Appendix A

Explanations for a negative supply response for cocoa producers in PNG

Across the major cocoa-producing provinces, the short-run price elasticity of supply response for cocoa producers was found to be significantly negative, especially for estates (Ruhle and Fleming 1998). The estimated short-run smallholder elasticity of supply response to world price changes was -0.06, and not significantly different from zero. However, for estates it was significant at -0.75. A more perverse supply response to producer price was found. Again the elasticity of response by estates (-1.49) was significantly greater than that by smallholders (-0.41) (Ruhle and Fleming 1998). Concern was raised by the authors over the specification of the model, given that the other tree crops (coconut, palm oil and coffee) had positively sloped supply curves (Fleming 1998a; Fleming 1998b; McLaren and Fleming 1998). The results were treated with caution, given that many cocoa producers in PNG usually intercrop coconuts and cocoa and the short-run supply response for copra was inelastic but significantly positive (0.124) (Fleming 1998).

Despite many neoclassical economists blaming results of perverse supply responses on bad data or poor analysis, several empirical studies have been published on the phenomenon. Saez and Shumway (1985) found negative supply elasticities for a range of agricultural products over ten regions of USA, and Frohberg and Kromer (1985) estimated a perverse response for dairy in Canada and wheat in Nigeria. Results from a US Department of Agriculture study (1983) on rice in Tanzania found a negative supply response, considered plausible for developing countries and poor regions.

It is interesting to note that Ady (1968) found cocoa growers in Old Ashanti province in Ghana responded perversely to price changes. It was suggested that cocoa producers were working for a 'target income'; however, it contradicted other studies carried out in the region over the same period and the known increases in production over the 'boom' years (Lim 1975). Ady explained that smuggling may have confused the effect of current prices on output or that the exclusion of management and government incentive variables could have affected the result.

Just and Zilberman (1992) provide three theoretical explanations for a negative short-run supply curve. First, in cases where imperfect capital markets prevent borrowing, farmers may deplete their soils when prices are low. Given the theory of intertemporal decision making, farmers sacrifice future productive capacity in order to increase intermediate income in periods of low prices. This scenario would be applicable for poor farmers or under chaotic financial market conditions where credit constraints prevent income stabilisation from borrowing against the future in poor income periods. This scenario may be applicable to cocoa smallholders in PNG who have limited access to credit, especially in East Sepik and Madang.

Second, a perverse supply response may occur if an indebted farmer is threatened by bankruptcy. Under the theory of safety principles (Freund 1956; Katoaka 1963), and utility theory (Machina 1982; Quiggin 1982), a farmer faced with a binding credit constraint will be more willing to substitute labour for leisure in periods of low prices to meet obligations. Empirical work is limited but a study of 228 married farm women in Yolo County, California (Thompson, Gwynn and Sharp 1987) showed women's participation in farming activities tended to increase in times of economic adversity. The study did not confirm the negative supply response but supported the hypothesis that farm families tend to work harder during periods of depressed world prices. This suggests that supply response tends to decline and possibly become negative in periods of recession. When debt constraints are no longer binding, the neoclassical response may again resume where increased prices induce increased input use. This may be a plausible explanation for indebted PNG largeholders who borrowed heavily with the introduction of the SG1 in 1981. When the SG1 did not perform as expected, largeholders were left with loans still outstanding in a climate of low world cocoa prices.

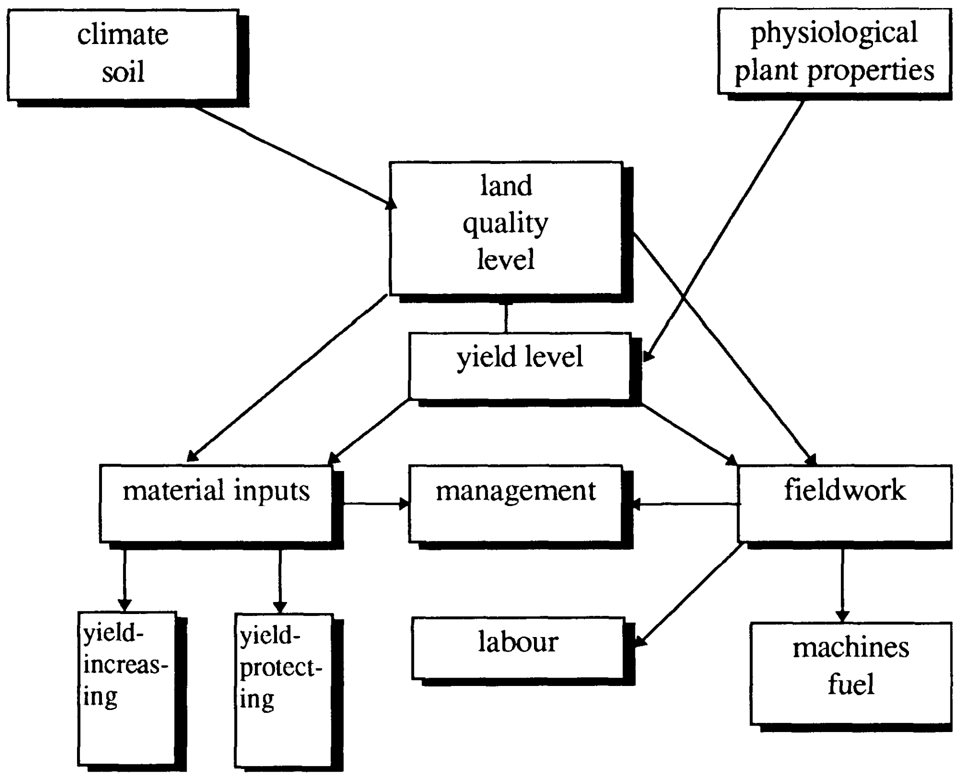
Finally, negative supply elasticities may prevail where farmers' wealth is affected by changes in land prices under the existence of decreasing absolute risk aversion. Based on the theory of decision making under risk aversion (Arrow 1971), the degree of risk aversion is dependent on wealth. Hence, land prices will decrease in periods of decreasing prices, resulting in a decline in the farmer's wealth. Given decreasing absolute risk aversion, increased risk aversion occurs and the avoidance effect can temporarily overcome the profit motive, resulting in a negative supply response. This explananation is not applicable to PNG cocoa producers. Smallholders are not considered very risk averse since they are not solely dependent on the income from cocoa. They are able to obtain income from other farm activities such as coconuts or betel nut. In addition, land is customarily owned; hence, land prices are not a relevant issue.

Appendix B

Scientific approaches to yield determination

An example of a pure scientific approach to yield determination is van Keulen and Wolf's (1986) hierarchical procedure approach (see Figure B.1). The approach assumed producers are output maximisers, striving to obtain potential yields. Van Keulen and Wolf estimated potential yield, based on the soil properties and climatic conditions, quality of the land and bio-physical processes of the plant. For a given land quality, the yield potential was assumed to be fixed and therefore believed to be estimated with reasonable accuracy.

Figure B.1 A hierarchical procedure approach



Source: van Keulen and Wolf (1986).

The yield level was defined as both a dependent variable, determined by crop characteristics and land quality, and as an independent variable, dictating the required input combination for its realisation. The time required for the labour activities was considered independent of the yield level as it was assumed the activities would be performed anyway.

Crop growth models

The cocoa production model could be developed into a bio-economic model by incorporating a crop growth model. Information is available on the soils and climate in cocoa-producing areas of PNG. However, more work is required on establishing relationships between physiological processes, management practices and yields. Discussed below are the types of crop models available: static regression, physiological-based comprehensive process model, and the simplified process model.

Crop physiology models have been constructed for cocoa. Gerritsma and Wessel (1996) developed a dynamic explanatory simulation model, CAcao Simulation Environment (CASE) 1 & 2, for the growth and production of cocoa under potential and water-limiting conditions and without the influence of shade (Borchert 1973; Ng 1982; Anten 1990; Anten, Gerritsma and Wessel 1993; Gerritsma and Wessel 1996).

Static regression model

In the static regression model, crop yield is given as an algebraic function of environmental variables which influence yield. The coefficients of the equation are usually determined by statistical regression analysis for data sets consisting of the objective variable (yield) and predictor variables (environments). The predictor variables are usually selected on the basis of experiences or statistical methods.

The simplest form is (Wisiol 1987):

$$\mathbf{Y = a + bP}$$

where Y is yield and P is the precipitation in a particular period or a whole cropping season. A more comprehensive model for predicting maize yield in the US corn belt was developed by Thompson (1969) where monthly values of temperature, precipitation and technological trend were adopted for predictors. This model type was also employed in the USA's Large Area Crop Inventory Experiment (LACIE) in combination with crop area estimation by Landsat for forecasting yield. The LACIE yield model (MacDonald and Hall 1980) is represented by the identity:

$$\mathbf{Y = A + B + C}$$

where A is the preceding year's yield for average weather, B is the yearly adjustment for technology trend and C is the effect of current weather. Since weather elements are often correlated, statistical crop-weather regression models, where predictors must be mutually exclusive, are considered unstable. Weather indices are often used to avoid this problem.

Static regression models have been widely used for national and regional yield forecasting by such organisations as USDA and the Japanese Ministry of Agriculture, Forestry and Fisheries (Horie et al. 1992). These models give reasonably accurate predictions, given that environments, cultivars and technology do not deviate greatly from those used in the model. Hence, if conditions change, a new model would be required. Another disadvantage is the model's inability to predict time-dependent processes of growth and yield formation.

Crop simulation models

Simulation models of crop and soil processes are predominantly mechanistic models which estimate crop yields deterministically from soil and climatic data (Cox, Parton, Shulman and Ridge 1997). Where regression models analyse environment-yield relationships in fields or regions, physiologically based process models or mechanistic dynamic models integrate crop physiology and biophysical processes. The behaviour of the crop-environment system in mechanistic models is automatically determined by environments and initial conditions.

Simultaneous differential equations are used to simulate dynamic processes of crop growth and development. Physiologically based process models consist of current crop state variables (X), rate variables (R), representing changes in the state variables, environmental variables (E) and coefficients and parameters depicting relationships among X, R, and E. A general form is written as:

$$\mathbf{X = \int R\ dt \text{ and } R = f(X,E).}$$

Comprehensive process models require detail on crop development, photosynthesis, respiration, substrate partitioning, organ formation, transpiration and/or nitrogen uptake. Some of the data on the physiological processes require laboratory work. Given the amount of detail required, the comprehensive models have limited applicability for regional and national purposes. They are more useful for understanding the complexity of crop-environment dynamics based on the underlying biophysics and physiology (Horie et al. 1992).

Simplified process models are based on well specified field data and simplified relations between variables, requiring less parameters than the comprehensive models. They use only closely related data; hence, the resolution and accuracy of prediction are inversely related to the distance (Seligman 1976).

Cocoa physiology models

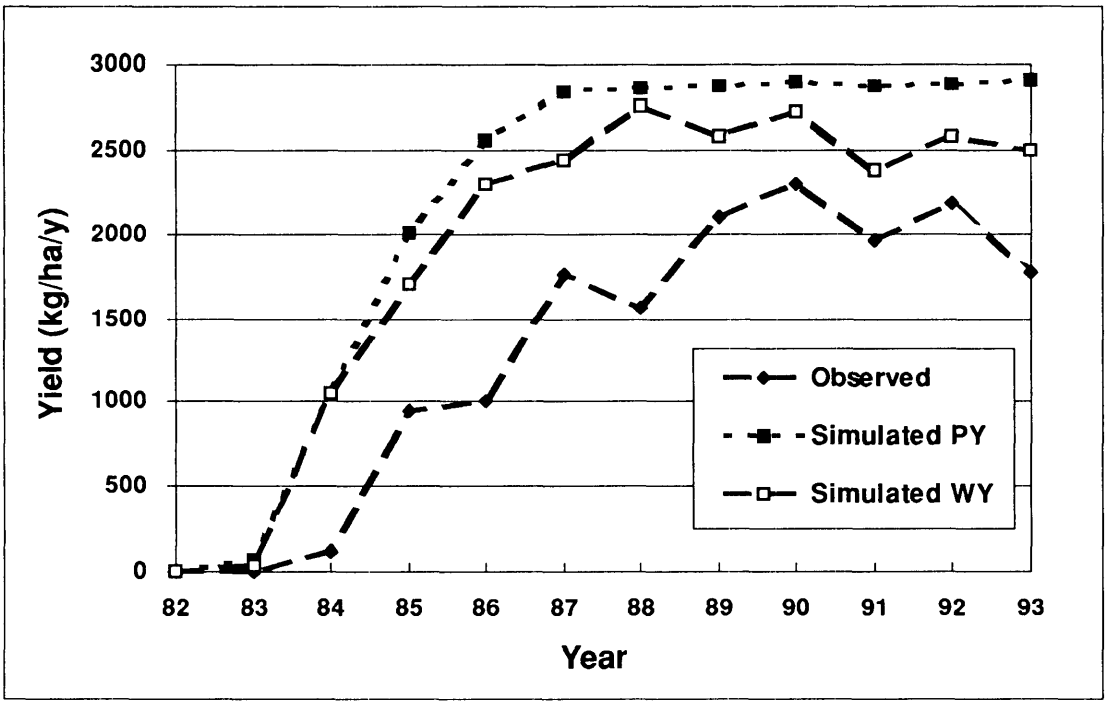
Explanatory dynamic simulation models have been developed predominantly for annuals and biennials. Based on the underlying general physiological processes of plants and crops, they allow for crop growth and production to be quantified under existing circumstances but also for environments not yet tested. This approach has also been extended to perennials, but applications are fewer. Models exist for oil palm (Dufrene 1990; van Kraalingen et al. 1989), rubber (Monteny 1987), with fragmentary studies on cocoa (Anten, Gerritsma and Wessel 1993). The flushing patterns of cocoa were modelled by Borchert (1973) while Ng's (1982) quantitative model calculated the potential crop photosynthesis and the influence of shade and cocoa tree vigour on potential productivity. Anten's (1990) more complete analysis of the cocoa production system enabled estimation of potential productivity levels and identified gaps in the current knowledge on the crop physiology of cocoa.

Anten, Gerritsma and Wessel (1993) adopted a modelling approach to assess the growth and production of cocoa. They developed a quantitative model to study the influences of weather and soils on growth and production of cocoa in three different environments over periods of at least ten years. A water balance was introduced and limitations due to water stress on the cocoa were accounted for.

Gerritsma and Wessel (1996) developed a dynamic explanatory simulation model, CAcao Simulation Environment (CASE) 1 & 2, for the growth and production of cocoa under potential and water-limiting conditions and without the influence of shade. CASE2 consisted of three modules: crop, soil water balance and evapotranspiration. The crop module calculated light interception for the shade and cocoa crop, canopy assimilation, cocoa crop growth and development, water uptake and transpiration. The soil water balance module simulated the soil water content, its distribution, soil evaporation and drainage. The evapotranspiration module calculated potential evapotranspiration.

Weather variables—minimum and maximum temperature, daily short-wave radiation, early morning vapour pressure, average wind speed and rainfall—were used and soil parameters were estimated from sand and clay fractions for each relevant soil layer. The model was validated with 11 years of yield data from BAL estates in Sabah, Malaysia. Figure 3.1 depicts the simulations for potential production (upper line) and water-limited production (middle line) compared with the actual field observations (lower line).

Figure B.2 Observed and simulated yield profile for cocoa in Malaysia, 1982-93.



Source: Gerritsma (1996).

Gerritsma and Wessel (1996) compared dry matter production and yields for sites in Ghana, Indonesia and PNG. When water was not a limiting factor, yields were found to be relatively stable, with the highest recorded in PNG and the lowest in Ghana. Water stress created large fluctuations over the period.

Table B.1 Average pod yield in Ghana, Indonesia and PNG under potential and water-limited conditions

Production (ton. ha^{-1} y^{-1})	Ghana (ton ha^{-1} y^{-1})	Indonesia (ton. ha^{-1} y^{-1})	PNG (ton ha^{-1} y^{-1})
Potential	2.5	2.6	2.7
Water limited	1.6	2.1	2.6

Source: Gerritsma and Wessel (1996).

Appendix C

Model equations

Equations for the modules can be found on disc 2, **appc.doc**.

They are listed in the following order:

C.1 Export module

C.2 Area module

C.3 Land suitability module

C.4 Output module

C.5 Break-even module.

Appendix D

Regression statistics for FOB prices on DIS prices are given below.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.988843
R Square	0.97781
Adjusted R Square	0.975344
Standard Error	53.13868
Observations	11

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1119843	1119843	396.5846	9.43E-09
Residual	9	25413.47	2823.719		
Total	10	1145257			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-78.4926	59.52136	-1.31873	0.219828	-213.139	56.15419	-213.139	56.1541869
X Variable 1	0.911609	0.045776	19.91443	9.43E-09	0.808056	1.015163	0.808056	1.01516262

Appendix E

Structure of the state-space model

The model formulation was taken directly from Mutunga, Fleming and Coelli (1995), and adjusted for different circumstances in PNG. Their model was in turn derived from Kalaitzandonakes and Shonkwiler (1992), differing in terms of estimation methods and choice of variables. Mutunga et al. used maximum likelihood estimates, obtained via the Kalman filter algorithm rather than a generalised least squares formulation adopted by Kalaitzandonakes and Shonkwiler (1992).

Theory of the state-space model

In the state-space model, decision variables and initial conditions are specified in the state-space form. Following Knapp and Konyar (1991), Kalman filter recursions are then applied to provide optimal estimates of the state-space state variables, their associated variance-covariance matrix and the value of the log-likelihood function. Simplex procedures are used to obtain iterations over the values of the parameters, to generate estimates of the the unknown parameters that maximise the value of the log-likelihood function. Data on new plantings are also used to obtain estimates of the unobservable replantings and new plantings.

The state-space model[1] is expressed as:

(1) $A_t = a_t X_t + \beta M_t + e_t, \ t = 1, \ldots, T$ (measurement equation)

(2) $X_t = \Phi_t X_{t-1} + \gamma Z_t + v_t, \ t = 1, \ldots, T$ (transition equation).

where: A_t = observed cocoa plantings,

X_t = a 2x1 state vector, of new plantings and replantings of cocoa (unobserved),

a_t = a 1x2 vector relating the observed total plantings (Y_t) with the state vector (X_t),

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[1] *For more on state-space models, refer to Harvey (1981), Harvey (1989) and Judge et al. (1985).*

Q_t = a 1xK vector of exogenous variables in the measurement equation,

Z_t = a 2xK vector of exogenous variables in the transition equations,

Φ_t = a 2x2 transition matrix of interactions between new plantings and replantings,

γ and β are matrices of unknown parameters, and

e_t is a vector of serially uncorrelated disturbances with zero mean and covariance matrix H, such that $e_t \sim WN(0,H_t)$, where *WN* implies white noise.

The disturbance vector, v_t, is also a vector of serially uncorrelated disturbances with mean zero and covariance matrix Q_t, such that $v_t \sim WN(0,Q_t)$.

The following assumptions are made for the state-space form of the model. The unobservable state vector is assumed to be generated by the Markov-process nature of the transition equation. We also assume that $var(X_0) = P_0$, where X_0 is the initial state vector, $E(e_t v_s') = 0$, $E(e_t X_0') = 0$ and $E(v_t X_0') = 0$ for all $s, t = 1, \ldots, T$.

The system can be seen as linear if it is assumed that α_t, M_t, H_t, Φ_t, Z_t and Q_t are non-stochastic. Furthermore, total plantings are assumed to be measured without error. Thus, the sum of new plantings and replantings equals total plantings and then equations (1) and (2) become:

(3) $A_t = [1\ 1]\, X_t$

and

(4) $X_t = \Phi X_{t-1} + \gamma Z_t + v_t$, respectively.

The measurement equation (3) has become an identity, where $[1\ 1]$ represents a (1x2) vector of ones.

Following Kalaitzandonakes and Shonkwiler (1992, p. 346), the cocoa planting decisions are thus cast in the state-space form as follows:

$$(5) \qquad A_t = [1\ 1]\begin{bmatrix} R_t \\ N_t \end{bmatrix}$$

$$(6) \begin{bmatrix} R_t \\ N_t \end{bmatrix} = \begin{bmatrix} \Phi_{11} \Phi_{12} \\ \Phi_{21} \Phi_{22} \end{bmatrix} \begin{bmatrix} R_{t-1} \\ N_{t-1} \end{bmatrix} + \begin{bmatrix} \gamma_{11}\ 0\ \gamma_{13}\ 0\ 0 \\ \gamma_{21} \gamma_{22} 0 \gamma_{24} \gamma_{25} \end{bmatrix} \begin{bmatrix} P_t \\ O_t \\ DB_t \\ DV_t \end{bmatrix} + \begin{bmatrix} v_{1t} \\ v_{2t} \end{bmatrix}$$

where:

$X_t' = [R_t, N_t]$,

$Z_t = [P_t, O_t, DB_t, DV_t]$,

N_t = new plantings (unobserved),

R_t = replantings (unobserved),

P_t = real price of cocoa,[2]

O_t = real producer price of coconuts,

DB_t = dummy variable representing Bougainville crisis,

DV_t = dummy variable representing volcanic eruption,

v_{1t}= white noise error term in the replanting equation,

v_{2t} = white noise error term for the new replanting equation,

$Q_t = \begin{bmatrix} \sigma_1^2 0 \\ 0\ \sigma_2^2 \end{bmatrix}$, and

Φ and γ are matrices of unknown parameters to be estimated.

The unknown parameters were estimated using maximum likelihood estimation procedures with a Kalman filter. The starting values for replantings and new plantings were assumed to be equal, and half the value of the total plantings in the first quarter

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[2] *Generated by deflating nominal prices using the CPI.*

(1980). The starting values for the unkown parameters (γ) were assumed to be equal to zero. Also, the starting values of both Φ_{11} and Φ_{22} were assumed to take the value of a small positive number (0.1) while the off-diagonal elements of that matrix were assumed to be zero. It is important to note that the zeros in the matrix determine the behaviour of the estimates of the unobserved state vector.

The Kalman Filter

The Kalman filter consists of a system of prediction, updating and smoothing equations.[3] The maximum likelihood estimates of the unknown parameters were obtained using the simplex method.[4]

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[3] *The use of the Kalman filter on the estimation of a state-space model is derived from Harvey (1981), Harvey (1989) and Judge et al. (1985) and the derivation of the Kalman filter used in this study can be found in Mutunga et al. (1995, p. 7-10).*

[4] *Subroutines for the Kalman filter calculations were kindly supplied by Dr Howard Doran of the Department of Econometrics, University of New England.*

Appendix F

Estimates from the state-space model

Smallholdings

$\Phi_{11} = 0.852$
$\Phi_{12} = 0.294$
$\Phi_{21} = 0.333$
$\Phi_{22} = 0.138$
$\gamma_{11} = 2.761E\text{-}002$
$\gamma_{14} = 3.533E\text{-}002$
$\gamma_{21} = 1.781$
$\gamma_{22} = 0.489$
$\gamma_{23} = -4.724E\text{-}002$
$v_{1t} = -5.029E\text{-}003$
$v_{2t} = 0.258$
value of the log likelihood function (LLF) = -35.828

obs	replant	newpl	totpl
1	0.177	0.532	0.709
2	0.307	0.133	1.240
3	0.855	0.342	1.436
4	0.993	0.398	1.340
5	0.943	0.377	0.952
6	0.796	0.311	1.114
7	0.771	0.309	1.003
8	0.725	0.288	1.429
9	0.825	0.339	1.121
10	0.789	0.315	1.111
11	0.767	0.307	1.260
12	0.798	0.323	2.307
13	1.123	0.474	1.318
14	1.014	0.400	1.291
15	0.945	0.376	1.341
16	0.921	0.369	1.470
17	0.946	0.382	1.148
18	0.865	0.343	0.819
19	0.723	0.281	1.489
20	0.841	0.347	1.175
21	0.814	0.326	0.828
22	0.698	0.273	1.016
23	0.688	0.276	1.030
24	0.686	0.276	0.886

25	0.643	0.256	0.453
26	0.492	0.188	0.474
27	0.414	0.161	0.361
28	0.337	0.130	0.235
29	0.257	0.098	0.097
30	0.172	0.063	0.101
31	0.125	0.047	0.185
32	0.124	0.050	0.391
33	0.184	0.078	0.264
34	0.180	0.072	0.148
35	0.144	0.055	0.311
36	0.172	0.071	0.187
37	0.151	0.014	0.170
38	0.134	0.007	0.181
39	0.128	0.006	0.238
40	0.141	0.012	0.049
41	0.093	-0.011	0.069
42	0.072	-0.018	0.095
43	0.068	-0.018	0.011
44	0.041	-0.031	0.000
45	0.058	-0.037	0.000
46	0.068	-0.034	0.000
47	0.073	-0.032	0.026
48	0.084	-0.027	0.105

Largeholdings

Φ_{11} = 3.771E-002
Φ_{12} = 3.661E-002
Φ_{21} = 2.9438E-002
Φ_{22} = 0.971
γ_{11} = 1.036
γ_{14} = 2.1454E-002
γ_{21} = 2.205
γ_{22} = -0.868
γ_{23} =-8.258E-003
v_{1t} = 0.110
v_{2t} = 6.675E-002
LLF = -60.088

obsn	repl	newpl	totpl
1	0.159	0.159	0.318
2	0.012	0.159	0.557
3	0.020	0.515	0.645
4	0.024	0.607	0.602
5	0.022	0.574	0.428

6	0.016	0.479	0.501
7	0.018	0.468	0.451
8	0.017	0.440	0.612
9	0.023	0.495	0.480
10	0.018	0.465	0.476
11	0.017	0.449	0.540
12	0.020	0.468	1.121
13	0.041	0.729	0.640
14	0.023	0.652	0.628
15	0.023	0.613	0.652
16	0.024	0.603	0.858
17	0.032	0.686	0.670
18	0.025	0.646	0.478
19	0.017	0.544	0.869
20	0.032	0.662	0.733
21	0.027	0.660	0.516
22	0.019	0.567	0.634
23	0.023	0.572	0.642
24	0.024	0.576	0.501
25	0.018	0.517	0.256
26	0.009	0.381	0.268
27	0.010	0.317	0.204
28	0.007	0.255	0.168
29	0.006	0.207	0.069
30	0.002	0.138	0.072
31	0.003	0.105	0.132
32	0.005	0.112	0.246
33	0.009	0.165	0.166
34	0.006	0.157	0.093
35	0.003	0.122	0.196
36	0.007	0.149	0.108
37	0.005	0.118	0.099
38	0.005	0.098	0.105
39	0.005	0.090	0.138
40	0.006	0.100	0.028
41	0.002	0.057	0.039
42	0.002	0.041	0.054
43	0.003	0.038	0.006
44	0.001	0.016	0.000
45	0.022	0.001	0.000
46	0.022	-0.015	0.000
47	0.023	-0.024	0.012
48	0.023	-0.024	0.121

Appendix G

Excel Files of Simulation Runs

Excel files are set up for the results of simulation runs for each sub-sector:

Madang smallholders = **MDGSH.xls**

Madang largeholders = **MDGLH.xls**

ENB smallholders = **ENBSH.xls**

ENB largeholders = **ENBLH.xls**

East Sepik smallholders = **ESSH.xls**

The sub-sector files contain 10 sheets with the results of the following scenarios:

Description of simulation run	**Name of sheet**
Base run	base
5 per cent devaluation under price support	5%
10 per cent devaluation under price support	10%
15 per cent devaluation under price support	15%
Removal of price support	psupport
Removal of price support and 10% devaluation	psup-10%
Figure of the change in output for the above scenarios	output
Figure for change in area for the devaluation scenarios	area
Figure for change in profit for the devaluation scenarios	profit
Change in input use and cost with and without the price support	inputs

PSUPPORT.xls contains simulation runs on each sub-sector for:

(a) with price support (base run)

(b) without price support

(c) without price support and a 10 per cent devaluation.

The aggregated sub-sector results for the percentage change from the base run to scenarios (b) and (c) are on sheets labelled:

Without price support = **psupport**

Without price support and a 10 per cent devaluation = **psupdev.**

The NPV cost of the scheme in each sub-sector is on the sheet labelled **costkina.**

The NPV loss of output from the removal of the scheme is on sheet **cost-Q.**

The losses in net value of output under increasing prices for each sub-sector are on sheets labelled:

Madang smallholders = **ADB-MDGSH**

Madang largeholders = **ADB-MDGLH**

ENB smallholders = **ADB-ENBSH**

ENB largeholders = **ADB-ENBLH**

East Sepik smallholders = **ADB-ESSH.**

DEVAL.xls contains the simulation runs for a 5,10 and 15 per cent devaluation for each sub-sector.

NPVOUTPUT.xls contains the NPV of output for all sub sectors under low world price scenarios.

Appendix H

Determination of area figures using PNGLIS and MASP

To initially identify the area under cocoa, the MASP[1] and PNGRIS were overlaid in order to obtain the agricultural systems and corresponding resource mapping units (RMUs) that contained cocoa cash income activities. RMUs with negligible area within the agricultural system and/or highly unlikely characteristics for cocoa growing were rejected (e.g. areas of steep slopes). Areas under cocoa were classified according to the ratings given in Table H.1.

Table H.1 Significance of cocoa cash-earning activities

Rating	Cash income (per household)
Highly significant	greater than 250 kina
Significant	51 to 250 kina
Little significance	11 to 50 kina
Not significant	less than 10 kina

Source: MASP (1994).

The estimated areas were unrealistically high with the inclusion of the overlap between the RMU and the agricultural system in the area calculations (see Table H.2). This was expected since the data base was not specifically designed to map areas of cash cropping activities but more to identify the existence and significance in monetary terms of cropping activities in the agricultural system.

[1] *MASP provides information on smallholder agriculture sorted by agricultural systems. An agricultural system is defined as an area of similar agricultural crops and practices (Allen et al. 1994).*

Table H.2 Area under cocoa

Sector	ENB (hectares)	East Sepik (hectares)	Madang (hectares)
Smallholders			
Minor	93 600	724 600	400 300
Significant		595 600	189 700
Very significant	92 000		
Largeholders	46 200		19 800

Source: MASP (1994).

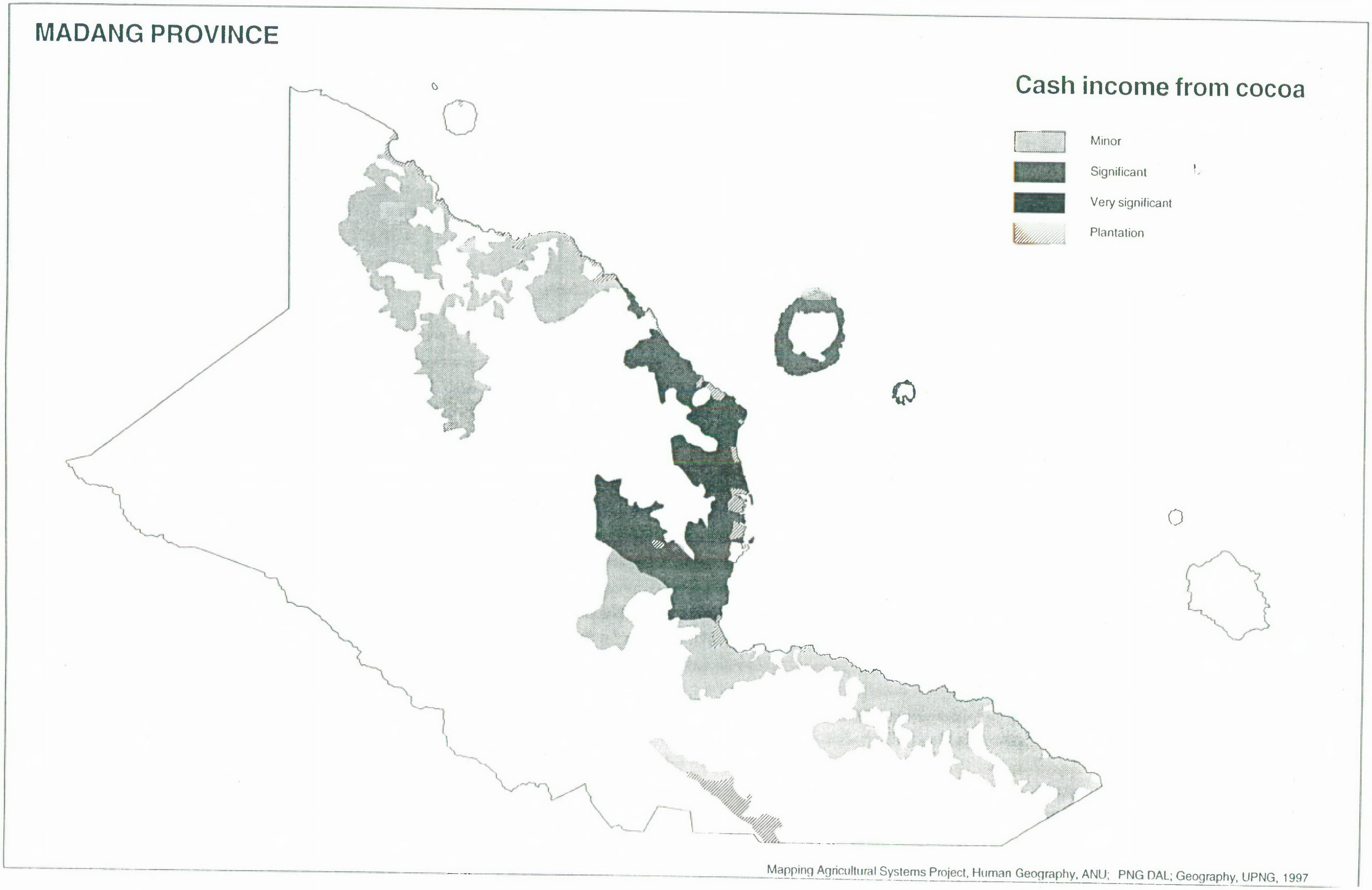

MADANG PROVINCE
Cash income from cocoa
Minor
Significant
Very significant
Plantation
Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1997

Figure 11.2 Area under cocoa in East Sepik province

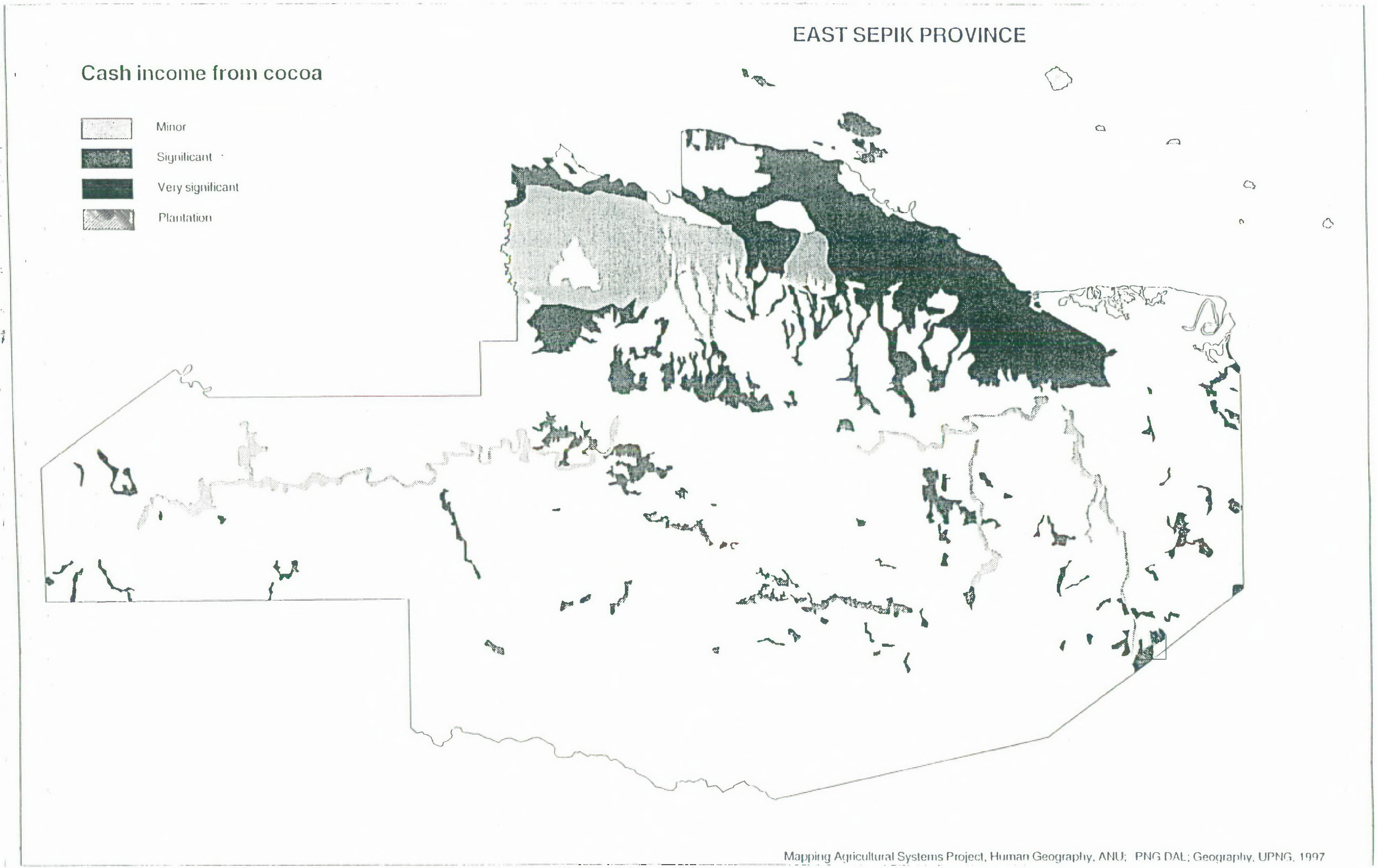
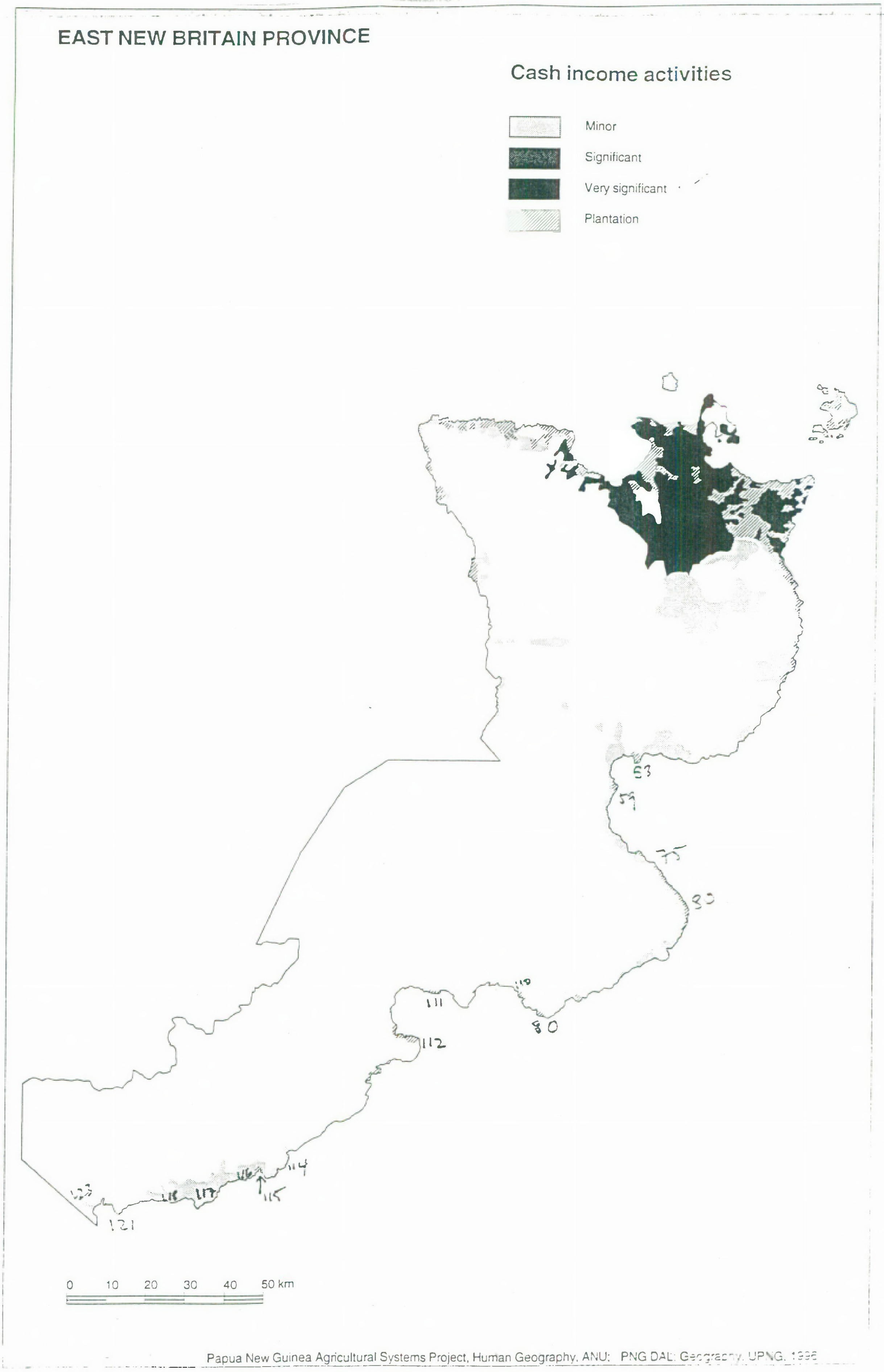


Figure H.3 Area under cocoa in ENB province



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