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PROSPECTS FOR SUSTAINABLE CROP PRODUCTION TECHNOLOGIES IN EAST TIMOR

A thesis presented in partial fulfilment of the requirements for the
degree of *Doctor of Philosophy (PhD)* in
Natural Resource Management



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ABBREVIATIONS

ACF	Action Contre la Faim
ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
AFP	Air-filled porosity
AGSE	Agricultural Engineering Service
AMCAP	Ainaro and Manatuto Community Activation Project
ANU	Australian National University
AP	Agricultural population
AS	Aggregate stability
AusAID	Australian Agency for International Development
BD	Bulk density
BIMAS	Bimbingan Intensifikasi Massa
BPS	Biro Pusat Statistik
Buw	Barley unweeded
Bw	Barley weeded
C	Carbon
CC	Continuous cropping
CH ₄	Methane
CO ₂	Carbon dioxide
CNRT	Concelho Nacional da Resistencia Timorese
CPR	Crop-pasture rotation
CT	Conventional tillage
DA	District administration
DAP	Draft animal power
DD	Double disking
DIT	Dili Institute of Technology
ET	East Timor
ETADEP	Ema maTA Dalam ba Progresu
ETTA	East Timor Transitional Administration
FAO	Food and Agriculture Organization
FAO/RAP	FAO Regional Asia & Pacific

FAOSTAT	FAO Statistics
F_c	Field capacity
GDP	Gross domestic product
GIS	Geographical information system
GLM	General linear model
GMD / D_{gm}	Geometric mean diameter
GNP	Gross net product
GoTL	Government of Timor-Leste
HDI	Human Development Index
HT	High tension
ISO	International Students Office
KPa	Kilopascal
K_s / K_{sat}	Saturated hydraulic conductivity
K_{unsat}	Unsaturated hydraulic conductivity
LT	Low tension
MAFP	Ministério de Agricultura, Florestas, e Pescas
MB	Mobile brigade
MPC	Mechanization Possibility Curve
MR	Moisture release
MT	Manual tillage
MWD / D_{mw}	Mean weight diameter
N	Nitrogen
NGO	Non-governmental organization
NO ₂	Nitrous oxide
NT	No-tillage
NZ	New Zealand
NZAID	New Zealand Assistance for International Development
P	Phosphorus
PP	Permanent pasture
PASC	Pilot agricultural service centre
PR	Penetration resistance
PSD	Pore-size distribution
PUSLAWITA	Pusat Latihan Wirausaha Tani

Puw	Potato unweeded
Pw	Potato weeded
RAW	Readily available water
RDTL	República Democrática de Timor-Leste (<i>Democratic Republic of Timor-Leste</i>)
SAS	Statistical Analysis System
SOC	Soil organic carbon
SOM	Soil organic matter
SON	Soil organic nitrogen
SWCC	Soil water characteristic curve
TDR	Time domain reflectometry
TIDS	Timor Institute of Development Studies
TP	Total population
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
UNTL	Universidade Nacional de Timor-Leste
WB-JAM	World Bank Joint Assessment Mission
WC	Water content
WFP	World Food Program
WFP	Water-filled porosity
WSA	Water stable aggregates
WSSP	Water Supply and Sanitation Project
ZT	Zero tillage

Abstract

The prospects of sustainable crop production technologies in East Timor were discerned with relevant case studies and experimental data. An overview of the agricultural development in East Timor with particular emphasis on the traditional farming and cropping systems was presented complemented by the discussion on the aspects of agricultural mechanization and technological change and their socio-economic ramifications on food security. Empirical data from tillage trials, established both in East Timor and New Zealand, were gathered and discussed in the quest for a better understanding of tillage effects on soil structure and crop production environment.

The agro-climatic zones of East Timor provide a well-defined set of ecological boundaries upon which further collaborative research work can be developed. Given land resources as one of the major capital investments in agriculture development, the drive towards improvement and technical change in agriculture should be directed in a balanced combination, whenever appropriate, between technologies of *land-saving* (hybrid seeds, irrigation, and drainage) or *labour-saving* (mechanization, herbicides, varieties and cropping techniques) characteristics. Moreover, the justification for acquiring an improved technology for traditional farmers, to some extent, needs to conform to the features of their subsistence mode of farming. The emphasis in technology dissemination, therefore, will have to shift from communication to education.

Experimental results of this study on the effects of tillage, and no-tillage in particular as a form of conservation tillage, on the edaphic changes affecting cropping environment generally concur with the findings known in the literature. Organic carbon levels are generally restored with cropping in East Timor. In addition, soil bulk density and crop grain and biomass yield were not affected by tillage treatments. Soil compaction was significantly affected by tillage as shown by data from the Palmerston North experiment. Soil aggregate stability in the 0-10 cm topsoil was similar under all the tillage treatments. Manual tillage (MT) had the greatest number of soil aggregates on sieve after a 30-minute wet-sieving (68.3%)

followed by no-tillage (NT) (65.1), permanent pasture (PP) (62.6) and conventional tillage (CT) (56.5). Similarly, the top 0-10 cm soil under MT had significantly larger macroporosity (16.4%) than CT (9.23), NT (11.5), and PP (10.6). MT and CT significantly reduced the total C whereas N levels were significantly decreased by tillage (CT, MT and NT) compared to permanent pasture at the top 0-10 cm soil layer. Barley grain and biomass were unaffected by tillage whereas potato tuber yield and biomass were significantly less under no-tillage. Conventional tillage significantly increased water runoff but produced less leachate compared to no-till and permanent pasture. Total soil sediment loss was significantly lower under PP (95.8 kg/ha) and NT (132.9) compared to CT (3556.7) and MT (4652.2). pH of water runoff was significantly reduced under tillage treatments compared to that from permanent pasture whereas nitrogen losses were unaffected.

There are at least four major public policy components that will play vital roles in the development of sustainable crop production technologies in East Timor: (i) Agricultural research and development (ii) Agricultural extension (iii) International and regional networking (iv) Shift of policy focus. The policy approach needs to be decentralized and broad-based and conservation agriculture should be promoted as opposed to conventional production agriculture. Three major areas for the future research agenda include: (i) Integrated Farming Systems (ii) Soil tillage and erosion (iii) Applied science and technology. The last component may cover disciplines such as: food policy analysis, farm machinery selection and testing, soil testing and mapping, land evaluation and GIS, bio-energy technologies, improved local seed varieties, adaptive fodder crops for improved grazing and pasture management, appropriate agro-forestry and soil and water conservation technologies and cash crop initiatives.

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