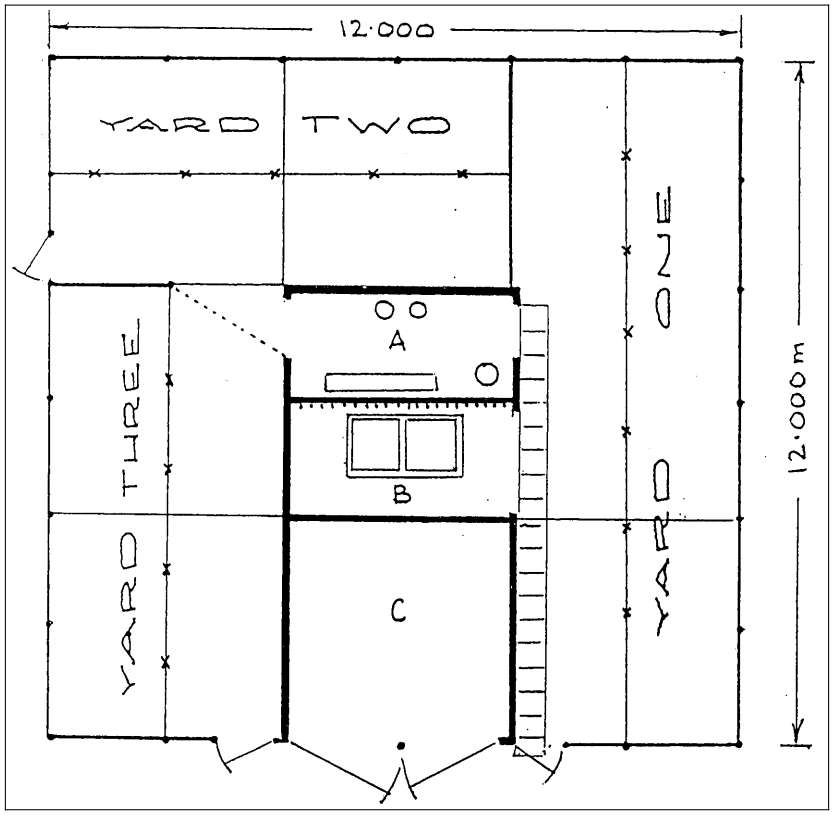

Figure 4: *Organic Survival Unit MKII*

Figure 4 shows our Organic Survival Unit MKII. It is comprised of an all-steel shed in three sections: the laying room with food and water hoppers (A), a double mulch/worm pit with bricked sides and no bottom to allow the worms to travel into any of the three surrounding yards (B), and a workshop and tractor shed which is convenient but not really necessary (C).

It works as follows; mulch and earthworms are placed in the mulch/worm pits and moistened from an in-situ tap. Yard One is covered with protein – hay, grass cuttings, torn newspaper, hessian bags or whatever is available. It is moistened from the in-situ overhead mains pressure or header tank sprinklers. One rooster and a dozen hens are introduced.

After approximately four months, the poultry is shifted into Yard Two, where the process is repeated.

Lets us now see what we have in Yard One. The soil has been deep tilled by the earth worms moving from the pits to get the moist protein. The soil has been surface tilled by the poultry scratching for the earthworms. The symbiotic fungi beneath the damp protein has conditioned the soil which is now weed free because the poultry eats everything which germinates. The soil has been fertilised by the poultry and the earthworms. The earthworms surface during the evening to seek food and to defecate when the poultry is asleep. The yard is now bug free because the poultry eats every moth, grub, pupae and every other living piece of protein they can get their beaks to.

The soil is now ready for planting vegetable seeds.

In early trials we found that insects would eat and infest the vegetables unless they were heavily mulched. At first we thought the protection was due to protecting the root systems from heat stress but soil analysis showed an increase in available zinc after heavy mulching and earthworm activity. We now suspect the combination of earthworm activity and symbiotic fungi is maintaining the plants in balance with the soil, without stress. The resulting balance is not tempting nature's forces to destroy the plants.

After the vegetable seeds germinate we immediately mulch around the young plants and maintain the mulch throughout the season. Besides maintaining healthy plants it is also a form of weed control whilst reducing evaporation.

Figure 5 shows the unit with the first crop planted in 1989. Note the little self-sown Paw-Paw tree on the right of the photograph. It will be mentioned later.

Figure 5: *The first crop in the Organic Survival Unit MKII*

Figure 6 shows the poultry yard. As soon as the cockerels start raping their sisters and aunts they are converted to table birds.

Remember the little self-sown paw paw tree. It proved to be bi-sexual. Figure 7 shows a paw-paw picked at 8 months. At the age of 21 months it had six bearing branches with 102 mature size fruit.

The paw-paw is just one example of many self-sown fruits, including melons and pumpkins. We have also grown many vegetables, not shown here, which demonstrates that dead soil can be regenerated and produce quality vegetables and fruit using organic principles.

Figure 6: *The poultry yard in the Organic Survival Unit MKII*

Figure 7: *Paw-paw picked at eight months*

One of the enjoyable segments in this little project is that of domestic and farm waste disposal. In the home we have a three bin waste system;

- Bin One contains paper and cardboard.
- Bin Two contains hard waste for recycling or erosion gully land fill.
- Bin Three contains protein waste.

If you build your own unit you may enjoy doing this. Each morning, whilst still half asleep and weather permitting, don your slippers or “wellies” and do the following;

1. Take Bin One (paper) and Bin Three (protein) up to the Organic Survival unit which has the mulch pile outside its wire walls.

2. Tear up the paper & cardboard and put it on the mulch heap.

3. Give the protein to the poultry and waste a bit of time talking nonsense to the chickens.

4. Rinse out the bins at the worm/mulch pit tap and collect the eggs in one and put the vegetables and fruit you have picked in the other.

5. Return to the house, wash the eggs and place in the cartons provided by your eager neighbours who barter or illegally buy your surplus eggs. That money goes to the purchase of grain and pellets. Surprisingly, at the end of the year, you find the unit is self supporting and your fruit, vegetables eggs and table birds only cost you some enjoyable labour.

After those five morning exercises you find that you are fully awake and your psyche is in excellent shape to face the challenges of the day.

In winding up this session I will show you another project at the homestead which was an aesthetic and ecological success but, in our case, a total failure as a food producer.

Judy wanted a Japanese bridge and pond. I thought I would make it part of an experiment in aquaculture. Two waterfalls were put in place to oxygenate the water. Water weed and lilies, from the lake, were added to allow an eco system to develop. Two baby Sleepy Cod were caught from the lake and put into the pond.

The Sleepy Cod are now 40cm long and they feed themselves from the eco system which has developed in the pond. No chemicals are added to the pond but the water is filtered through a plastic membrane. An occasional tit-bit from the table is offered when visitors wish to see them. Sleepy cod is a delicacy which costs A$80 per plate in Singapore.

Figure 8 shows the pond with Judy near the waterfalls coming from Mount Judith (she doesn't like that name for some reason). We have a problem. When I am in the pond, cleaning the filter, the cod rest on my feet and look up at me. They let me tickle their bellies. One has turned pure white whilst the other is a mottled black. They are named Angelica and Diablo. They are family – we can't eat them!

Before closing, I should mention another simple system we use to convert hardpan to arable soil. When we select a particularly degraded area and use it to stack iron, timber, seldom used farm implements and things we will keep but never use, the area becomes a microcosm.

Small reptiles, insects and birds use the stacks as havens. They dig, hunt, nest, mate, breed, defecate and die in and on the ground beneath the stacks. The wind carries seeds which hit the stacks and drop to the ground. After rain the moisture is retained for longer because of the micro tillage and reduced evaporation. The natural mulch from wind blown vegetation and old growth plus the moisture allows the growth of fungi. The environment is now suited to earthworms which may discover it on an evening migration. Natural symbiosis is at work.

Within three years we need to extract our stacked material from the mini jungle and find another degraded area for storage. The once degraded soil has been tilled,

Figure 8: *The pond*

fertilised and conditioned by a host of microbes and animals in symbiotic relationships.

That wraps up this session. It has all been fairly simple and I hope you may have gained some of the joy we experienced in discovering how to convert hardpan into arable soil without mechanical tillage or chemicals whilst enjoying the surrounding beauty and first class food.