

**A study in progress: Please do not quote.**

**EAST TIMOR STUDY GROUP (ETSG)**

**Working Paper: 06**

# **Agricultural Mechanization for a Sustainable Development of East Timor**

**by**

**Edmundo Viegas\***

\* Edmundo Viegas is a member of the East Timor Study Group (ETSG) and is currently undertaking his Master's Degree in Applied Sciences majoring in Agricultural Engineering at Massey University, Palmerston North, New Zealand.

Correspondence: Agricultural Engineering Department, Institute of  
Technology and Engineering,  
Massey University, Palmerston North, New Zealand  
Phone: 64-6-3504356. Fax. : 64-6-3505640  
e-mail : edmundo.viegas.1@uni.massey.ac.nz

## **I. Introduction**

Sustainability concerns whether a given level of productivity can be maintained over time. Sustainability of the agriculture management system and its capacity to continue producing on a long term basis is a problem when human activities cause ecological changes that undermine agroecosystem function. Agriculture might be seen as a 'stretching' of nature, and so involves risks of soil degradation.

Soil degradation has occurred in East Timor. Agriculture development during East Timor's history has resulted in a substantial change in its biophysical ecosystem. So far no specific research has been done to assess the degree of soil and land degradation. However, based on experience and visual observations, it is obvious that to a certain extent East Timor's agroecosystem has deteriorated. Soil lacking fertility and subject to erosion under traditional farming practices along the northern part of East Timor and elsewhere, and barren hills and mountains in the north of Manatuto, Dili and Liquica, are among the relevant cases to be mentioned. Along the southern coast, agricultural lands in Betano, for instance, are now hardly able to produce two sequential crops in a year, due to water shortage and lack of soil fertility. Erlier, under a rain-fed cropping system, the areas of Betano and Natarbora (known as the most fertile soils in East Timor) used to produce two crops per year, and had a reasonably high agricultural production.

The facts mentioned above are the result of many factors, not only farming and agriculture related practices. However, a sustainable agriculture demands sustainable land and water resources management, which perhaps, in our case, has not happened during the past decades. This paper, is to some extent an expression of personal and subjective views. However, inspired by the spirit of this conference, I do expect more attention to be given to the issues of agriculture management in East Timor. In my view, a scientific and strategic plan should be put in place now, and followed by populist policies and action.

Concepts and strategies of managing the environment in a sustainable way will not be the main focus of this paper. These issues are dealt with effectively elsewhere (Barrow, 1995a; 1995b; 1994; Bartelmus, 1994). My main interest is in the role of mechanized agriculture in East Timor as part of sustainable agriculture development.

This paper therefore, aims to present a descriptive and analytical study of agricultural mechanization in a sustainable agriculture development of East Timor. The suggested agricultural mechanization involves both replacement and improvement of the existing traditional farming system. Special focus will be given to its impacts on soil and water conservation. Thus sustainability in this paper will be largely associated with the efforts to sustain the availability and capability of soil and water for agriculture development.

## **II. Agriculture Development**

### A. Traditional Farming System

#### *1. Issues*

Traditional farming systems in East Timor have not change much since the early 20th century. Shifting cultivation and bush-fallow rotation are widely used. Shifting cultivation involves clearing and burning natural vegetation, cultivating the cleared area for a season or two, then moving to a new area while the old one regains its fertility under natural vegetation regrowth (Richards, 1985). Lal(1995) identified general issues of agricultural sustainability in humid and arid/semi-arid tropics. Among the issues relevant to East Timor are:

- high subsistence agricultural usage of the land
- reduction in the fallow period
- soils of low fertility and low yields due to no-input agriculture
- soil degradation due to fertility depletion, accelerated erosion, structural deterioration and reduction in soil organic matter
- high risk of crop failure
- water shortage
- difficulties of mechanizing farm operations

The degree of severity of soil erosion and water runoff under traditional farming systems depends on the soil, land-use intensity, relief and cultural practices. Runoff and erosion are generally low if the fallow period is long enough to restore soil physical properties and increase the soil organic matter content. East Timor provincial departments of

agricultural and forestry have tried agroforestry programs widely in the region with limited success. On the other hand, small projects in this field, run by NGOs such as Etadep's project in Balibar and Puslawita's program in Dare, both located in the steeplands south of Dili, have shown successful results. The main reason for this difference may be attributed to the intensive participatory approach used by the NGO's.

## *2. Climate and sustainability*

East Timor climatic conditions are characterized by a long dry period of high temperature combined with the occurrence of a more or less pronounced wet season. Climate is often the most critical determinant of the sustainability of the farming system. As temperature increases and the amount of precipitation decreases the development of sustainable cropping systems becomes increasingly more difficult (Lal,1995). The lower temperature in mountainous areas of the region with moderate to high rainfall are often an advantage for certain crops e.g. coffee and cocoa in Ermera and fruit crops in Maubisse. But the steepness of slope increases the risk of soil degradation if no preventive measures are taken. Forestry may thrive on the slopes at lower altitudes, while grazing can be extensive above the tree line.

Generally speaking, it is important to recognize that farmers in East Timor have adopted dryland farming to nature. Dryland farming is mainly dependent on natural rainfall during the growing season and on moisture stored during fallow periods. Exceptions may be found on irrigated rice lands in certain areas near rivers of Liquica (R. Loes), Manatuto (R. Laclo), Manufahi (R. Carau-ulun) and Bobonaro (R. Nunura). Microclimate conditions might also vary within a region. Microclimate and soils may dictate which farming options are to be used in a particular area or district.

## *3. Soil degradation*

A significant process leading to soil degradation is the deterioration of soil structure and the associated restriction of water and air movement through the soil. Generally, there are a number of factors and processes contributing to soil degradation. The following are those given by Lal (1989).

a. Processes (actions and interactions)

- physical: deterioration in soil structure (compaction, crusting, accelerated erosion and hard-setting), imbalance in water/air ratio (wetness / drought) and extremes of temperature;
- chemical: leaching, fertility depletion, laterization and toxification;
- biological: decline in biomass, reduction in organic matter content and decrease in population of microbia;

b. Factors (agents and catalysts)

- Agricultural activities: deforestation, excessive and untimely ploughing, intensive row cropping and monoculture, indiscriminate and excessive use of chemicals and excessive grazing and high stocking rate.
- Industrial activities: waste and effluent disposal;
- Urbanization: application of city waste, conversion of land to non-agriculture use.

The results of interactions among the above factors and processes are evident in East Timor. To establish the significance of soil degradation requires an assessment of how widespread it is, how severe the damage is, and whether or not it is controllable or reversible. This situation becomes further complicated, as farming nowadays has tended to become more dependent upon petroleum for energy, fertilizers, pesticides, etc. The mass introduction of heavy agricultural machinery and new varieties of crop seeds during the last decade has led to a certain degree of soil degradation.

#### *4. Lowland rice farming*

In most of the lowland areas with relatively fertile soils, traditional systems seem to be ecologically stable. 'Halai natar' using a group of local buffaloes is a common method operated by traditional farmers to grow lowland rice. The method is also known as the 'rencah' system and is widely used in other remote areas of Indonesia. This system only implies puddling the soil by using the animals to run across the field while there is very shallow water ponded in soil surface. Stubble and trash can be also effectively incorporated into the soil. Viegas (1991), in a study of this traditional farming technique, found no significant difference in most of the soil properties, comparing to conventional tillage (plough-harrow-rotary tiller).

This technique is often found in areas where irrigation water is available and access to farm machinery is limited. Because the tillage is reduced under this system, it can be considered as a practice of conservation tillage, which will

be discussed later in this paper. A similar technique, using a rotary hoe in order to puddle the soil, without any prior cultivation, was developed in southern NSW Australia (Humphreys, et al, 1996).

#### *5. Need for alternative farming system?*

It is my belief that the traditional farming systems mentioned above have been developed by the farmers to best utilize the soil resources and climate sequences. This development has occurred over a long period of time and passed through a series of 'experiments' from generation to generation. In most cases, the traditional system is ecologically stable and works as long as the farmers are willing to remain at the subsistence level.

There are urgent reasons to improve productivity even on soils where yield decline does not occur rapidly. However, it is worthwhile to consider the following passage quoting by Richards (1985) with respect to West African experience.

*'Any reform of shifting cultivation, if reform is necessary, may involve the obligations to persuade the native farmer to modify his methods of farming... It would therefore appear most necessary to first understand the underlying principles of traditional farming systems before attempting to impose new and alternative (and possibly not well tried) methods on a conservative people.'*

Understanding the problems involved, and the advantages of, the traditional farming system, and the difficulties of introducing satisfactory alternative systems, would be the basis for a cautious and balanced assessment in East Timor. Over the last decades, with the introduction of mechanized agriculture, especially in food cropping sector, it seemed that the government has tried to change too much too quickly, without carefully assessing the merits and dangers of the proposed changes.

### B. Agricultural Mechanization

#### *1. Forms of mechanization*

As for the future, there will be time when an increase in agricultural productivity will be a necessity. Therefore, the challenge is not only to achieve higher production, but also to turn the type of growth into a more dynamic one, based on institutional innovation, technical progress and the general mobilization of traditional agriculture. In this context, agricultural mechanization could have good results.

A general description of mechanization (according to Ruthenberg, 1985) is given below.

- (1) Preparatory activities
  - land preparation
  - preparation of plant material
- (2) Planting / seeding
- (3) Crop management
  - fertilizer application
  - irrigation
  - thinning and weeding
- (4) Harvesting
- (5) Processing

The above description might vary depending on the crops grown. The mechanized farming system in East Timor is heavily concentrated on farm machinery and implements for seedbed preparation and weed cultivation, such as a tractor with moldboard plough, disk ploughs, disk harrows and rotary tillers. These machinery and implements are widely used for rice and maize production in rotation with legumes.

## 2. Agriculture machinery

The table below shows the latest figures for tractors in East Timor. This number of tractors involves a wide range of types. Among others are: 2-wheel drive and 4-wheel drive tractors made by Massey Ferguson, Ford, Fiat, and Kubota.

Table 1. Tractors in East Timor, 1997

Tractors	Working	Broken	Total
Hand tractor	276	11	287
Small size	15	5	20
Medium size	44	15	59
Big tractor	31	20	51
<b>Total</b>	<b>366</b>	<b>51</b>	<b>417</b>

Source: Dinas Pertanian Tanaman Pangan, Timor Timur

The detailed distribution of tractors is presented in the Appendix 1. More than a half of the medium plus big size tractors are not available for working. This can indicate the severe damage to tractors and the scarcity of reliable tractor workshops. The only tractor workshop available in East Timor is the one run by CV. Rio de Oiro in Dili. Spare parts have to be ordered from Jawa, either directly by the workshop or through spare parts distributors like

Duta Motor and UD. Palma.

Hand tractors contributed more than a half to the number of tractors operating in East Timor. Interestingly, larger number of hand tractors is present in the district of Bobonaro and these tractors are mainly under private ownership. Bobonaro in 1997 was the greatest rice producer among all the districts (14,762 tons out of 67,141 tons of the total production of East Timor in 1997). This can be seen in the Appendix 2.

It is understandable that farmers in Bobonaro and Viqueque are attracted to purchase hand tractors of their own.

Among the benefits are:

- Tractor operations can be better timed. A buffalo can work 6 hours per day, while tractors can operate day and night in peak seasons.
- Tractor ploughing provides better weed control.
- The rectangular lay-out of fields allows efficient tractor operations.
- Tractors can be used for several clearly defined purposes in the farming system: ploughing, shelling and transport.

It can be assumed that an increase in tractor numbers is economically attractive from the farmers' point of view. But the major question is whether or not this may negatively affect the generation of employment, and crop production.

### *C. Effects of tractorization*

There are two basic views on the effect of introducing tractors: the 'substitution view' and the 'net contribution view' (Ruthenberg, 1985).

The substitution view sees tractors and traction animals as two different sources of power which technically are substitutes. An operation performed by tractors is assumed to be feasible if done by animals in combination with implements. In places where the labour force is ample, tractorization would lead to a redistribution of income in favour of larger farmers who are in a position to use tractors more effectively than smaller ones. The net contribution view considers tractorization as an essential step in agricultural development, which can decisively increase production without necessarily displacing labour.

However, tractor surveys in India, Pakistan and Nepal failed to provide evidence on the positive effects of tractorization in the increases of cropping intensity, yields, timeliness, and gross return. This supports the view that tractors are substitutes for labour and animals (Ruthenberg, 1985).

### III. Agriculture In The Future

#### A. Systems approach

Agriculture was once thought of only as a production system which involved the assembly of numerous inputs such as land, labour, fertilizer and machinery, the combining of these inputs, and the collection of the various agricultural products (Squires, 1991). Today farming has become much more complex. The farmer operates at the interface between the biophysical and the socio-economic environment. Because of the soil and land degradation mentioned in the beginning of this paper, other ways of managing our natural resources must be explored if agriculture is to survive.

The systems approach is a methodology for dealing objectively, and as often practicable, scientifically, with the complexity of systems. Widdowson (1987) used the term “scientific approach towards a holistic agriculture”. He interestingly describes this new approach as:

*‘...not a return to the farming employed by our ancestors; it is a system which takes all the modern knowledge of the agricultural and other natural scientists, and develop practical methods of putting the knowledge into practice, ideally with no damage to the environment, but at worst with the very minimum of harm.’*

The following farming practices are among those to be considered in the future:

- Organic Farming
- Conservation Tillage
- Precision Farming

In practice, the principles of organic farming practices have been to some extent inherently built up into the East Timor traditional farming systems. Conservation tillage and precision farming are nowadays adopted everywhere

around the world. With an understanding of soil limitations, and crop requirements, it is possible to avoid excessive, expensive and often ecologically harmful tillage. This does not mean ploughless agriculture on all soils and crops, but it does mean that unnecessary soil manipulation and wasteful use of energy and resources can be minimized. The use of Global Positioning System ( GPS ) in agriculture could greatly enhance the precision in farming practices.

#### B.On-Farm experimentation

The heavy task of enhancing the modern agriculture in the future will be the responsibility of all the people of East Timor, and in particular the following agents:

1. The government, for funding allocation and appropriate regulations,
2. The university, for research and development programs,
3. NGO and agricultural extension workers, skilled and committed to community development,
4. Business network including manufacturing,
5. Farmer groups.

A place where those agents could meet and cooperate is on-farm experimentation. The chief advantage of experimenting on farms is that, by putting researchers in touch with the farmers' views and conditions, it considerably broadens the researchers' understanding of the technical as well as social aspects of farming systems. On-farm experimentation generates new ideas and techniques that can be channeled into rural communities. These ideas and techniques are likely to be relevant and acceptable to the farmers, and to perform well under actual farm conditions.

#### **IV. Conclusion**

This paper concludes by stressing the importance of the future agricultural modernisation in East Timor. It will be difficult to manage the agricultural resources to meet the present needs without jeopardising the needs of future generations in East Timor. Therefore, an integrated systems approach is needed.

#### **Bibliography**

- Barnett, V., Payne, R. and Steiner, R. (1995), *Agricultural Sustainability: Economic, Environmental and Statistical Considerations*, John Wiley & Sons.
- Barrow, C.J. (1995a), *Developing the environment, Problems & Management*, Longman Scientific & Technical

- Barrow, C.J. (1995b), Sustainable development, Concept, value and practice, TWPR, 17 (4).
- Barrow, C.J. (1994), Land degradation, Cambridge University Press.
- Bartelmus, P. (1994), Environment, growth and development, Routledge, London
- Humphreys, E., Muirhead, W.A., Fawcett, B.J., Townsend, J.T., Murray, E.A. (1996), Puddling in Mechanised Rice Culture: Impacts on Water use and the productivity of rice and post-rice crops, In: Management of clay soils for rainfed lowland rice-based cropping systems, Aciar Proceedings No. 70.
- Lal, R. (1995), Tillage systems in the tropics, Management options and sustainability implications, FAO Soils Bulletin No 71.
- Lal, R. (1989), Agroforestry systems and soil surface management of a tropical Alfisol. I-VI Agroforestry Systems No. 8
- Richards, P. (1985), Indigenous Agricultural Revolution, Hutchison, London.
- Ruthenberg, H. (1985), Innovation Policy for Small Farmers in the Tropics, Clarendon Press, Oxford
- Squires, V.R. (1991), A systems approach to agriculture In: Dryland farming, a systems approach (Eds. Squires, V.R. and Tow, P.), Sydney University Press.
- Viegas, E.S.S. (1991), Kajian perbandingan sifat fisik lahan sawah yang diolah secara tradisional dan cara kultur teknis di Timor Timur, Gadjah Mada University, Indonesia
- Widdowson, R.W. (1987), Towards holistic agriculture, a scientific approach, Pergamon Press, New York.

**Appendix 1.** Alat dan Mesin Pertanian di Kabupaten, Propinsi Timor Timur T.A. 1997/1998  
(DPTP Timor Timur, 1997)

No.	Kabupaten	Traktor tangan			Traktor Mini			Traktor Kecil			Traktor Medium			Traktor Besar			
		B	R	Jml	B	R	Jml	B	R	Jml	B	R	Jml	B	R	Jml	
1	Aileu	5	0	5	1	0	1	0	0	0	0	1	1	1	1	1	2
2	Ainaro	0	1	1	0	0	0	0	0	0	5	0	5	1	2	3	3
3	Ambeno	68	1	69	0	0	0	0	0	0	0	1	1	0	2	2	2
4	Baucau	35	0	35	2	0	2	0	0	0	2	0	2	2	1	3	3
5	Bobonaro	110	1	111	1	1	2	0	0	0	9	1	10	2	2	4	4
6	Kovalima	4	1	5	3	0	3	0	0	0	4	1	5	0	1	1	1
7	Dili	3	0	3	0	0	0	0	0	0	1	0	1	2	0	2	2
8	Ermera	2	2	4	0	0	0	0	0	0	3	3	6	2	2	4	4
9	Lautem	3	0	3	1	0	1	0	0	0	11	4	15	5	0	5	5
10	Liquica	2	0	2	0	0	0	0	0	0	2	0	2	1	1	2	2
11	Manatuto	1	0	1	2	1	3	0	0	0	2	0	2	5	2	7	7
12	Manufahi	23	5	28	0	1	1	2	1	3	2	0	2	8	5	13	13
13	Viqueque	20	0	20	3	1	4	0	0	0	3	4	7	2	1	3	3
	JUMLAH	276	11	287	13	4	17	2	1	3	44	15	59	31	20	51	51

No.	Kabupaten	Power thresher			Pedal thresher			Dryer (peng.)			Sabit bergerigi			Pompa air			
		B	R	Jml	B	R	Jml	B	R	Jml	B	R	Jml	B	R	Jml	
1	Aileu	1	1	2	2	0	2	0	0	0	95	0	95	2	0	2	2
2	Ainaro	2	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Ambeno	0	0	0	48	1	49	0	0	0	0	0	0	2	0	2	2
4	Baucau	64	2	66	0	0	0	0	0	0	32	4	36	0	0	0	0
5	Bobonaro	10	2	12	0	0	0	0	0	0	0	0	0	4	0	4	4
6	Kovalima	51	0	51	0	3	3	0	0	0	0	0	0	6	0	6	6
7	Dili	0	0	0	0	0	0	1	0	1	0	0	0	7	0	7	7
8	Ermera	4	1	5	0	0	0	0	0	0	170	5	175	6	0	6	6
9	Lautem	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Liquica	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
11	Manatuto	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
12	Manufahi	28	4	32	0	0	0	0	0	0	34	0	34	0	0	0	0
13	Viqueque	30	0	30	11	0	11	0	0	0	0	0	0	0	0	0	0
	JUMLAH	198	12	210	61	5	66	1	0	1	331	9	340	27	0	27	27

No.	Kabupaten	Handsprayer			Power sprayer			Hand daster			Mist blower			Swing fog		
		B	R	Jml	B	R	Jml	B	R	Jml	B	R	Jml	B	R	Jml
1	Aileu	87	15	102	0	0	0	0	0	0	15	0	15	0	0	0
2	Ainaro	61	0	61	0	0	0	0	0	0	2	0	2	5	0	5
3	Ambeno	37	0	37	0	0	0	0	0	0	2	0	2	20	0	20
4	Baucau	33	0	33	0	0	0	0	0	0	2	0	2	30	0	30
5	Bobonaro	181	32	213	3	0	3	0	0	0	5	0	5	25	0	25
6	Kovalima	48	0	48	0	0	0	0	0	0	0	0	0	20	0	20
7	Dili	5	8	13	2	1	3	0	0	0	1	0	1	110	0	110
8	Ermera	48	8	56	1	0	1	0	0	0	1	0	1	0	0	0
9	Lautem	79	0	79	0	0	0	0	0	0	5	2	7	0	0	0
10	Liquica	33	0	33	0	0	0	0	0	0	3	0	3	0	0	0
11	Manatuto	35	1	36	0	0	0	0	0	0	1	0	1	20	0	20
12	Manufahi	152	26	178	0	0	0	0	0	0	2	0	2	20	0	20
13	Viqueque	120	0	120	0	0	0	0	0	0	7	0	7	20	0	20
	JUMLAH	919	90	1009	6	1	7	0	0	0	46	2	48	270	0	270



**Appendix 2. LUAS TANAM, LUAS PANEN, RATA<sup>2</sup> HASIL DAN PRODUKSI  
TANAMAN PANGAN DAN HORTIKULTURA  
PROPINSI TIMOR TIMUR  
TAHUN: 1997 (Januari s/d Desember 1997)**

No.	Kabupaten	Padi Sawah Insus				Padi Sawah Inmum				Padi Sawah Non Intens				Jumlah Padi Sawah			
		Luas Tanam (Ha)	Luas Panen (Ha)	Rata <sup>2</sup> Hasil (T/Ha)	Prod. (Ton)	Luas Tanam (Ha)	Luas Panen (Ha)	Rata <sup>2</sup> Hasil (T/Ha)	Prod. (Ton)	Luas Tanam (Ha)	Luas Panen (Ha)	Rata <sup>2</sup> Hasil (T/Ha)	Prod. (Ton)	Luas Tanam (Ha)	Luas Panen (Ha)	Rata <sup>2</sup> Hasil (T/Ha)	Prod. (Ton)
1	Ambeno	244	226	4,69	1.060	943	878	3,28	2.880	449	433	2,38	1.031	1.637	1.537	3,23	4.971
2	Bobonaro	886	886	4,80	4.253	2.534	2.309	3,87	8.936	706	678	2,32	1.573	3.926	3.873	3,81	14.762
3	Ermera	74	74	4,70	348	678	657	3,72	2.444	236	236	1,97	465	988	967	3,37	3.257
4	Kovalima	598	558	4,75	2.650	336	314	4,10	1.287	442	436	2,42	1.055	1.476	1.308	3,82	4.992
5	Manufahi	164	164	4,70	771	349	334	3,25	1.083	120	90	2,63	237	633	588	3,75	2.091
6	Aileu	106	106	4,51	478	265	260	3,70	953	121	115	2,51	289	492	481	3,59	1.720
7	Manatuto	0	0	0	0	843	843	4,45	3.751	163	160	3,46	554	1.006	1.003	4,29	4.305
8	Baucau	355	355	4,88	1.732	1.416	1.414	3,98	5.628	1.645	1.629	2,81	4.577	3.416	3.398	3,51	11.937
9	Dili	3	3	4,50	14	30	28	3,90	109	40	40	2,10	84	73	71	2,92	207
10	Ainaro	28	28	4,50	128	58	148	3,86	581	315	305	2,82	860	501	481	3,24	1.569
11	Liquica	0	0	0	0	67	62	3,91	240	100	100	2,24	224	167	162	2,88	465
12	Viqueque	438	431	4,85	2.090	1.882	1.846	3,92	7.236	1.628	1.611	2,83	4.559	3.948	3.888	3,57	13.885
13	Lautem	58	58	4,59	266	302	288	3,32	956	607	592	2,97	1.758	967	938	3,18	2.980
	<b>JUMLAH</b>	2.955	2.889	4,77	13.790	9.703	9.381	3,85	36.084	6.572	6.425	2,69	17.266	19.230	18.695	3,59	67.141