Projeto GESEP/IPEA

A ECONOMIA DO DESFLORESTAMENTO DA AMAZÔNIA

Projeto Coordenado por
Eustáquio J. Reis

SUMÁRIO

Rio, 30/06/93

De: Eustáquio J. Reis
Coordenador do Projeto "Economia do Desflorestamento da Amazônia

Para: Bernard Beymer

Ref.: Relatório Final da Fase 1 do Projeto "A Economia do Desflorestamento da Amazônia Brasileira"

Conforme proposto nos Têrmos de Referência, os objetivos do ultimos do projeto são:

- integração informatizada de bases de dados geo-referenciadas com informações fito-ecológicas e sócio econômicas sôbre a Amazônia brasileira com informações disponiveis no IBGE e no INPE;

- preparação de um documento de anàlise do processo de desflorestamento da Amazônia, seus principais determinantes econômicos e demográficos, sua contribuição para o agravamento do efeito estufa e as perspectivas futuras do problema.

Esses objetivos foram cumpridos apenas parcialmente nessa primeira fase do projeto. Dentre as razões para a não consecução dos objetivos propostos pelo projeto destacam-se os problemas têcnicos na obtenção dos dados junto ao INPE e ao IBGE (ver correspondência anexa).

Diante dêsses problemas, adotou-se como estratègia alternativa levantar diretamente os dados mais importante que fossem passiveis de obtenção dessa forma. Naturalmente, isso impôs custos e atrasos adicionais pela falta de uma infraestrutura cartogràfica e capacitação têcnica adequadas.

Dentre as informações assim levantadas encontram-se a biomassa e a malha rodoviária da Amazônia Legal. O Anexo 1 intitulado "Base de dados municipais sôbre o volume de madeira e a biomassa florestal da Amazônia Legal", de autoria de Claudio Boher, apresenta a metodologia e os resultados referentes ao primeiro aspecto. O Anexo 2 intitulado "Estimativas da extensão da malha rodoviária em nivel municipal para a Amazônia Legal", de autoria de Maria José Pessoa, apresenta a metodologia e reultados referentes ao segundo aspecto.

O Anexo 3 intitulado "The impact of the forest industry in Amazonia deforestation", de autoria de Alfredo Noel Iusem, apresenta um relatório de pesquisa sôbre os determinantes e perspectivas da indústria madeireira da Amzônia Legal. Esse è certamente um aspecto da maior importância na Amazônia Legal, sobretudo quando se tem uma avaliação das condições futuras.

O Anexo 4 intitulado "As tendencias do progresso tècnico na Amazônia Legal" apresenta, em caràter preliminar, a anàlise de um aspecto fundamental no processo de desflorestamento da Amazônia Legal e que, dessa forma, era identificado como uma das tarefas bàsicas do projeto nos seus Têrmos de Referencia.

Finalmente, dois outros relatórios de minha autoria se originaram do projeto. O primeiro, em co-atuoria com Peter May, intitula-se "The user structure in Brazil$ tropical rain forest@." e o segundo, co-autorado por Elisa P. Reis, se intitula "Taming Change Imbalances: Deforestation in the Amazon."

PRESIDÊNCIA DA REPÚBLICA
SECRETARIA DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

São José dos Campos, 22 de abril de 1993

OF. DPI-081/93

Dr. Estáquio J. Reis
Av. Pres. Antônio Carlos, 51/ 17o. andar
CEP 20020-010, Rio de Janeiro - RJ

Prezado Eustáquio,

Após nosso último contato telefônico, tivemos a oportunidade de trabalhar, junto com a Direção do INPE, na busca de recursos para conclusão do Sistema de Informação *Amazônia*, com a digitalização das áreas que faltam.

Como é de seu conhecimento, as áreas que ainda não incorporamos à base de dados são as de execução mais complexa já que concentra a maior parte das áreas desflorestadas. Como referencia, considere que os cerca de 2/3 que já temos digitalizados incluem cerca de 10% do total das áreas desflorestadas.

A complexidade do projeto faz com que os custos para sua conclusão sejam elevados, se comparados aos recursos disponíveis no momento, e estão recebendo atenção especial da Direção do INPE para sua obtenção, que espera-se esteja próxima. Infelizmente, até a obtenção de recursos no volume necessário, estaremos continuando o projeto em ritmo lento, sem previsão para seu término.

Como coloquei durante nosso último contato, o INPE entende o transtorno que os presentes atrasos estão gerando sobre o projeto Economia do Desflorestamento na Amazônia e gostaria de ressaltar que o projeto seguirá seu curso normal tal logo tenhamos os recursos disponíveis.

Finalmente, como forma de minimizar o impacto dos presentes atrasos, conforme sua sugestão, a Direção do INPE determinou que sejam geradas cópias das 64 cenas Landsat do meio da década passada utilizadas no projeto, para enviar-lhe.

Colocando-me a sua disposição para quaisquer ações possíveis, que possam diminuir o impacto dos atrasos do projeto, subscrevo-me,

Atenciosamente,

Diógenes S. Alves

CC: Eng. Marcio Barbosa, Diretor
Dr. Luiz Gylvan Meira Filho
Dr. Luis Alberto Vieira Dias, OBT
Dr. João Roberto dos Santos, DSM

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PRESIDÊNCIA DA REPÚBLICA
SECRETARIA DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

SJC, 04/06/93

OF. DPI-107/93

Dr. Eustáquio Reis
IPEA
Av. Pres. Antonio Carlos, 51 - 17o. andar
Rio de Janeiro - RJ

Prezado Eustáquio,

Em resposta aos pedidos formulados em suas últimas correspondencias, e conforme acordado em nossa conversa telefônica de ontem, estou enviando anexos:

1. Disquete contendo os limites municipais da Amazonia Legal (disquete etiquetado ESTADOS.ARC) no formato ARC/INFO. Refira-se ao arquivo leia-me para mais detalhes sobre conteúdo e formato.

2. Disquete contendo os limites municipais dos estados da Amazonia Legal (disquete etiquetado projeto EST) no formato SGI.

3. Disquete contendo os valores de áreas desflorestadas para as células do estado do Mato Grosso que temos completadas, após todos os processos de digitalização e verificação (disquete etiquetado Relatórios). Refira-se aos relatórios e veja o formato adotado:

   MIR-ORB/PT-DDMMYY-UF área (km2)

   onde MIR é o índice da carta no Mapa Indice de Referencia na escala 1:250.000, ORB/PT é a órbita e o ponto que designam a cena Landsat-TM, DDMMYY designa dia, mes e ano e UF designa a unidade da federação.

4. Pequeno *Atlas*, em que estão desenhadas as cartas MIR com as cenas Landsat sobrepostas. Este *Atlas* permitir-lhe-á encontrar a posição da célula na carta e, também, dará indicação da parte ocupada pela célula na carta. Como os relatórios que estou enviando apresentam áreas desflorestadas por célula, acredito que o pequeno *Atlas* deverá ser-lhe útil.

Como discutimos ontem, a estratificação das áreas desflorestadas por município será feita oportunamente, utilizando metodologia especificada pelo Dr. Gylvan Meira, que permite encontrar extensão e taxas de desflorestamento por município. Os dados que envio agora, permitiriam que você já fizesse uma primeira análise dos dados, segundo seus critérios.

Esperando que não exite em contactar-me caso necessite de qualquer informação adicional, envio-lhe o mais caloroso abraço,

Diógenes S. Alves

Cópia: Eng. Marcio Barbosa, Diretor

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RELATÓRIO FINAL

Bohrer
INFL-AML
'25.01.93

BASE DE DADOS MUNICIPAIS SOBRE O VOLUME DE MADEIRA E A BIOMASSA FLORESTAL DA AMAZONIA LEGAL.

Relatório técnico apresentado ao GESEP/IPEA como parte da pesquisa
" A economia do desflorestamento da Amazônia Brasileira "

Claudio Belmonte de Athayde Bohrer
Janeiro de 1993

1. OBJETIVOS

O objetivo deste trabalho è o de organizar em nivel municipal informações levantadas pelo inventário florestal realizado pelo Projeto RADAMBRASIL na àrea da Amazônia Legal, abrangendo as Regiões Fitoecológicas das Florestas Ombrôfilas Densa e Aberta. Este relatório è parte da pesquisa "A Economia do Desflorestamento da Amazônia Brasileira", ora em desemvolvimento no IPEA, cujo objetivo mais amplo è desenvolver modelos quantitativos que possibilitem simular a ocupação e o desflorestamento nessa região, avaliar suas causas e consequencias econômicas e ambientais, bem como os custos e benefocios das alternativas de politicas governamentais.

A base de dados inclui informações sobre vàrias caracteristicas da vegetação florestal da Amazônia Brasileira, permitindo estimar as diferenças regionais do seu volume de madeira e conteúdo de biomassa. Essas informações, organizadas em nivel municipal, permitem tornar mais detalhadas em termos geogràficos, e portanto mais precisas, as estimativas do potencial econômico da exploracáo de madeira, bem como as emissões de CO2 resultantes do desflorestamento das vàrias regiões da Amazônia Brasileira.

2 - ESTIMATIVAS DE BIOMASSA DA AMAZONIA

A importancia da região Amazônica para a manutenção do equilibrio no nivel de carbono da atmosfera è amplamente reconhecida pela comunidade cientifica (Brown e Lugo,1982; Fearnside,1985; Woodwell et al,1983). Entretanto o mesmo não ocorre quando se trata de quantificar esta importancia. A estimativa da quantidade de carbono estocada na biomassa da floresta amazônica, das quantidades de carbono emitidas para a atmosfera pelas queimadas e da perda e acumulação de carbono pela floresta atravès de seus mecanismos naturais são objeto ainda de muitas discussões e incertezas.

Diversos autores tem-se utilizado de critèrios diferentes nestas estimativas. O critèrio mais difundido inicialmente foi o da utilização de dados de biomassa mèdia da floresta obtidos diretamente no campo atravès de amostragem destrutivas, extrapolando-se então este valor para a àrea total coberta por florestas na região (Brown e Lugo,1982; Fearnside,1985).

Brown e Lugo (1986,1992) criticam esse enfoque, afirmando que o uso de dados coletados em um ùnico e/ou alguns poucos locais, geralmente em parcelas amostrais de pequeno tamanho, não è compativel com a anàlise do problema a nivel regional ou global, jà que não considera a variação da biomassa a nivel regional ou geogràfico. Estes autores alertam ainda para a possibilidade de tendenciosidade na seleção das areas de amostragem, o que pode conduzir a uma superestimativa da biomassa total a nivel regional. Propòem a utilização de dados provenientes de inventàrios florestais, mais abundantes e geralmente cobrindo grandes extensões de terra, na estimativa da biomassa total em diferentes regiões geogràficas, levando-se em conta ainda as diversas formações florestais existentes nos tròpicos e as diferenças climàticas e de habitats, responsàveis por variações na biomassa florestal.

O uso deste novo enfoque sofreu vàrias criticas (Fearnside,1986;1992) devido ao fato de que grande parte dos inventàrios florestais realizados na região teve por objetivo principal a estimativa do volume de madeira para exploração comercial, concentrando-se basicamente no extrato arbòreo e geralmente desprezando-se a biomassa das plantas sem valor comercial potencial. Deste modo, o uso destes dados poderia conduzir a uma subestimativa da biomassa total da floresta. Brown e Lugo (1992) rebatem as criticas, observando que as plantas não inventariadas contribuem com apenas uma pequena parte da biomassa total, que està concentrada principalmente nos troncos e copas das àrvores maiores.

Sombroek (1992), comentando os trabalhos citados, ressalta a grande variação na biomassa das florestas na região, geralmente ligada a fatores ambientais locais como solo e clima, alèm de alertar para a importancia da ação antròpica anterior à intensificação da colonização, geralmente negligenciada. Comenta ainda a importancia do carbono estocado na biomassa subterrànea e na matèria orgànica do solo, o qual, estimado pelo autor a partir de perfis de solo em diferentes partes da região, aparenta ser equivalente ao contido na biomassa aèrea. Para comprovar-se esta hipòtese são necessàrios mais estudos no campo, com maior abrangencia geogràfica.

De qualquer maneira, a metodologia proposta vem sendo refinada, com o uso de equações de regressão obtidas a partir de dados de levantamentos de biomassa, correlacionados a estimativas normalmente obtidas nos inventàrios florestais, tais como Dap, àrea basal e altura mèdia da floresta, permitindo ainda estimar-se a biomassa dos ou-

tros componentes da floresta através do uso de fatores de correção (Brown & Lugo,1992).

Entretanto, esforços devem ser feitos no sentido de se avaliar com maior precisão a biomassa de cada um dos diversos componentes dos ecossistemas amazônicos, pois somente deste modo poderá ser estimada a importancia de cada para a biomassa total dos ecossistemas. Como tais estudos são de execução cara e trabalhosa, as incertezas quanto à biomassa dos ecossistemas da região deverão permanecer ainda por algum tempo.

3. INVENTARIOS FLORESTAIS NA AMAZONIA

O levantamento dos recursos florestais na Amazonia brasileira iniciou-se em meados da dêcada de 1950, com os inventários florestais realizados pela FAO em cooperação com o governo brasileiro na região do baixo Amazonas (Brasil,1974; Heinsdijk,1957). No inicio da dêcada de 1970 o Projeto RADAMBRASIL realizou o levantamento dos recursos naturais em toda a região Amazônica, com base em imagens de radar (Brasil,1973-83). O Projeto produziu informações cartográficas na escala 1:1.000.000 sobre diversos temas (geologia, solos, relevo, vegetação), acompanhadas de relatório técnicos com dados coletados no campo.

O estudo referente à vegetação concentrou-se principalmente na avaliação do potencial dos recursos florestais da região para exploração madeireira, bem como o de algumas espécies para o extrativismo. Desde então, diversos inventários florestais vem sendo feitos na região, concentrados principalmente em áreas destinadas a projetos de desenvolvimento (represas de Samuel e Balbina, projeto Carajás, projetos de colonização do INCRA, etc) e em áreas destinadas à pesquisa (FLONA Tapajós, Reservas do INPA).

Os diferentes inventários possuem algumas diferenças metodológicas, principalmete quanto ao tamanho minimo das árvores medidas e o tamanho das parcelas amostrais, devido aos diferentes objetivos de cada inventário e ao crescente conhecimento sobre as caracteristicas estruturais das florestas amazônicas. Além disso, os seus resultados se aplicam somente às áreas objeto dos levantamentos, que somadas cobrem apenas uma pequena porcentagem da área da AML. Deste modo, os dados do Projeto RADAMBRASIL são os únicos que cumprem os requisitos de uniformidade metodológica e abrangencia espacial, indispensáveis para a sua utilização no planejamento a nivel regional.

4. METODOLOGIA

4.1. Classificação da vegetação

Apesar de ser conhecida principalmente pela presença da flo-

resta tropical úmida, a Região Amazônica possui uma grande variedade de tipos de vegetação, que cobrem extensões variáveis de terra (Salgado e Brazão,1980). Após os levantamentos feitos pelo Projeto RADAMBRASIL, foi possível obter-se um conhecimento abrangente da vegetação em toda a região. Contudo ainda existem divergências quanto à classificação dos diferentes tipos de vegetação. Neste trabalho foi adotada a classificação utilizada por Salgado e Brazão (1988), desenvolvida por Veloso e Góes Filho (1982) a partir do sistema de classificação sugerido por Ellemberg e Mueller-Dombois (1965/6) para a UNESCO.

A tabela 1 mostra o recobrimento dos diferentes tipos de vegetação na região. O tipo de vegetação predominante é a Floresta Ombrófila Densa, que recobre cerca de 40% da região, seguida pela Floresta Ombrófila Aberta, cobrindo aproximadamente 21,5% da área da AML. A Campinarana, também conhecida como Caatinga Amazônica, recobre os solos arenosos da bacia do Rio Negro. A Savana (Cerrado), ocupa extensas áreas ao Sul/Sudeste da AML, o litoral do Amapá, parte de Roraima, bem como áreas isoladas circundadas pela floresta em toda a região, totalizando cerca de 14,3% da área total.

As Florestas Estacionais Semidecidual e Decidual ocupam áreas de transição, com ocorencia de um período seco de mais de tres meses, no Mato Grosso, Rondonia, Maranhão e Roraima. Ocorrem ainda as Áreas das Formações Pioneiras com influencia fluvial (várzeas e buritizais), fluvio-marinha (manguezais) ou marinha (restingas). Os Refúgios Ecológicos ocupam relevos residuais do Escudo Guianense. Têm importancia ainda as áreas classificadas como de Tensão Ecológica (ecotono) ou de contato entre dois ou mais tipos de vegetação, cobrindo 16% da região.

Tabela 1 - Tipos de vegetação da Amazônia Legal

Tipo de vegetação	Area (Km2)	%
Floresta Ombrófila Densa	1.997.348	40,12
Floresta Ombrófila Aberta	1.071.643	21,53
Floresta Estacional Semidecidual	62.840	1,26
Floresta Estacional Decidual	67.683	1,36
Campinarana	57.256	1,15
Savana	709.760	14,26
Savana Estépica	12.194	0,25
Formações Pioneiras	120.838	2,43
Refúgio Ecológico	440	-
Áreas de Tensão Ecológica	795.532	15,98
Total	4.978.247	100,00

Fonte: Araújo, Jordy e Fonseca (1986)

O dados disponiveis para o presente trabalho concentram-se nas Florestas Ombròfilas Densa e Aberta, que cobrem uma maior extensão territorial (61,65% da área total) e possuem biomassa e potencial madeireiro mais elevados, possuindo ainda uma diversidade biológica consideravelmente maior do que os outros tipos de vegetação. Entretanto, reconhecemos que devam ser feitos esforços no sentido de se avaliar com maior precisão o volume e a biomassa mèdia dos outros tipos de vegetação da região, para aprimorar-se ainda mais as estimativas dos estoques de carbono contido na vegetacão da Amazônia.

As Florestas Ombròfilas Densa e Aberta estão caracterizadas por diferentes formações, relacionadas ao habitat local, ou seja, o tipo de terreno e a altitude onde se encontra a floresta. Os dados utilizados se referem a um total de seis formações florestais, quatro para a Floresta Densa e duas para a Floresta Aberta, a seguir discriminadas:

- Floresta Densa Aluvial (Da) - recobre as planicies aluviais da região, sofrendo inundações periòdicas.

- Floresta Densa das Terras Baixas (Db) - recobre os terrenos com altitude menor do que 100 metros da planície Amazônica.

- Floresta Densa Submontana (Ds) - terrenos entre 100 e 600 metros de altitude.

- Floresta Densa Montana (Dm) - terrenos entre 600 e 1500 metros de altitude.

- Floresta Aberta das Terras Baixas (Ab) - terrenos abaixo de 100 metros de altitude.

- Floresta Aberta Submontana (As) - terrenos entre 100 e 600 metros de altitude.

4.2. Amostragem da Vegetação

O material bàsico utilizado para e execução do projeto consistiu-se de còpias do mapa de vegetação, contendo a localização dos pontos de amostragem (Oliveira Filho,no prelo) e do mapa da divisão territorial da AML, ambos na escala 1.2.500.000, bem como de tabelas contendo os dados de aproximadamente 2200 amostras do inventàrio florestal realizado pelo Projeto RADAMBRASIL. O material foi cedido pelo IBGE através da sua Diretoria de Geociências..

Através da superposição dos mapas, identificou-se os pontos de amostragem localizados dentro dos limites de cada município. Foram elaboradas tabelas para cada estado da AML, contendo a numeração do pontos de amostragem por município, reunidos em micro-regiões homogêneas. A etapa seguinte consistiu na obtencão dos dados sobre cada

ponto de amostragem nas tabelas.

Conforme a descrição da metodologia utilizada no inventário florestal (Brasil,1973-83), as amostras foram selecionadas de acordo com as caracteristicas predominantes em cada folha ao milionêsimo, através da anâlise dos diferentes padrões observados nas imagens de radar, procurando-se cobrir a variacão da vegetação na região. A área das amostras foi de um hectare (20x500m). Foram medidas todas as árvores com circunferencia a 1,30 metros (Cap) maior do que 100cm (Dap>31,8 cm). Foram medidos o Cap e a altura do fuste ou altura comercial. O volume total (V) foi calculado através da fórmula:

V = 3,1416 * D2 * H * F , onde
D = Diâmetro (cm)
H = Altura do fuste (m)
F = fator de forma (0,7)

Numa primeira etapa, os dados aproveitados foram o tipo de formação florestal, o número de árvores e de espécies, o diâmetro médio à altura do peito (Dap), a altura mèdia dos fustes, e o volume total de madeira com casca de cada amostra. Numa segunda etapa serão incluidos dados sobre o volume por classe de comercialização (mercados externo/interno). As tabelas foram organizadas em planilhas do tipo Lotus 123, compativeis com micro-computadores IBM-PC AT/XT.

4.3 . Estimativa da Biomassa

A partir dos dados originais, foi estimado o volume mèdio da floresta para cada municipio (vide Anexo). A biomassa aérea mèdia da floresta nos municipios foi estimada, a partir do volume mèdio, através das seguintes equações, desenvolvidas por Brown e Lugo (1992):

SB = VEF * WD Eq. 1

TAGB = Vol (m3/ha) * VEF * WD * BEF Eq. 2 , onde

TAGB = Biomassa aérea total
VEF = Fator de expansão do volume (1,25)
WD = Densidade mèdia da madeira (0,69 Mg/cm3)
SB = Biomassa em pé de árvores com Dap > 10 cm
BEF = Fator de expansão da biomassa (1,74 , para SB > 190 Mg/ha)
BEF = Exp (3,213 - 0,506 Ln (SB)), para SB < 190 Mg/ha

5 - RESULTADOS E DISCUSSÃO

5.1 - Localização dos Pontos de Amostragem

A Tabela 2 apresenta um sumário dos resultados a nivel estadual. Foram identificados pontos de amostragem em 147 municipios, cobrindo 30% do total dos municipios ou 73% da área total da AML. Os

estados com o maior número de pontos de amostragem foram o Amazonas (1108), Pará (333) e Mato Grosso (219). Em termos da percentagem dos municípios com amostras, sobressaem-se o Amazonas, Acre, Roraima e Rondonia, nos quais a maioria dos municípios foram amostrados. Os mesmos estados se destacam pela área amostrada em relação à área total do estado. Os estados de Tocantins e Goiás por sua vez não possuem nenhum ponto de amostragem em seu território. O Maranhão está coberto por apenas oito amostras.

Há diversas razões para esta cobertura amostral desigual. Em primeiro lugar, os estados de Tocantins, Mato Grosso e Maranhão possuem grande parte do seu território coberto por cerrados ou savanas, florestas estacionais e áreas de transição ou de tensão ecológica, tipos de vegetação não abrangidos pelos dados disponíveis. Nos estados do Amapá e Roraima, as áreas de savana pertencem a poucos municípios com grande extensão territorial, sendo que alguns possuem também áreas com floresta, incluídas no levantamento.

Tabela 2 - Resumo dos Resultados por Estado da Amazonia Legal

	No. de Municipios	Area km2	% do Estado	Volume Medio m3/ha
Acre	11	149.617	98.05	110.700
Amapa	5	91.526	65.81	190.622
Amazonas	54	1.442.002	93.06	119.187
Maranhao	6	38.937	14.96	122.201
Mato Grosso	16	279.600	30.88	85.800
Para	32	962.848	78.49	115.191
Rondonia	17	196.253	82.42	112.071
Roraima	16	197.253	87.50	98.454
AML	147	3.597.683	72.95	119.278

Uma segunda razão é que nas áreas levantadas no início do Projeto RADAMBRASIL, incluindo o Maranhão e partes do Pará e de Tocantins, foram feitas poucas amostras de inventário. A medida que o projeto prosseguiu o levantamento em outras áreas, os trabalhos de campo foram sendo intensificados, resultando num maior número de amostras feitas nessas áreas em relação ás áreas iniciais.

Um terceiro motivo que não deve ser desprezado é que na época da execução dos levantamentos, o processo de colonização da região já se encontava em andamento em diversas áreas, como ao longo da rodovia Belém-Brasilia, incluindo-se ainda as áreas de colonização mais antiga, como a zona Bragantina no Pará e a zona dos babaçuais no Maranhão. Nestas áreas, a falta de amostras pode ter sido ocasionada simplesmente pela falta de florestas, em grande parte já removidas.

5.2 - Volume de Madeira

Oliveira Filho (1991), utilizando-se da mesma base de dados, não encontrou diferenças volumètricas significativas entre as seis formações das Florestas Ombròfilas Densa e Aberta, considerando toda a àrea da Amazonia Legal. A anàlise dos dados a nível regional e local demonstra contudo a existencia de variações regionais nos dados quantitativos, não considerando-se a formação florestal na qual as amostras estão localizadas (Tabela 2,Anexos). Como exemplo marcante, o volume mèdio do Amapà è o dobro do do Mato Grosso. Nos outros estados, a mèdia do volume se situa entre 100-120 m3/ha, mas com variações significativas entre os municípios.

A vegetação responde de modo diferenciado às variações dos fatores ambientais e de suas interações, e estas por sua vez variam de modo significativo nas diferentes regiões geogràficas. O menor volume mèdio registrado no Mato Grosso, em Roraima e alguns municípios do Parà, è causado provavelmente pela ocorrencia de um perìodo seco mais longo. Novas anàlises poderão indicar a influencia de outros fatores, como a fertilidade do solo e o relevo, no volume das florestas da região.

O presente trabalho evidencia de modo claro as diferenças regionais quanto ao volume mèdio nas florestas da AML, indicando as àreas de maior ou menor potencial volumètrico, a partir da atual divisão territorial da região. A disponibilidade destes dados poderà portanto servir para o refinamento das anàlises e dos modelos econômicos e ambientais utilizados no planejamento do desenvolvimento da região (Reis e Guzmàn,1992). No entanto, os dados devem ser utilizados com as devidas reservas, devido à pequena intensidade amostral em diversos municípios.

5.3. Biomassa da Floresta

A estimativa da biomassa da floresta a partir do volume de madeira comprovou a grande variação desta na diferentes regiões da AML. Os resultados foram agrupados por municipio e estado (Vide Anexo). A mèdia geral não ponderada para a AML foi de 232,041 Tn/ha. A biomassa total da àreas ocupadas pelas florestas ombròfilas, calculada a partir da biomassa mèdia da AML, è igual a 35,607 GT. O valor equivalente em Carbono, considerando-se um teor de 50% na biomassa, è de 16,803 GT de C.

A tabela 3 mostra a estimativa do Carbono liberado anualmente pela queima da biomassa aèrea no perìodo 1978/89. Utilizou-se das estimativas existentes da àrea jà desmatada na AML (INPE,1992), considerando que a totalidade do Carbono contido na biomassa è liberada para a atmosfera. A quantidade total para a AML foi de 0,245 GT/ano, ou um total de 4,727 GT de C atè 1989. Este valor pode ser considerado ainda alto, pois parte da àrea desflorestada era coberta por flo-

restas estacionais ou de transição (áreas de contato), com biomassa média consideravelmente menor (Brown e Lugo,1992). Infelizmente não há dados disponíveis sobre a incidencia do desmatamento nos diferentes tipos de floresta da AML.

TABELA 3 - Biomassa aérea média e carbono liberado para a atmosfera no período 1978/1989

	Desflorestamento 78/89 km2/ano	Biomassa média Tn/ha	Carbono liberado (1000000 T/ano)
Acre	620	236,299	7,325
Amapá	60	309,071	0,927
Amazonas	1510	245,081	18,504
Maranhao	2450	248,124	30,395
Mato Grosso	5140	208,351	53,546
Para	6990	240,987	84,225
Rondonia	2340	237,740	27,815
Roraima	290	223,003	3,234
Tocantins	1650	232,487	19,180
AML	21130	232,041	245,152

A base de dados organizada a partir deste trabalho poderá servir de subsídio para um refinamento ainda maior da estimativa da biomassa total contida nas florestas densa e aberta, incluindo-se as variações regionais a nível de município, microrregião e estado. Esta base poderá vir a ser ampliada, com a adição de dados provenientes de outros estudos e inventários florestais executados e/ou em execução, bem como de dados referentes a outros tipos de vegetação natural (savana, florestas estacionais, campinarana) ou antropizada (florestas secundárias, babaçuais, pastagens) existentes na região. Para tanto, é necessário que os pontos de amostragem estejam referenciados geograficamente (mapas, coordenadas) e que as metodologias utilizadas sejam compatíveis com a análise global dos dados.

5. CONCLUSÃO

A metodologia empregada mostrou-se compatível com o objetivo do trabalho. A escala de 1:2.500.000 possibilita uma melhor visualização dos dados para a Amazonia Legal, permitindo o refinamento das análises a nível regional, sem perda no entanto do nível de detalhamento, essencial para a incorporação das diferenças regionais nas análises.

A base de dados obtida nos inventários florestais executados pelo Projeto RADAMBRASIL, organizada a nível municipal, possibilita

uma avaliação preliminar do potencial florestal de cada município ou microrregião. Permite ainda fazer-se uma estimativa da biomassa existente e/ou queimada nas àreas de expansão da fronteira agrícola, ou atè mesmo anàlises de cunho ecològico ou florístico, como a variação do nûmero de àrvores, de espècies, da altura mèdia e do volume nas florestas ao longo da região. A apresentação dos dados em formato digital facilita a sua difusão, aplicação e combinação com outros dados sobre a região.

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QUADRO DOS VALORES MEDIOS DO VOLUME DE MADEIRA E
BIOMASSA AEREA POR MUNICIPIO DA AMAZONIA LEGAL

TABELA 1 - AMAZONAS

MUNICIPIO	AREA?1 Km2	VOLUME m3/ha	BIOMASSA Tn/ha	SB	LN(SB)	BEF
130090002 Alvaraes	5911	111.113	236.73420	95.8349625	4.562627	2.470227
130090008 Anama	2415	169.062	291.27814	145.815975	4.982345	1.997573
130090010 Anori	6578	129.397	255.23705	111.604912	4.714965	2.286969
130040020 Atalaia do Norte	75406	110.425	236.00894	95.2415625	4.556416	2.479003
130100030 Autazes	7421	115.549	241.35687	99.6610125	4.601774	2.421778
130080040 Barcelos	120418	112.435	238.12145	96.9751875	4.574455	2.455488
130040060 Benjamin Constant	8621	113.318	239.04343	97.736775	4.582277	2.445788
130100063 Beruri	16833	108.377	233.83639	93.4751625	4.537695	2.501588
130100068 Boa Vista do Ramos	2575	78.628	199.55762	67.81665	4.216807	2.942605
130060070 Boca do Acre	22015	92.230	215.92356	79.548375	4.376365	2.714367
130070080 Borba	43636	118.800	244.68789	102.465	4.629521	2.388014
130100083 Caapiranga	9317	129.933	255.75879	112.067212	4.719098	2.282191
130060090 Canutama	30400	119.679	245.58058	103.223137	4.636893	2.379123
130100110 Careiro	6405	79.199	200.27221	68.3091375	4.224043	2.931851
130900120 Coari	57064	129.058	254.90650	111.312525	4.712341	2.290007
130900130 Codajas	18185	153.882	278.05067	132.723225	4.888265	2.094966
130050140 Eirunepe	15753	113.667	239.40684	98.0377875	4.585352	2.441985
130050150 Envira	12848	140.123	265.47817	120.856087	4.794600	2.196647
130040160 Fonte Boa	12092	152.963	277.22911	131.930587	4.882275	2.101325
130070170 Humaita	32494	135.008	260.64581	116.4444	4.757413	2.238371
130050180 Ipixuna	13533	104.735	229.92094	90.3339375	4.503513	2.545233
130100185 Iranduba	2318	112.300	237.98016	96.85875	4.573253	2.456981
130100190 Itacoatiara	6193	149.880	274.45462	129.2715	4.861914	2.123086
130050195 Itamarati	25495	117.765	243.63248	101.572312	4.620770	2.398611
130100200 Itapiranga	4348	108.835	234.32404	93.8701875	4.541912	2.496256
130090210 Japura	55572	96.048	220.29386	82.8414	4.416927	2.659224
130050220 Jurua	20233	135.848	261.44568	117.1669	4.763616	2.231357
130040230 Jutai	69264	140.157	265.50999	120.885412	4.794843	2.196377
130060240 Labrea	67803	108.313	233.76816	93.4199625	4.537105	2.502336
130100250 Manacapuru	7201	75.902	196.10933	65.465475	4.181522	2.995614
130100255 Manaquiri	3955	89.147	212.32732	76.8892875	4.342366	2.761468
130100260 Manaus	10962	96.195	220.46035	82.9681875	4.418457	2.657167
130070270 Manicore	66243	136.099	261.68420	117.385387	4.765462	2.229274
130090280 Maraa	16617	108.490	233.95680	93.572625	4.538737	2.500269
130100290 Maues	40617	128.526	254.38688	110.853675	4.708211	2.294798
130100300 Nhamunda	14093	123.757	249.67935	106.740412	4.670399	2.339126
130100310 Nova Olinda do Norte	7300	110.194	235.76492	95.042325	4.554322	2.480630
130080320 Novo Airao	37859	117.030	242.88013	100.938375	4.614510	2.406221
130070330 Novo Aripuana	13533	136.921	262.46377	118.094362	4.771483	2.222492
130100340 Parintins	6119	118.143	244.01847	101.898337	4.623975	2.394724
130060350 Pauini	43005	141.111	266.40123	121.708237	4.801626	2.188851
130100353 Presidente Figueiredo	30032	107.282	232.66627	92.530725	4.527540	2.514475
130100356 Rio Preto da Eva	5802	144.037	269.11589	124.231912	4.822150	2.166238
130080360 Santa Isabel do Rio Negro	61752	129.256	255.09962	111.4833	4.713874	2.298231
130040370 Santo Antonio do Ica	12221	115.241	241.03884	99.3953625	4.599105	2.425051
130080380 Sao Gabriel da Cachoeira	108530	106.770	232.11707	92.089125	4.522756	2.520569
130040390 Sao Paulo de Olivenca	19729	141.817	267.05883	122.317162	4.806617	2.183330
130100395 Sao Sebastiao do Uatuma	11182	148.616	273.30876	128.1813	4.853445	2.132204
130040406 Tabatinga	3154	107.633	233.04201	92.8334625	4.530807	2.510323

130060410	Tapaua	89032	105.653	230.91426	91.1257125	4.512240	2.534018
130090420	Tefe	23676	127.789	253.66523	110.216012	4.702460	2.301486
130040423	Tonantins	6391	99.380	224.03654	85.71525	4.451030	2.613730
130090426	Uarini	10152	133.306	259.01738	114.976425	4.744727	2.252786
130100430	Urucara	21699	108.220	233.66899	93.33975	4.536246	2.503424
13	Amazonas	1549586	119.187	9114.5469	102.798787	7861.296	88.66395

Area Total dos Municipios	1442002
% da Area do Estado	93.06
No. de Municipios	54

TABELA 2 - ACRE

	MUNICIPIO	AREA?1 Km2	VOLUME m3/ha	BIOMASSA Tn/ha	SB	LN(SB)	BEF
120030005	Assis Brasil	3991	75.851	196.04422	65.4214875	4.180850	2.996633
120030010	Brasileia	3885	106.611	231.94625	91.9519875	4.521266	2.522471
120020020	Cruzeiro do Sul	24401	98.161	222.67477	84.6638625	4.438688	2.630104
120020030	Feijo	19632	138.070	263.54952	119.085375	4.779840	2.213114
120020033	Mancio Lima	6911	99.807	224.51155	86.0835375	4.455318	2.608066
120030034	Manoel Urbano	21055	104.137	229.27149	89.8181625	4.497787	2.552618
120030040	Rio Branco	14294	120.311	246.22038	103.768237	4.642159	2.372791
120030045	Senador Guiomard	2161	194.553	312.20359	167.601962	5.122784	1.860547
120030050	Sena Madureira	23051	101.714	226.62052	87.728325	4.474244	2.583208
120020060	Tarauaca	22099	118.013	243.88579	101.786212	4.622874	2.396059
120030070	Xapuri	8137	133.750	259.44320	115.359375	4.748052	2.248999
12	Acre	152589	110.700	236.29911	95.47875	4.558903	2.474886

Area Total dos Municipios	149617
% da Area do Estado	98.05
No. de Municipios	11

TABELA 3 - MATO GROSSO

	MUNICIPIO	AREA?1 Km2	VOLUME m3/ha	BIOMASSA Tn/ha	SB	LN(SB)	BEF
513320025	Alta Floresta	20975	83.985	206.16209	72.4370625	4.282718	2.846085
513320140	Aripuana	67672	119.272	245.16766	102.8721	4.633486	2.383227
513320320	Colider	4121	79.991	201.25908	68.9922375	4.233993	2.917126
513320350	Diamantino	13324	55.659	168.24712	48.0058875	3.871323	3.504718
513320410	Guaranta do Norte	9831	73.830	193.44620	63.678375	4.153845	3.037863
513320455	Itauba	6908	39.622	142.24393	34.173975	3.531464	4.162346
513320510	Juara	13112	77.504	198.14324	66.8472	4.202409	2.964121
513320515	Juina	26444	94.005	217.96649	81.0793125	4.395427	2.688312
513320558	Marcelandia	14591	82.462	204.30668	71.123475	4.264417	2.872563
513320621	Nova Canaa do Norte	7711	62.414	178.04200	53.832075	3.985869	3.307359
513320629	Paranaita	4484	69.091	187.20928	59.5909875	4.087504	3.141570
513320642	Peixoto de Azevedo	17363	63.559	179.64810	54.8196375	4.004048	3.277075
513320680	Porto dos Gauchos	16986	38.323	139.92076	33.0535875	3.498130	4.233149
513320730	Rio Claro	26550	73.268	192.71736	63.19365	4.146203	3.049631
513320777	Santa Terezinha	12042	75.104	195.08807	64.7772	4.170953	3.011678
513620860	Vila Rica	7486	71.266	190.09778	61.466925	4.118499	3.092684

51	Mato Grosso	905441	85.800	208.35114	74.0025	4.304098	2.815460

Area Total dos Municipios	279600
% da Area do Estado	30.88
No. de Municipios	16

TABELA 4 - RONDONIA

	MUNICIPIO	AREA91 Km2	VOLUME m3/ha	BIOMASSA Tn/ha	SB	LN(SB)	BEF
110010001	Alta Floresta D'Oeste	4985	84.293	206.53524	72.7027125	4.286378	2.840818
113690034	Alvorada D'Oeste	2838	73.585	193.12881	63.4670625	4.150521	3.042977
110010002	Ariquemes	14280	130.683	256.48702	112.714087	4.724854	2.275554
110010004	Cacoal	4499	105.651	230.91212	91.1239875	4.512221	2.534043
110010005	Cerejeiras	10605	62.362	177.96871	53.787225	3.985035	3.308754
110010008	Costa Marques	21116	99.899	224.61376	86.1628875	4.456239	2.606850
110010009	Espigao D'Oeste	4669	97.588	222.03170	84.16965	4.432834	2.637906
110010010	Guajara-Mirim	25258	97.483	221.91366	84.0790875	4.431757	2.639344
110010011	Jaru	10267	133.479	259.18338	115.125637	4.746024	2.251309
110010012	Ji-Parana	6907	104.120	229.25300	89.8035	4.497623	2.552829
110010015	Ouro Preto do Oeste	6162	128.307	254.17266	110.664787	4.706505	2.296779
110010018	Pimenta Bueno	10664	111.615	237.26196	96.2679375	4.567135	2.464600
110010020	Porto Velho	52510	119.274	245.16969	102.873825	4.633503	2.383207
110010025	Presidente Medici	1451	118.500	244.38246	102.20625	4.626992	2.391071
110010028	Rolim de Moura	3222	137.774	263.27025	118.830075	4.777694	2.215518
113690029	Santa Luzia D'Oeste	1539	105.116	230.33374	90.66255	4.507144	2.540561
110010030	Vilhena	15543	77.315	197.90440	66.6841875	4.199967	2.967786
11	Rondonia	238439	112.071	237.74031	96.6612375	4.571212	2.459520

Area Total dos Municipios	196514
% da Area do Estado	82.42
No. de Municipios	17

TABELA 5 - RORAIMA

	MUNICIPIO	AREA91 Km2	VOLUME m3/ha	BIOMASSA Tn/ha	SB	LN(SB)	BEF
140110005	Alto Alegre	25501	107.475	232.87295	92.8971875	4.529338	2.512190
140110010	Boa Vista	42307	99.185	223.81927	85.5470625	4.449066	2.616329
140110020	Cararai	54088	96.079	220.32898	82.8681375	4.417250	2.658790
140110030	Mucajai	21297	78.955	199.96717	68.0986875	4.220957	2.936432
140110050	Sao Joao da Baliza	18898	110.912	236.52255	95.6616	4.560816	2.472492
140110060	Sao Luiz	35172	116.931	242.77861	100.852987	4.613663	2.407252
14	Roraima	225436	98.454	223.00286	84.916575	4.441669	2.626140

Area Total dos Municipios	197253
% da Area do Estado	87.50
No. de Municipios	6

TABELA 6 - PARA

	Area	Volume	Biomassa			
	Km2	m3/ha	Tn/ha	SB	LN(SB)	BEF
150160030 Alfua	5439	95.720	219.92190	82.5585	4.413507	2.663831
150120040 Alenquer	22692	126.822	252.71516	109.383975	4.694864	2.310349
150140050 Almeirim	67870	163.462	286.47126	140.985975	4.948660	2.031913
150150060 Altamira	153862	79.629	200.80862	68.6800125	4.229458	2.923829
150150070 Anajas	6672	101.533	226.42122	87.5722125	4.472463	2.585537
150130100 Aveiro	21085	123.114	249.03766	106.185825	4.665190	2.345300
150160180 Breves	9763	134.416	260.08059	115.9338	4.753019	2.243354
150200270 Conceicao do Araguaia	8780	86.451	209.13058	74.5639875	4.311657	2.804713
150160280 Curralinho	3358	130.761	256.56263	112.781362	4.725451	2.274867
150120300 Faro	15376	118.784	244.67161	102.4512	4.629386	2.388177
150130360 Itaituba	165578	135.854	261.45138	117.174075	4.763660	2.231307
150190370 Itupiranga	15890	124.223	250.14335	107.142337	4.674158	2.334682
150190380 Jacunda	9207	208.865	323.34549	180.146062	5.193767	1.794907
150120390 Juruti	6942	56.728	169.83575	48.9279	3.890347	3.471143
150190420 Maraba	14320	184.087	303.79078	158.775037	5.067488	1.913340
150180470 Moju	11726	119.244	245.13922	102.84795	4.633251	2.383511
150120480 Monte Alegre	26762	107.610	233.01740	92.813625	4.530593	2.510594
150120510 Obidos	28704	153.127	277.37770	132.073762	4.883360	2.100172
150120530 Oriximina	109122	130.565	256.37259	112.612312	4.723951	2.276594
150220550 Paragominas	21903	122.580	248.50347	105.72525	4.660843	2.350464
150160560 Portel	22315	167.442	289.89597	144.418725	4.972716	2.007329
150140590 Porto de Moz	19104	130.530	256.33863	112.582125	4.723682	2.276903
150140600 Prainha	10422	157.047	280.86124	135.453037	4.908624	2.073495
150200613 Redencao	5240	116.522	242.35873	100.500225	4.610159	2.411524
150220618 Rondon do Para	13471	157.259	281.04847	135.635887	4.909973	2.072080
150200670 Santana do Araguaia	10958	71.848	190.86312	61.9889	4.126632	3.079982
150120680 Santarem	26058	166.648	289.21606	143.7339	4.967963	2.012163
150150730 Sao Felix do Xingu	80205	63.739	179.89925	54.9748875	4.006876	3.272389
150190750 Sao Joao do Araguaia	3223	93.161	216.99755	80.3513625	4.386409	2.700608
150160780 Sen. Jose Porfirio	33689	149.955	274.52245	129.336187	4.862415	2.122549
150190810 Tucurui	5124	146.138	271.04797	126.044025	4.836431	2.150423
150260830 Viseu	8987	192.792	310.80438	166.2831	5.113691	1.869127
15 Para	1227530	115.191	240.98717	99.3522375	4.598671	2.425583
Area Total dos Municipios	962048					
% da Area do Estado	78.44					
No. de Municipios	32					

TABELA 7 - AMAPA

Municipio	Area91	Volume	Biomassa			
	Km2	m3/ha	Tn/ha	SB	LN(SB)	BEF
160280010 Amapa	13060	121.165	247.08222	104.504812	4.649233	2.364314
160280020 Calcoene	16965	191.565	309.82563	165.224812	5.107307	1.875176
160270030 Macapa	24557	174.955	296.25029	150.898687	5.016608	1.963239
160270040 Mazagao	12032	186.673	305.69151	161.005462	5.081438	1.899882
160270050 Oiapoque	24912	204.901	320.29926	176.727112	5.174606	1.812394
16 Amapa	139068	190.622	309.07127	164.411475	5.102372	1.879864
Area Total dos Municipios	91526					
% da Area do Estado	65.81					
No. de Municipios	5					

TABELA 6 - MARANHAO

	MUNICIPIO	AREA91 Km2	VOLUME m3/ha	BIOMASSA Tn/ha	SB	LN(SB)	BEF
210340200	Boa Jardim	8468	104.105	229.23669	89.7905625	4.497479	2.553015
210290260	Candido Mendes	3358	153.080	277.31595	132.01425	4.882909	2.100651
210290290	Caruatapeba	12128	120.645	246.55781	104.056312	4.644932	2.369465
210380530	Imperatriz	5853	107.190	232.56768	92.451375	4.526682	2.515567
210340690	Moncao	4441	155.680	279.65087	134.274	4.899882	2.082688
210291240	Turiacu	4689	112.310	237.99063	96.867375	4.573342	2.456870
21	Maranhao	278323	122.201	248.12361	105.398362	4.657747	2.354150

Area Total dos Municipios 38937
% da Area do Estado 13.99
No. de Municipios 6

Amazonia Legal

Area Total dos Municipios 3597683
% da Area da AML 73.32
No. Total de Municipios 147

ESTIMATIVAS DA EXTENSÃO DA MALHA RODOVIARIA EM NIVEL MUNICIPAL PARA A AMAZÔNIA LEGAL

Relatório de pesquisa elaborado para o projeto "A Economia do Desflorestamento da Amazônia Brasileira", financiado pelo GESEP/IPEA.

Maria José Silveira Pessôa

ESTIMATIVAS DA EXTENSÃO DA MALHA RODOVIARIA EM NIVEL MUNICIPAL PARA A AMAZÔNIA LEGAL, 1976.

A disponibilidade de dados referentes à malha rodoviária, a nível municipal, constitui-se num fator importante na estimação do processo de desmatamento da Amazônia, uma vez que a extensão das rodovias é um dos determinantes fundamentais de tal processo.

Entretanto, as estatiscas disponiveis apresentam esses dados somente agregados a nivel Estadual. Para a extensão de rodovias por municcipio, foram feitas estimativas a partir dos mapas rodoviários por Estado, publicados no Album Cartográfico Rodoviário, elaborado pelo departamento nacional de estradas de Rodagem, DNER, em 1977. As informações contidas nessa publicação referem-se à situação de dezembro de 1976. Os mapas indicam rodovias federais e estaduais (ou territoriais), pavimentadas e não pavimentadas, em implantação, leito natural, etc. Entretanto, não são indicados os limites municipais e as quilometragens das rodovias. Outro problema é que o conjunto de mapas não segue o padrão de escalas dos mapas elaborados pelo IBGE, o que dificulta a compatibilização dos mesmos com outros mapas que apresentem esses limites.

Uma deficiencia básica das estimativas obtidas é não incluir as rodovias municipais que não estão identificadas nos mapas.

Note-se, contudo, que na análise dos fatôres determinantes do desmatamento interessa, sobretudo, a identificação das rodovias estaduais e federais pois essas podem ser consideradas como fatôres exógenos em relação ao processo de desmatamento, tanto no sentido de antecedência temporal como na motivação para sua construção. As rodovias municipais, em contraposição, seriam endógenas, no sentido de serem motivadas e avançarem simultaneamente ao processo de desmatamento.

Na Tabela 1 são apresentadas as estimativas da rede rodoviária por município, refentes às estradas pavimentadas, não pavimentadas, em pavimentação e em implantaçã e, na Tabela 2, são apresentadas as estimativas referentes à rede rodviária planejada.

Tabela 1
Amazonia Legal - 1975
Extensao da malha rodoviaria por municipio.
(Em Km)

MUNICIPIO	CODIGO GEOGRAFICO	Extensao da Malha Rodoviaria											
		Em Trafego						Em Implantacao			Em Pavimentacao		
		Pavimentada			Nao Pavimentada								
		Estadual	Federal	Total	Estadual	Federal	Total	Estadual	Federal	Total	Estadual	Federal	Total
RONDONIA													
ALTA F STA D'OESTE	110010001												
ALVORADA D'OESTE	113690034												
QUEMES	110010002					210.65	210.65						
IXI	113710003				7.58		7.58						
ACOAL	110010004					60.62	60.62						
EREJEIRAS	110010005												
ORADO DO OESTE	110010006												
TA MARQUES	110010008				69.71		69.71						
SPIGAO D'OESTE	110010009												
UAJARA-MIRIM	110010010					45.47	45.47		71.23	71.23			
U	110010011					56.07	56.07						
PARANA	110010012					45.47	45.47						
ACHADINHO DO OESTE	113690013				30.31		30.31						
OVA BRASILANDIA DO OESTE	113690029												
O PRETO DO OESTE	110010015					53.04	53.04						
ENTA BUENO	110010018					143.97	143.97						
ORTO VELHO	110010020		15.15	15.15		624.39	624.39						
RESIDENTE MEDICI	110010025					28.79	28.79						
IK DE MOURA	110010028					15.15	15.15						
TA A DO OESTE	113690034												
AO MIGUEL DO GUAPORE	110010032												
ILHENA	110010030				22.73	113.66	136.40						
A NOVA DO MARMORE	110010033					78.81	78.81		90.93	90.93			
OTAL		0.00	15.15	15.15	130.33	1476.09	1606.43	0.00	162.16	162.16	0.00	0.00	0.00
ESTADO DO ACRE													
SSIS BRASIL	120030005								22.73	22.73			
SILEIA	120030010								83.35	83.35		15.15	15.15
ZEIRO DO SUL	120020020								60.62	60.62			
EIJO	120020030					45.47	45.47		106.09	106.09			
ANCIO LIMA	120020033								133.36	133.36			
OEL URBANO	120030034					15.15	15.15		57.59	57.59			
CIDO DE CASTRO	120030038				37.89	30.31	68.20						
IO BRANCO	120030040	9.09	37.89	46.98		136.40	136.40		30.31	30.31		30.31	30.31
NA MADUREIRA	120030050					128.78	128.78	30.31		30.31			
ADOR GUIONARD	120030045	22.73	22.73	45.47	22.73	68.20	90.93					22.73	22.73
AUACA	120020060					15.15	15.15		193.92	193.92			

APURI	120030070							60.62		60.62	22.73	128.82	151.55
[redacted]L		31.83	60.62	92.45	60.62	439.44	500.07	90.93	687.97	778.90	22.73	197.01	219.74
[redacted] ESTADO DO AMAZONAS													
[redacted]LVARAES	130090002												
[redacted]KATURA	130040006												
[redacted]	130090008												
[redacted]	130090010												
[redacted]UI	130100014					203.72	203.72						
[redacted]TALAIA DO NORTE	130040020					125.94	125.94						
[redacted]ZES	130100030												
[redacted]ELOS	130080040					92.60	92.60		92.60	92.60			
[redacted]RREIRA	130100050												
[redacted]NJAMIN CONSTANT	130040060												
[redacted]RI	130100063												
[redacted]VISTA DO RAMOS	130100068												
[redacted]CA DO ACRE	130060070					92.60	92.60						
[redacted]RBA	130070080		92.60	92.60									
[redacted]RANGA	130100083												
[redacted]AMA	130060090		92.60	92.60		92.60	92.60		37.04	37.04			
[redacted]RARI	130050100												
[redacted]REIRO	130100110		140.75	140.75									
[redacted]RO DA VARZEA	130100115		11.11	11.11									
[redacted]	130090120												
[redacted]DAJAS	130090130												
[redacted]RUNEPE	130050140												
[redacted]A	130050150												
[redacted] BOA	130040160												
[redacted]AJARA	130050165					55.56	55.56						
[redacted]MAITA	130070170		270.39	270.39		118.53	118.53						
[redacted]NA	130050180												
[redacted]UB	130100185	37.04		37.04				18.52		18.52			
[redacted]CDATIara	130100190	18.54		18.54	111.12		111.12						
[redacted]MARATI	130050195												
[redacted]RANGA	130100200												
[redacted]A	130090210												
[redacted]RUA	130050220												
[redacted]TAI	130040230												
[redacted]A	130060240								25.93	25.93			
[redacted]APURU	130100250				18.52		18.52						
[redacted]AQUIRI	130100255				18.52		18.52						
[redacted]NAUS	130100260	37.04	37.04	74.08		92.60	92.60						
[redacted]ORE	130070270		222.24	222.24		74.08	74.08						
[redacted]	130090280												
[redacted]ES	130100290					92.60	92.60						
[redacted]MUNDA	130100300												
[redacted]OLINDA DO NORTE	130100310												
[redacted]AIRAO	130080320												
[redacted]O ARIPUANA	130070330					74.08	74.08						
[redacted]INTINS	130100340												
[redacted]	130060350												

PRESIDENTE FIGUEIREDO	130100353					148.16	148.16						
RIO PRETO DA EVA	130100356	37.04		37.04									
SANTA ISABEL DO RIO NEGRO	130080360					222.24	222.24						
SANTO ANTONIO DO ICA	130040370												
SAO GABRIEL DA CACHOEIRA	130080380					44.45	44.45		85.19	85.19			
SAO PAULO DE OLIVENCA	130040390												
SAO SEBASTIAO DO UATUMA	130100395												
SILVES	130100400												
TABATINGA	130040406												
TAPAUA	130060410												
TEFE	130090420												
TONANTINS	130040423												
UARINI	130090426												
URUCARA	130100430												
URUCURITUBA	130100440												
TOTAL		129.66	866.74	996.39	148.16	1529.75	1677.91	18.52	240.76	259.28	0.00	0.00	0.00
ESTADO DE RORAIMA													
ALTO ALEGRE	140110005												
BOA VISTA	140110010				330.38	256.12	586.50						
BONFIM	140110015				43.95	131.85	175.80		30.31	30.31			
CARACARAI	140110020					387.97	387.97						
MUCAJAI	140110030					71.23	71.23						
NORMANDIA	140110040				68.20		68.20		80.32	80.32			
SAO JOAO DA BALIZA	140110050					45.47	45.47		113.66	113.66			
SAO LUIZ	140110060					150.03	150.03		83.35	83.35			
TOTAL		0.00	0.00	0.00	442.53	1042.66	1485.19	0.00	307.65	307.65	0.00	0.00	0.00
ESTADO DO PARA													
ABE A	150180010				36.00		36.00						
ACARA	150210020				97.20		97.20	126.00		126.00			
AFUA	150160030									9.00			
ALENQUER	150120040				108.80		108.80		10.80	10.80			
ALMEIRIM	150140050								198.00	198.00			
ALTAMIRA	150150060				64.80	25.20	90.00		378.00	378.00			
ANAJAS	150160070												
ANANINDEUA	150250080		7.20										
AUGUSTO CORREA	150240090												
AVEIRO	150130100					54.00	54.00						
BAGRE	150180110												
BAIAO	150180120												
BARCARENA	150180130				10.80		10.80						
BELEM	150250140		7.20	7.20									
BENEVIDES	150250150		7.20	7.20									
BOM JESUS DO TOCANTINS	150190157				64.80			14.40		14.40			
BONITO	150240160		14.40	14.40									
BRAGANCA	150240170	54.00	28.80	82.80									
BREJO GRANDE DO ARAGUAIA	150190175					28.8	28.80						

[redacted]EVES	150160180										
[redacted]JARU	150220190										
CACHOEIRA DO ARARI	150170200										
[redacted]META	150180210					10.80		10.80			
[redacted]PANEMA	150240220		21.60	14.40	36.00						
[redacted]PITAO POCO	150220230										
CASTANHAL	150240240			21.60	21.60						
[redacted]HAVES	150170250										
[redacted]LARES	150230260										
[redacted]NCEICAO DO ARAGUAIA	150200270					61.20		61.20			
CONCORDIA DO PARA	150220275					18.00		18.00			
[redacted]URIONOPOLIS	150190277					90.00		90.00			
[redacted]RRALINHO	150160280										
[redacted]URUCA	150230290										
DOM ELIZEU	150220293			18.00	18.00	54.00		54.00			
[redacted]ARO	150120300										
[redacted]RRAFAO DO NORTE	150220307										
[redacted]URUPA	150160310										
IGARA[redacted]CU	150240320			25.20	25.20						
[redacted]GARAPE-MIRI	150180330					10.80		10.80			
[redacted]HANGAPI	150240340										
[redacted]NITUIA	150220350			18.00	18.00						
ITAITUBA	150130360						406.80	406.80		162.00	162.00
[redacted]TUPIRANGA	150190370						64.80	64.80			
[redacted]CUNDA	150190380						136.80	136.80	36.00		36.00
[redacted]URUTI	150120390										
LIMOEIRO DO AJURU	150180400										
[redacted]AE DO RIO	150220405										
[redacted]GALHAES BARATA	150230410										
[redacted]RABA	150190420					90.00	54.00	144.00			
MARACANA	150230430										
[redacted]RAPANIM	150230440										
[redacted]CILANDIA	150140445						126.00	126.00			
MELGACO	150160450										
MOCAJUBA	150180460										
[redacted]JU	150180470					36.00		36.00	79.20		79.20
[redacted]NT [redacted]GRE	150120480					144.00		144.00			
[redacted]UANA	150170490										
NOVA TIMBOTEUA	150240500			14.40	14.40						
[redacted]IDOS	150120510					79.20		79.20		21.60	21.60
[redacted]IRAS DO PARA	150180520					36.00		36.00			
ORIXIMINA	150120530					18.00		18.00		594.00	594.00
OUREM	150220540			36.00	36.00						
[redacted]RILANDIA DO NORTE	150150060										
[redacted]CAJA	150160548						72.00	72.00			
PARAGOMINAS	150220550			115.20	115.20	108.00		108.00			
PARAUAPEBAS	150190553										
[redacted]IXE-BOI	150240560		7.20	14.40	21.60						
[redacted]NTA DE PEDRAS	150170570										
PORTEL	150160580										
PORTO DE MOZ	150140590					10.80		10.80			
[redacted]AINHA	150140600					36.00		36.00			
[redacted]MAVERA	150230610										
REDENCAO	150200613						126.00	126.00			

RIO MARIA	150200616				54.00		54.00							
[redacted]ONDON DO PARA	150220618				187.20		187.20	90.00		90.00				
[redacted]UROPOLIS	150130619					54.00	54.00		43.20	43.20				
SALINOPOLIS	150230620													
SALVATERRA	150170630													
[redacted]SANTA CRUZ DO ARARI	150170640													
[redacted]SANTA ISABEL DO PARA	150240650		18.00	18.00										
SANTA MARIA DAS BARREIRAS	150200658				72.00		72.00							
[redacted]SANTA MARIA DO PARA	150240660		7.20	7.20										
[redacted]SANTANA DO ARAGUAIA	150200670													
[redacted]SANTAREM	150120680		144.00	144.00	25.20	226.80	252.00							
SANTAREM NOVO	150230690													
SANTO ANTONIO DO TAUA	150230700													
[redacted]SAO CAETANO DE ODIVELAS	150230710													
[redacted]SAO DOMINGOS DO CAPIM	150220720		126.00	126.00	57.60		57.60							
SAO FELIX DO XINGU	150150730													
[redacted]SAO FRANCISCO DO PARA	150240740		25.20	25.20										
[redacted]SAO GERALDO DO ARAGUAIA	150200745													
SAO [redacted] DE PIRABAS	150230747													
SAO [redacted] DO ARAGUAIA	150190750					46.80	46.80							
[redacted]SAO MIGUEL DO GUAMA	150240760		25.20	25.20										
[redacted]SAO SEBASTIAO DA BOA VISTA	150160770													
SENADOR JOSE PORFIRIO	150160780					90.00	90.00							
SOURE	150170790													
[redacted]TAILANDIA	150210795				90.00		90.00	28.80		28.80				
[redacted]TOME-ACU	150210800				165.60		165.60							
TUCUMA	150150808													
TUCURUI	150190810					140.40	140.40							
[redacted]URUARA	150140815					72.00	72.00							
[redacted]VIGIA	150230820													
VISEU	150260830		46.80	46.80										
XINGUARA	150200840				57.60		57.60							
[redacted]TOTAL			82.80	734.40	810.00	1886.40	1724.40	3610.80	374.40	1407.60	1782.00	0.00	0.00	0.00
[redacted]														
ESTADO DO AMAPA														
[redacted]														
[redacted]AM	160280010				154.00	94.00	248.00							
CALCOENE	160280020				76.00	208.00	284.00							
FERREIRA GOMES	160280023				20.00	142.00	162.00		34.00	34.00				
[redacted]ARANJAL DO JARI	160270027								130.00	130.00				
[redacted]MACAPA	160270030				236.00	140.00	376.00		246.00	246.00				
MAZAGAO	160270040				134.00		134.00							
SANTANA	160270060				34.00		34.00							
[redacted]TARTARUGALZINHO	160280070													
[redacted]TIAPOQUE	160280050					474.00	474.00							
TOTAL			0.00	0.00	0.00	654.00	1058.00	1712.00	0.00	410.00	410.00	0.00	0.00	0.00
[redacted]														
[redacted] ESTADO DE TOCANTINS														
ALIANCA DO TOCANTINS	173480035			42.45	42.45	62.26		62.26						
[redacted]ALMAS	523490040					70.75		70.75						
[redacted]ALVORADA	523480070			28.30	28.30			0.00						

ANANAS	523450100			22.64		22.64			
APARECIDA DO RIO NEGRO	173470110			22.64		22.64			
ARAGUACEMA	523460190					0.00			
ARAGUACU	523500200			50.94		50.94			
ARAGUAINA	523450210	62.26	62.26	178.29		178.29	56.60		56.60
ARAGUATINS	523450220				28.30	28.30			
ARAPOEMA	523460230	8.49	8.49	96.22		96.22			
ARRAIAS	523490240			101.88		101.88			
AUGUSTINOPOLIS	523450255			28.30		28.30			
AURORA DO NORTE	523490270			36.79		36.79			
AXIXA DO TOCANTINS	523450290					0.00			
BABACULANDIA	523450300			28.30		28.30			
BARROLANDIA	173480310	14.15	14.15	14.15		14.15			
BERNARDO SAYAO	173460320					0.00			
BREJINHO DE NAZARE	523480370	28.30	28.30	56.60		56.60			
BURITI DO TOCANTINS	173450380			14.15		14.15			
CASEARA	173460390			56.6		56.60			
COLINAS DO TOCANTINS	523460550	42.45	42.45			0.00			
COLMEIA	523461670			19.81		19.81			
COMBINADO	173490555			14.15		14.15			
CONCEICAO DO TOCANTINS	523490560			56.60		56.60			
DOUTO DE MAGALHAES	523460600			28.30		28.30			
DUERISTALANDIA	523480610			48.11		48.11	14.15		14.15
DUERODIANOPOLIS	523490700			84.90		84.90			
DIVINAPOLIS DO TOCANTINS	173480710			84.9		84.90			
DOIS IRMAOS DO TOCANTINS	523460720			99.05		99.05			
DUERE	523480730			33.96		33.96			
FATIMA	523480755	33.96	33.96	28.30		28.30			
FIGUEIROPOLIS	523480765	19.81	19.81			0.00			
FILADELFIA	523450770			56.60		56.60			
FORMOSO DO ARAGUAIA	523480820			14.15		14.15			
GOIANORTE	173460830	48.11	48.11			0.00			
GOIATINS	523470900			84.90		84.90			
GURARAI	523480930	56.60	56.60	50.94		50.94			
GURUPI	523480950	84.90	84.90	48.11		48.11			
ITACAJA	523471050			90.56		90.56			
ITAGUATINS	523451070			28.30	8.49	36.79			
ITAPORA DO TOCANTINS	523461110			8.49		8.49			
JUVENTINA	523471240			62.26		62.26			
MARIANOPOLIS DO TOCANTINS	173461250								
MIRACEMA DO TOCANTINS	523481320	39.62	39.62	28.30		28.30			
MIRANORTE	523481330	56.60	56.60	28.30		28.30			
MONTE DO CARMO	523481360			48.11		48.11			
NATIVIDADE	523491420			99.05		99.05			
NAZARE	523451430			19.81		19.81			
NOVA OLINDA	523451488	28.30	28.30			0.00			
NOVA ROSALANDIA	173481500	14.15	14.15	42.45		42.45			
NOVO ACORDO	523471510			28.30		28.30			
PALMEIROPOLIS	523491575			56.60		56.60			
PARAISO DO TOCANTINS	523481610	65.09	65.09	36.79		36.79			
PARANA	523491620			161.31		161.31			
PEDRO AFONSO	523471650			28.30		28.30			
PEIXE	523481660	50.94	50.94	158.48		158.48			
PEQUIZEIRO	173461665			14.15		14.15			

INDORAMA DO TOCANTINS	523491700						0.00						
[redacted]	523481750						0.00	28.30		28.30			
[redacted]A ALTA DO TOCANTINS	523471790				70.75		70.75						
[redacted]E ALTA DO BOM JESUS	523491780				45.28		45.28						
ORTO ALEGRE DO TOCANTINS	173491800				14.15		14.15						
[redacted]O NACIONAL	523481820				175.46		175.46						
[redacted]A NORTE	173451830												
[redacted]ESIDENTE KENNEDY	523481840		36.79	36.79	59.43		59.43						
IO SONO	523471875.				56.60		56.60						
[redacted]AIO	173451880				19.81		19.81						
[redacted]SEBASTIAO DO TOCANTINS	523452030						0.00						
[redacted]A ROSA DO TOCANTINS	173491890												
ANTA TEREZA DO TOCANTINS	173471900						0.00						
[redacted]VALERIO DA NATIVIDADE	173492049				33.96		33.96						
[redacted]ANOPOLIS	523482065						0.00						
[redacted]O [illegible] DO TOCANTINS	523452080				16.98		16.98						
AGUATI[illegible]	523492090				56.60		56.60						
[redacted]ARUSSU DO PORTO	173482100	93.39		93.39			0.00						
[redacted]NTINIA	523472110				164.14		164.14						
[redacted]ANTINOPOLIS	523452120		76.41	76.41	90.56	65.09	155.65						
ANDERLANDIA	523452208		56.60	56.60	5.66		5.66						
[redacted]IOA	523452210	121.69		121.69			0.00						
[redacted]TAL		215.08	894.28	1109.36	3342.23	101.88	3444.11	99.05	0.00	99.05			
[redacted]ESTADO DE GOIAS (1)													
[redacted]OS BELOS	523490490				56.60		56.60						
ORANGATU	523501800		79.24	79.24	70.75		70.75						
[redacted]MIGUEL DO ARAGUAIA	523502020				147.16		147.16						
[redacted]TAL		0.00	79.24	79.24	274.51	0.00	274.51	0.00	0.00	0.00	0.00	0.00	0.00
[redacted] DO MARANHAO (1)													
CAILANDIA	210380005					135.86	135.86						
[redacted]NTARA	210300020	28.31		28.31									
[redacted]MIRA DO MARANHAO	210340040												
[redacted]TO PARNAIBA	210420050				37.74		37.74						
ARANTE DO MARANHAO	210380060												
[redacted]ATUBA	210300070				18.87		18.87						
[redacted]E	210390095				84.915		84.92						
RARI	210300100		28.31	28.31									
XIXA	210320110		9.44	9.44									
[redacted]BAL	210350120	3.77	50.95	54.72	18.87		18.87						
[redacted]RI	210300130												
[redacted]SAS	210420140				28.31	113.22	141.53						
ARRA DO CORDA	210390160					84.92	84.92						
[redacted]DITO LEITE	210430180				47.18	9.44	56.61						
[redacted]IMAO	210300190	28.31		28.31	28.31		28.31						
OM JARDIM	210340200		9.44	9.44									
URITI BRAVO	210410230				84.92		84.92						
[redacted]PIO	210360240												

[redacted]UARI	210300250											
CANDIDO MENDES	210290260		28.31	28.31				28.31	28.31			
CATANHEDE	210360270		28.31	28.31	28.31	18.87	47.18					
[redacted]ROLINA	210420280					98.12	98.12					
[redacted]RUTAPERA	210290290											
CAXIAS	210360300		75.48	75.48	179.27		179.27	60.38	60.38			
[redacted]DRAL	210300310											
[redacted]DO	210360330	9.44	88.69	98.12	84.92		84.92					
[redacted]LINAS	210410350				22.64	66.05	88.69					
COROATA	210360360		47.18	47.18	28.31		28.31			18.87	18.87	
[redacted]URURUPU	210300370				3.77		3.77					
[redacted]N PEDRO	210400380				18.87		18.87			9.44	9.44	
[redacted]SPERANTINOPOLIS	210350400				9.44		9.44					
ESTREITO	210420405					47.18	47.18					
[redacted]RTALEZA DOS NOGUEIRAS	210420410				41.51		41.51					
[redacted]RTUNA	210410420				28.31		28.31					
[redacted]DOFR[redacted] VIANA	210290430		18.87	18.87								
GONCAL[redacted] DIAS	210400440				28.31		28.31					
[redacted]OVERNADOR ARCHER	210400450				9.44		9.44					
[redacted]VERNADOR EUGENIO BARROS	210400460											
[redacted]RACA ARANHA	210400470											
GRAJAU	210390480				169.83	96.24	266.07					
[redacted]IMARAES	210300490											
[redacted]ATU	210320510											
IGARAPE GRANDE	210350520	28.31		28.31	15.10		15.10					
IMPERATRIZ	210380530		84.92	84.92	28.31		28.31					
[redacted]APECURU-MIRIM	210360540		33.97	33.97	9.44		9.44					
[redacted]AO LISBOA	210380550				9.44		9.44					
JOSELANDIA	210350560											
LAGO DA PEDRA	210340570	22.64		22.64	22.64		22.64					
[redacted]AGO DO JUNCO	210350580	22.64		22.64								
[redacted]GO VERDE	210350590				11.32		11.32					
LIMA CAMPOS	210350600	18.87		18.87						11.32	11.32	
LORETO	210430610				18.87	37.74	56.61					
LUIS DOMINGUES	210290620		18.87	18.87								
[redacted]TI	210300650											
MIRADOR	210440670											
MIRANDA DO NORTE	210360675											
[redacted]IRINZAL	210300680				64.16		64.16					
[redacted]NCAO	210340690		37.74	37.74	9.44		9.44					
MONTES ALTOS	210380700		32.08	32.08	18.87	13.21	32.08					
MORROS	210320710											
[redacted]NA RODRIGUES	210370720											
[redacted]VA IORQUE	210440730											
OLHO D'AGUA DAS CUNHAS	210350740	15.10	18.87	33.97								
PACO DO LUMIAR	210310750											
[redacted]ALMEIRANDIA	210300760				9.44		9.44					
[redacted]ARAIBANO	210440770					28.31	28.31					
PASTOS BONS	210440800				28.31	79.25	107.56					
PAULO RAMOS	210340810	13.21		13.21	18.87		18.87					
[redacted]EREIRAS	210350820	18.87		18.87								
[redacted]NALVA	210300830				15.10		15.10					
PERI-MIRIM	210300840	11.32		11.32	9.44		9.44					
PINDARE-MIRIM	210340850		33.97	33.97								

[redacted]EIRO	210300860				84.92		84.92						
O XII	210350870		18.87	18.87	18.87		18.87						
RAPEMAS	210360880												
[redacted] DE PEDRAS	210350890				43.40		43.40						
[redacted] FRANCO	210380900		66.05	66.05		66.05	66.05						
ESIDENTE DUTRA	210400910					32.08	32.08		28.31	28.31			
ESIDENTE JUSCELINO	210320920				5.66		5.66						
[redacted]DENTE VARGAS	210370930												
[redacted]HAO	210420950					79.25	79.25						
SARIO	210310960		33.97	33.97	3.77	18.87	22.64						
MBAIBA	210430970				9.44	47.18	56.61						
[redacted] HELENA	210300980				18.87		18.87						
[redacted] INES	210340990		37.74	37.74									
NTA LUZIA	210341000		94.35	94.35	41.51	58.50	100.01		28.31	28.31			
NTA LUZIA DO PARUA	210291003		66.05	66.05									
[redacted] RITA	210361020		24.53	24.53									
[redacted] ANTONIO DOS LOPES	210351030								37.74	37.74			
O BEI	210301050				24.53		24.53						
O DOMINGOS DO MARANHAO	210401070				13.21	41.51	54.72						
[redacted]ELIX DE BALSAS	210431080					28.31	28.31						
[redacted]DAO BATISTA	210301100				9.44		9.44						
O JOSE DO RIBAMAR	210311120	13.21		13.21									
O LUIS	210311130	9.44	28.31	37.74	9.44		9.44						
[redacted]UIS GONZAGA DO MARANHAO	210351140	5.66	28.31	33.97	13.21		13.21						
[redacted]ATEUS DO MARANHAO	210351150		28.31	28.31									
O RAIMUNDO DAS MANGABEIRAS	210431160				9.44	66.05	75.48						
O VICENTE FERRER	210301170				18.87		18.87						
[redacted] NOVO	210391180					37.74	37.74						
[redacted]IRA DO NORTE	210441190					13.21	13.21						
SSO FRAGOSO	210421200				47.18	37.74	84.92						
MBIRAS	210361210												
[redacted]M	210401230				9.44	47.18	56.61						
[redacted]CU	210291240				41.51		41.51						
RGEM GRANDE	210371270				13.21	49.06	62.27						
ANA	210301280				9.44		9.44						
[redacted]IA DO MEARIM	210301290		69.82	69.82	28.31		28.31						
[redacted]I [redacted]EIRE	210341300	13.21		13.21									
DOCA	210341400												
[redacted]		262.29	1141.64	1403.93	1764.35	1451.10	3215.45	0.00	183.04	183.04	0.00	39.63	39.63
[redacted]													
ESTADO DE MATO GROSSO													
[redacted]													
[redacted]ZAL	513350010					17.24	17.24						
JA BOA	513320020					86.20	86.20						
TA FLORESTA	513320025												
[redacted]ARAGUAIA	513370030		51.72	51.72	103.44		103.44						
[redacted]GARCAS	513360040		55.17	55.17	113.78		113.78						
TO PARAGUAI	513340050				86.20		86.20						
TO TAQUARI	513360060				86.20		86.20						
[redacted]AS	513320080												
[redacted]AIANA	513640100				86.20		86.20						
AGUAINHA	513370120				86.20		86.20						

RAPUTANGA	513330125				86.20		86.20			
[redacted]NAPOLIS	513340130				62.06	51.72	113.78			
[redacted]PUANA	513320140									
ARAO DE MELGACO	513350160				34.48		34.48			
ARRA DO BUGRES	513340170				189.64		189.64			
[redacted]RA DO GARCAS	513320180				113.78	120.68	234.46			
[redacted]ERES	513330250				110.34	231.02	341.35			
AMPINAPOLIS	513640260									
AMPO NOVO DO PARECIS	513630263									
[redacted]PO VERDE	513360267				120.68	34.48	155.16			
[redacted]ARANA	513320270					51.72	51.72			
ASTANHEIRA	513320285									
APADA DOS GUIMARAES	513320300				27.58		27.58			
[redacted]UDIA	513320305									
[redacted]ALINHO	513640310					41.38	41.38			
OLIDER	513320320					86.20	86.20			
ONODORO	513630330					120.68	120.68			
[redacted]ABA	513350340	17.24	17.24	34.48	89.65	68.96	158.61			
[redacted]ISE	513340345				82.75		82.75			
IAMANT[redacted]	513320350				27.58	113.78	141.37			
[redacted] AQUINO	513360360				68.96		68.96			
[redacted]UEIROPOLIS D'OESTE	513650380				34.48		34.48			
[redacted]ERAL CARNEIRO	513370390				27.58	51.72	79.30			
JARANTA DO NORTE	513320410					86.20	86.20	17.24	17.24	
[redacted]RATINGA	513370420				179.30		179.30			
[redacted]AVAI	513650450				24.14		24.14			
[redacted]UBA	513320455					34.48	34.48			
TIQUIRA	513360460	51.72	68.96	120.68	86.13		86.13			
[redacted]IARA	513360480		34.48	34.48	27.58	34.48	62.06			
[redacted]ADA	513350490				10.344		10.34			
[redacted]URU	513330500					27.58	27.58			
JARA	513320510									
[redacted]IVA	513320515									
[redacted]ENA	513320517									
[redacted]SCIMEIRA	513360520		27.58	27.58						
JCAS DO RIO VERDE	513630525					68.96	68.96			
[redacted]IARA	513320530				86.20		86.20	51.72	51.72	
[redacted]EL	513320558							51.72	51.72	
[redacted]TUPA	513320560							68.96	68.96	
[redacted]RASSOL D'OESTE	513330562				51.72		51.72			
[redacted]RES	513320590					17.24	17.24			
[redacted]ELANDIA	513340600				27.58	34.48	62.06			
[redacted]SSA SENHORA DO LIVRAMENTO	513350610				41.38	86.20	127.58			
[redacted]VA BRASILANDIA	513320620				51.72		51.72			
[redacted] CANAA DO NORTE	513320621									
[redacted] MUTUM	513630622					75.856	75.86			
[redacted]VA OLIMPIA	513650623				20.69		20.69			
[redacted]VA XAVANTINA	513320625					31.03	31.03			
[redacted] HORIZONTE DO NORTE	513320627									
[redacted] SAO JOAQUIM	513640628				75.86		75.86			
[redacted]RANAITA	513320629									
[redacted]RANATINGA	513320630				127.58		127.58			
[redacted]A PRETA	513360637		120.68	120.68						
[redacted]TO DE AZEVEDO	513320642									

POCONE	513350650				231.02	44.82	275.84						
PONTE BRANCA	513370670				120.68		120.68						
[illegible]ONTES E LACERDA	513330675					86.20	86.20						
[illegible]ORTO ALEGRE DO NORTE	513620677												
PORTO DOS GAUCHOS	513320680												
PORTO ESPIRIDIAO	513650682				86.20	41.38	127.58						
[illegible]XOREO	513370700				189.64	68.96	258.60						
[illegible]RIMAVERA DO LESTE	513640704				103.44		103.44						
QUATRO MARCOS	513330710												
RESERVA DO CABACAL	513650715												
[illegible]IBEIRAO DA CASCALHEIRA	513640718					113.784	113.78						
RIO BRANCO	513330720				17.24		17.24						
RIO CLARO	513320730												
[illegible]ONDONOPOLIS	513360760		51.72	51.72	68.96		68.96						
[illegible]OSARIO OESTE	513350770				24.14	34.48	58.62						
[illegible]ALTO DO CEU	513330775				20.69		20.69						
SANTA TEREZINHA	513320777												
SANTO ANTONIO DO LEVERGER	513350780	41.38	86.20	127.58	96.54		96.54						
[illegible]O FELIX DO ARAGUAIA	513320785				58.62	237.91	296.53		162.06	162.06			
SAO [illegible] DOS QUATRO MARCOS	513650710				27.58		27.58						
SINOP	513320790					10.34	10.34						
SORRISO	513630792					155.16	155.16						
[illegible]NGARA DA SERRA	513340795				24.14	141.37	165.50						
TAPURAH	513630800					34.48	34.48						
TERRA NOVA DO NORTE	513320805					17.24	17.24						
TESOURO	513370810				44.82	51.72	96.54						
[illegible]RIXOREU	513370820				96.54	68.96	165.50						
VARZEA GRANDE	513350840				17.24	17.24	34.48						
VERA	513320850												
VILA BELA DA SANTISSIMA TRINDA	513330550				44.82	158.61	203.43						
[illegible]LA RICA	513620860												
TOTAL		110.34	513.75	624.09	3720.32	2854.94	6575.26	0.00	351.70	351.70	0.00	0.00	0.00

[illegible]FONTE: DNER, Album Cartografico rodoviario,1977.

OBS.:(1) Considera apenas os municipios pertecentes a Amazonia Legal.

Tabela 2

Amazonia Legal - 1975

Extensao da malha rodoviaria planejada por municipio.

(Em Km)

MUNICIPIO	CODIGO GEOGRAFICO	Planejadas Estadual	Federal	Total
RONDONIA				
ALTA FLORESTA D'OESTE	110010001			
ALVORADA D'OESTE	113690034		71.23	71.23
ARIQUEMES	110010002	60.62		60.62
CABIXI	113710003	25.76		25.76
CACOAL	110010004			
CEREJEIRAS	110010005			
COLORADO DO OESTE	110010006	53.04		53.04
COSTA MARQUES	110010008	83.33	153.07	236.39
ESPIGAO D'OESTE	110010009			
GUAJARA-MIRIM	110010010	190.95		190.95
JARU	110010011			
JI-PARANA	110010012		15.15	15.15
MACHADINHO DO OESTE	113690013			
NOVA BRASILANDIA DO OESTE	113690029			
OURO PRETO DO OESTE	110010015		56.07	56.07
PIMENTA BUENO	110010018			
PORTO VELHO	110010020	163.67		163.67
PRESIDENTE MEDICI	110010025			
[illegible] DE MOURA	110010028			
SANTA LUZIA DO OESTE	113690034			
SAO MIGUEL DO GUAPORE	110010032		45.47	45.47
VILHENA	110010030	34.86	201.56	236.42
VILA NOVA DO MARMORE	110010033			
TOTAL		612.23	542.54	1154.77
ESTADO DO ACRE				
ASSIS BRASIL	120030005	96.99		96.99
BRASILEIA	120030010	40.92		40.92
CRUZEIRO DO SUL	120020020	227.33	156.10	383.42
FEIJO	120020030	283.40	106.09	389.48
MANCIO LIMA	120020033	134.88		134.88
MANOEL URBANO	120030034	450.10		450.10
PLACIDO DE CASTRO	120030038	18.19		18.19
RIO BRANCO	120030040	306.13		306.13
SENA MADUREIRA	120030050	524.36		524.36
SENADOR GUIOMARD	120030045			
TARAUACA	120020060	325.83		325.83
XAPURI	120030070	45.47		45.47

TOTAL		2453.59	262.18	2715.78
ESTADO DO AMAZONAS				
ALVARAES	130090002	137.048		137.05
AMATURA	130040006			
ANAMA	130090008			
ANORI	130090010			
APUI	130100014		203.72	203.72
ATALAIA DO NORTE	130040020	111.12	666.72	777.84
AUTAZES	130100030	66.67	74.08	140.75
ELOS	130080040			
BARREIRINHA	130100050			
BENJAMIN CONSTANT	130040060		55.56	55.56
BERURI	130100063			
BOA VISTA DO RAMOS	130100068			
BOCA DO ACRE	130060070		37.04	37.04
BORBA	130070080	88.90	270.39	359.29
CAAPIRANGA	130100083			
CANUTAMA	130060090	118.53		118.53
CARAUARI	130050100	233.35	103.71	337.06
CAREIRO	130100110	37.04		37.04
CAREIRO DA VARZEA	130100115	48.15	22.22	70.38
COARI	130090120			
CODAJAS	130090130			
EIRUNEPE	130050140	111.12		111.12
ENVIRA	130050150	55.56		55.56
FONTE BOA	130040160			
GUAJARA	130050165	11.11		11.11
HUMAITA	130070170			
XUNA	130050180			
IRANDUBA	130100185			
ITACOATIARA	130100190			
ITAMARATI	130050195			
ITAPIRANGA	130100200			
JAPURA	130090210	29.63	177.79	207.42
JURUA	130050220	70.38		70.38
JUTAI	130040230		129.64	129.64
LABREA	130060240	25.93	296.32	322.25
MANACAPURU	130100250			
MANAQUIRI	130100255			
MANAUS	130100260			
MANICORE	130070270	129.64		129.64
MARAA	130090280			
MAUES	130100290	81.49	148.16	229.65
NHAMUNDA	130100300			
NOVA OLINDA DO NORTE	130100310	74.08		74.08
NOVO AIRAO	130080320			
NOVO ARIPUANA	130070330		259.28	259.28
PARINTINS	130100340	25.93		25.93
PAUINI	130060350	18.52	55.56	74.08
PRESIDENTE FIGUEIREDO	130100353			
RIO PRETO DA EVA	130100356			

SANTA ISABEL DO RIO NEGRO	130080360	129.64		129.64
SANTO ANTONIO DO ICA	130040370	44.45	118.53	162.98
SAO GABRIEL DA CACHOEIRA	130080380		659.31	659.31
SAO PAULO DE OLIVENCA	130040390	18.52	74.08	92.60
SAO SEBASTIAO DO UATUMA	130100395			
SILVES	130100400			
TABATINGA	130040406			
TAPAUA	130060410	55.56	285.21	340.77
TEFE	130090420	55.56		55.56
TONANTINS	130040423	48.15		48.15
UARINI	130090426	81.49		81.49
URUCARA	130100430			
URUCURITUBA	130100440			
TOTAL		1907.56	3637.33	5544.89
ESTADO DE RORAIMA				
ALTO ALEGRE	140110005	880.51		880.51
BOA VISTA	140110010	833.53		833.53
BONFIM	140110015	134.88		134.88
CARACARAI	140110020	242.48		242.48
MUCAJAI	140110030	212.17		212.17
NORMANDIA	140110040	272.79	37.89	310.68
SAO JOAO DA BALIZA	140110050	37.89		37.89
SAO LUIZ	140110060	131.85		131.85
TOTAL		2746.09	37.89	2783.97
ESTADO DO PARA				
ABAETETUBA	150180010	18.00		18.00
ACARA	150210020			
AFUA	150160030		43.20	43.20
ALENQUER	150120040		43.20	43.20
ALMEIRIM	150140050	129.60		129.60
ALTAMIRA	150150060	601.20	302.40	903.60
ANAJAS	150160070	61.20	122.40	183.60
ANANINDEUA	150250080			
AUGUSTO CORREA	150240090			
AVEIRO	150130100	82.80		82.80
BAGRE	150180110	162.00		162.00
BAIAO	150180120	72.00		72.00
BARCARENA	150180130			
BELEM	150250140			
BENEVIDES	150250150			
BOM JESUS DO TOCANTINS	150190157			
BONITO	150240160			
BRAGANCA	150240170			
BREJO GRANDE DO ARAGUAIA	150190175			
BREVES	150160180	64.80		64.80
BUJARU	150220190			
CACHOEIRA DO ARARI	150170200			

CAMETA	150180210	90.00		90.00
CAPANEMA	150240220			
CAPITAO POCO	150220230	36.00		36.00
CASTANHAL	150240240			
CHAVES	150170250	36.00		36.00
COLARES	150230260			
CONCEICAO DO ARAGUAIA	150200270			
CONCORDIA DO PARA	150220275			
CURIONOPOLIS	150190277			
CURRALINHO	150160280			
CURUCA	150230290			
DOM ELIZEU	150220293			
FARO	150120300	226.80		226.80
C FAO DO NORTE	150220307	28.80		28.80
GURUPA	150160310	25.20		25.20
IGARAPE-ACU	150240320			
IGARAPE-MIRI	150180330	36.00		36.00
INHANGAPI	150240340			
IRITUIA	150220350	7.20		7.20
ITAITUBA	150130360	36.00	439.20	475.20
ITUPIRANGA	150190370		72.00	72.00
JACUNDA	150190380	54.00		54.00
JURUTI	150120390	72.00		72.00
LIMOEIRO DO AJURU	150180400			
MAE DO RIO	150220405	18.00		18.00
MAGALHAES BARATA	150230410			
MARABA	150190420		230.40	230.40
MARACANA	150230430			
MARAPANIM	150230440			
MEDICILANDIA	150140445	72.00		72.00
MELGACO	150160450	18.00		18.00
MOCAJUBA	150180460	18.00		18.00
	150180470	79.20		79.20
MONTE ALEGRE	150120480			
MUANA	150170490		43.20	43.20
NOVA TIMBOTEUA	150240500			
OBIDOS	150120510		216.00	216.00
OEIRAS DO PARA	150180520	36.00		36.00
ORIXIMINA	150120530		144.00	144.00
OUREM	150220540	7.20		7.20
OURILANDIA DO NORTE	150150060	54.00	187.20	241.20
PACAJA	150160548	90.00		90.00
PARAGOMINAS	150220550	198.00		198.00
PARAUAPEBAS	150190553	1.88	108.00	109.88
PEIXE-BOI	150240560			
PONTA DE PEDRAS	150170570		25.20	25.20
PORTEL	150160580	198.00		198.00
PORTO DE MOZ	150140590	61.20		61.20
PRAINHA	150140600	43.20		43.20
PRIMAVERA	150230610			
REDENCAO	150200613	36.00	10.80	46.80
RIO MARIA	150200616	36.00		36.00
RONDON DO PARA	150220618	21.60		21.60
RUROPOLIS	150130619			
SALINOPOLIS	150230620			

SALVATERRA	150170630				
SANTA CRUZ DO ARARI	150170640				
SANTA ISABEL DO PARA	150240650				
SANTA MARIA DAS BARREIRAS	150200658	72.00	216.00	288.00	
SANTA MARIA DO PARA	150240660				
SANTANA DO ARAGUAIA	150200670	198.00	111.60	309.60	
SANTAREM	150120680	133.20		133.20	
SANTAREM NOVO	150230690				
SANTO ANTONIO DO TAUA	150230700				
SAO CAETANO DE ODIVELAS	150230710				
SAO DOMINGOS DO CAPIM	150220720				
SAO FELIX DO XINGU	150150730				
SAO FRANCISCO DO PARA	150240740				
S' RALDO DO ARAGUAIA	150200745		43.20	43.20	
São JOAO DE PIRABAS	150230747				
SAO JOAO DO ARAGUAIA	150190750		28.80	28.80	
SAO MIGUEL DO GUAMA	150240760				
SAO SEBASTIAO DA BOA VISTA	150160770				
SENADOR JOSE PORFIRIO	150160780	36.00	169.20	205.20	
SOURE	150170790				
TAILANDIA	150210795	43.20		43.20	
TOME-ACU	150210800	10.80		10.80	
TUCUMA	150150808	64.80		64.80	
TUCURUI	150190810	162.00		162.00	
URUARA	150140815				
VIGIA	150230820				
VISEU	150260830	25.20		25.20	
XINGUARA	150200840	57.60		57.60	
TOTAL		3630.68	2556.80	6186.68	
ESTADO DO AMAPA					
AmapA	160280010				
CALCOENE	160280020	350.00		350.00	
FERREIRA GOMES	160280023	60.00		60.00	
LARANJAL DO JARI	160270027	156.00		156.00	
MACAPA	160270030	308.00		308.00	
MAZAGAO	160270040	272.00		272.00	
SANTANA	160270060				
TARTARUGALZINHO	160280070				
OIAPOQUE	160260050	144.00		144.00	
TOTAL		1290.00	0.00	1290.00	0.00
ESTADO DE TOCANTINS					
ALIANCA DO TOCANTINS	173480035				
ALMAS	523490040	45.28		45.28	
ALVORADA	523480070				
ANANAS	523450100	28.30		28.30	
APARECIDA DO RIO NEGRO	173470110				
ARAGUACEMA	523460190		42.45	42.45	
ARAGUACU	523500200	56.60		56.60	
ARAGUAINA	523450210		90.56	90.56	

ARAGUATINS	523450220	76.41		76.41
ARAPOEMA	523460230	14.15		14.15
ARRAIAS	523490240		48.11	48.11
AUGUSTINOPOLIS	523450255			
AURORA DO NORTE	523490270			
AXIXA DO TOCANTINS	523450290			
BABACULANDIA	523450300	39.62		39.62
BARROLANDIA	173460310			
BERNARDO SAYAO	173460320	59.43		59.43
BREJINHO DE NAZARE	523480370			
BURITI DO TOCANTINS	173450380	8.49		8.49
CASEARA	173460390			
COLINAS DO TOCANTINS	523460550	14.15		14.15
[illegible]IA	523461670		16.98	16.98
[illegible]INADO	173490555			
CONCEICAO DO TOCANTINS	523490560			
COUTO DE MAGALHAES	523460600			
CRISTALANDIA	523480610			
DIANOPOLIS	523490700	67.92		67.92
DIVINAPOLIS DO TOCANTINS	173480710			
DOIS IRMAOS DO TOCANTINS	523460720			
DUERE	523480730			
FATIMA	523480755			
FIGUEIROPOLIS	523480765	36.79		36.79
FILADELFIA	523450770	28.30		28.30
FORMOSO DO ARAGUAIA	523480820	22.64	141.50	164.14
GOIANORTE	173460830			
GOIATINS	523470900		101.88	101.88
GUARAI	523480930		70.75	70.75
GURUPI	523480950		16.98	16.98
ITACAJA	523471050	42.45	107.54	149.99
ITAGUATINS	523451070			
[illegible]ORA DO TOCANTINS	523461110			
LIZARDA	523471240		42.45	42.45
MARIANOPOLIS DO TOCANTINS	173461250			
MIRACEMA DO TOCANTINS	523481320			
MIRANORTE	523481330			
MONTE DO CARMO	523481360	42.45		42.45
NATIVIDADE	523491420	110.37	110.37	220.74
NAZARE	523451430			
NOVA OLINDA	523451488			
NOVA ROSALANDIA	173481500			
NOVO ACORDO	523471510	70.75	28.30	99.05
PALMEIROPOLIS	523491575		19.81	19.81
PARAISO DO TOCANTINS	523481610			
PARANA	523491620	164.14	217.91	382.05
PEDRO AFONSO	523471650	90.56	107.54	198.10
PEIXE	523481660		70.75	70.75
PEQUIZEIRO	173461665			
PINDORAMA DO TOCANTINS	523491700		19.81	19.81
PIUM	523481750			
PONTA ALTA DO TOCANTINS	523471790	209.42	62.26	271.68
PONTE ALTA DO BOM JESUS	523491780			
PORTO ALEGRE DO TOCANTINS	173491800			
PORTO NACIONAL	523481820	14.15		14.15

PRAIA NORTE	173451830			
PRESIDENTE KENNEDY	523481840			
RIO SONO	523471875	65.09		65.09
SAMPAIO	173451880	16.98		16.98
SAO SEBASTIAO DO TOCANTINS	523452030			
SANTA ROSA DO TOCANTINS	173491890			
SANTA TEREZA DO TOCANTINS	173471900		19.81	19.81
SAO VALERIO DA NATIVIDADE	173492049			
SILVANOPOLIS	523482065	19.81		19.81
SITIO NOVO DO TOCANTINS	523452080			
TAGUATINGA	523492090		56.60	56.60
TAQUARUSSU DO PORTO	173482100	42.45		42.45
TOCANTINIA	523472110			
T TINOPOLIS	523452120			
VANDERLANDIA	523452208	28.30		28.30
XAMBIOA	523452210		28.30	28.30
TOTAL		1415.00	1420.66	2835.66
ESTADO DE GOIAS (1)				
CAMPOS BELOS	523490490			
PORANGATU	523501800			
SAO MIGUEL DO ARAGUAIA	523502020	65.09		65.09
TOTAL		65.09	0.00	65.09
ESTADO DO MARANHAO (1)				
ACAILANDIA	210380005		28.31	28.31
ALCANTARA	210300020			
AMARANTE DO MARANHAO	210340040	24.53		24.53
ALTO PARNAIBA	210420050	69.82		69.82
AMARANTE DO MARANHAO	210380060	215.12		215.12
ANAJATUBA	210300070			
ARAME	210390095	28.31		28.31
ARARI	210300100			
AXIXA	210320110			
BACABAL	210350120			
BACURI	210300130	5.66		5.66
BALSAS	210420140		64.16	64.16
BARRA DO CORDA	210390160	313.24		313.24
BENEDITO LEITE	210430180			
BEQUIMAO	210300190			
BOM JARDIM	210340200			
BURITI BRAVO	210410230			
CAJAPIO	210300240	22.64		22.64
CAJARI	210300250	13.21		13.21
CANDIDO MENDES	210290260	37.74		37.74
CATANHEDE	210360270			
CAROLINA	210420280	94.35	15.10	109.45
CARUTAPERA	210290290			
CAXIAS	210360300	33.97	18.87	52.84
CEDRAL	210300310			

CODO	210360330	62.27		62.27
COLINAS	210410350	32.08		32.08
COROATA	210360360	47.18		47.18
CURURUPU	210300370	41.51		41.51
DOM PEDRO	210400380			
ESPERANTINOPOLIS	210350400	15.10		15.10
ESTREITO	210420405	28.31		28.31
FORTALEZA DOS NOGUEIRAS	210420410	66.05		66.05
FORTUNA	210410420			
GODOFREDO VIANA	210290430	39.63		39.63
GONCALVES DIAS	210400440	41.51	18.87	60.38
GOVERNADOR ARCHER	210400450			
GOVERNADOR EUGENIO BARROS	210400460		28.31	28.31
ARANHA	210400470			
GRAJAU	210390480	75.48		75.48
GUIMARAES	210300490	18.87		18.87
ICATU	210320510		18.87	18.87
IGARAPE GRANDE	210350520			
IMPERATRIZ	210300530		75.48	75.48
ITAPECURU-MIRIM	210360540	18.87		18.87
JOAO LISBOA	210380550	47.18		47.18
JOSELANDIA	210350560			
LAGO DA PEDRA	210340570	60.38		60.38
LAGO DO JUNCO	210350580			
LAGO VERDE	210350590			
LIMA CAMPOS	210350600			
LORETO	210430610	18.87	24.53	43.40
LUIS DOMINGUES	210290620	58.50		58.50
MATINHA	210300650	18.87		18.87
MIRADOR	210440670	269.84		269.84
MIRANDA DO NORTE	210360675		24.531	24.53
MONINZAL	210300680	22.64		22.64
AO	210340690	43.40		43.40
MONTES ALTOS	210380700	22.64		22.64
MORROS	210320710	50.95	18.87	69.82
NINA RODRIGUES	210370720			
NOVA IORQUE	210440730			
OLHO D'AGUA DAS CUNHAS	210350740			
PACO DO LUMIAR	210310750			
PALMEIRANDIA	210300760			
PARAIBANO	210440770			
PASTOS BONS	210440800	37.74		37.74
PAULO RAMOS	210340810	103.79		103.79
PEDREIRAS	210350820			
PENALVA	210300830	18.87		18.87
PERI-MIRIM	210300840			
PINDARE-MIRIM	210340850			
PINHEIRO	210300860	9.44		9.44
PIO XII	210350870			
PIRAPEMAS	210360880	18.87		18.87
POCAO DE PEDRAS	210350890	15.10		15.10
PORTO FRANCO	210380900	60.38		60.38
PRESIDENTE DUTRA	210400910	18.87	22.64	41.51
PRESIDENTE JUSCELINO	210320920			
PRESIDENTE VARGAS	210370930			

RIACHAO	210420950	37.74		37.74
ROSARIO	210310960			
SAMBAIBA	210430970		30.19	30.19
SANTA HELENA	210300980			
SANTA INES	210340990	18.87		18.87
SANTA LUZIA	210341000	66.05		66.05
SANTA LUZIA DO PARUA	210291003			
SANTA RITA	210361020			
SANTO ANTONIO DOS LOPES	210351030			
SAO BENTO	210301050	5.66		5.66
SAO DOMINGOS DO MARANHAO	210401070			
SAO FELIX DE BALSAS	210431080			
SAO JOAO BATISTA	210301100	32.08		32.08
S [illegible]SE DO RIBAMAR	210311120			
Sao LUIS	210311130			
SAO LUIS GONZAGA DO MARANHAO	210351140	13.21		13.21
SAO MATEUS DO MARANHAO	210351150	9.44		9.44
SAO RAIMUNDO DAS MANGABEIRAS	210431160	60.38		60.38
SAO VICENTE FERRER	210301170			
SITIO NOVO	210391180	56.61		56.61
SUCUPIRA DO NORTE	210441190	28.31		28.31
TASSO FRAGOSO	210421200			
TIMBIRAS	210361210	56.61		56.61
TUNTUM	210401230	18.87		18.87
TURIACU	210291240	79.25		79.25
VARGEM GRANDE	210371270	37.74		37.74
VIANA	210301280	39.63		39.63
VITORIA DO MEARIM	210301290			
VITORINO FREIRE	210341300	18.87		18.87
ZE DOCA	210341400		41.51	41.51
TOTAL		2821.87	430.24	3251.30
ESTADO DE MATO GROSSO				
ACORIZAL	513350010			
AGUA BOA	513320020			
ALTA FLORESTA	513320025			
ALTO ARAGUAIA	513370030			
ALTO GARCAS	513360040			
ALTO PARAGUAI	513340050			
ALTO TAQUARI	513360060			
APIACAS	513320080			
ARAGUAIANA	513640100		86.20	86.20
ARAGUAINHA	513370120			
ARAPUTANGA	513330125			
ARENAPOLIS	513340130	17.24		17.24
ARIPUANA	513320140	310.32	234.46	544.78
BARAO DE MELGACO	513350160			
BARRA DO BUGRES	513340170	17.24		17.24
BARRA DO GARCAS	513320180			
CACERES	513330250			
CAMPINAPOLIS	513640260			
CAMPO NOVO DO PARECIS	513630263			

CAMPO VERDE	513360267		96.544	96.54
CANARANA	513320270		17.24	17.24
CASTANHEIRA	513320285	20.688		20.69
CHAPADA DOS GUIMARAES	513320300			
CLAUDIA	513320305			
COCALINHO	513640310	317.22	68.96	386.18
COLIDER	513320320			
COMODORO	513630330		72.41	72.41
CUIABA	513350340		62.06	62.06
DENISE	513340345			
DIAMANTINO	513320350			
DOM AQUINO	513360360			
FIGUEIROPOLIS D'OESTE	513650380			
AL CARNEIRO	513370390			
GUARANTA DO NORTE	513320410			
GUIRATINGA	513370420			
INDIAVAI	513650450			
ITAUBA	513320455			
ITIQUIRA	513360460	51.72		51.72
JACIARA	513360480			
JANGADA	513350490			
JAURU	513330500			
JUARA	513320510	17.24		17.24
JUINA	513320515		17.24	17.24
JURUENA	513320517	51.72		51.72
JUSCIMEIRA	513360520			
LUCAS DO RIO VERDE	513630525	68.96		68.96
LUCIARA	513320530		62.06	62.06
MARCELANDIA	513320558			
MATUPA	513320560			
MIRASSOL D'OESTE	513330562			
MORES	513320590		62.06	62.06
ELANDIA	513340600			
NOSSA SENHORA DO LIVRAMENTO	513350610			
NOVA BRASILANDIA	513320620			
NOVA CANAA DO NORTE	513320621			
NOVA MUTUM	513630622		51.72	51.72
NOVA OLIMPIA	513650623			
NOVA XAVANTINA	513320625		68.96	68.96
NOVO HORIZONTE DO NORTE	513320627	34.48		34.48
NOVO SAO JOAQUIM	513640628		137.92	137.92
PARANAITA	513320629			
PARANATINGA	513320630	131.02	158.61	289.63
PEDRA PRETA	513360637			
PEIXOTO DE AZEVEDO	513320642			
POCONE	513350650			
PONTE BRANCA	513370670			
PONTES E LACERDA	513330675	44.82		44.82
PORTO ALEGRE DO NORTE	513620677			
PORTO DOS GAUCHOS	513320680	51.72		51.72
PORTO ESPIRIDIAO	513650682			
POXOREO	513370700			
PRIMAVERA DO LESTE	513640704		68.96	68.96
QUATRO MARCOS	513330710			
RESERVA DO CABACAL	513650715			

RIBEIRAO DA CASCALHEIRA	513840718		68.96	68.96
RIO BRANCO	513330720			
RIO CLARO	513320730	93.10		93.10
RONDONOPOLIS	513360760			
ROSARIO OESTE	513350770			
SALTO DO CEU	513330775			
SANTA TEREZINHA	513320777		44.82	44.82
SANTO ANTONIO DO LEVERGER	513350780	41.38		41.38
SAO FELIX DO ARAGUAIA	513320785		296.53	296.53
SAO JOSE DOS QUATRO MARCOS	513650710			
SINOP	513320790			
SORRISO	513630792		24.14	24.14
TANGARA DA SERRA	513340795	34.48		34.48
T W	513630800	120.68		120.68
TERRA NOVA DO NORTE	513320805			
TESOURO	513370810	27.58		27.58
TORIXOREU	513370820			
VARZEA GRANDE	513350840			
VERA	513320850	51.72	96.54	148.26
VILA BELA DA SANTISSIMA TRINDA	513330550	6.90	127.58	134.47
VILA RICA	513620860		44.82	44.82
TOTAL		1510.22	1968.81	3479.03

FONTE: DNER, Album Cartografico rodoviario,1977.

OBS.:(1) Considera apenas os municipios pertecentes a Amazonia Legal.

The Impact of the Forest Industry in Amazonian Deforestation

Report submitted to GESEP/IPEA as part of the project "The Economics of Deforestation in Brazilian Amazônia"

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1. Forest Industry in Amazônia: basic features

Participation of the forest industry in the total value of national industrial production decreased between 1960 and 1975, but exhibited a slight recovery between 1975 and 1980 (see table 1). This recovery was due to two main factors: expansion of pulp production and, more significantly, the large increase of sawnwood production in Amazônia, which led the forest industry in this region to achieve a participation of 42% of the value of the output of the sector nationwide in 1980 (up from 1.4% in 1970) and of 13% of the value of the total industrial output of the region in the same year (up from 6% in 1965), as shown also in table 1.

This evolution can also be followed through the number of sawmills in activity in the region, which jumped from 89 in 1952 to 1639 in 1981 (see table 2), and through the total volume of timber extraction, which shows an increase of 255% at the regional level between 1975 and 1980 (from 4,500,000 m^3 to 11,500,000 m^3), in contrast with a nationwide increase of only 15% in the same period, so that the regional participation in national timber volume went from 14% in 1975 to 32% in 1980 (see table 3).

It can be said that during this period forest industry in Amazônia ceased to be a marginal sector of the regional economy and became, rather, a lever of regional development, absorbing a significant fraction of available local manpower and attracting also settletrs from other regions of the country.

This huge increase was not uniformly distributed across the region. It was concentrated mainly in Rondônia and Pará (where forest sector output attained in 1980 61% and 28% respectively of the total industrial output in each state). In Amapá and Roraima participation of the forest industry in total industrial output attained also very high levels in 1980 (34% and 68% respectively) but in these two cases total industrial output in 1980 was much less significant (see tables 4 and 5).

This regional imbalance is also evident from the data on the number of sawmills by state in 1978 and 1981; during this period there was an increase of 77% in Rondônia (from 141 to 250) and of 70% in Pará (from 510 to 866). Let us add that in the following year Rondônia registered an aditional increase of 55% with 387 sawmills in activity in 1982 (see table 6). Both states together achieved in 1981 78% of the total production of sawnwood in the region, estimated in 5,388,000 m^3 (see table 7). This last figure, parenthetically, indicates, when compared with the values in table 3, an average input-output coeffcicient of .47, which can be considered low by national and international standards.

This spectacular increase of the forest industry in Amazônia was due to several reasons. In the first place, the high level of expansion of the Brazilian economy between 1975 and 1980, which generated a significant increase in the demand for sawnwood (see table 8). At the same time, rapid depletion of natural coniferous forests in the South and Southeast of the country, combined with the fact that most plantation output was directed toward pulp production, generated additional demand of nonconiferous natural timeber, most of which is found in Amazônia (see table 9). A third factor behind this increase was the opening of permanent roads in the region, linking it to the main consumption centers in the South and Southeast of the country, as well as to sea and river ports. The development of the forest industry in Pará is directly linked to the opening of the Belém-Brasilia highway (BR 153). In the case of Rondônia a similar role was played by the Porto Velho-Vilhena (BR 364) and Porto Velho-Guajará Mirim (BR 319) highways. Paving of the segment of BR 364 between Porto Velho and Cuiabá in 1985 gave additional incentive to the forest industry in Rondônia.

The process we have just briefly described could suggest the idea of a thriving and healthy modern industrial sector expanding in a previously uncharted area. This is not exactly the case. Table 10 presents the size distributions of sawmills in the region in 1980, showing that 92% of the sawmills (generating 71% of total produced volume) correspond to establishments with a capacity below 10,000 m^3/year. It is worthwhile to notice that almost

all owners possessed just one sawmill, and the few cases of several sawmills belonging to just one firm occured only in the small size bracket (less than 5,000 m^3/year) [14].

These small size sawmills, some of which can be described as "semi-nomadic" (changing locations at short intervals to follow the colonization frontier), consist in most cases of a small office and a shed containing just three saws (a circular, a plane and a ribbon one) and a diesel oil fueled electricity generator. They hire unqualified workers which are laid out during the slack period corresponding to the rainy season. As a whole, they lag decades behind modern industry practises in technology, management, personnel training, finantial capabilities, etc., not only when compared to foreign companies but also with large timber firms in the South and Southeast of the country. As a consequence they have been unable to introduce previously unknown species in out-of-region markets, since they lack marketing mechanisms, do not offer certainty on volume of future deliveries, and are not capable of sustaining a continuous flow and ensuring required quality standards. In addition, most of them lack "export mentality" i.e. they consider out-of-region sales as a back up activity to fill the slack of reduced local demand when it occurs. Thus, out-of-region penetration efforts are irregular and non-systematic. As a consequence, new markets are not reached and old ones are sometimes lost.

It must be understood that in addition to these defficiences (and in some cases provoking or reinforcing them), forest industry in Amazônia confronts all the difficulties common to timber exploitation in tropical rain forest: an environment which is highly hostile to any human activity, rampant endemic diseases (e.g. paludism), lack of infra-estructure (most local roads are transitable only half of the year, halving and sometimes paralyzing sawmill activities during the remaining six months), lack of reliable electricity supply (forcing sawmills to use inefficient diesel oil generators), lack of qualified local manpower, etc.

In the second half of the 1980's (for which we still have very few reliable data) two new obstacles were added to the unfavorable factors mentioned above. One of them is

the recession that plagued the Brazilian economy during most of the decade, drastically reducing the rate of increase of sawnwood demand. Also, since very few species are sold for out-of-region consumption (mainly mahoganny (*Swietenia macrophylla*), "virola" (*Virola* spp), "cerejeira" (*Torresia* spp) and "angelim" (*Hymenolobium petraeum*)), their wide spatial distribution and low density have rapidly exhausted resources within short distance of the permanent roads which gave raise to the industry expansion ten years earlier. This situation confronts sawmill owners with an unhappy alternative: either hauls of more than 200 km, which in most cases is profitable only for mahoganny, or adoption of the semi-nomadic pattern mentioned above, moving the sawmill closer to valuable timber, but farther away from urban infra-estructure, thus increasing costs and decreasing efficiency. The combination of all these factors put the small and medium size sawmills in a very hard position as early as 1985 (see [7]). Later on we will explore the consequences of this situation on the future dynamics of the sector.

On the other hand, there exists a sizeable number of big sawmills, which operate on a large scale and have a structure typical of modern industry. These sawmills are responsible for the introduction of Amazonian sawnwood, other than mahoganny, "virola" and "cerejeira", in the consumption centers in the South and Southeast of Brazil. Some of these sawmills are competitive with large first world companies especialized in tropical timber extraction, and are located mainly in Mato Grosso and the South of Pará. There are indicators that their number and capacity has increased during the last few years, but we have yet no reliable data on this point. The future evolution of the Amazonian forest industry is crucially dependent upon the ability of this modern sector to attain a dominant position in the market, but according to current evidence, it will take some time before this happens.

While data on domestic production and consumption of Amazonian wood is not very reliable, the situation is better for exports, all of which go thorough official registration (there seems to be some smuggling of timber through land boundaries, mainly from Ro-

raima to Venezuela, but in any case not in large quantities). Tables 11 and 12 contain quantities and value of exported Amazonian sawnwood (there is also a negligeable amount of timber, and a not so negligeable amount of boards and panels, exported from Amazônia, representing however less than 20% of exported Amazonian sawnwood in quantity). We mention that blank entries in tables 11 and 12 do not mean null exports of the corresponding species, but rather that such species was included in the "other species" line in that given year. Since category "other species" in [2] does not distinguish, of course, between Amazonian and non-Amazonian sawnwood, we have included in it only sawnwood exported through Amazonian ports, which we assume comes exclusively from Amazonian timber. We assume at the same time that no Amazonian sawnwood from "other species" of Amazonian origin is exported through out-of-region ports. These assumptions seem reasonable except for Paranaguá port, through which some Amazonian and some non-Amazonian sawnwood is exported. We have added therefore a special line in tables 11 and 12 for "other species" exported through Paranaguá port, and present two "total" lines: with and without "other species" exported through Paranaguá.

The main buyers of Amazonian sawnwood in the period covered by tables 11 and 12 were the United Kingdom and Germany, followed by other Western European countries, USA and Japan.

Table 14 highlights some relevant consequences extracted from tables 11 and 12. First, the absolute dominance of mahoganny with respect to all other species, both in terms of quantities and value, with "virola" in a distant second place. In the period under consideration mahoganny exports represented between 23.6% and 55.2% of Amazonian sawnwood exports in quantity, and between 46.4% and 70.7% in value. For mahoganny plus "virola" these percentages increase to 35.8% to 72.5% in quantity and 55.1% to 78.8% in value.

These figures are significant because there is a wide consensus in the sense that at current extraction rates Brazilian mahoganny resources in nonprotected areas will be depleted in the short run (a survey made in 1985 among producers and exporters resulted in

an average expected remaining lifetime of 12 years for commercial extraction of Brazilian mahoganny; see [7]).

The second conclusion from table 11 is that exports represent a very small fraction of Amazonian sawnwood. In order to compare with the timber extraction values shown in table 18, we must convert tons of sawnwood into volume of timber with bark. Assuming an average density of .58 ton/m^3 (most of exported Amazonian sawmwood comes from species in the density category of .5 to .65, according to [13]), a sawnmill input-output coefficient of .5 (i.e. .5 m^3 of sawnwood per cubic meter of timber without bark, according to [7]) and 7.7% of volume corresponding to bark (RADAMBRASIL forest inventories), the figures in the last line of table 18 translate into line 5 of table 14. If we consider the values given by IBGE Extractive Production Surveys (table 18), only between 1.4% and 2% of extracted Amazonian timber between 1982 and 1984 was used for exported sawnwood (if we use extraction data from IBGE 1985 Agricultural Census, these data drop by a factor of 5). These values would not increase if we take into account exported boards and panels, because most of them are manufactured from discarded wood from timber used for sawnwood (i.e. we would have higher values in the last line of table 11, but little difference in lines 5 and 6 of table 14, due to the increase in the input-output coefficient).

In section 4 we discuss some prospects for the future evolution of Amazonian sawnwood exports.

Before closing this section, a caveat is in order with respect to the quality of the data on Amazonian sawmills output used above, and even more so in connection with the data in section 2, where we attempt to estimate forest industry output at the county ("município") level. The geographic features of the region, combined with the low population density, makes census surveys quite inefficient. In the case of the forest industry, data becomes even less reliable, not only because of the "semi-nomadic" characteristics of some of its segments, but also because most sawmills incur in one or more illegal procedures: tax evasion (mainly the so called "reforestation tax" due whenever natural timber is extracted)

exploitation of forbidden tracts (national parks, Indian reservations, etc.), violation of local traffic regulations prohibiting transit of heavy trucks in some county roads, etc., not to mention pervasive failure to comply with labor legislation. All this makes sawmill owners extremely reluctant to answer surveys and disclose accurate information. As a consequence, most of the output data quoted above has been obtained through indirect estimations. We have used the data which appears to be most reliable, but there is considerable disagreement among experts on many of these figures. For instance, 1980 non-coniferous sawnwood consumption in 1980, given a value of 8,401,000 m^3 in table 9, has been estimated as 8,630,000 m^3 in [8], 6,070,000 m^3 in [11] and 9,500,000 in [10]. In section 2 we will discuss particularly this problem in connection with IBGE estimates of forest industry output in Amazônia at the county level.

2. Estimation of available commercial volume and extraction rates

2.1. Definition of variables and data processing

In another technical report within the current project (see [3]), data from forest inventories undertaken by RADAMBRASIL project in Legal Amazônia were used to estimate average standing timber volume in m^3 per hectare in 147 counties ("municípios") corresponding to the 1991 county distribution. In order to compare such figures with extraction data of previous years, these data were reaggregated into the 93 corresponding countiers for the 1980 county distribution. Variable $VOL(i)$ contains this average standing volume (with bark) for county i in m^3/ha, taken from [3].

The second step of the process consisted of apportioning this volume in commercial classes taking into account the commercial, quality and diameter classes used in the

RADAMBRASIL inventories. These inventories classify tree species in four commercial classes, which, broadly speaking, correspond to species with commercial potential in foreign markets, nonlocal domestic markets, local markets and without commercial potential at all. Individual trees are classified in 4 quality classes, and by diameter. On the basis of this classification we have defined three commercial classes, A, B and C, as follows:

- Class A includes trees belonging to commercial class I, quality class 1 and diameter of 50 *cm* or more.

- Class B includes trees belonging to commercial classes I and II, quality class 1 and diameter of 50 *cm* or more.

- Class C includes trees belonging to commercial classes I, II and III, quality classes 1 and 2 and diameter of 50 *cm* or more.

We observe that, at a variant with inventory classes, classes A, B and C are not disjoint, but rather class C contains class B which contains class A. In principle, classes A, B and C could also be understood as including timber marketable in foreign markets, in foreign and non local domestic markets, and in foreign, nonlocal and local domestic markets respectively. It could be argued that class C should include also trees of quality class 3, but trees of this quality class seem to be used mostly for fuel and charcoal rather than sawnwood. Also, class C could include trees of smaller diameter, say 40 *cm* or more, rather than 50 *cm* or more. Unfortunately, the RADAMBRASIL simultaneous classification by commercial, quality and diameter classes considers only two diameter categories: below and above 50 *cm*.

RADAMBRASIL inventories provide average values for the fraction of the total volume corresponding to each combination of commercial, quality and diameter class for each of six forest categories: dense alluvial, dense lowland, dense midland, dense highland, open lowland and open highland. From this data we obtained the percentage volume corresponding to classes A, B and C for each of the six forest categories. Since the values so obtained were reasonable close to each other within the four categories of dense forests and also within the two categories of open forests, we averaged them inside each of these two groups of forest

categories. As a result, we found that classes A, B and C contain 6.64%, 11.68% and 31.32% of standing volume of open forests respectively, and 5.43%, 10.47% and 21.36% of standing volume in dense forests respectively. In order to average these two sets of values, we used weights of .324 for open forests and .676 for dense forests. These weights resulted from the average standing volumes of 105.068 m^3/ha and 117.773 m^3/ha for open and dense forests respectively, together with the values for total area occupied by open and dense forests in Legal Amazônia (1,071,043 km^2 and 1,997,348 km^2 respectively, according to [1]). The final result obtained in this way indicates average values of 5.82%, 10.86% and 24.59% for classes A, B and C respectively.

We proceed then to define variables $ACVA(i)$, $ACVB(i)$ and $ACVC(i)$ as:

$$ACV(X)(i) = VOL(i) \times P(X) \times ((FLORAR(i) - FLORAD(i))$$

where $P(X)$ is equal to 5.82, 10.86 and 24.59 for $X = A, B$ and C respectively, $FLORAR(i)$ is the original forest cover of county i in km^2 and $FLORAD(i)$ is the deforested area of county i in km^2. In the counties belonging to Amazonas, Amapá and Maranhão, for which $FLORAD(i)$ is not available, we took $FLORAD(i) = 0$. It follows that $ACV(X)(i)$ represents total available commercial volume (with bark) of trees belonging to class X in county i in m^3.

In the next step we consider variables $VExt85(i)$ and $VCA85(i)$ corresponding to timber extraction in m^3 per year according to the IBGE 1985 Extractive Production Survey (EPS from now on) and the IBGE 1985 Agricultural Census (AC from now on) respectively. We define then variables $PVExt85(i)$ and $PVCA85(i)$ as:

$$PVExt85(i) = 100 \times VExt85(i)/ACVC(i)$$

$$PVCA85(i) = 100 \times VCI85(i)/ACVC(i)$$

so that $PVExt85(i)$ and $PVCA85(i)$ indicate percentage of available commercial volume extracted each year in county i at the 1985 extraction rate according to EPS and AC respectively. Table 15 lists the values of $ACV(X)(i)$, $(X = A, B, C)$, $PVExt85(i)$ and $PVCA85(i)$ for each county. Table 16 contains a summary of table 1 with totals for each state (including only counties for which values of the variables are available).

We mention that EPS consists of "educated guesses" made by local experts, while AC, in principle, surveys all industrial establishments. On the other hand EPS data cover, in principle, the 93 counties for which $VOL(i)$ is available, while AC offers data for only 44 of such counties. In table 17 we give number and total area of counties covered by each of the sources. We observe that variables $ACV(X)(i)$ and $PVExt85(i)$ cover 68.44% of the area of Legal Amazônia, while $PVCA85(i)$ covers only 43.48% of the same area. This difference, however, is much less significant in terms of timber extraction: according to EPS these 93 counties produced 92.4% of the timber extracted in 1985 in Legal Amazônia, while, according to AC, the 44 counties produced 88.10% of timber extracted in Legal Amazônia (though, of course, this smaller difference could be due just to sawmills missed by AC in counties for which it gives no data).

2.2. Discussion of aggregated results

Table 16 contains our main results at the state aggregation level. The 93 counties (corresponding to 147 counties in 1991) covering 68.44% of Legal Amazônia, have an estimated potential of 2136 $10^6 m^3$ of standing timber of export class quality, 3987 $10^6 m^3$ of timber adequate for either foreign or domestic consumption and 8994 $10^6 m^3$ of timber of commercial value at large. In 1985 extraction in these counties attained 21.3 $10^6 m^3$ or .236% of total commercial available volume according to EPC, and 95.7 $10^6 m^3$ or 1.064% of total commercial available volume according to AC. 74.5% of all commercial available volume is located in the states of Pará and Amazonas.

Data on available commercial volume (variables $ACV(X)(i)$) can be considered reasonably reliable. The main error sources in their estimation are:

1. Possible inadequacy of the definition of classes A, B and C, in the sense that they may not reflect accurately (as discussed above) volumes of wood adequate for foreign, nonlocal domestic and local domestic markets.

2. Ambiguity in the classification of trees in quality classes in the forest inventories.

3. Errors resulting from considering average values for the proportion of volume in classes A, B and C, as discussed in the previous section.

4. Approximations made in the determination of the fraction of the county area covered by forests (variables $FLORAR(i)$ and $FLORAD(i)$).

Despite the accumulated effect of these errors, it seems quite safe to state that available commercial volume is more than half and less than twice the values in tables 15 and 16 in the Appendix, under any sensible definition of commercial classes. Unfortunately the situation is much worse regarding extraction data: AC gives a value 4.5 times higher than EPS, so that, at 1985 extraction levels, all commercial timber resources in Amazônia would be depleted in 94 years according to AC but only in 424 years according to EPS. It is not easy to make a definite statement on which of these set of data is closer to the actual values. Table 18 gives total extracted timber volume in Legal Amazônia according to EPS between 1982 and 1985, and according to AC in 1985. EPS values are consistent with Amazonian timber extraction data given in [4] (table 3), where a careful critical analysis is made of the various sources on Amazonian timber production up to 1980, while the AC figure implies a more than nine fold increase in 5 years with respect to the data in [4]. EPS series also fits better with several IBDF estimates (e.g. [9], as shown in table 6). On the other hand, all factors mentioned in the first progress report regarding the difficulty of gathering accurate data on Amazonian sawmill activities favor the assumption that EPS might grossly underestimate actual extraction, whose value could then be closer to AC figures.

2.3. Data assessment at the county level.

The discrepancies between EPS anc AC become wider at the county level, where values ofter differ by factor of more than one hundred. Some values were considered outliers and were adjusted: In Itacoatiara, Nhamunda and Novo Airão counties (Amazonas) EPS values for 1985 were more than 10 times higher than both the average for the years 1982-1984 and the average for the years 1986-1987. Consequently we chose the 1986 EPS values as proxies for the 1985 ones. Also, some counties exhibit exceedingly high extraction levels: Afua (Pará) extracted according to EPS 25.87% of its available volume in 1985, and more than 20% in each year between 1982 and 1987. According to AC, Rio Branco (Acre), Sena Madureira (Acre) and Santana do Araguaia extracted in 1985 34.91%, 11.67% and 15.34% of their commercial available volume. Although such values seem physiscally impossible at first sight, it should be remembered that IBGE data refers to timber extracted by sawmills located in a given county, which does not necessarily coincides with timber extracted from that county. Average hauls from tract to sawmill are of the order of 100 km (and more than 200 km for valuable timber) and such hauls frequently cross intercounty boundaries. So data from counties with better infraestructure and higher industrial concentration are likely to overestimate actual extraction (e.g. state capitals, like Rio Branco). As a consequence, data aggregated at the state level (table 16) is likely to be much more robust than data at the county aggregation level. Despite such factors, we have the feeling that the data from the four counties mentioned above is inaccurate (particularly in the case of Afua and Santana do Araguaia).

In general AC data is higher than EPS data, excepting in the following counties:

PARÁ: Portel, Porto de Moz, Santarém, Santo Domingos do Capim.

MARANHÃO: Imperatriz, Moncão.

The following counties register an annual extraction rate of more than 1% according to EPS:

PARÁ: Anajas, Conceição do Araguaia, Curralinho, Paragominas, Santana do Araguaia, Santo Domingos do Capim, Tucuruí.

MARANHÃO: Imperatriz.

The same holds true for the following counties according to AC:

RONDÔNIA: Porto Velho.

ACRE: Rio Branco, Sena Madureira.

AMAZONAS: Autazes, Barreirinha, Carauarí, Juruá, Manaus.

PARÁ: Paragominas, Conceição do Araguaia, Santana do Araguaia.

MARANHÃO: Turiacu.

MATO GROSSO: Aripuana, Chapada dos Guimaraes.

We remark that reliability of the data of those counties which exhibit apparently reasonable values for either AC or EPS is also quite doubtful. This is corroborated by our failed attempt to establish a correlation between extraction rates at the county level obtained in table 15, and some pertinent socio-economic indicators, which we describe in the next subsection.

2.4. Correlation between extraction rates and socio-economic indicators.

It is reasonable to expect that extraction rates should be higher in counties with higher population density, higher road density and closer to consumption centers. We remark that the distortion mentioned above, in the sense that extracted timber is asigned to counties where it is processed and not where it is extracted, should reinforce, rather than diminish, a positive correlation between extraction rates and such variables.

In order to test this hypothesis we chose a very simple linear model of the form:

$$Y = A_0 + A_1 X_1 + A_2 X_2 + A_3 X_3$$

where Y is either $PVExt85$ or $PVCA85$ of table 15, and X_1, X_2 and X_3 are $DIST2$, $ROADEN$ and $POPDEN$, obtained from the project database, indicating distance to Brasília (taken as a proxy for distance to consumption centers), road density and 1985 population density for each county respectively.

Tables 19 and 20 contain the results of the linear regressions for variables $PVExt85$ and $PVCA85$ respectively. As can be seen in these tables, the results are disappointing. In the case of $PVExt85$ (table 19), we get negative estimated coefficients for $DIST2$ and $ROADEN$, which are rather counterintuitive, particularly the last one, and a positive coefficient only for $POPDEN$, but the t-values indicate that such results are of no statitstical significance, excepting perhaps for $DIST2$ which, with an almost 0 (and in fact negative) coefficient has no explanatory power at all. The values of r^2 confirm the failure of the test.

The situation is somewhat better for $PVCA85$, but not better enough. Here we have negative coefficients, with t-values indicating lack of statistical significance, for $DIST2$ and $POPDEN$. $ROADEN$, on the other hand, appears with a positive coefficient, and a t-value indicating some statistical significance. The resulting model would be:

$$PVCA85 = .121 + 2.509 ROADEN$$

indicating a reasonable monotonic relation between road density and extraction rates. However, the magnitude of the t and the r^2 values suggests that this model has only marginal statistical significance.

A second attempt, using the same data reaggregated according to the 1970 county distribution, shows slightly better results for both models, but the tiny improvement is almost surely due to just the smaller number of observations and does not deserve further discussion.

This exercise reinforces our conviction that the quality of our timber extraction data is quite low, which agrees with the opinion of several experts, and is related to the factors discussed at the end of section 1. We did not attempt other regressions, either with more

sophisticated functional forms or with other possible explanatory variables, because the clues indicating weakness of the data are strong enough to suggest that any better adjustment which could be thus obtained is more likely to be coincidental than to indicate a true functional relation.

Our final conclusion on the data of table 15 is the following: data on available commercial volume (columns $ACVA$, $ACVB$, $ACVC$) is reasonably reliable and can be used for future studies. Data on column $PVExt85$ can be at best interpreted as lower bounds for the extraction rates, excepting perhaps the eight counties mentioned in subsection 2.3 with extraction rates exceeding 1%.

Even such interpretation is admissible only because we lack any other data source. We see no possible use for data in column $PVCA85$ at the county level. A field survey to gather more reliable extraction data is strongly recommended, though we acknowledge that any such survey would confront the obstacles mentioned at the end of section 1.

Regarding table 16, the values in columns $PVExt85$ seem more reasonable, again just as lower bounds for annual extraction rates (as discussed above, it is likely that real values lie between $PVExt85$ and $PVCA85$) since they are in better agreement with other sources and experts' opinions. However, caution must be exercised when handling data obtained through addition of values of very little individual reliability.

3. The contribution of the forest industry to Amazonian deforestation.

Despite the weakness of the timber extraction data in tables 15, 16 and 18, we will make an attempt to quantify the contribution of the forest industry to Amazonian deforestation in terms of deforested area.

We cannot just take the values of table 18 and divide them by the average value of standing volume per hectare, because timber extraction requires auxiliary land clearing with additional deforestation effects.

This land clearing consists of the opening of temporary secondary roads, from the permanent road network to the tract to be exploited, opening of paths ("ramais") from the secondary roads to be used by tractors, and clearing of yards where timber pulled by tractors is stored until it is picked up by the trucks.

A field survey in Rondônia ([7]) estimated the area of secondary roads and paths as between 25 and 120 m^2/ha, with an average value of 70 m^2/ha, and an average of one 2500 m^2 yard per each 50 exploited hectares. This gives between 75 and 170 m^2/ha, with an average of 120 m^2/ha, for auxiliary land clearing. The same source indicates timber yields of between 2 and 10 m^3/ha, with an average value of 5 m^3/ha (this data is consistent with the average values of about 6.5 m^3/ha and 12 m^3/ha for timber from commercial classes A and B, resulting from the percentages given in subsection 2.1 combined with an average standing volume of 113 m^3/ha). Taking the average values of 120 m^2 of land clearing per exploited hectare, and 5 m^3 of extracted timber per hectare, we get a very rough estimate of 24 m^2 of auxiliary land clearing per extracted cubic meter (this estimate is certainly rough, but possibly more reliable than the data in table 18). This value would be substantially lower under extensive exploitation of timber of commercial class C. Assuming that the value above holds for the whole Amazonian region, we can estimate the annual area deforested for timber production in the following way. Average tree volume, according to RADAMBRASIL forest inventories, is 113 m^3/ha, i.e. 88 m^2 of forest area per cubic meter of timber. Adding 24 m^2 of auxiliary land clearing, we have 112 m^2 of deforestation per cubic meter of extracted timber. Taking the values in the first column of table 18 as lower bounds for timber extraction, we conclude that deforestation due to the forest industry attained at least 1932 km^2 in 1982, 2127 km^2 in 1983, 2300 km^2 in 1984 and 2619 km^2 in 1985 (according to AC the last figure would be five times higher).

Even assuming that the extraction rate and land clearing data are correct, we cannot take the preceeding figures at face value, due to a factor that to some extent is the key to the understanding of the role of the Amazonian forest industry. Excepting for species of very high value (mainly mahoganny) most of the timber extracted in Amazonia comes from tracts designated for clearing, independently of the value of the standing timber. In other words, sawmills are called to extract timber just before the complete clearing of the tract, wchich will be used for other purposes (cattle growing, agriculture, etc) and therefore such tracts would be deforested with or without intervention of the forest industry. In this sense, differently from the situation in Southeast Asia or Equatorial Africa, the Amazonian forest industry has not played up to now the role of the driving force behind deforestation.

It is not easy to estimate the fraction of tracts where timber extraction is not followed by immediate full land clearing. However, in a survey made in 1985 in Rondônia, while collecting data for [7], sawmill owners reported that about 80% of their timber (excluding mahoganny) was being extracted from clearing designated areas (usually they can recognize such a situation because other clearing preparation activities are under way when they arrive; in fact, sometimes, when for any reason they reach the tract after the appointed date, they find that it has been already burnt out, with all its commercially valuable timber, which emphasizes the fact that for many landowners timber exploitation is a secondary activity, the revenue from which has very little impact upon their land clearing decisions).

If we assume then that this estimate 20% of timber volume coming from tracts where no clearing occurs shortly after timber extraction remains valid when applied to the whole region, then contribution of the forest industry to deforestation falls to a level of between 400 and 500 km^2/year between 1982 and 1985 (or 2500 km^2 according to AC). It must be emphasized that this 20% value is not solid, and its extension to the whole Amazonian region is quite doubtful.

While this fact pushes down the estimated values of land deforested by the forest industry, there is another factor which acts in the opposite direction, and particularly

in tracts which are not cleared after timber extraction. The secondary roads and paths mentioned above are temporary, and in many case they become intransitable by trucks just after the rain season following their opening, but even so they are openings in the forest which can be used by pedestrians for many years. It is reported that in many cases they are used by migrant settlers to have access to otherwise inaccesible areas (taking sometimes advantage of the yards for permanent settlement), where they start their own land clearing activities, mainly for agriculture. Data in [7] indicates an average of 400 m of secondary roads and 1600 m of paths per km^2. In view of the data above, this means at least 900 km of secondary roads and 3600 km of paths opened every year, which is not a negligeable amount, despite their relatively short lifetime. But we know of no way to quantify deforestation by other agents induced by the secondary roads opened by the forest industry.

4. Future perspectives for the Amazonian forest industry.

Any attemps to make forecasts in an economy as unstable as the Brazilian one may be considered a completely futile exercise of futurology. And even more so for a sector of the economy for which we lack all kind of reliable data. With this in mind, this section must be considered as a very tentative and somewhat ill-founded attempt to answer the following question.

Is it possible that the relatively secondary role of the forest industry in Amazonian deforestation that we observe today may be drastically altered within the foreseenable future, so that it becomes, if not the driving force, at least a decisive factor in the deforestation process?

This question is not an idle one, since the forest industry is indeed the driving today force behind deforestation in Equatorial Africa and Southeast Asia.

In order to provide some hints pointing toward an answer to this question, we analyze separately the domestic and the foreign markets.

In the domestic front, a key factor which is a necessary condition for such an alteration is the end of the recession in which the Brazilian economy has foundered for more than ten years. The reason is the following. The process of substitution of subtropical and temperate natural timber by Amazonian one is already over, with the depletion of the first one. Since at the same time, the four or five valuable Amazonian species which entered the market during that process are also being depleted, and will become more and more expensive due to longer transportation hauls, the only way to operate the drastic change mentioned above would be the massive introduction of new Amazonian species in the Southeast and the South. As discussed in section 1, the small to medium size sawmills are structurally unable to accomplish that. The change would take place only if the modern sector of the industry becomes dominant. This requires high capital investment. Such investment could occur through the entrance in the market of either leading foreign firms especialized in tropical timber or modern domestic forest companies which operate in the Southeast and South with timber extracted from plantation forests (mainly pinus and eucalyptus).

The foreign companies have been very reluctant to enter the Brazilian market, where their participation is marginal (one of them rejected some years ago the offer to extract the timber to be flooded by the Tucurui dam), and are not likely to change this attitude in the near future. They operate basically with timber exported to Europe and Japan, and they prefer to stay in Africa and Southeast Asia, where both local costs and freight cost to Europe and Japan respectively are lower than in Brazil. At the same time, they share with companies in all other economic sectors a lack of confidence in the future performance of the Brazilian economy as a whole. It is pretty safe to state that no substantial foreign investment in the sector will take place until the Brazilian economy shows signs of a solid and long term recovery.

Regarding the domestic companies, some of them, like those operating in the pulp and

paper and in the boards and panels sectors, are certainly state-of-the-art enterprises with technological capabilities to enter the Amazonian timber market. However, in this case also the recession acts as a severe deterrent to new heavy investments, particularly in an area like tropical timber, in which they have no past experience, and where the environmental obstacles mentioned in section 1 imply serious risks.

The recession acts also on other levels. It keeps the rate of increase of domestic demand at a low (and perhaps negative) rate, increasing the risks just mentioned, particularly in the face of the heavy investments required by the installation of large modern sawmills. Also, it stops public investment in infraestructure, mainly roads and electric power stations. We have already commented that the opening of roads in the region was a crucial factor for the expansion of the industry in the seventies, and this is equally true for the drastic change under discussion. A very large amount of commercial timber, particularly in commercial class B, is located in areas whose distance to permanent roads makes it too expensive to compete with sawnwood from plantation forests in the South. Also, large areas within the region lack reliable electric power supply, an elementary prerequisite for the installation of a large and modern sawmill. In part of the region the situation in this respect will improve substantially if and when the Balbina and Samuel hydroelectric power stations become fully operative.

Regarding the foreign market, its negligeable participation up to now (see table 14) makes it unlikely that it could induce a change as the one under discussion. However, it has been argued that the depletion of the tropical rainforest in Equatorial Africa and Southeast Asia could make of Brazil the only remaining big producer of tropical timber, in which case the leading foreign firms could change their minds and enter massively the Brazilian market. Let us make it clear that this will not happen immediately. Though the annual extraction rates in some African and Southeast Asian countries run as high as 5% of available commercial volume, no such depletion is foreseen within the next decade. At the same time, it must be remembered that tropical timber can be substituted by other

products, including nontropical timber. In this sense, it is convenient to make a distinction between the few species of very high value and the other commercial species.

In the case of mahoganny, it is likely that available Brazilian resources in nonprotected areas will become depleted bewfore the African rainforest. Though the forecast mentioned in section 3, of full depletion by 1997, seems now overly pessimistic, the end cannot be much further down the road. In this respect it is worthwhile to mention the attempts to open protected areas, like Indian reservations and national forests, to so called rational mahoganny exploitation. For instace, the Kajapó indians agreed to such a proposal in 1984, accepting the offer of a foreign timber company (in one of the few foreign ventures in the sector) with startling economic results for the tribe. In other cases, like in the Rio Guaporé Biological Reserve (Rondônia), the result was full havoc, because extraction was not limited to mahoganny, but included other species which were essential to the ecosystem, which the reserve was supposed to preserve. Also the proposal is to some extent euphemistical because a large fraction of such areas has been opened "de facto" due to lack of control, and mahoganny has become as scarce there as in nonprotected areas.

Regarding species of commercial class A but less valuable than mahoganny and "virola", it is not clear at all that depletion of African and Asian rainforests will open the European markets to them. One ádvantage of African timber (at least those which has been mainly exploited up to now), lies in its proximity to the ports, which is not the case for Brazilian one. If Brazilian timber from less valuable species turns out to be substantially more expensive than African timber currently exploited, this one, after depleted, could perfectly be substituted by other products. At this point it is worthwhile to mention that the high cost of Brazilian port operations considerably increases freight costs for imported sawnwood. This is partly due to obsolete port infraestructure (and here again the recession becomes a barrier for the expansion of the sector) and partly to institutional factors. The new port legislation currently under consideration could improve the situation at least in this respect.

Finally, we must consider the effect of the growing opposition of a sizeable fraction of

the European public opinion to the use of tropical timber, based mainly in the allegedly catastrophic global environmental consequences of the disappearance of the tropical rainforest (up to now, no similar phenomenon has taken place in Japan, the other big consumer of tropical timber). In most European countries legislation is being considered to hinder or suppress imports of tropical timber, and some of it has already been approved. Austria became the leader in this process, when regulations were enacted last year forbidding the introduction in the country of any product made from tropical timber (journalistic reports inform that in March 1993 such regulations were weakened or reppealed after the Indonesian threat of boycotting all Austrian products). Though the extent and consequences of this process cannot be predicted, it is likely that pressure against tropical timber will tend to increase in the near future. Even if no legislation is finally enacted, intrinsic substitutability of tropical timber makes it quite vulnerable to changes in consumer preferences: if a substantial number of consumers become convinced that cutting mahoganny will increase the "greenhouse" effect and cause draughts and floods in their own country, the high value of mahoganny could drop quite fast, whether the connection between mahoganny extraction and the floods is real or not.

In this respect, we cannot discard the the appearance of similar preservationist pressures inside Brazil. There have been already political movements against illegal extraction of timber from Indian reservations. Though such pressures have not yet been extended to legally extracted tropical timber, it should be remarked that a growing consumer awareness has been developing during the last few years among the urban middle class, and a massive introduction of Amazonian timber, going beyond the classical high value species (say species of commercial class B) could very well provoke responses similar to those registered in Europe. Such a process could be supported by the sawnwood industry in the Southeast and the South, which would confront competition with pinus, its main product, in the segment of less expensive wood (one should note that southeast sawnwood, extracted from plantation forests under regular rotations, is not environmentally objectionable).

We can conclude this discussion by stating that it is more likely that the drastic alteration mentioned in the question at the top of this section will not occur. The end of the current recession is a necessary condition for it. But even in such a case, many signs point in the direction of a situation where the forest industry will still have a subordinated role in the process of Amazonian deforestation, with extraction rates kept at current levels or registering a bounded increase which would not change too much the current picture. But of course, such a statement can be made only in terms of probabilities, and the initial question cannot receive at this point any definite answer.

Table 1

Forest industry output

	1960	1970	1975	1980
Forest industry output (nationwide) (10^6 1980 US$)	–	1191	4214	8398
Forest industry output (Amazônia) (10^6 1980 US$)	–	17	112	454
Sawnwood and panels output (Amazônia) (10^6 1980 US$)	–	17	112	349
Pulp: (Amazônia) (10^6 1980 US$)	–	–	–	105
Forest output/total industrial output(nationwide) (%)	5.8	4.7	4.4	4.6
Forest output/total industrial output(Amazônia) (%)	6.1	8.1	11.1	12.9

Source:[7]

Table 2

Sawmills in Amazônia

	1952	1965	1973	1978	1981
Sawmills	89	194	287	793	1639

Source: [9]

Table 3

Timber Production (10^6 m^3)

	1975	1976	1977	1978	1979	1980
Nationwide	31.5	33.2	32.3	32.3	31.6	36.2
Amazônia	4.5	5.9	6.7	7.7	8.4	11.5
Amazônia as % of total	14.3	17.8	20.7	23.8	26.6	31.8

Source: [4]

Table 4

Forest industry output (10^6 1980 US$)

	1970	1975	1980
Rondônia		15.7	73.0
Acre	0.2	1.0	5.5
Amazonas	5.4	28.8	59.3
Roraima		1.5	7.9
Pará	10.5	68.7	313.2
Amapá	6.6	11.5	25.9
Amazônia	22.7	127.2	484.8

Source: [4]

Table 5

Forest industry output/ total industry output (%)

	1975	1980
Rondônia	28.6	61.2
Acre	1.0	5.5
Amazonas	5.0	2.8
Roraima	40.0	68.3
Pará	61.4	69.0
Amapá	29.3	33.8
Amazônia	11.1	12.9

Note: total industrial output includes mining exception Rondonia.

Source: [4]

Table 6

Sawmills in Amazônia

	1978	1981
Rondônia	141	250
Acre	35	61
Amazonas	89	62
Roraima	18	17
Pará	510	866
Amapá		60
Maranhão (Imperatriz)		105
Mato Grosso		218
Total	793	1639

Source: [9]

Table 7

Sawnwood production in Amazônia (1981)

	$10^6\ m^3$
Pará	3600
Amazonas	156
Amapá	162
Rondonia	628
Roraima	54
Acre	24
Maranhão (Imperatriz)	153
Mato Grosso	611
Total	5388

Source: [9]

Table 8

Nationwide sawnwood consumption and GNP

	1975	1976	1977	1978	1979	1980
Sawnwood consumption (10^6 m^3)	9.565	10.891	12.302	12.973	13.413	14.319
G N P (US $/capita)	1211	1389	1534	1695	1820	1949

Source:[6], [5]

Table 9

Coniferous and nonconiferous sawnwood demand nationwide

	1975	1976	1977	1978	1979	1980
Coniferous sawnwood (10^6 m^3)	3.962	4.511	4.984	5.246	5.521	5.918
Nonconiferous sawnwood (10^6 m^3)	5.603	6.380	7.318	7.727	7.892	8.401

Source:[12]

Table 10

Sawmills and production by size class (1980)

Annual output (m^3)	Number of sawmills	%	Total production 10^6 m^3	%
Less than 5000	1049	64	1.544	29
5000 - 10000	459	28	2.267	42
More than 10000	131	28	1.582	29
Total	1639		5.392	

Source: [14]

TABLE 11

EXPORTED AMAZONIAN SAWNWOOD (QUANTITIES, tons)

Year	1980	1981	1982	1983	1984	1987
CEDRO	1,756	1,011	1,026	5,073	2,840	2,347
JACARANDA	671	148	228	326	265	303
SUCUPIRA	4,031	6,973	10,677	5,101	410	3,863
VIROLA	29,804	5,444	7,950	26,600	17,919	38,894
MOGNO	28,190	24,313	33,085	47,240	27,697	124,092
ASSACU				85	497	50
CEDRORANTA				23	110	197
FREIJO				181	519	386
IPE, PAU D'ARCO				194	865	2,122
QUARUBA, CAFEARANA				100	1,219	808
ANDIROBA						9,187
CEREJEIRA						1,786
ANGELIM						1,965
JATOBA						8,889
PAU MARFIM						588
TATAJUBA						599
OTHER SPECIES	51,889	40,837	35,681	17,904	12,687	26,367
TOTAL	116,340	78,596	88,647	102,824	77,715	222,841
OTHER SPECIES (through Paranagua)	3,012	4,267	1,073	1,394	1,504	1,753
TOTAL (including Paranagua)	119,352	82,863	89,720	104,218	79,219	224,594

Source: [2]

TABLE 12

EXPORTED AMAZONIAN SAWNWOOD (VALUE, 10**3 US$)

Year	1980	1981	1982	1983	1984	1987
CEDRO	557	400	456	2,008	900	1,035
JACARANDA	253	113	179	141	151	276
SUCUPIRA	914	1,854	2,683	1,104	770	784
VIROLA	5,078	1,033	1,487	5,871	3,902	8,749
MOGNO	14,450	12,820	13,779	21,401	13,087	76,197
ASSACU				9	32	30
CEDRORANTA				3	11	328
FREIJO				61	123	136
IPE, PAU D'ARCO				42	167	600
QUARUBA, CAFEARANA				16	161	152
ANDIROBA						1,923
CEREJEIRA						611
ANGELIM						379
JATOBA						1,642
PAU MARFIM						210
TATAJUBA						118
OTHER SPECIES	8,884	7,421	6,115	3,488	2,422	6,980
TOTAL	30,135	23,641	24,669	34,144	21,745	107,130
OTHER SPECIES (through Paranagua)	984	1,507	441	491	399	614
TOTAL (including Paranagua)	31,124	25,148	25,140	34,635	22,144	107,744

Source: [2]

TABLE 13

SCIENTIFIC NAMES OF EXPORTED SPECIES

ANDIROBA	Carapa spp.
ANGELIM	Hymenolobium patraeum
ASSACU	Hura crepitans
CEDRO	Cedrela spp.
CEDRORANTA	Cedrela spp.
CEREJEIRA	Torresia spp.
FREIJO	Cordia goeldiana
JACARANDA	Jacaranda capaia
JATOBA	Humenaea spp.
MOGNO	Swietenia macrophylla
PAU D'ARCO	Tabebuia spp.
PAU MARFIM	Agonandra brasiliensis
QUARUBA	Vochysia spp.
SUCUPIRA	Diplotropis spp.
TATAJUBA	Bagassa guianensis
VIROLA	Virola spp.

Source: [13]

TABELA 14

RELEVANT EXPORTS INDICATORS

Year	1980	1981	1982	1983	1984	1987
Mahoganny exports as percentage of total exports in quantity (%)	23.6	29.2	36.9	45.3	35.0	55.2
Mahoganny exports as percentage of total exports in value (%)	46.4	51.0	54.8	61.8	59.1	70.7
Mahoganny plus virola exports as percentage of total exports in quantity (%)	48.6	35.8	45.8	60.8	57.6	72.5
Mahoganny plus virola exports as percentage of total exports in value (%)	62.7	55.1	60.7	78.8	76.7	78.8
Estimated volume of timber with bark corresponding to exported sawnwood (10**3 m**3)	443	307	333	387	294	831
Percentage of extracted timber used for exported sawnwood (%)			1.9	2.0	1.4	

Source: [2] and Table 18

TABLE 15

AVAILABLE COMMERCIAL VOLUME PER COUNTY AND COMMERCIAL CLASS AND ANNUAL EXTRACTION AS PERCENTAGE OF AVAILABLE COMMERCIAL VOLUME

Columns ACVA, ACVB, ACMC: Available commercial volume (with bark) for commercial classes A, B and C in 10**6 m**3.

Column PVExt85: Annual extraction according to IBGE 1985 Extractive Survey as a percentage of available commercial volume for commercial class C, in %.

Column PVCA85: Annual extraction according to IBGE 1985 Agricultural *Census* as a percentage of available commercial volume for commercial class C, in %.

OBSERVATIONS:

1. .000 in any of the last two columns indicates less than .0005%; - indicates missing information.

2. Data on Rondonia, Acre, Roraima, Para and Mato Grosso counties consider forest area in each county net of recent deforestation; data on Amazonas, Amapa and Maranhao counties consider forest area in each county according to original vegetation cover.

RONDONIA (UF 11)

County		ACVA	ACVB	ACVC	PVExt85	PVCA85
1.	Porto Velho	126.973	236.712	534.710	.247	3.647
	ALL COUNTIES	126.973	236.712	534.710	.247	3.647

ACRE (UF 12)

County		ACVA	ACVB	ACVC	PVExt85	PVCA85
2.	Assis Brasil	1.734	3.233	7.299	.000	-
3.	Brasileia	1.832	3.414	7.710	.097	-
4.	Cruzeiro do Sul	13.684	25.510	57.603	.018	.085
5.	Feijo	15.395	28.701	64.809	.010	.283
6.	Mancio Lima	3.950	7.364	16.629	.016	-
7.	Manoel Urbano	12.698	23.673	53.455	.003	-
9.	Rio Branco	8.176	15.243	34.419	.505	34.910
10.	Sena Madureira	13.317	24.826	56.056	.019	-
11.	Senador Guionard	1.690	3.150	7.113	.366	11.670
12.	Tarauaca	14.869	27.719	62.592	.012	-
13.	Xapuri	5.426	10.115	22.840	.035	-
	ALL COUNTIES	92.270	173.106	390.525	.070	3.349

AMAZONAS (UF 13)

County		ACVA	ACVB	ACVC	PVExt85	PVCA85
14.	Anori	7.113	13.261	29.945	.001	.074
15.	Atalaia do Norte	48.461	90.344	204.005	.004	-
16.	Autazes	4.764	8.881	20.054	.000	2.632
17.	Barcelos	41.290	76.976	174.816	.001	-
18.	Barreirinha	36.722	68.460	154.587	.004	4.816
19.	Boca do Acre	11.817	22.030	49.746	.000	-
20.	Borba	53.121	99.032	223.620	.001	.011
21.	Canutama	20.094	37.461	84.589	.022	-
22.	Caraubari	87.718	163.528	369.258	.010	1.050
23.	Careiro	4.438	8.273	18.681	.001	.010

24.	Coari	41.240	76.882	173.605	.004	-
25.	Codajas	16.257	30.308	68.437	.002	.226
26.	Eirunepe	10.421	19.428	43.870	.000	-
27.	Envira	10.477	19.533	44.107	.000	.136
28.	Fonte Boa	92.473	172.394	389.276	.006	.103
29.	Humaita	23.732	44.243	99.903	.025	-
30.	Ipixuna	13.220	24.646	55.653	.000	-
31.	Itacoatiara	7.818	14.574	32.909	.004	.008
32.	Itapiranga	5.893	10.987	24.808	.001	.015
33.	Japura	15.314	24.820	56.045	.003	-
34.	Jurua	15.997	29.822	67.341	.004	5.349
35.	Labrea	41.036	76.501	172.745	.008	.020
36.	Manacapuru	11.633	21.686	48.968	.014	.808
37.	Manaus	8.455	15.736	35.594	.083	1.866
38.	Manicore	47.638	88.810	200.539	.006	-
39.	Maraa	11.147	20.782	46.926	.003	-
40.	Nhamunda	9.887	17.872	40.357	.001	-
41.	Nova Olinda do Norte	4.575	8.530	19.260	.000	-
42.	Novo Airao	33.123	61.750	139.435	.004	.010
43.	Novo Aripuana	25.995	48.462	103.430	.005	.233
44.	Parintins	3.875	7.224	16.313	.017	-
45.	Pauini	35.192	65.607	148.144	.000	-
46.	S. Isabel do Rio Negro	11.464	21.372	48.260	.000	-
47.	S. Antonio do Ica	11.693	21.799	49.225	.000	.121
48.	S. Gabriel da Cachoeira	6.067	11.310	25.538	.000	-
49.	Silves	4.440	8.278	18.692	.001	.011
50.	Tefe	29.307	54.637	123.373	.053	.162
51.	Urucara	23.093	43.051	97.212	.001	.011
	ALL COUNTIES	883.515	1648.622	3719.266	.037	.477

RORAIMA (UF 14)

County		ACVA	ACVB	ACVC	PVExt85	PVCA85
52.	Boa Vista	87.416	162.967	367.990	.011	.569
	ALL COUNTIES	87.416	162.967	367.990	.011	.569

PARA (UF 15)

County		ACVA	ACVB	ACVC	PVExt85	PVCA85
55.	Afua	2.709	5.050	11.403	25.870	-
56.	Alemquer	14.889	27.757	62.677	.001	-
57.	Almeirim	61.028	113.771	256.703	.246	-
58.	Altamira	70.307	131.071	295.966	.003	-
59.	Anajas	3.772	7.033	15.880	3.024	-
62.	Aveiro	18.878	35.193	79.469	.032	-
70.	Breves	7.052	13.147	29.687	1.010	-
79.	Conceicao do Araguaia	7.601	14.170	31.997	7.476	12.650
80.	Curralinho	1.940	3.616	8.165	1.212	-
82.	Faro	9.618	17.931	40.490	.003	-
88.	Itaituba	126.690	236.183	533.317	.012	-
89.	Itupiranga	9.260	17.263	38.982	.077	.103
90.	Juruti	2.109	3.931	8.876	.017	-
93.	Maraba	31.547	58.812	132.801	.030	.077
98.	Monte Alegre	14.484	27.002	60.971	.001	-
101.	Obidos	20.498	38.214	86.289	.012	-
103.	Oriximina	80.646	150.345	339.488	.004	.006
105.	Paragominas	14.679	27.366	61.795	3.095	3.275
108.	Portel	34.469	73.581	166.151	.192	.055
109.	Porto de Moz	11.040	20.582	46.476	1.765	.032
110.	Prainha	24.599	45.859	103.551	.009	.423
117.	Santana do Araguaia	6.754	12.591	28.431	1.417	15.335
118.	Santarem	21.949	40.918	92.396	.228	.039

122. S. Domingos do Capim	28.048	52.290	118.073	1.059	.631
123. S. Felix do Xingu	38.986	72.680	164.117	.005	.252
125. S. Joao do Araguaia	2.245	4.186	9.452	.212	-
128. Senador Jose Porfirio	28.673	53.455	120.704	.005	-
131. Tucurui	3.450	6.525	14.733	2.104	-
133. Viseu	5.536	10.320	23.303	.127	-
ALL COUNTIES	708.459	1321.962	2982.343	.548	.816

AMAPA (UF 16)

County	ACVA	ACVB	ACVC	PVExt85	PVCA85
134. Amapa	7.670	14.298	32.285	.022	-
135. Calcoene	14.583	27.187	61.390	.007	-
136. Macapa	23.601	43.998	93.351	.167	-
137. Mazagao	46.568	86.815	196.034	.119	-
138. Oiapoque	24.153	45.027	101.674	.003	-
ALL COUNTIES	115.149	214.866	484.737	.085	.120

MARANHAO (UF 21)

County	ACVA	ACVB	ACVC	PVExt85	PVCA85
152. Bom Jardim	5.097	9.503	21.458	.065	-
156. Candido Mendes	2.645	4.932	11.136	.060	-
159. Carutapera	8.269	15.415	34.809	.009	-
179. Imperatriz	7.929	14.781	33.376	1.353	.063
192. Moncao	3.361	6.265	14.147	.182	.127
237. Turiacu	4.798	8.944	20.196	.654	2.743
ALL COUNTIES	32.098	59.895	135.122	.468	.438

MATO GROSSO (UF 51)

County	ACVA	ACVB	ACVC	PVExt85	PVCA85
249. Aripuana	63.663	118.684	267.997	.038	4.070
254. Chapada dos Guimaraes	26.349	49.122	110.921	.700	5.782
ALL COUNTIES	90.012	167.961	378.918	.231	4.571

TABLE 16

SUMMARY OF TABLE 15 BY STATE

State	ACVA	ACVB	ACVC	PVExt85	PVCA85
Rondonia	126.973	236.712	534.710	.247	3.647
Acre	92.770	173.106	390.525	.070	3.349
Amazonas	883.515	1648.622	3719.266	.037	.477
Para	708.459	1321.962	2982.343	.548	.816
Roraima	87.416	162.967	367.990	.085	.120
Maranhao	32.098	59.895	135.122	.468	.438
Mato Grosso	90.012	167.961	378.918	.231	4.571
TOTAL	2136.440	3986.554	8993.608	.236	1.064

TABLE 17

COUNTY AND AREA COVERAGE OF VARIABLES

	ACV(X) and PVExt85 coverage		PVCA85 coverage	
	Counties(1980)	Area(km**2)	Counties(1980)	Area(km**2)
Rondonia	1	196,514	1	196,514
Acre	11	149,617	4	60,218
Amazonas	38	1,442,002	21	794,629
Para	29	962,848	12	419,376
Roraima	1	197,253	1	197,253
Amapa	5	91,526	0	0
Maranhao	6	38,937	3	26,245
Mato Grosso	2	457,240	2	279,600
TOTAL	93	3,358,297	44	2,151,275

TABLE 18

TIMBER EXTRACTION IN LEGAL AMAZONIA ACCORDING TO EPS AND AC

Year	Quantity (10**3 m**3)	
	EPS	AC
1982	17,251	
1983	18,997	
1984	20,541	
1985	23,386	108,601

TABLE 19

REGRESSION ANALYSIS OF PVExt85 AGAINST DIST2, ROADEN AND POPDEN

Variable	Estimate	t-value
Intercept	.0161	1.955
DIST2	-.0000	-1.623
ROADEN	-.2266	-.746
POPDEN	.0004	.692

r-square	.0360
Adjusted r-square	.0036

TABLE 20

REGRESSION ANALYSIS OF PVCA85 AGAINST DIST2, ROADEN AND POPDEN

Variable	Estimate	t-value
Intercept	.0121	.366
DIST2	-.0000	-.204
ROADEN	2.5085	3.417
POPDEN	-.0024	-1.755

r-square	.2320
Adjusted r-square	.1771

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Introtp
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AS TENDÊNCIAS DO PROGRESSO TÉCNICO NA AMAZÔNIA

INTRODUÇÃO

É amplamente aceito, hoje em dia, que não se pode falar em crescimento econômico sem se levar em conta os custos que este crescimento provoca no meio ambiente. Na Amazônia, este estudo de preservação analisa o desenvolvimento na produção agrícola na área de fronteira Amazônica com o objetivo de avaliar a contribuição do progresso técnico para a preservação ambiental.

A inovação trazida por ciências como a biotecnologia e a engenharia genética colocam muitos desafios a vencer. Como preservar as tradicionais riquezas em estoque quando tantos delas carecem? Sim, outras formas de riquezas estão por vir e a readaptação é exigida. Mas quando chegará ao menos favorecido? A transição não é fácil nem rápida, pois depende da conscientização de muitos, ao mesmo tempo que é imperiosa e inevitável.

Os aspectos do progresso técnico, abordados durante este estudo, seguem a linha de pesquisa ambientalista. Eles foram organizados da seguinte forma: a) um breve retrospecto das mudanças políticas, b) o crescimento recente do produto bruto e dos fatores produtivos, c) mudanças tecnológicas, e, d) aumentos na produtividade.

I) BREVE RETROSPECTO DAS POLÍTICAS REGIONAIS

Resumidos os fatos que fizeram história no século XX, destaca-se a estrutura de exportação de produtos primários que trouxe à Amazônia os precursores da revolução industrial. No final do século XIX, o grande projeto de produção de borracha, promovido por Henry Ford na Região do Tapajós (Belterra e Fordlândia), destinava-se a atender a indústria automobilística para a fabricação de pneumáticos. Por volta de 1926, a primeira missão científica japonesa se estabeleceu em Tomé-Açú com 189 pessoas em 600.000 hectares (Loureiro, 1990).

Mais de 80.000 pessoas, na sua maioria nordestinos migraram para a Amazônia. Iniciou-se a construção da Ferrovia Madeira-Mamoré e a implantação do sistema de comunicações pelo Marechal Rondom. Logo após esse período, a competição com mercados externos, também exportadores de borracha (ex. Malásia), fez com que o ciclo da borracha perdesse força e jamais voltasse a ser o mesmo.

No começo dos anos 60 a burguesia local teve garantido, pelo governo, o mesmo direito dos grupos de fora da região para a exploração dos extensivos castanhais. Até 1965 o projeto Jari Florestal, para a produção de celulose e papel com reflorestamento, assumiu o controle de 19 das 250 concessões de castanhais feitas durante aquela determinação.

Por volta de 1967 foi anunciada a descoberta de ferro em Carajás e de manganês em Buritirana pela subsidiária da United States Steel Corporation. Em 1970 o governo estabeleceu o Programa de Integração Nacional que gerou uma série de medidas que facilitavam a integração da região amazônica. Dentre as medidas estavam pesados investimentos em projetos de infra-estrutura como a construção de estradas de rodagem, assentamento de colonos e incentivos fiscais adotados mediante o apoio internacional. Neste mesmo ano, 1970, a Vale do Rio Doce

associa-se com a U.S. Steel na exploração de minério de ferro em Carajás. Somente parte do compromisso assumido com o Programa de Integração Nacional fez-se cumprir, como será visto mais tarde.

I) O CRESCIMENTO RECENTE DO PRODUTO BRUTO E DOS FATORES PRODUTIVOS

Uma análise comparativa do crescimento do Produto Interno Bruto Total e da Agricultura a custos de fatores, de 1970 a 1985, mostra o destaque das taxas de crescimento anuais do PIB da Região Norte em relação ao PIB do Brasil, veja Tabela 1 no texto, para taxas de crescimento, Figura 1 e Tabela A1 em anexo. Neste período, a participação do produto agrícola no PIB é de 13% no país e de 22% na Região Norte. O dinamismo na agricultura revela o caráter de fronteira na Região Norte. O valor da produção na agricultura da Região Norte praticamente triplicou no período de 75 a 80, enquanto no Brasil, a agricultura mais que dobrou o seu valor de produção. No qüinqüênio seguinte, 80 a 85, houve um decréscimo destes valores, devido a recessão.

Tabela 1. Taxas de Crescimento Anuais do Produto Interno Bruto

Período	PIB Total		PIB Agrícola	
	Brasil	R.Norte	Brasil	R.Norte
1970-1975	9.92%	9.75%	8.51%	7.46%
1975-1980	10.68%	19.87%	18.46%	24.06%
1980-1985	1.38%	6.70%	-8.90%	-2.20%

Fonte: IBGE - Diretoria de Pesquisas, Departamento de Contas Nacionais.

A Tabela 2 mostra as taxas de crescimento dos principais fatores produtivos terra, trabalho e crédito rural na agropecuária da Região Norte (Figura 2). Observa-se os

descompassos entre a evolução das taxas de crescimento do PIB no setor agrícola com aquelas observadas para os principais fatores da produção. A evolução do crédito rural, em especial, mostra as oscilações alarmantes na oferta de capital circulante. É também surpreendente o significativo aumento das terras agropastoris no período que vai de 1980 a 1985. Este último crescimento se deve principalmente ao aumento das terras para pastagens, como se verá posteriormente. Enquanto isto, o PIB da Região na agricultura apresentava indícios recessivos, veja também Tabelas A2.1 e A2.2, em anexo, para valores reais.

Tabela 2. Taxas de Crescimento Anual de Terras Agropastoris, Pessoal Ocupado na Agricultura e Crédito Rural na Região Norte

Período	Área Total	Pessoal Ocupado	Crédito Rural
1970-1975	5.12%	8.63%	0.64%
1975-1980	7.93%	4.61%	71.60%
1980-1985	20.00%	7.12%	-24.68%

Fonte: Anuários do IBGE

a) Terra

A evolução da área cultivada em culturas permanente e temporária, no país e na Região Norte de 1940 a 1985, pode ser visto nas Figuras 3 e 4, respectivamente. No Brasil, a área de lavoura permanente oscilou entre 4 e 10 milhões de hectares enquanto a lavoura temporária oscilou entre 13 e 42 milhões de hectares, durante esse período. Para a Região Norte, nota-se um decréscimo do número de hectares cultivados em ambas as lavouras para o período que se segue a II Guerra, havendo nova recuperação a partir de 1975. Os dados colhidos durante 1940 são questionáveis e fica aqui observada a necessidade de obter

indicadores complementares para detectar os fatos que levaram a tal variação. Estes mesmos gráficos, incluindo as áreas de pastagens, podem ser vistos nas Figuras 5 e 6, onde destaca-se o crescimento das áreas de pastagens entre 1980 e 1985 para a Região Norte.

A comparação do crescimento das áreas de lavoura permanente, temporária e de pastagens, no Brasil e na Região Norte (Figuras 7 e 8), mostra que, no país, o maior crescimento é na área de lavoura temporária, seguido de área em pastagens e área em lavoura permanente, enquanto que na Região Norte as áreas de pastagem crescem mais, seguindo-se de área em lavouras temporárias e área em lavoura permanente.

Tabela 3. Taxas de Crescimento das Áreas Agropastoris no Brasil (em %)

Período	Lav. Permanente	Lav.Temporária	Pastagem
40 a 50	-3.05	1.32	0.04
50 a 60	5.75	3.53	1.29
60 a 70	0.43	2.28	2.34
70 a 75	0.99	3.99	1.45
75 a 80	4.54	4.09	1.05
80 a 85	-1.21	1.89	0.53

Fonte: Anuários da FIBGE

Tabela 4. Taxas de Crescimento das Áreas Agropastoris na Região Norte (em %)

Período	Lav. Permanente	Lav.Temporária	Pastagem
40 a 50	-16.57	-10.82	5.15
50 a 60	5.24	6.67	-0.91
60 a 70	2.50	3.96	7.15
70 a 75	12.55	14.56	3.59
75 a 80	18.36	4.79	7.89
80 a 85	5.36	10.33	22.01

Fonte: Anuários da FIBGE

O Estatuto da Terra, lei 4505 de 30/11/64, considera que a terra em estado natural (floresta) é improdutiva. A tributação nestes casos é maior do que para as terras de pastagem. A manutenção destas áreas em estado natural só é permitida para pesquisas e experimentação, visando o desenvolvimento da agricultura.

Embora exista desde 1976, a resolução nº 2525 do Conselho Deliberativo da SUDAM que proíbe a concessão de incentivos fiscais em área de floresta, a mesma não tem sido respeitada como se verifica com o acentuado crescimento das áreas de pastagens desde 1985.

A legislação fundiária que surge com a constituição de 1988 é considerada o principal elemento motivador para o desmatamento recente na região amazônica (20 milhões de hectares em 1989, segundo o INPE). Alega-se que os posseiros ficaram preocupados em provar que suas posses eram legítimas e ganhar os benefícios citados no Estatuto da Terra. O Decreto 97637 de 10/04/89 suspendeu a concessão de recursos do FINAM e créditos oficiais para a pecuária na região.

b) Mão-de-obra

A estimativa da população rural no total da população para os anos de 1980 e 1985, Amazônia Legal, foi de 54% e 53%, respectivamente (Censos Demográficos FIBGE). A Tabela 6 mostra as taxas de crescimento do pessoal ocupado nas lavouras, para o Brasil e Região Norte, desde 1940.

Tabela 6 - Taxas de Crescimento de Mão-de-Obra Ocupada nas Lavouras

Período	Brasil	Região Norte
1940 a 1950	-0.34%	-1.51%
1950 a 1960	3.49%	5.24%
1960 a 1970	1.32%	5.55%
1970 a 1975	2.91%	8.63%
1975 a 1980	0.79%	4.61%
1980 a 1985	2.15%	7.12%

Fonte: Anuários da FIBGE

As médias de crescimento de mão-de-obra na lavoura, para a Região Norte, ficam acima das médias brasileiras. Ainda assim, a escassez deste fator de produção na área de fronteira representa um dos maiores estrangulamentos ao desenvolvimento e, em contra-partida, uma das maiores garantias de preservação do meio ambiente.

A ação fundiária do INCRA entre 70 e 80 promoveu a implantação de projetos integrados de colonização, alguns implantados com a participação do FINSOCIAL, abrangendo 40000 famílias, com aproximadamente 35000 famílias sendo beneficiadas pela regularização fundiária. Dentre os projetos de colonização, oficial e particular, ocorreram sucessos e fracassos. O segredo do sucesso parece ter sido a consonância ocorrida entre as condições econômicas em que foram estabelecidos os projetos e as reais necessidades do produtor (veja Almeida et.al. 1992).

Uma análise da condição do produtor da Região Norte, desde 1960 até 1980, é baseada na Tabela A3 e indica que a maioria dos estabelecimentos tem como produtor o proprietário, 47%, correspondendo à uma área que é de 56% da área total dos estabelecimentos. Seguindo-se em importância, vem o ocupante com o número de estabelecimentos médio de 40%, com uma área que corresponde a 24% da área total. Logo em seguida tem-se o

arrendatário com 10% dos estabelecimentos e 16% da área total e finalmente, a parceria com 3% dos estabelecimentos e 3% da área total.

Quando se deseja ver esta distribuição do produtor segundo a escala hierárquica de área do estabelecimento pode-se recorrer a Tabela A4. O grande produtor, com terras acima de 10000 ha, teve o número de estabelecimentos correspondente à média de 0,2%, entre 1960 e 1980. A participação destes estabelecimentos no total da área foi de 38,5%. Ainda classificado como grande produtor, tem-se as terras que ficam entre 10000 e 1000 ha com 0,9% dos estabelecimentos e 22,6% da área. O médio produtor, com área entre 1000 e 100 ha, teve 12,6% dos estabelecimentos, com área correspondente a 24,1% do total. O pequeno produtor, com área entre 100 e 10 ha, tem 43,6% dos estabelecimentos e 12,6% da área. Finalmente, o micro produtor que tem até 10 ha de terra corresponde a 42,6% dos estabelecimentos e 1,3% do total da área.

O fluxo migratório, segundo a região de origem que tem destino na Região Norte, pode ser observado na Tabela A5. Entre 1960 e 1970 a participação média do número de migrantes homens e mulheres com destino na Região Norte e vindos do Nordeste correspondeu a 85,85%, vindos do Centro-Oeste, 21,15%. A participação do número de migrantes vindos da Região Norte com destino ao Sudeste correspondeu a 18,1% e com destino ao Sul foi de 1,65%. Recentemente, o quadro de migrações parece ter modificado substancialmente, com muitos migrantes sulistas vindo se estabelecer em áreas como Rondônia e Mato Grosso.

Com o objetivo de se obter uma aproximação dos rendimentos do pessoal ocupado na região da Amazônia Legal, três indicadores foram calculados: a média, a moda (valor que ocorre com maior freqüência) e a mediana (média aritmética dos dois valores centrais), da população economicamente ativa. Esses indicadores foram obtidos através das classes de rendas mensais do censo

demográfico de 1980. As classes são assim divididas: até 1/4 de salário mínimo, considerando como ponto médio 0.125 do salário mínimo (sm); de 1/4 a 1/2 sm (ponto médio 0,375 sm); de 1/2 a 1 sm (0,75 sm); de 1 a 2 sm (1,5 sm); de 2 a 5 sm (3,5 sm); 5 a 10 sm (7,5 sm); 10 a 20 sm (15,0 sm), sendo que a ausência de ponto médio para a última classe fez com que essa não fosse considerada. Feitos os cálculos obteve-se: a) mediana igual a 1,579 salários mínimos, b) a moda igual a 1,701 salários mínimos, e, c) média igual a 2,216 salários mínimos, sendo assim, a curva de distribuição é desviada para a direita com assimetria positiva.

c) Créditos Agropecuários

Os recursos de crédito rural estão divididos em três categorias: custeio, investimento e comercialização da safra. O total de volume de financiamentos teve sua origem nos fundos mútuos das cooperativas. Posteriormente, esta atividade foi absorvida pelo Sistema Nacional de Crédito Rural, administrado pelo Banco Central, que tem por agentes financeiros os bancos comerciais e oficiais, como o Banco do Brasil com sua carteira de crédito rural.

Mais recentemente, desde 1980, o valor de créditos agrícola e pecuário dados pelo Banco do Brasil na Região Norte podem ser observados nas Figura 9 e 10, respectivamente, Tabela A6. Os créditos concedidos para a pecuária são cerca de 10 a 20% do crédito concedido à agricultura na Região Norte, no entanto, as taxas de crescimento dos créditos na pecuária têm sido as maiores.

Os gráficos das Figuras 11 e 12 mostram os índices de crédito rural total e do crédito oferecido pelo Banco do Brasil para a agricultura e pecuária da Região Norte, respectivamente. Nota-se que os financiamentos se alternam em crescimento segundo as diversas categorias. Todos os índices seguem uma tendência de

queda até 1984 quando voltam a crescer gradativamente. Em 1985 a taxa de crédito tornou-se atrativa aos investidores e 950 novos projetos foram aprovados pela SUDAM, sendo que 631 destinavam-se a pecuária. Em 1988, o crédito rural proveniente das mais diversas fontes ganhava impulso, enquanto o financiamento do Banco do Brasil, em contraste, apresentava queda depois da boa recuperação ocorrida em 1987. O crédito pecuário e principalmente a categoria de custeio foram os que mais cresceram de 1989 a 1990.

As taxas de crescimento do créditos concedidos pelo Banco do Brasil que estimulam o investimento, principal determinante de progresso técnico, é mostrada na Tabela 5, a seguir:

Tabela 5 - Taxas de Crescimento do Crédito Rural (modalidade Investimento) da Região Norte

Período	Agrícola	Pecuária
1980 a 1981	-43,53%	10,80%
1981 a 1983	-47.74%	-47.08%
1983 a 1984	-73.18%	-69.79%
1984 a 1985	150.93%	117.88%
1985 a 1986	111.35%	573.01%
1986 a 1987	349.55%	210.61%
1987 a 1988	-99.69%	-99.65%
1988 a 1989	207.28%	-68.55%
1989 a 1990	340.41%	4542.68%

Fonte: Anuários da FIBGE

II) TECNOLOGIA

Neste item os fatores que podem ser analisados se relacionam a técnica de cultivo e aos produtos derivados de uma tecnologia criada para incrementar a produção primária. Dentre esses últimos fatores pode-se citar: tratores, fertilizantes e defensivos agrícolas.

A agricultura da região amazônica não deveria se afastar muito do modelo original da floresta onde as espécies raramente aparecem isoladas (monocultura). O cultivo múltiplo combinado, de preferência entre as lavouras permanentes, permite que haja uma troca de elementos que são liberados por algumas espécies e que são essenciais à sobrevivência de outras espécies. O retorno econômico, desse tipo de agricultura ecologicamente apropriado, ainda é difícil de avaliar, mesmo porque é ainda objeto de pesquisa.

Em Rondônia, observa-se alguns tímidos consórcios entre culturas: café-seringueira, cacau-seringueira, café-cacau-seringueira, cacau-banana-virola. Também os cultivadores japoneses desenvolveram esta técnica com a pimenta-do-reino e o mamão, o dendê, o arroz de altiplano e o trigo. Eles aproveitam os efeitos residuais da aplicação de fertilizantes usados na lavoura de pimenta-do-reino para implantar outras lavouras como a de cacau, por exemplo. O Brasil é o terceiro produtor mundial de pimenta-do-reino depois da Malásia e da Índia.

Com relação à produção animal, verifica-se que o búfalo tem demonstrado melhor adaptação ao clima amazônico do que o próprio gado bovino. Milhões de hectares em pastagens inundáveis que não servem para a criação de bovinos são ideais para os bubalinos, além do ganho de peso do búfalo ser maior em pastos naturais e de menor qualidade.

O dado que diz respeito a fertilizantes e defensivos agrícolas disponível no Censo Agropecuário ou nos Anuários Estatísticos da FIBGE é o número de estabelecimentos na Região Norte que faz uso de fertilizantes e defensivos.

Sabe-se que até o final da década de 70 a demanda por fertilizantes no Brasil cresceu à uma taxa superior a 13% a.a.,

enquanto o produto agrícola cresceu a 4,5% a.a.. O uso de defensivos agrícolas cresceu em torno de 17% a.a..

Dados globais para o Brasil e restante do mundo representam alguns indicadores segundo Lopes et.al. (1991).

Tabela 7 - Estimativa do Uso de Fertilizantes (NPK) para o Brasil e Restante do Mundo - 1988/1989

País	Kg/Ha
Holanda	741
China	224
URSS	118
EUA	95
Brasil	52
Argentina	5

Fontes: FAO - FIBGE - IFA - Fertilizer Consumption Statistics Dez 88.

Na Tabela A7 é mostrado o indicador do consumo de fertilizantes por área cultivada, segundo o tipo de lavoura para o Brasil.

O número de tratores usados na agricultura, desde 1940, para o Brasil e Região Norte pode ser visto nas Tabelas A2.1 e A2.2, respectivamente. Suas taxas de crescimento aparecem logo abaixo.

Tabela 8 - Taxas de Crescimento Anual do Número de Tratores para o Brasil e Região Norte.

Período	Brasil	Região Norte
1920-1940	3,48%	6.78%
1940-1950	9.50%	8.90%
1950-1960	22.04%	21.57%
1960-1970	10.46%	10.11%
1970-1975	14.27%	8.99%
1975-1980	11.03%	27.44%
1980-1985	4.09%	15.64%

Fonte: Anuário Estatístico do FIBGE

A revolução que se espera que a biotecnologia e a engenharia genética venham a trazer sobre o ciclo de vida dos vegetais e a obtenção de sementes e plantas com características pré-determinadas, modificará muitas das necessidades dos fatores produtivos acima mencionados. Se espera pelo lançamento de equipamentos para semeaduras e colheitas antes possíveis apenas manualmente. Com espécies vegetais mais adaptadas ao clima e ao solo, as mesmas podem fixar seu próprio nitrogênio revertendo a tendência de adaptação do solo à planta, conseguida através de fertilizantes. Os pesticidas biológicos de manipulação genética têm maior resistência às pragas e fungos e potencializam a utilização dos produtos tradicionais. Outras técnicas como: o uso de variedades resistentes, a rotação de culturas e a aplicação de inseticidas com espectro de ação seletivo são formas alternativas de combate as doenças.

III) PRODUTIVIDADE

O consumo dentro dos próprios estabelecimentos agropecuários, por produto da lavoura temporária da Região Norte, é mostrado nas Tabelas A8, em anexo. Na Tabela 9, vê-se uma resumo da participação do total consumido pelos

estabelecimentos no total produzido, para 1980 e 1985, dos estados da Região Norte.

Tabela 9 - Relação entre Consumo e Produção Total dos Estabelecimentos

Produto	1980	1985
Arroz	5,01%	5,98%
Feijão	16,57%	14,32%
Mandioca	94,88%	92,68%
Milho	39,31%	31,80%

Fonte: Censo Agropecuário Estadual 1980 e 1985.

A taxa de crescimento anual de cada lavoura entre 80 e 85 para o total da produção nos estados da Região Norte e a produção consumida nos estabelecimentos é mostrada na Tabela 10.

Tabela 10 - Taxas Anuais de Crescimento de 1980 a 1985 da Produção nos Estados do Norte

Produto	Total	Consumida
Arroz	-3,25%	0,18%
Feijão	7,73%	4,62%
Mandioca	1,31%	0,84%
Milho	9,21%	4,68%

Fonte: Censo Agropecuário Estadual 1980 e 1985.

O gráfico da Figura 12 mostra a evolução do efetivo pecuário bovino juntamente com o respectivo valor do efetivo. Observa-se que o efetivo cresceu constantemente à exceção do ano de 1985. O valor correspondente passou por decréscimos acentuados de 1980 a 1982, o mesmo se dando de 1985 a 1987. A Tabela A16 mostra as taxas de crescimento do efetivo pecuário.

A evolução dos índices da produção para um período de 7 anos, de 1977 a 1987, para as lavouras temporárias e permanentes pode ser visto nos gráficos das Figuras 13 e 14, respectivamente. O produto que mais se destaca na lavoura

temporária é o milho com crescimento de 2,5 vezes em 10 anos. Veja também Tabela A9, em anexo. Na lavoura permanente tem-se o cacau em destaque crescendo 20 vezes a quantidade em 10 anos. Seguindo-se em importância tem-se o café crescendo 12 vezes neste período. As taxas de crescimento correspondentes á produção são mostradas na Tabela A10.

Também os valores da produção e seus respectivos preços, no período que vai de 1977 a 1987, são mostrados nas Tabelas A11 e A12 e nos gráficos das Figuras 15 e 16.

A evolução da produtividade nos Estados do Norte somados ao Maranhão e Mato Grosso para 1970, 1975, 1980, 1985 e 1988 é vista nas Tabelas A13.

A produtividades destes mesmos estados comparada a produtividade brasileira e estrangeira para o ano de 1988 pode ser vista na Tabela A14.

Tem-se ainda, na Tabela A15, as taxas anuais de crescimento da produtividade nas principais lavouras da Região Norte, mais os Estados do Mato Grosso e Maranhão desde 1970. A lavoura que mais cresceu em produtividade foi a de cacau, entre 1980 e 1985, e a que mais decresceu foi a de café, entre 1985 e 1988.

RESUMINDO

O objetivo desse breve estudo foi fazer uma análise geral e preliminar de algumas variáveis agregadas representativas do progresso técnico na agropecuária da Região Amazônica. O mesmo deverá servir de subsídio ou parâmetro para estudos minuciosos, a nível desagregado, que sem dúvida serão necessários aos planos de desenvolvimento sustentado.

Fig 1:

Indices do Produto Interno

por Regiao e Setor

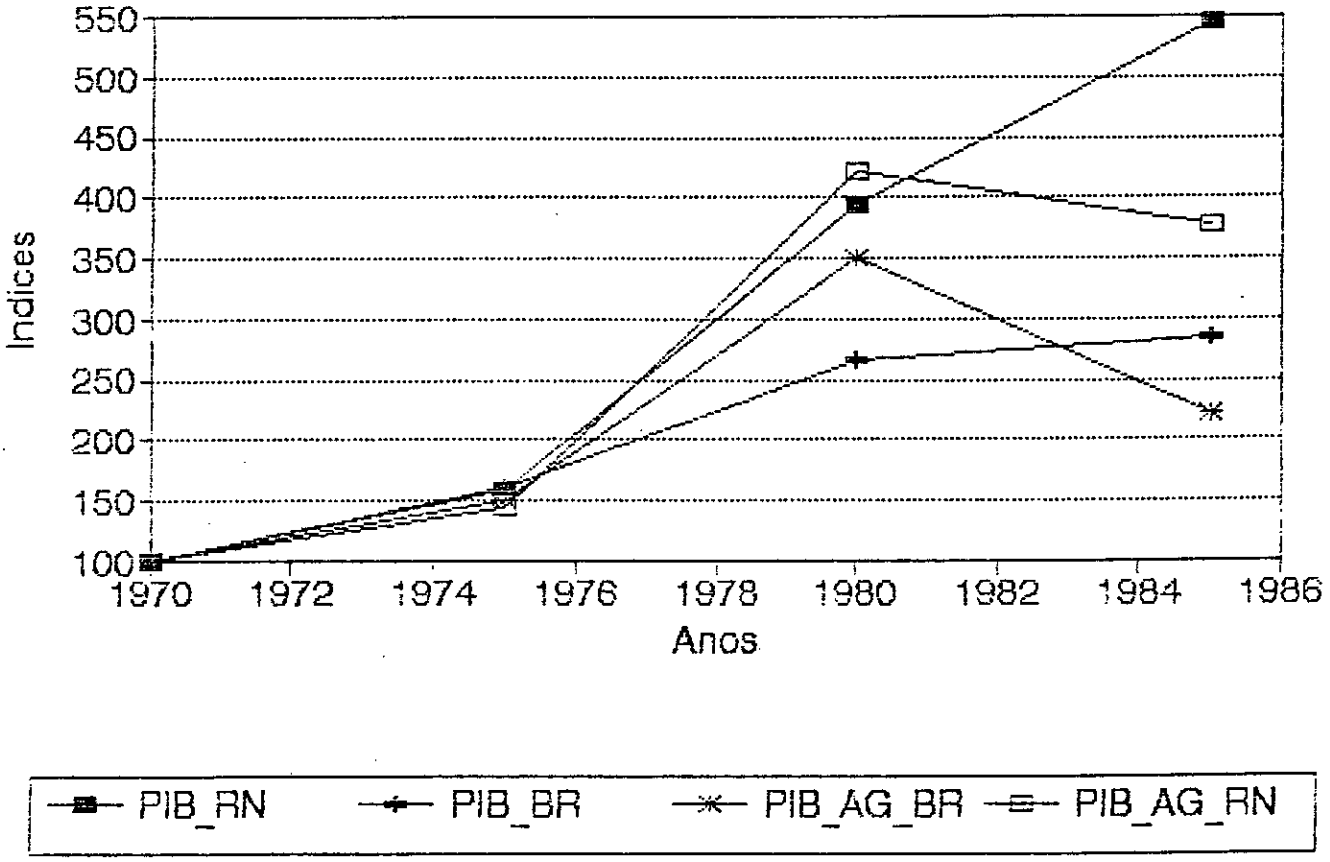


TABELA A1.

Produto Interno Bruto por Regiao e a participacao da R. Norte

Anos	Brasil Milhao Cr$	Reg.Norte Milhao Cr$	% RN
1970	4171106	93371	2.24
1975	6693185	148681	2.22
1980	11114842	368033	3.31
1985	11901202	509048	4.28

Produto Interno Bruto Agricola e Participacao da R. Norte

Anos	Brasil Milhao Cr$	Reg.Norte Milhao Cr$	% RN
1970	522929	21993	4.21
1975	786695	31510	4.01
1980	1835087	92611	5.05
1985	1151627	82858	7.19

FONTE: FIBGE - DIRETORIA DE PESQUISA, DEPARTAMENTO DE CONTAS NACIONAIS

Fig 2 :

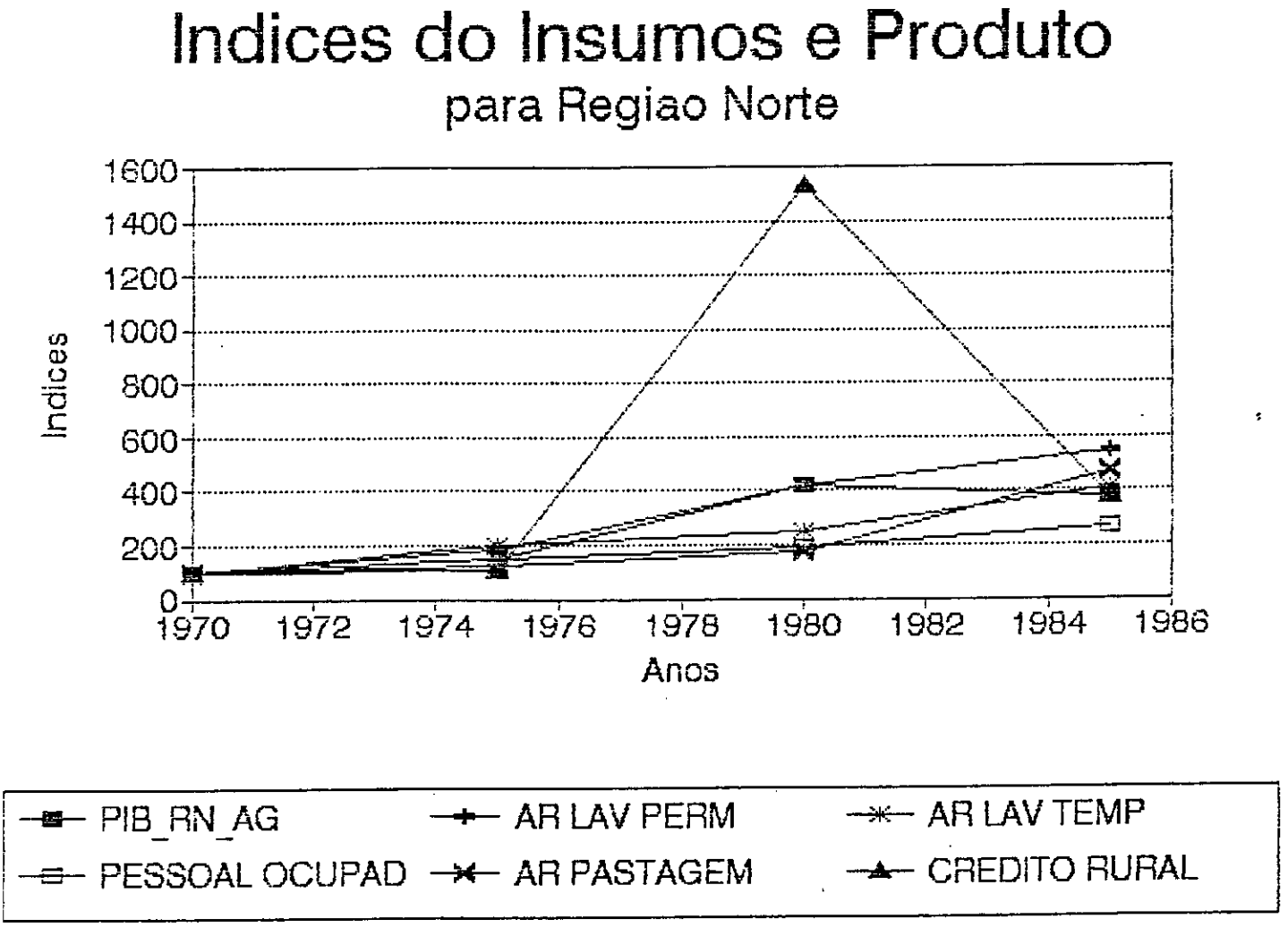

Indices do Insumos e Produto
para Regiao Norte
Indices
1600
1400
1200
1000
800
600
400
200
0
1970
1972
1974
1976
1978
1980
1982
1984
1986
Anos
PIB_RN_AG
AR LAV PERM
AR LAV TEMP
PESSOAL OCUPAD
AR PASTAGEM
CREDITO RURAL

TABELA 22.1

Evolucao dos Fatores da Producao no Brasil

Ano	Area em hectares			Pess.Ocup	gado bov	Tratores
	Perman.	Tempor.	Pastagem			
				6259078	31986681	1706
1940	5958138	12864792	1.07E+08	11339949	34387243	3379
1950	43691134	14670869	1.08E+08	10963338	44561346	8372
1960	7645227	20750822	1.22E+08	15454526	55841278	61345
1970	7984069	25999731	1.54E+08	17627089	78562250	165870
1975	8385393	31615961	1.66E+08	20345692	1.02E+08	323113
1980	10472135	38632128	1.74E+08	21163735	1.18E+08	545205
1985	9853026	42427500	1.79E+08	23543208	1.28E+08	666309

* valor estimado

Taxas de Crescimento dos Fatores no Brasil
(em percentagem)

Periodo	Perman.	Tempor.	Pastagem	Pess.Ocup	gado bov	Tratores
40 a 50	-3.05	1.32	0.04	-0.34	2.63	9.50
50 a 60	5.75	3.53	1.29	3.49	2.28	22.04
60 a 70	0.43	2.28	2.34	1.32	3.47	10.46
70 a 75	0.99	3.99	1.45	2.91	5.29	14.27
75 a 80	4.54	4.09	1.05	0.79	3.04	11.03
80 a 85	-1.21	1.89	0.53	2.15	1.65	4.09

TABELA A2.2

Evolucao dos Fatores da Producao na Regiao Norte

Ano	Area em hectares			Pess.Ocup	gado bov	Tratores
	Perman.	Tempor.	Pastagem			
						7
1940	379726	541860	1471936	380188	999041	26
1950	62049	172463	2432412	326502	1020305	61
1960	103397	328905	2219749	544028	1234882	430
1970	132366	484765	4428116	934024	1706177	1127
1975	239015	956354	5281440	1412647	2129609	1733
1980	555226	1208287	7722487	1769757	3948406	5825
1985	720956	1975305	20876442	2496046	5273372	12045

* valor estimado

Taxas de Crescimento dos Fatores Regiao Norte
(em percentagem)

Periodo	Perman.	Tempor.	Pastagem	Pess.Ocup	gado bov	Tratores
40 a 50	-16.57	-10.82	5.15	-1.51	0.21	8.90
50 a 60	5.24	6.67	-0.91	5.24	1.93	21.57
60 a 70	2.50	3.96	7.15	5.55	3.29	10.11
70 a 75	12.55	14.56	3.59	8.63	4.53	8.99
75 a 80	18.36	4.79	7.89	4.61	13.14	27.44
80 a 85	5.36	10.33	22.01	7.12	5.96	15.64

Fig 3:

Area Cultivada por Tipo de Lavoura

Brasil, 1940 a 1985

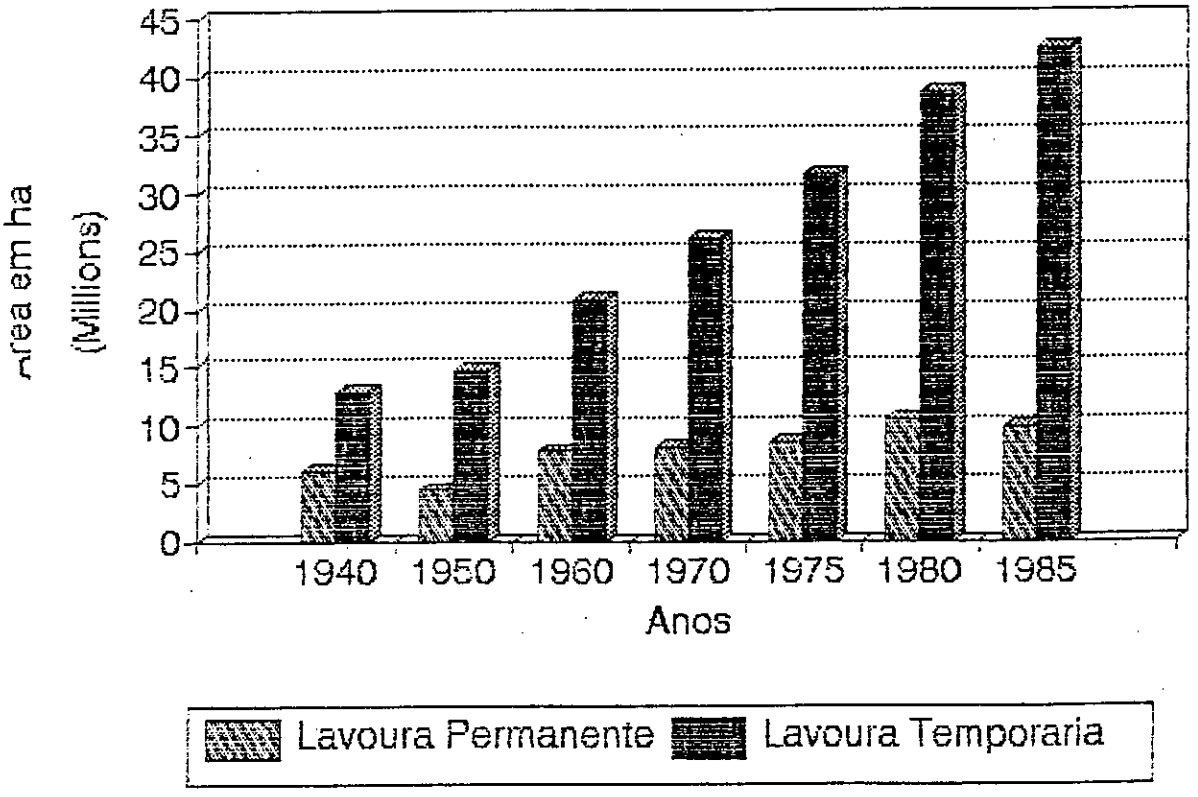


Fig 4:

Area Cultivada por Tipo de Lavoura

Regiao Norte, 1940 a 1985

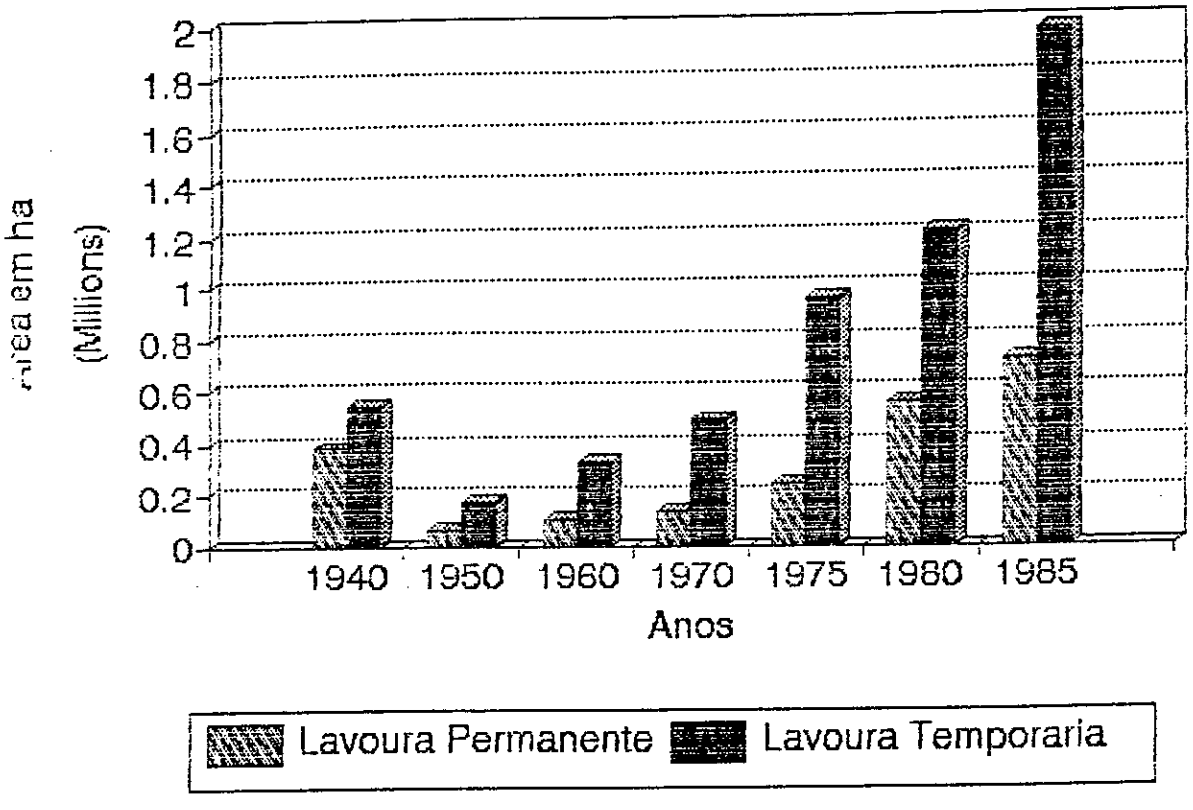


Fig 5:

Evolucao por Tipo de Lavoura

Brasil

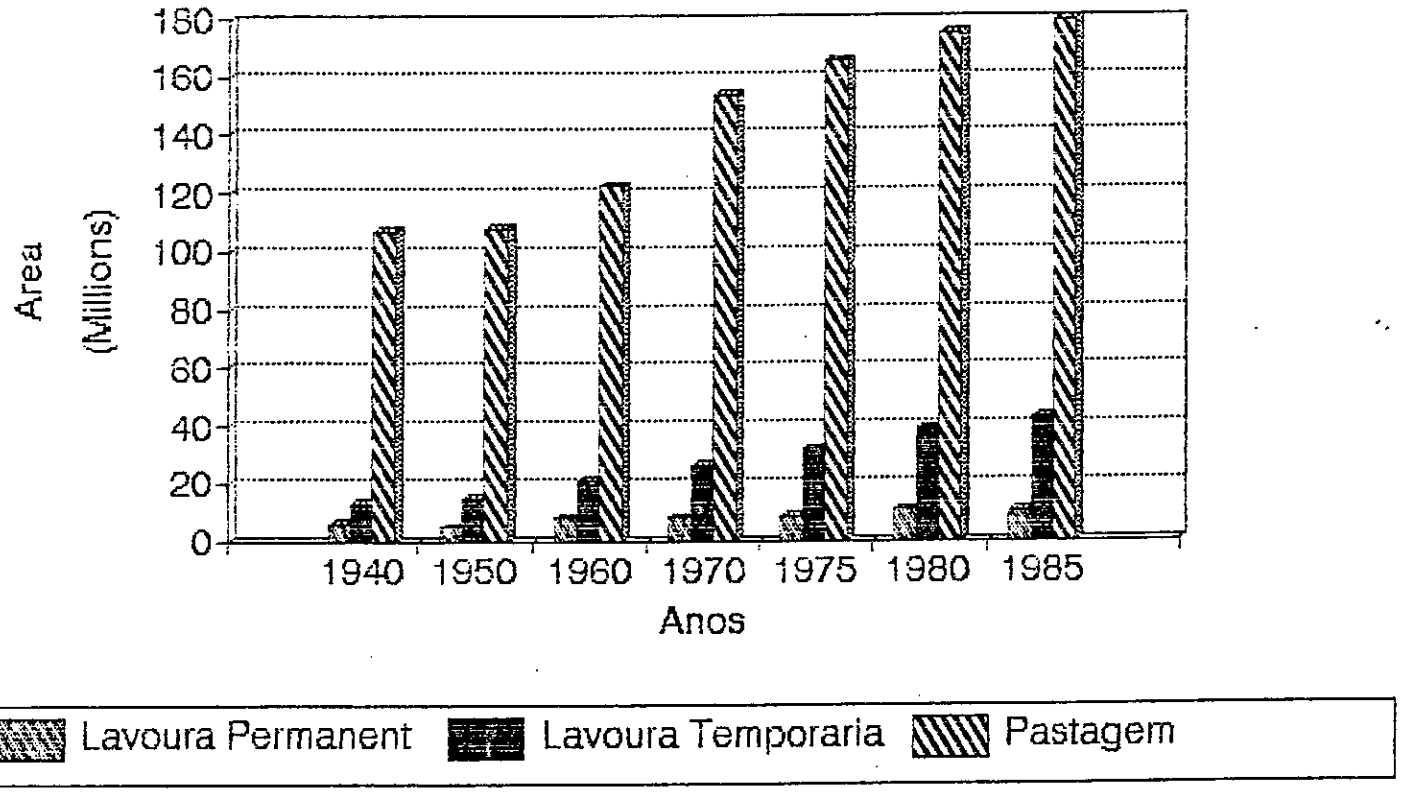


Fig 6 :

Evolucao por Tipo de Lavoura

Regiao Norte

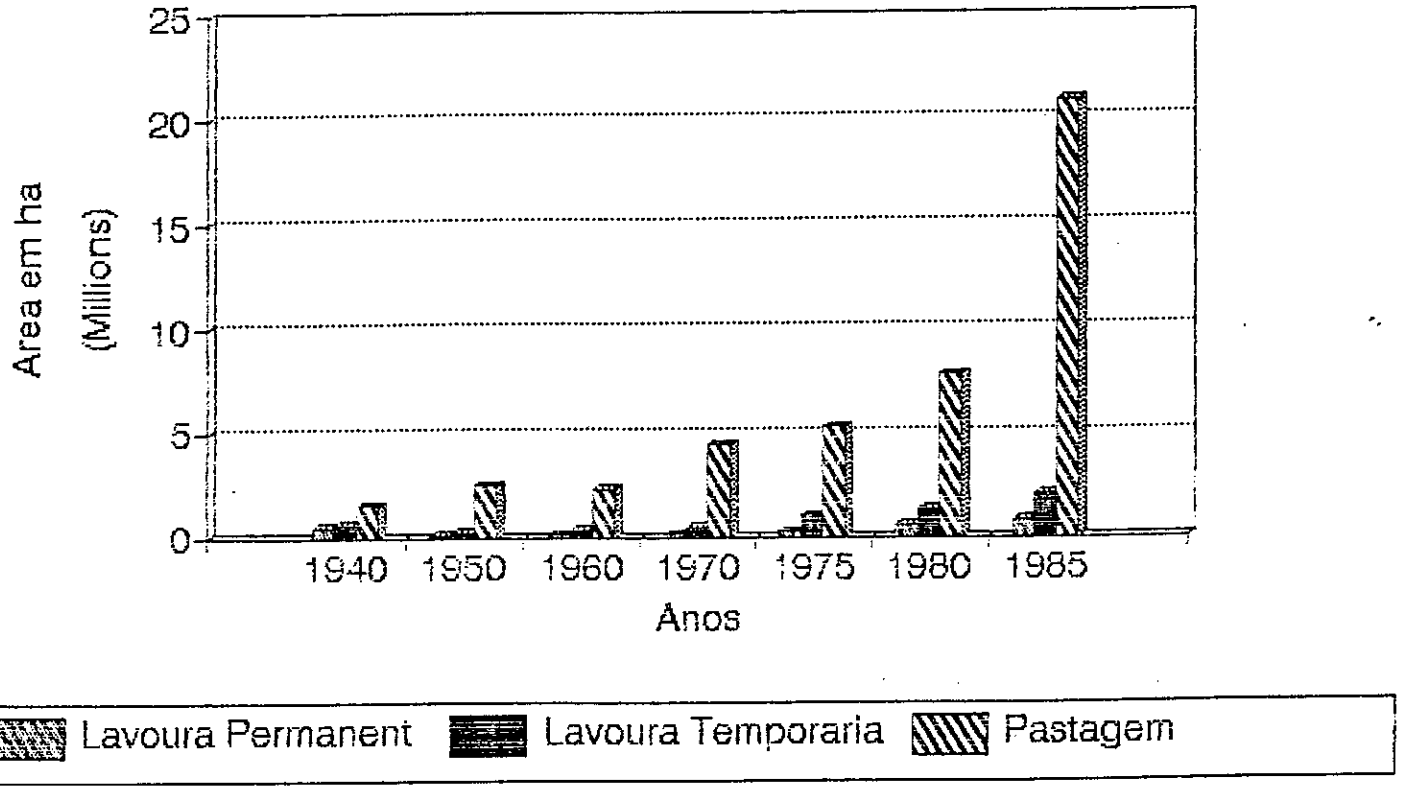


FIG 7:

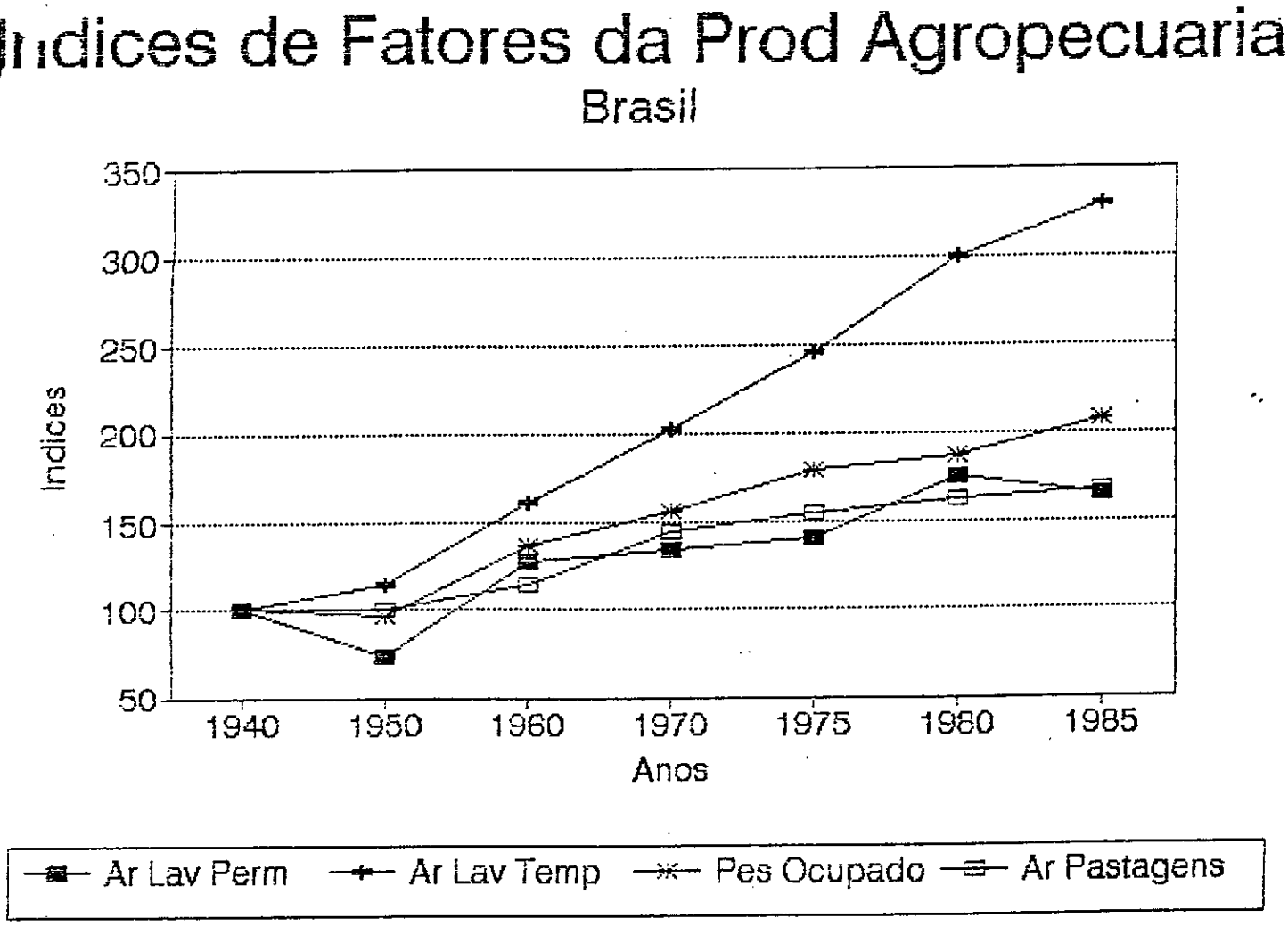
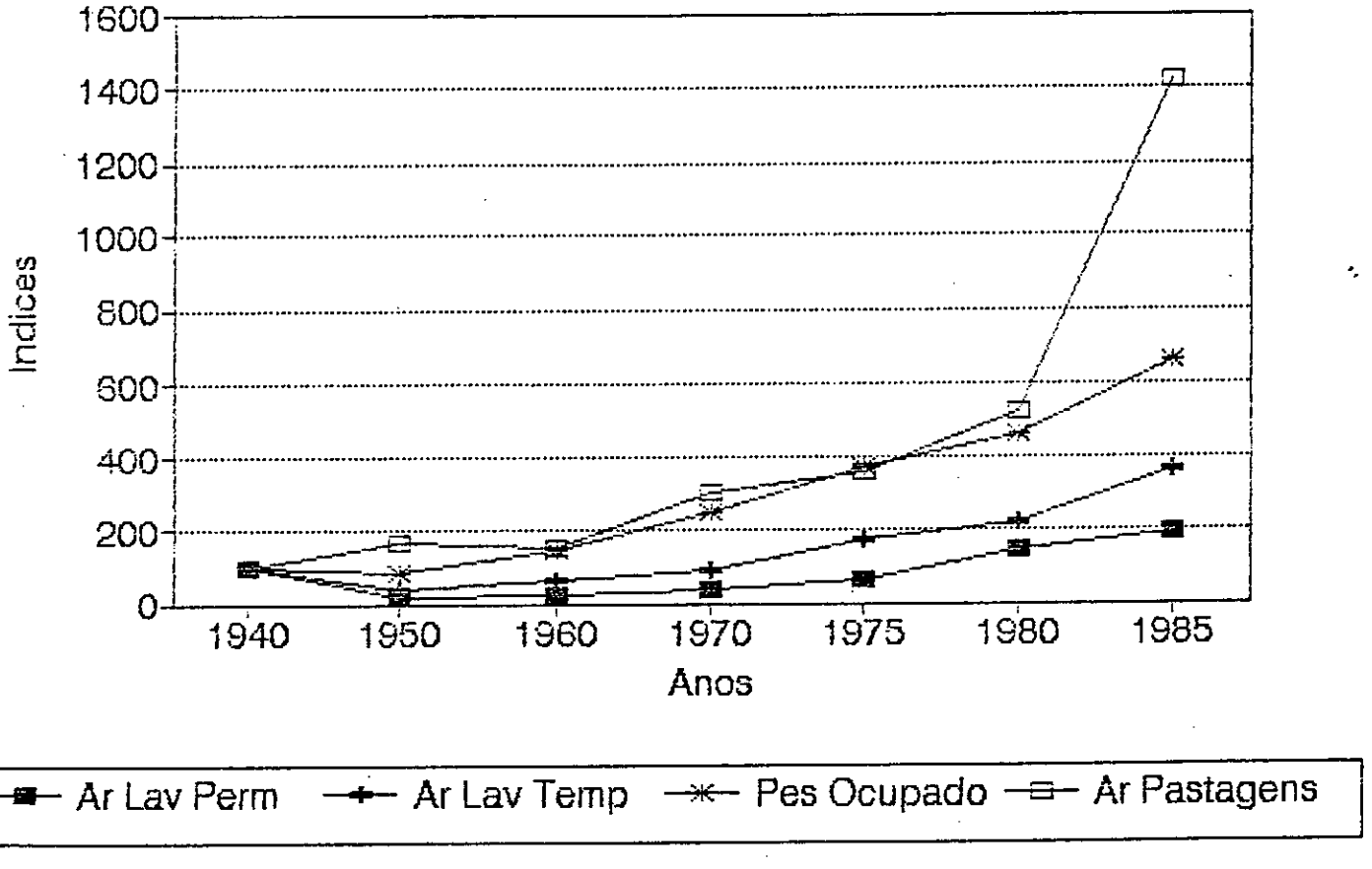

Indices de Fatores da Prod Agropecuaria
Brasil
350
300
250
200
150
100
50
Indices
1940
1950
1960
1970
1975
1980
1985
Anos
Ar Lav Perm
Ar Lav Temp
Pes Ocupado
Ar Pastagens

Fig. 8;

Indices de Fatores da Prod Agropecuaria

Regiao Norte



TABECA A3.

DISTRIBUIÇÃO DAS TERRAS NA AMAZÔNIA DE ACORDO COM A CONDIÇÃO DO PRODUTOR: 1960 - 1980

ANO	CONDIÇÃO DO PRODUTOR																			
	PROPRIETÁRIO				ARRENDATÁRIO				PARCEIRO				OCUPANTE				TOTAL			
	ESTAB.		ÁREA		ESTAB.		ÁREA		ESTAB.		ÁREA		ESTAB.		ÁREA		ESTAB.		ÁREA	
	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%
1960	70225	57,0	9.413.933	50,0	12.322	10,0	4.938.617	25,0	6397	5,0	1.119.921	6,0	34 353	28,0	3.670059	19,0	123 297	100	19.142 530	100
1970	101.513	39,0	13.076081	56,0	33.671	13,0	5.602.144	16,0	4534	2,0	628.661	3,0	121627	46,0	5.875256	25,0	261145	100	23.182 144	100
1980	185.499	46,0	26.178.384	62,0	28.937	7,0	3.145.937	8,0	7190	2,0	329.243	1,0	186531	45,0	12.186.287	29,0	407157	100	41.839.851	100
VARIAÇÃO (1960 - 1980)	115.274	164	16.764.451	178	16615	135	-1792680	-36	793	12	-790678	-71	151178	440	8516228	232	283860	230	22697321	119

FONTE: Censos Agropecuários: 1960, 1970 e 1980. IBGE.

Amazônia Clássica = Região Norte = Amazonas, Pará, Acre, Rondônia, Roraima e Amapá.

TAB. A4 :

DISTRIBUIÇÃO DAS TERRAS NA AMAZÔNIA POR TIPO DE PRODUTOR E POR ESTRATO DE AREA: 1960 - 1980

ESTRATOS DE ÁREA / ANO	MICRO - PRODUTOR 0 ⊢— 10					PEQUENO - PRODUTOR 10 ⊢— 100					MEDIO - PRODUTOR 100 ⊢— 1000					GRANDE - PRODUTOR 1000 ⊢— 10.000					GRANDE - PRODUTOR 10.000 ⊢—					TOTAL				
	ESTAB.		ÁREA		ÁREA MÉDIA	ESTAB.		ÁREA		ÁREA MÉDIA	ESTAB.		ÁREA		ÁREA MÉDIA	ESTAB.		ÁREA		ÁREA MÉDIA	ESTAB.		ÁREA		ÁREA MÉDIA	ESTAB.		ÁREA		ÁREA MÉDIA
	ABS	%	ABS	%		ABS	%	ABS	%		ABS	%	ABS	%		ABS	%	ABS	%		ABS	%	ABS	%		ABS	%	ABS	%	
1960	67.516	50,0	267.172	1,0	3,96	37.452	42,5	1.020.431	7,0	28,20	8.262	6,2	2.256.384	10,0	272,98	1.579	1,0	4.619.078	20,0	2923,32	433	0,3	14.691.021	62,0	33928,48	135242	100	23.453.089	100	173,40
1970	107.271	41,9	382.913	1,7	3,57	106.941	41,8	3.493.954	15,1	32,69	39.378	15,4	8.188.907	35,2	207,45	2.082	0,8	5.734.783	24,7	2754,45	135	0,1	5.400.157	23,3	40002,69	256805	100	23.182.884	100	91,93
1980	146.628	36	570.402	1,4	3,89	190.339	46,6	6.114.563	15,8	33,28	68.407	16,8	12.466.924	29,5	182,24	4.026	1	9869510	23,2	2458,20	399	0,1	12.904625	30,3	32367,44	407.998	100	42.546.024	100	104,30
VARIAÇÃO 1960 - 1980	79312	117,1	303.230	113,9	3,83	132.887	231,5	5094132	31,8	38,34	56.145	708,8	10.210.540	452,6	179,63	2.449	155,1	5.270.432	114,1	2152,08	37	8,6	1786398	12,2	46280,98	272.756	201,7	19092936	82,0	70,01

FONTE: Censos Agropecuários: 1960, 1970 e 1980. IBGE

Amazonia= Região Norte: Amazonas, Pará, Acre, Rondonia, Roraima e Amapá

TAB 15

COMPOSIÇÃO DO FLUXO MIGRATÓRIO DA REGIÃO NORTE, POR PROCEDÊNCIA E DESTINO: 1960 - 1970

REGIÕES	IMIGRAÇÃO (A)				EMIGRAÇÃO (B)				SALDO MIGRATÓRIO (C=A-B)			
	HOMENS		MULHERES		HOMENS		MULHERES		HOMENS		MULHERES	
	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%
I PROCEDÊNCIA ESPECIFICADA	57.543	92,7	43.103	93,4	21.854	100,0	24.917	100,0	35.689	100,0	18.186	100,0
NORDESTE	34.656	56,2	25.412	55,1	4.756	21,8	4.861	19,5	30.100	74,9	20.551	98,8
SUDESTE	6.585	10,6	5.038	10,9	8.891	40,7	11.519	46,2	-2.306	-5,7	-6.481	-30,5
CENTRO OESTE	11.750	18,9	9.375	20,3	4.341	19,9	4.285	17,2	7.409	18,4	5.090	23,9
SUL	4.350	7,0	3.278	7,1	3.864	17,6	4.252	17,1	486	1,2	- 974	- 4,5
II PROCEDÊNCIA NAO ESPECIFICADA	4.514	7,3	3.038	6,6	-	-	-	-	4.514	11,2	3.038	14,3
III TOTAL	62.057	100,0	46.141	100,0	21.854	100,0	24.917	100,0	40.203	100,0	21.224	100,0

FONTE: *Tabela reelaborada a partir dos dados contidos em: - CARVALHO, José Alberto Magno de e MOREIRA, Morvan de Melo. Migrações Internas na Região Norte. Belém, SUDAM, 1974. Vol. 1, p. 55-58.*

(1) Nordeste: Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Fernando de Noronha, Sergipe e Bahia.

Sudeste : Minas Gerais, Espírito Santo e Rio de Janeiro.

Centro-Oeste: Mato Grosso, Goiás e Brasília.

Sul : São Paulo, Santa Catarina e Rio Grande do Sul.

Fig 9

Financiamento Agricola (Banco Brasil)

Regiao Norte

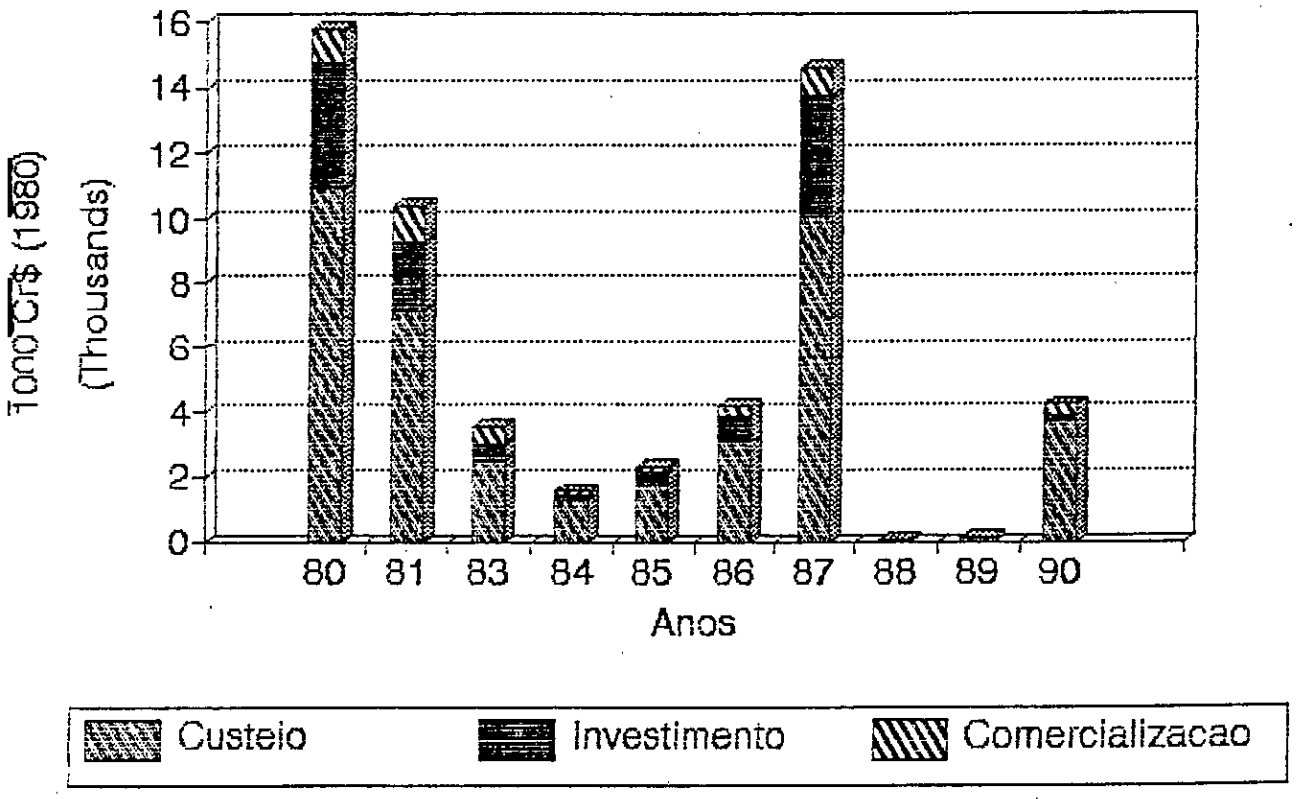
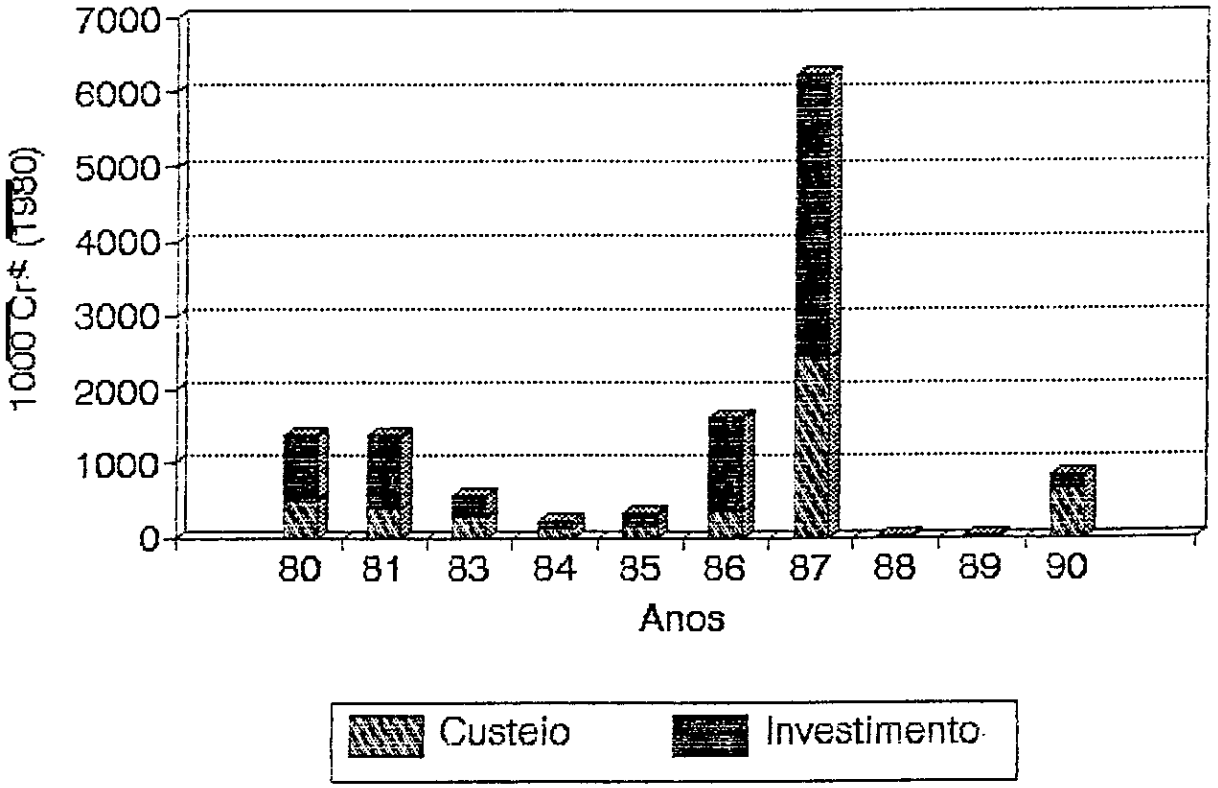


Fig 10:

Financiamento Pecuario (Banco Brasil)

Regiao Norte



TAB. A6;

Creditos Concedidos para Reg, Norte a precos

	tot	Agric cust	inv	com
1980	15819	10909	3787	1115
1981	10414	7153	2139	1119
1983	3775	2458	584	582
1984	1609	1295	157	157
1985	2379	1733	393	254
1986	4241	3050	831	360
1987	14714	10036	3735	943
1988	48	25	12	12
1989	182	114	36	32
1990	4239	3696	157	386

constantes de 1980(mil cruz)

tot	Pecuaria cust	inv	Cred.Rur
1439	479	906	25726
1379	375	1004	18220
563	281	281	12495
209	124	85	5323
343	158	185	6238
1607	361	1246	12829
6261	2392	3869	29094
17	3	13	75860
22	18	4	5704
888	659	196	15959

Fig 11:

Indices de Credito Agricola

Regiao Norte

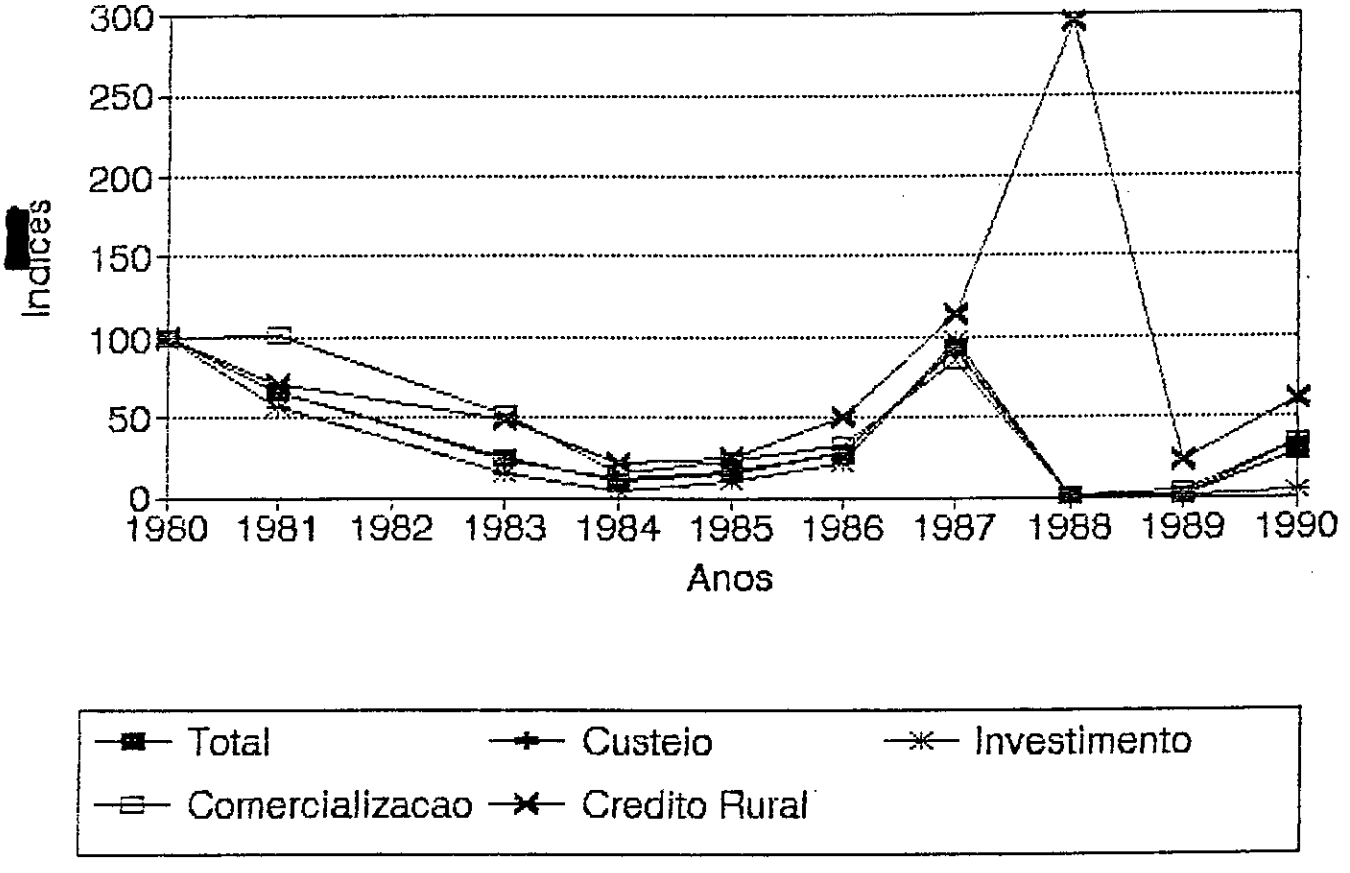
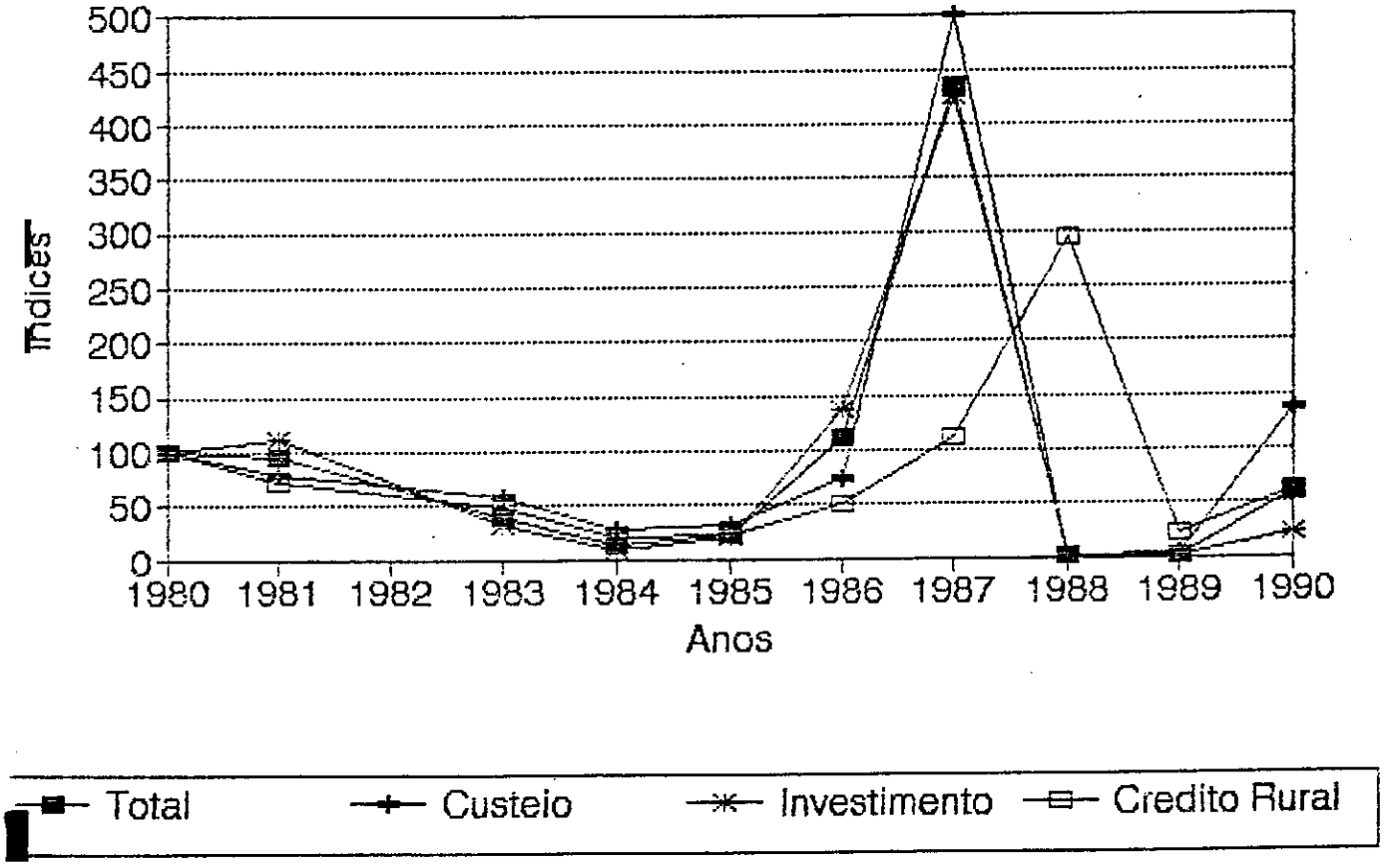


Fig 12:

Indices de Credito Pecuario

Regiao Norte



TAB. 47:

Consumo de Fertilizantes por Cultura no Brasil

Cultura	Area Plantada(1000 ha)			Consumo(1000 t)		
	1987	1988	1989	1987	1988	1989
Arroz	6083	5491	4175	850	797	564
Banana	472	519	490	130	134	119
Cacau	668	697	660	100	81	59
Cafe	2949	3037	3019	809	918	619
Cana ac	4979	4951	4904	1620	1710	1705
Feijao	6120	5531	5516	435	506	568
Laranja	819	883	880	290	342	394
Mandioca	1789	1909	1968	85	89	76
Milho	13462	13077	12598	1340	1380	1339
Pimenta	24	29	29	4	4	7
Soja	10609	12241	11491	1700	2072	1637
Pastagens	12784	12751	13448	75	102	94

Consumo de Fertilizantes por Cultura no Brasil

KG/HA		
1987	1988	1989
140	145	135
275	258	243
150	116	89
274	302	205
325	345	348
71	91	103
354	387	448
48	47	39
100	106	106
167	138	241
160	169	142
6	8	7

fl 8

Quantidade Total e Consumida por Estabelecimentos por Produto 1980

	Total(t)	Cons(t)	Relacao
Arroz	1412084	70866	5.01854
Feijao	76755	12720	16.57221
Mandioca	2686250	2548855	94.88525
Milho	359513	141328	39.31096

Est: Amazonas, Rondonia, Acre, Para, Mato Grosso, Amapa e Roraima

Quantidade Total e Consumida por Estabelecimentos por Produto 1985

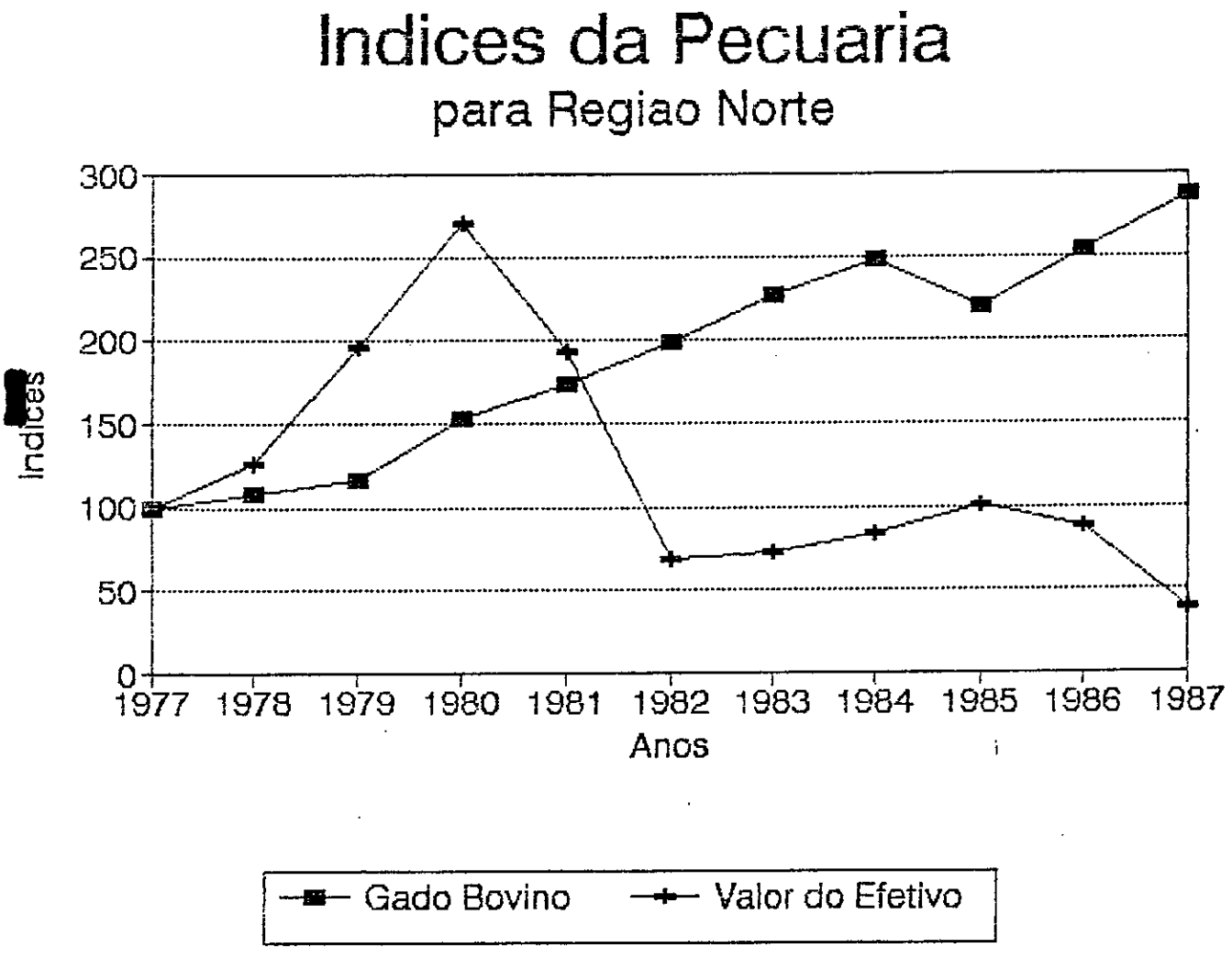
	Total(t)	Cons(t)	Relacao
Arroz	1196921	71529	5.976084
Feijao	111377	15946	14.31714
Mandioca	2867801	2658028	92.68523
Milho	558569	177623	31.79965

Est: Amazonas, Rondonia, Acre, Para, Mato Grosso, Amapa e Roraima

Taxas de Crescimento de 80 a 85 da Producao

	Total	Cons Estab
Arroz	-3.25222	0.196417
Feijao	7.730275	4.624388
Mandioca	1.316579	0.842333
Milho	9.212524	4.677706

Fig 12:


Indices da Pecuaria
para Regiao Norte
Indices
300
250
200
150
100
50
0
1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987
Anos
Gado Bovino
Valor do Efetivo

10. A 16 :

Efetivo de Gado Bovino Regiao Norte

	Valor	Cabecas	IGP	ValCor80
1977	5331	2401000	0.234	22782.05
1978	9371	2578000	0.325	28833.85
1979	22408	2800000	0.499	44905.81
1980	61563	3688000	1	61563
1981	92057	4168000	2.099	43857.55
1982	162999	4757615	10.442	15609.94
1983	551628	5458135	33.478	16477.33
1984	2079927	5946755	109.064	19070.7
1985	6086098	5273372	265.342	22936.81
1986	17286367	6095288	857.583	20157.08
1987	58627435	6899166	6728.6	8713.17

Taxas de Crescimento da Producao Pecuaria RN

Periodo	Valor	Cabecas
1977 a 1978	26.56	7.37
1978 a 1979	55.74	8.61
1979 a 1980	37.09	31.71
1980 a 1981	-28.76	13.02
1981 a 1982	-64.41	14.15
1982 a 1983	5.56	14.72
1983 a 1984	15.74	8.95
1984 a 1985	20.27	-11.32
1985 a 1986	-12.12	15.59
1986 a 1987	-56.77	13.19

Fig 13

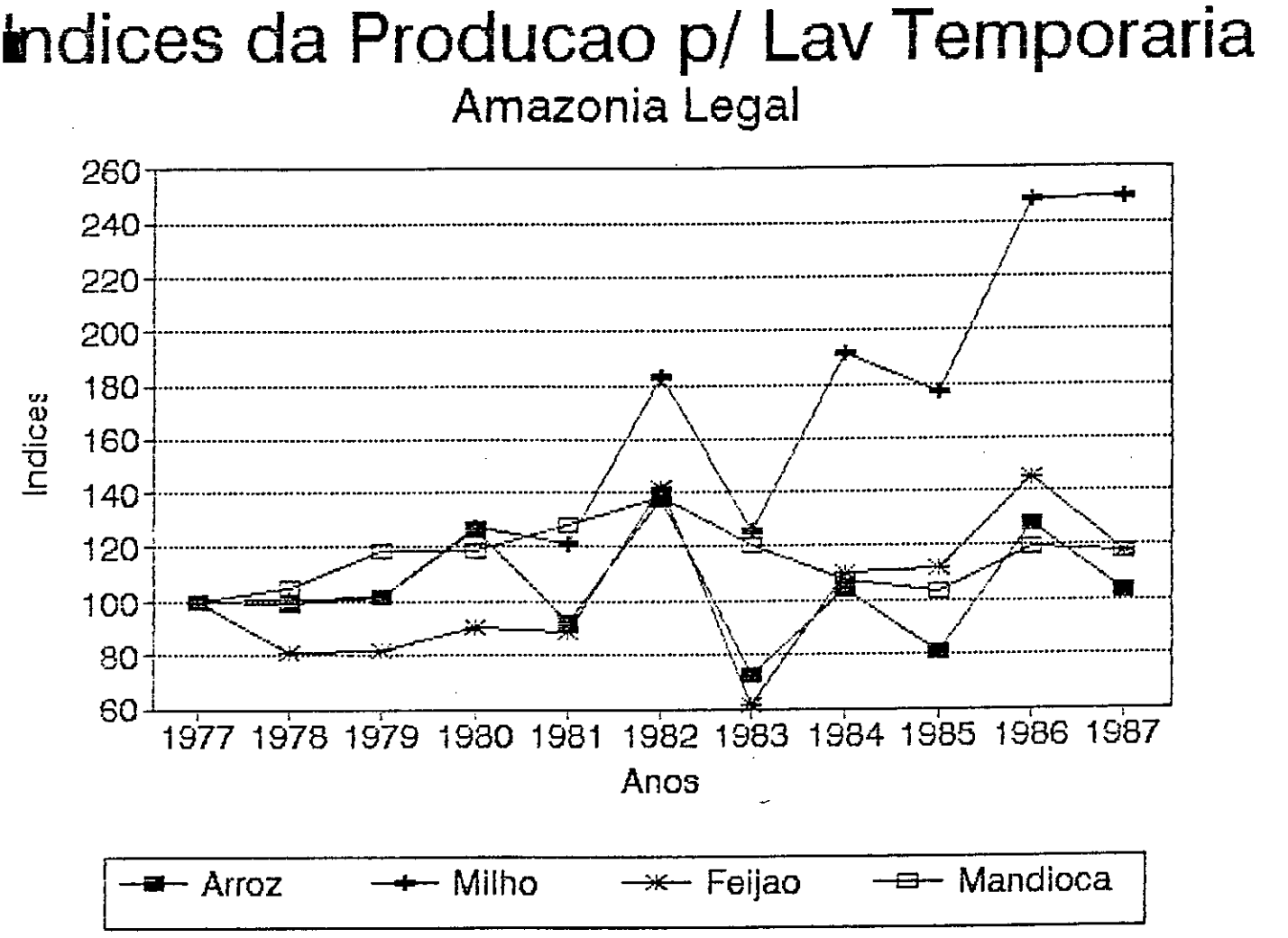
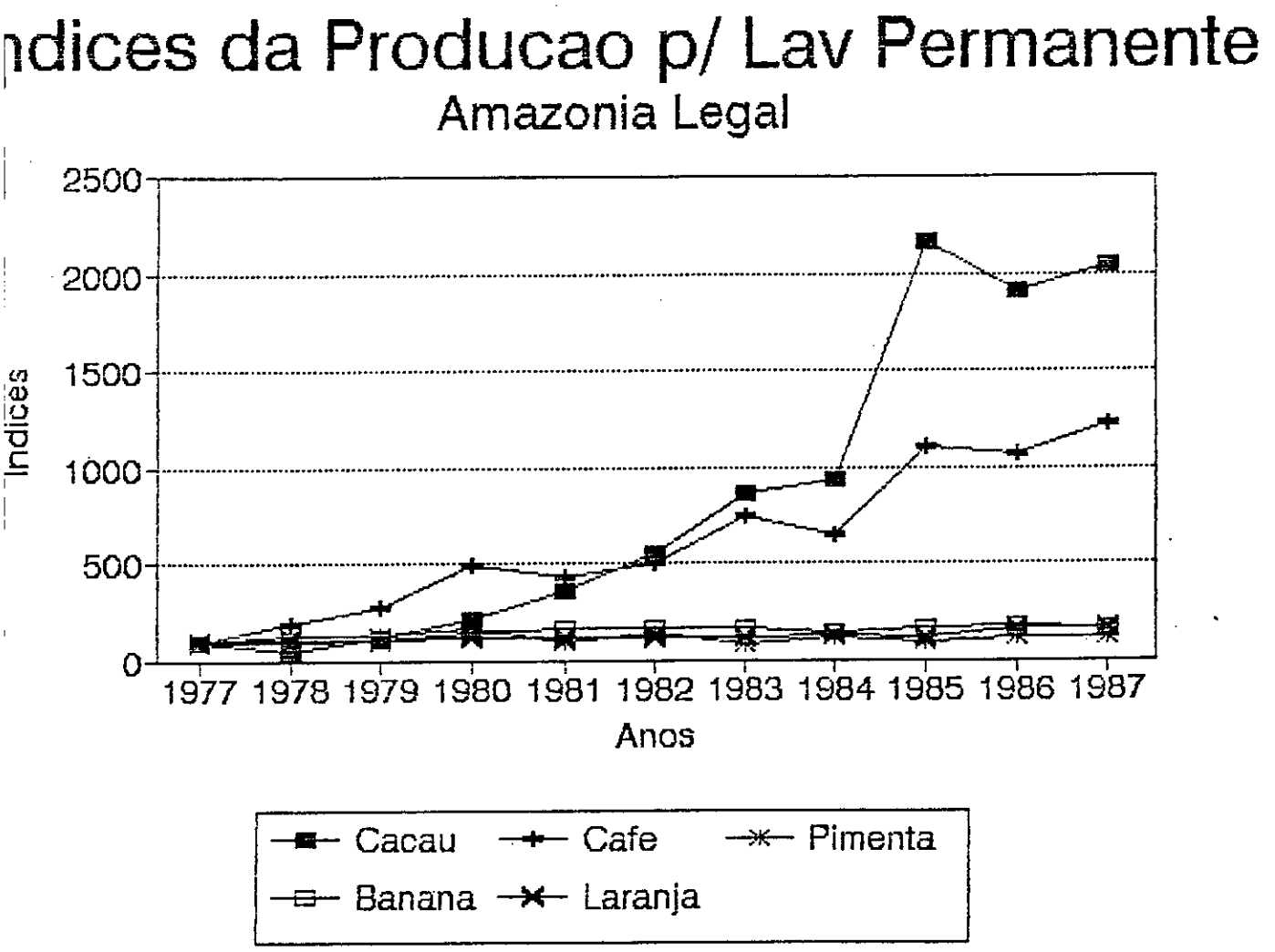

Indices da Producao p/ Lav Temporaria
Amazonia Legal
Indices
260
240
220
200
180
160
140
120
100
80
60
1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987
Anos
Arroz
Milho
Feijao
Mandioca

Fig 14:


ndices da Producao p/ Lav Permanente
Amazonia Legal
Indices
2500
2000
1500
1000
500
0
1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987
Anos
Cacau
Cafe
Pimenta
Banana
Laranja

TAB A9

Producao Agricola para a Amazonia Legal

Ano	Arroz(t)	Milho(t)	Feijao(t)	Mand(t)	Cacau(t)	Cafe(t)	Pim(t)
1977	2472779	539352	124584	4720508	2597	14911	35012
1978	2441270	539920	101125	4972322	1353	29584	44688
1979	2518605	549216	101297	5589893	2999	41474	47212
1980	3131101	685969	112219	5601479	5591	73828	59370
1981	2273493	655862	111026	6058290	9337	64594	36364
1982	3408531	989376	176519	6515836	14513	75854	49112
1983	1791821	676021	75978	5671509	22448	112315	30213
1984	2561745	1033213	136625	5084939	24290	97701	40794
1985	2000466	955004	138995	4860610	56223	164345	35330
1986	3169726	1340575	181055	5610432	49734	159245	42458
1987	2554430	1341258	146241	5557258	53114	182429	42443

Ban(1000c	Lar(1000f
54041	576977
50722	604164
56279	635026
75855	683817
90862	692969
86438	678115
97006	665315
78949	777666
88836	669012
94416	954247
87252	980517

TABELA A 10

Taxas de Crescimento da Producao Agricola - Amazonia Legal

Periodo	Arroz	Milho	Feijao	Mand	Cacau
1977 a 1978	-1.27	0.11	-18.83	5.33	-47.90
1978 a 1979	3.17	1.72	0.17	12.42	121.66
1979 a 1980	24.32	24.90	10.78	0.21	86.43
1980 a 1981	-27.39	-4.39	-1.06	8.16	67.00
1981 a 1982	49.92	50.85	58.99	7.55	55.44
1982 a 1983	-47.43	-31.67	-56.96	-12.96	54.68
1983 a 1984	42.97	52.84	79.82	-10.34	8.21
1984 a 1985	-21.91	-7.57	1.73	-4.41	131.47
1985 a 1986	58.45	40.37	30.26	15.43	-11.54
1986 a 1987	-19.41	0.05	-19.23	-0.95	6.80

Cafe	Fim	Ban	Lar
98.40	27.64	-6.14	4.71
40.19	5.65	10.96	5.11
78.01	25.75	34.78	7.68
-12.51	-38.75	19.78	1.34
17.43	35.06	-4.87	-2.14
48.07	-38.48	0.66	-1.89
-13.01	35.02	-9.26	16.89
68.21	-13.39	12.52	-13.97
-3.10	20.18	6.28	42.64
14.56	-0.04	-7.59	2.75

TAB A11:

Valor da Producao Agricola para a Amazonia Legal

Ano	Arroz	Milho	Feijao	Mand	Cacau	Cafe	Pim
1977	3899447	687625	762036	3335184	77773	182731	724367
1978	7125671	931875	622556	2723612	51433	344448	1061956
1979	12280566	1747696	1190351	4803684	151466	956524	2055790
1980	26131007	4156767	3870146	11754564	364698	2901398	3391776
1981	38461424	7708633	8516717	32035457	986554	4242653	2882380
1982	98119062	18500520	13743238	51868798	2070449	9703695	7613430
1983	1.67E+08	44434247	28848651	1.54E+08	20912484	41158644	32183776
1984	6.09E+08	1.56E+08	1.28E+08	4.69E+08	59970874	74504032	1.35E+08
1985	1.89E+09	5.59E+08	2.98E+08	1.72E+09	6.22E+09	1.11E+09	7.73E+08
1986	6451236	1730318	824815	4417450	853973	1919856	2271855
1987	11837563	4805000	2694869	14976387	2590400	3139306	6695518

Ban(1000cLar(1000f	IGP
518231 139977	0.234
542215 167080	0.325
914679 301168	0.499
2638079 771632	1
6403146 1810601	2.099
1[illegible]6340 3208239	10.442
39208010 8702349	33.478
35951887 35069507	109.064
2.56E+08 1.09E+08	265.342
890224 473358	857.583
3059561 1510057	6728.6

TAB A12

Preco da Producao Agricola para a Amazonia Legal

Ano	Arroz	Milho	Feijao	Mand	Cacau	Cafe	Pim
1977	1788.166	1445.671	6935.909	801.1636	33958.39	13896.19	23460.21
1978	2383.047	1409.129	5026.232	447.207	31036.07	9505.816	19401.63
1979	2592.769	1692.108	6248.617	456.9581	26856.17	12263.81	23154.31
1980	2214.446	1607.893	9150.966	556.8136	17308.12	10427.79	15158.84
1981	2138.579	1485.794	9697.082	668.4585	13356.94	8303.074	10020.13
1982	731.4901	475.1655	1978.426	202.2825	3625.181	3250.73	3939.264
1983	738.5677	520.9597	3009.429	215.5484	7383.707	2904.489	8442.861
1984	578.5317	367.9447	2287.863	224.2603	6006.721	1855.262	9058.383
1985	946.1795	585.3588	2140.509	353.145	11065.4	6749.825	21892.44
1986	629.7252	399.3601	1409.535	243.6156	5312.765	3730.205	16555.83
1987	182.7467	141.274	726.691	106.2742	1923.265	678.6113	6220.988

Ban(1000c	Lar(1000f
10874.02	275.0986
8727.66	225.7835
8642.269	252.187
9228.042	299.4169
8908.502	330.2954
3614.876	120.2225
3571.676	103.6706
2648.704	109.7138
2881.152	162.6129
2 7.316	153.4825
1[illegible]2.818	60.73227

Fig 15

Indices de Precos da Producao

Amazonia Legal

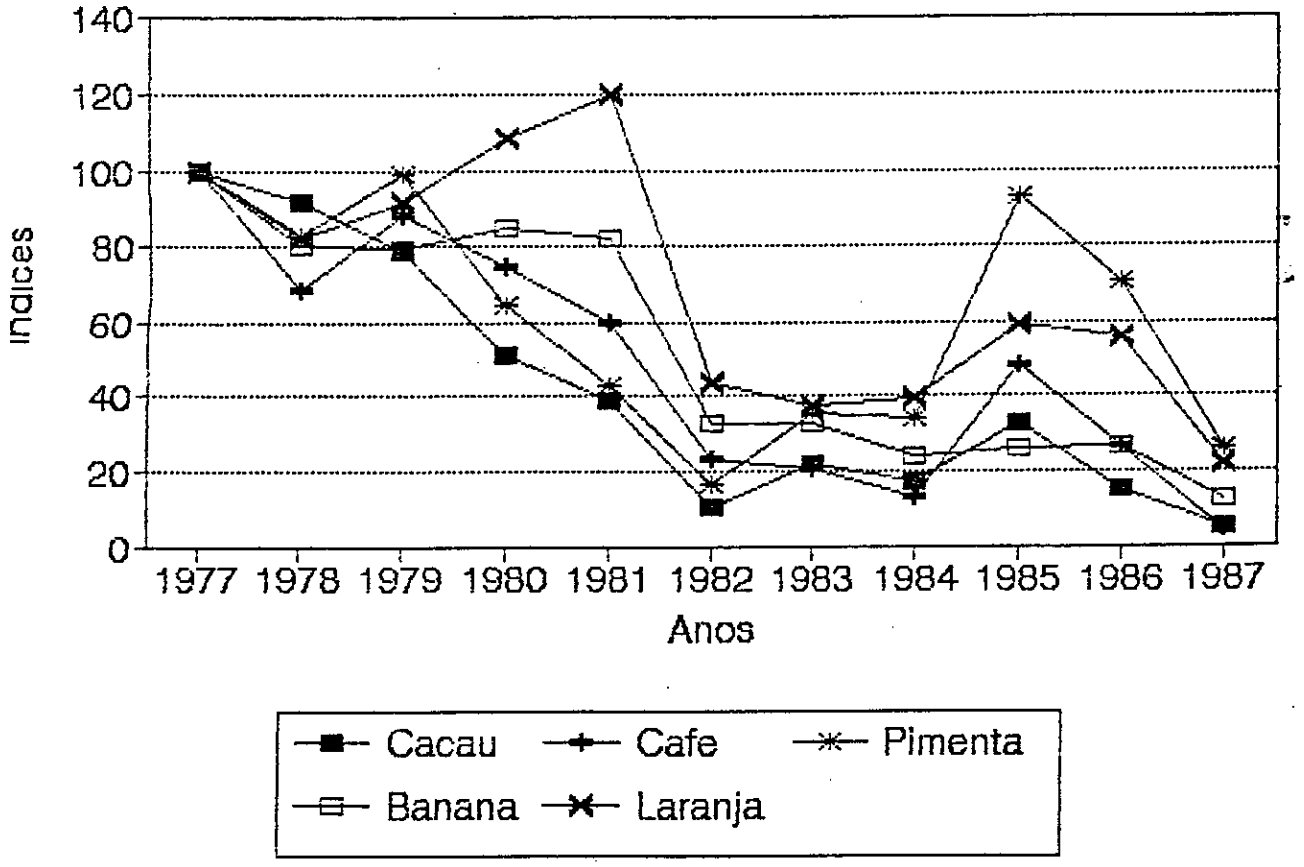
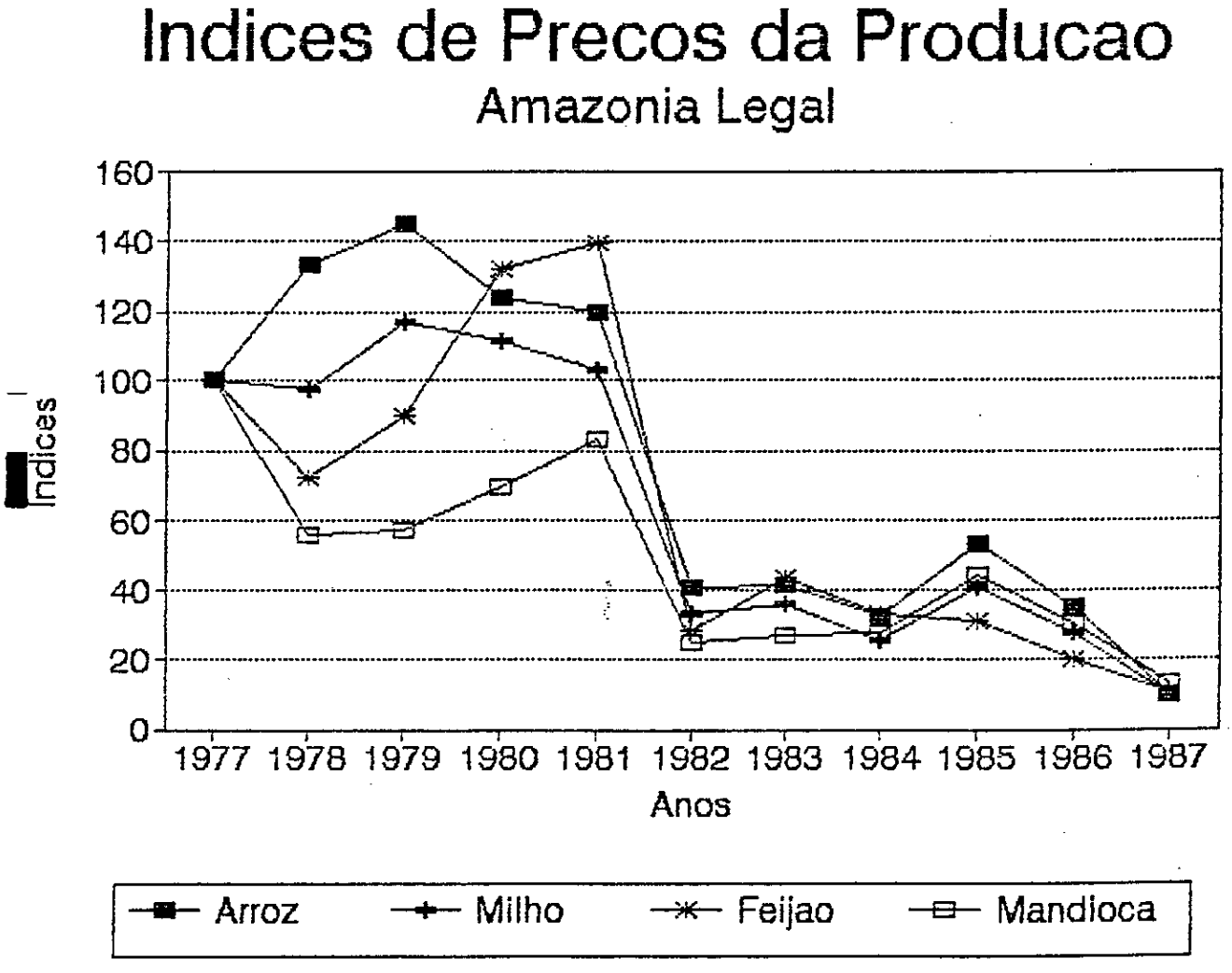


FIG 16:


Indices de Precos da Producao
Amazonia Legal
Indices
160
140
120
100
80
60
40
20
0
1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987
Anos
Arroz
Milho
Feijao
Mandioca

TAB A13

Produtividade Media das Lavouras (1980) Amazonia Legal

Lavoura	Area col (ha)	Quant(t)	kg/ha
Arroz	2155864	2845146	1320
Cacau	22902	5591	244
Cafe	55460	73610	1327
Cana Ac	41440	2006069	48409
Feijao	246625	113387	460
Mandioca	593686	6150586	10360
Milho	754299	635086	842
S; a	70511	117269	1663
	3940787	11946744	

Produtividade Media das Lavouras (1985) Amazonia Legal

Lavoura	Area col (ha)	Quant(t)	kg/ha
Arroz	1338383	1553244	1161
Cacau	87737	56223	641
Cafe	129239	164279	1271
Cana Ac	35428	2068649	58390
Feijao	307560	138588	451
Mandioca	467473	5074882	10856
Milho	850653	854378	1004
Soja	804379	1665729	2071
	4020852	11575972	

Produtividade Media das Lavouras (1988) Amazonia Legal

Lavoura	Area Pl (ha)	Quant(t)	kg/ha
Arroz	2112359	2776437	1314
Cacau	85404	59029	691
Cafe	174170	129250	742
Cana Ac	91190	4589169	50325
Feijao	353655	171741	486
Mandioca	497078	5396837	10857
Milho	1318296	1642373	1246
Soja	1348801	2730300	2024

Fonte: Anuario Estatistico 1990

3 A 13 (CONT):

Produtividade Media das Lavouras (1975) Amazonia Legal

Lavoura	Area col (ha)	Quant(t)	kg/ha
Arroz	1577423	2155719	1367
Cacau	9985	2295	230
Cafe	22679	24088	1062
Cana Ac	37662	1161433	30838
Feijao	162765	118553	728
Mandioca	419075	4441968	10599
Milho	675867	686732	1016
Soja	194280	272624	1403
	3099736	8863412	

F dutividade Media das Lavouras (1970) Amazonia Legal

Lavoura	Area col (ha)	Quant(t)	kg/ha
Arroz	977695	1394154	1426
Cacau	7584	2211	292
Cafe	11403	13786	1209
Cana Ac	48300	1542138	31928
Feijao	155836	116242	746
Mandioca	357027	4180263	11709
Milho	523401	489906	936
Soja	5809	8995	1548
	2087055	7747695	

FAO A14:

Produtividade Media das Lavouras (kg/ha) - 1988
Comparacao entre a Amazonia e o Restante do Mundo

L oura	Amazonia	Brasil	EUA	China	Venezuela	URSS
A. oz	1314	1786	6178	5034	2527	4394
Cafe	742	451	775	1350	289	-
Cana Ac	50325	62719	80591	52734	71429	-
Feijao	486	495	1578	1150	543	1200
Mandioca	10857	12191	-	14518	7852	-
Milho	1246	1880	5311	3730	2000	3810
Soja	2024	1717	1803	1346	-	950

Fonte: FAO (1989) e Anuario Estatistico FIBGE

TAB A15

Produtividade Media das Lavouras na Amazonia Legal

Ano	1970	1975	1980	1985	1988
Lavoura	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha
Arroz	1426	1367	1320	1161	1314
Cacau	292	230	244	641	691
Cafe	1209	1062	1327	1271	742
Cana Ac	31928	30838	48409	58390	50325
Feijao	746	728	460	451	486
Mandioca	11709	10599	10360	10856	10857
Milho	936	1016	842	1004	1246
Soja	1548	1403	1663	2071	2024
	1000cr$/ha				
Total	1.770	1.854	1.602	2.230	1.243
P nan	6.163	7.978	4.153	4.014	5.303
Tempor	1.480	1.504	1.476	1.992	1.033

Taxas Anuais de Crescimento da Produtividade

Ano	70 a 75	75 a 80	80 a 85	85 a 88
Lavoura				
Arroz	-0.85	-0.70	-2.54	2.52
Cacau	-4.64	1.21	21.29	1.52
Cafe	-2.56	4.56	-0.86	-10.20
Cana Ac	-0.69	9.44	3.82	-2.93
Feijao	-0.47	-8.79	-0.40	1.51
Mandioca	-1.97	-0.46	0.94	0.00
Milho	1.66	-3.69	3.59	4.40
Soja	-1.95	3.46	4.48	-0.45
T(.l	0.93	-2.88	6.84	-11.04
Perman	5.30	-12.24	-0.68	5.73
Tempor	0.33	-0.38	6.18	-12.30

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THE USER STRUCTURE IN BRAZIL'S TROPICAL RAIN FOREST

REPORT PREPARED FOR KIEL INSTITUTE FOR WORLD ECONOMICS
AS PART OF THE RESEARCH PROJECT:

INTERNATIONAL AND NATIONAL ECONOMIC POLICY MEASURES
FOR PROTECTING THE TROPICAL RAIN FOREST

PETER HERMAN MAY, UFRRJ

AND

EUSTÁQUIO J. REIS, IPEA/RIO

RIO DE JANEIRO

OCTOBER 1992

THE USER STRUCTURE IN BRAZIL'S TROPICAL RAIN FOREST[1]

Peter Herman May[2]
Eustáquio J. Reis[3]

ABSTRACT

This paper presents quantitative evidence on the relationship between forest conversion and the productivity of agropastoral activities in the Legal Amazon. The extraction of timber products such as wood, fuelwood and charcoal is related to the process of agropastoral expansion in this region with the aim of providing physical coefficients to define intersectoral connections in Brazil's economy.

The paper is organized as follows. Section I makes a geographical characterization of the original vegetation types of the region according to its principal geopolitical subdivisions. Section II presents evidence on deforestation rates and gross areas affected. Section III describes the principal sources of deforestation. Section IV describes sectoral activities and land occupation patterns distinguishing between "forested" and "non-forested" areas. Section V analyses major determinants of productivity in agropastoral activities following this broad vegetation distinction. Section VI provides gross estimates of wood removal associated with agropastoral expansion, and compares this with wood and fuel production figures. Conclusions are presented in Section VII.

---

[1] This study was prepared for Kiel Institute of World Economics, at the request of Manfred Wiebelt and Rainer Thiele as a contribution to the research project: International and National Economic Policy Measures for Protecting the Tropical Rain Forest.

[2] Visiting Professor and Coordinator, Programme in Ecological Economics and Agrarian Policy, Graduate Programme in Agricultural Development, Federal Rural University of Rio de Janeiro (UFRRJ).

[3] Senior Economist, Institute of Applied Economic Research (IPEA), Rio de Janeiro.

I. Characteristics of the Original Vegetation Cover

To characterize the original vegetation cover of the Brazilian Amazon, it is necessary first to describe the geopolitical divisions of the region. Sixty percent of the Amazon tropical forest, which covers an area of approximately 5.5 million km^2, is located within Brazilian national territory, where it covers 3.55 million km^2, representing nearly forty percent of this territory (Figure 1). This area very nearly coincides with the area termed the North region of Brazil, which includes seven states: Rondônia (RO), Acre (AC), Amazonas (AM), Roraima (RR), Pará (PA), Amapá (AP), and Tocantins (TO) (Figure 2).[4]

The region known as the Legal Amazon refers to a geographic area of approximately 5 million km^2 defined for regional planning purposes which adds to the North region those parts of the states of Mato Grosso and Maranhão which are located north of parallel 16 and west of meridian 44. It contains the entire area described as tropical forest in Brazilian segments of the Amazon river basin, but also contains significant areas of savanna and wetlands. This area totals about 58% of Brazilian national territory.

For the purposes of this study -- in which we intend to differentiate between land use and productivity in areas that were originally forested and those categorized within other vegetation types -- we have determined to include the entire Legal Amazon region.[5]

The Legal Amazon is by no means a uniform forest biome. Though predominantly a tropical forest region, it comprises a complex mosaic of forest and savanna, inundated lowlands, and steppes. In simplified terms, the major vegetation types distinguished within this region are: closed and open tropical forests, seasonal open forests, savannas, campinaranas, ecological transition areas and wetlands.

By superimposition of municipal boundaries on vegetation mapping conducted on the basis of Radambrasil imagery (IBGE, various issues), we have been able to identify the percentage share of the geographic area of Amazonian municipalities categorized in each vegetation type.[6] Table 1 presents the geographic composition of the Legal Amazon according to major vegetation types by state. These are described below according to the Brazilian vegetation classification system (Veloso et al., 1991).

---

[4] Reference is often made to the "old" North Region which excludes from the North region the state of Tocantins (TO), which was created in 1989. At least 84 percent of the Brazilian Amazon forests are located inside this region which is also referred to as *Hylea Amazônica* or "Classic Amazonia".

[5] In certain instances, it has been necessary for statistical reasons to restrict the area under analysis to the "Classic Amazon" states, with the addition of Mato Grosso alone. This is due to the recent division of Tocantins from Goiás, and the consequent difficulties of confining statistical analysis to those municipalities included within the Legal Amazon region in those cases where data is only tabulated on a state-by-state basis by the census bureau.

[6] There were at the time of the most recent population census (1991) some 508 municípios (municipalities) in existence in the Legal Amazon region. Based on the administrative divisions in existence in 1980 and 1985, we have classified vegetation composition for 307 of a total of 336 geographic units to serve as a base for the analysis presented below. The difference in number is due to more recent subdivisions, and to exclusion of 50 municipalities in Mato Grosso whose vegetation composition is unclear.

Figure 1 - Major Brazilian Ecossystems

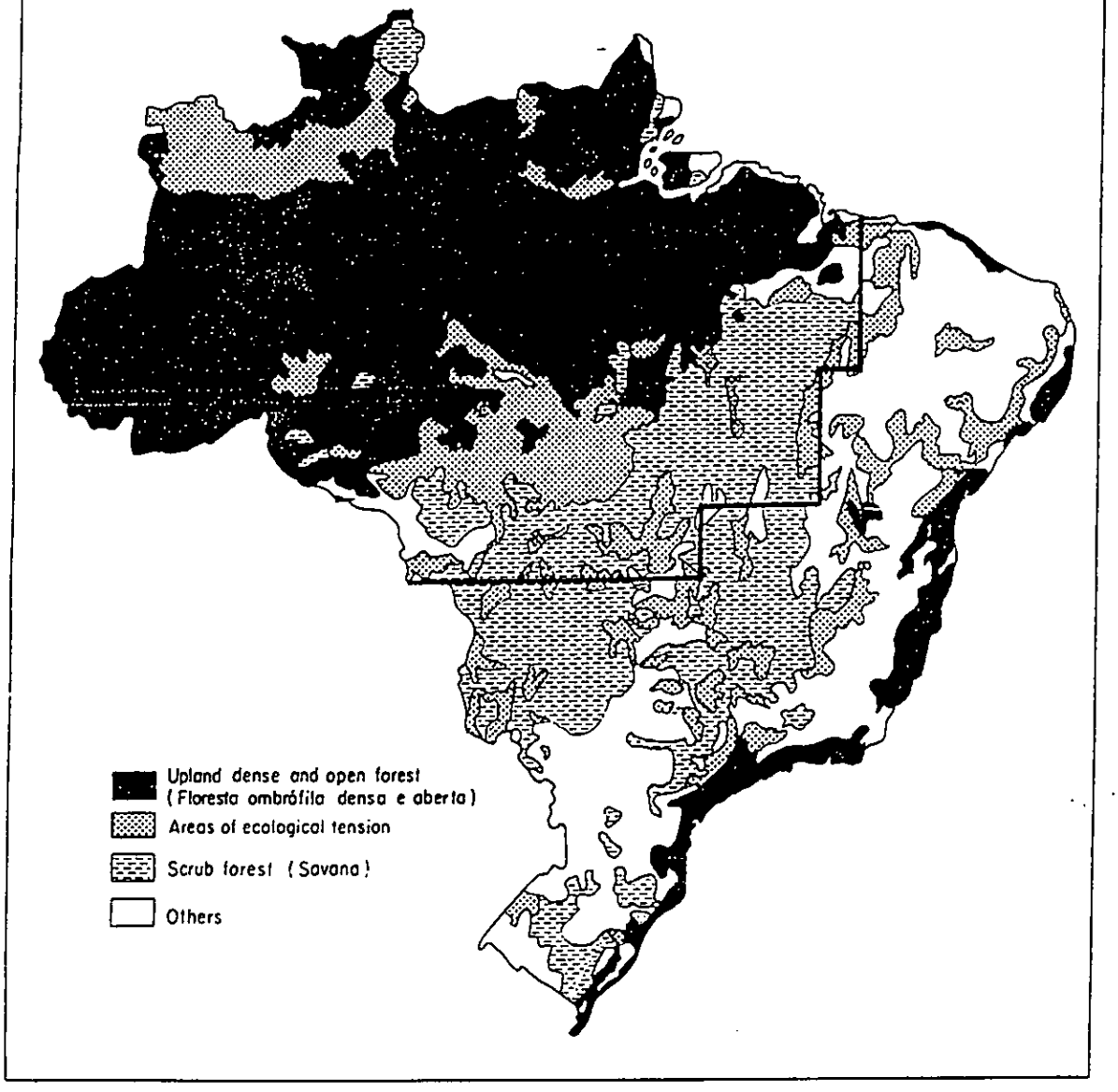

Figure 2

LEGAL AMAZÔNIA

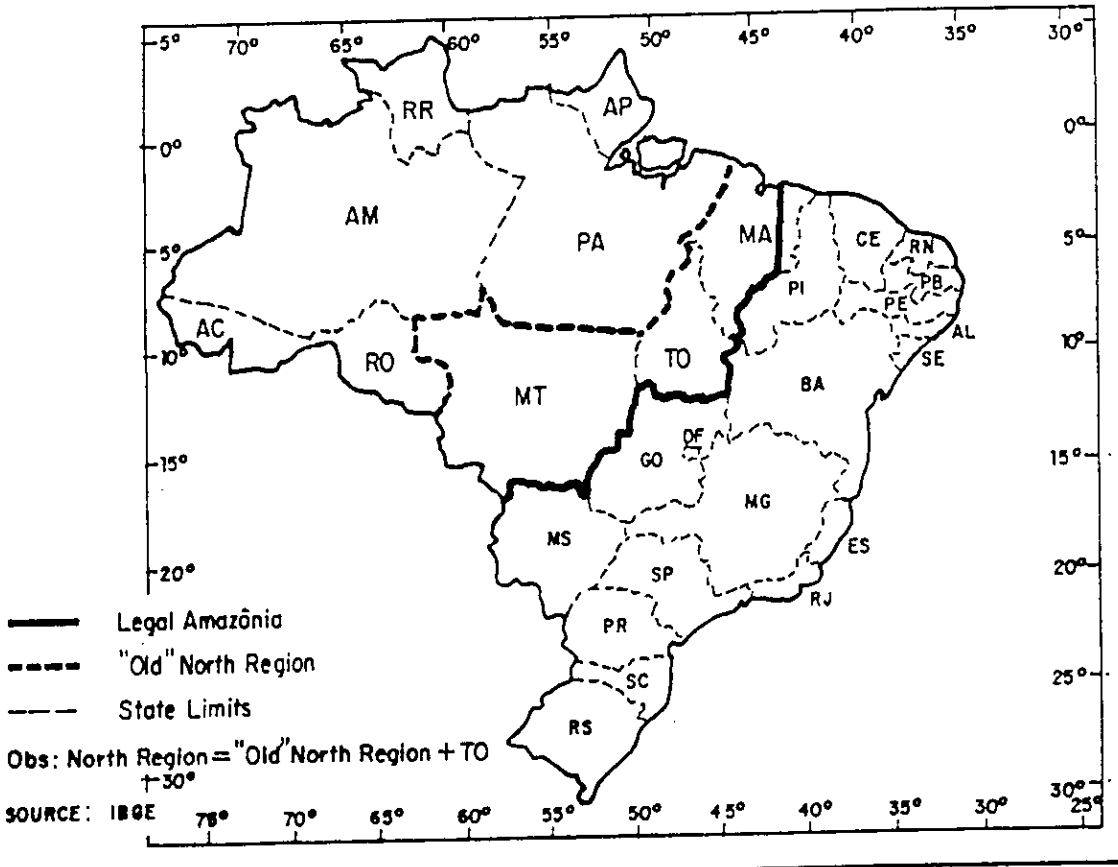

Table 1
Legal Amazon: Original Vegetation Cover by State

(Area in Km^2)

ORIGINAL VEGETATION	RO		AC		AM		RR		PA		AP		MA		MT		GO		AMAZON	
	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
FORESTS	222	93	153	100	1,265	82	150	66	1,167	95	110	79	142	52	332	55	59	21	3,600	77
• DENSE	177	74	153	100	1,231	80	127	56	1,079	88	106	76	96	35	225	37	21	8	3,215	69
• OPEN	14	6	0	0	0	0	18	8	8	1	0	0	39	14	64	11	4	2	147	3
• TRANSITION	31	13	0	0	34	2	4	2	80	7	4	3	7	2	44	7	33	12	238	5
NON-FORESTS	16	7	0	0	284	18	76	34	60	5	29	21	129	48	274	45	218	79	1,087	23
• SAVANNAS	9	4	0	0	9	1	36	16	32	3	11	8	111	41	274	45	218	79	701	15
• CAMPINARANA	0	0	0	0	258	17	39	17	0	0	0	0	0	0	0	0	0	0	298	6
• WETLANDS	7	3	0	0	17	1	0	0	28	2	18	13	18	7	1	0	0	0	89	2
TOTAL	238	100	153	100	1,550	100	225	100	1,228	100	139	100	271	100	606	100	277	100	4,687	100

SOURCE: REIS (unpublished data).

CLOSED AND OPEN FORESTS include areas categorized as *Floresta Ombrófila Densa* and *Floresta Ombrófila Aberta*, respectively, ranging in vegetation composition with increased altitude. In lowland areas along watercourses, these forests contain hardwoods such as *Ceiba* and *Virola* species, interspersed with many palm varieties in the understory, particularly *Euterpe* and *Mauritia*. As the riparian areas are those initially settled, these forests tend to be modified and the more valuable wood species removed by the riparian extractivists. In the far more extensive upland segments of the Amazon basin, the principal characteristic of this formation is a multi-storied architecture, with emergent trees reaching as high as 60 m., including such genera as *Parkia* and *Dinizia*. In other areas, these formations are clearer, due to high densities of bamboo, palms and vines. Some areas are now dominated by bamboo where the forest has been exploited for the noble hardwoods in the *Cedrela*, *Ocotea*, and *Aspidosperma* families. Other areas, such as central Maranhão and northern Tocantins have become dominated after initial clearing for cropland by palm forests made up of *Orbignya* species (babaçu). Closed and open forests jointly account for 68.6% of land area in the Legal Amazon region (see Table 1).

SEASONAL OPEN FORESTS unite areas categorized as *Floresta Tropical Caducifólia* in the Brazilian nomenclature, composed of deciduous vegetation that responds to pronounced dry and rainy seasons by loss of foliage in the unfavorable period. Fragments of these formations are found in southern Maranhão and Tocantins in submontane areas, which contain a range of valuable woods in families such as *Cedrela*, *Tabebuia* and *Jacaranda*, as well as in the Mato Grosso Pantanal depression. Together, these areas constitute only slightly over 3% of the Legal Amazon.

SAVANNAS, commonly known as *Cerrado* in Brazil, are open hardwood forests that occupy a substantial portion of the central plateau region of the nation, which lies on the eastern fringe of the tropical forest in the Legal Amazon. Their characteristic pattern of open grasslands with torturously twisted trees arise due to seasonal rainfall (average six month dry season), poor, highly leached acid soils presenting serious aluminum toxicity, limiting their viability for forestry or agriculture. Nevertheless, large areas of *Cerrado* in Brazil have been adapted for mechanized soybean cultivation and pasture establishment and the region harbors a profuse wealth of plant and animal life that has only recently been the subject of research (Eiten and Goodland, 1979). *Cerrado* land area accounts for nearly 15% of the Legal Amazon. Wood extracted from this region contributes chiefly for fuelwood and charcoal manufacture.

CAMPINARANAS are open fields interspersed with forestlands which are subject to inundation during much of the year and are generally sparsely covered with vegetation due to extremely high rainfall and poorly drained hydromorphic or sandy soils. Covering a total of 6.4% of the Legal Amazon, *campinarana* occurs in greatest profusion in the upper Rio Negro region, where rainfall exceeds 4,000 mm annually, in low scrub forests characterized by the presence of endemic palms.

WETLANDS lie within the category of *Formações Pioneiras*, which refer to coastal lowlands and mangroves, as well as seasonally inundated alluvial areas within the Mato Grosso Pantanal, and *varzeas* throughout the Amazon basin, in total accounting for less than 2 percent of the Legal Amazon region.

ECOLOGICAL TRANSITION defines areas at the interstices of two vegetation groupings, which contain characteristics of both. In the Amazon region, these areas are typically found within forested areas where there exist enclaves of savanna, accounting for a total of 5.1 percent of the Legal Amazon.

For the purposes of the present study, the original vegetation types were grouped in two general categories: **forests** (including dense and open tropical forests, seasonal open forests and ecological transition areas) and **non-forests** (including savanna, campinarana, and wetlands). Table 1 presents the summary distribution of forest and non-forest landscapes in the Legal Amazon by state.

For comparative analyses of land use and productivity at the municipal level we have adopted more restrictive criteria to classify "forested" and "non-forested" areas. Thus, municipalities which contain forests in more than 75 percent of their territory are considered "forested" areas, and those having less than 25 percent of their territory in forests are considered "non-forested" areas. Those municipalities which remain between these two parameters were termed "intermediate" for classification purposes. Based upon these categories, Table 2 characterizes the distribution of municipalities and their geographic area within these ranges in the Legal Amazon.

Table 2
Distribution of Legal Amazon Municipalities According to Forest Cover Classes

Forest Cover Class	Percent Distribution of Municipalities According to: Number	Geographic Area	Area in Forests	Average % in Forests
0 - 25%	21.50	12.30	1.73	10.80
25 - 50%	7.49	9.13	4.77	40.14
50 - 75%	8.14	10.23	8.22	61.72
75 -100%	62.87	68.34	85.28	95.84
Total	100.00	100.00	100.00	76.80
Absolute	[307]	[4,687]	[3,499]	-

SOURCE: IBGE

The resulting sample presents a thorough coverage of Amazonian municipalities in terms of both number and geographic area. The strata selected account for 260 (85 percent) of the 307 municipalities whose characteristics were analyzed for the Legal Amazon, and over 80 percent of regional land area. Moreover, the sample parameters assure a clear cut distinction between original vegetation types: on average, "forested" areas contain 96 percent of their area in forests while "non-forested" areas contain forest cover in only 11 percent of their area. It will thus be possible to uncover evidence of differentiation among these vegetation types regarding the economic variables of concern with a reasonable degree of statistical confidence.[7]

II. Evidence on Deforestation

The estimates of deforestation used in this study are based upon visual interpretation of anthropogenic activity from Landsat imagery, conducted by the Brazilian National Institute for Space Research (INPE).[8] In these estimates, the precision is greater in forested areas, since other vegetation cover categories such as savannas or ecological transition areas pose major difficulties for the correct identification of anthropogenic activity. Table 3 presents estimates of deforested areas in the Legal Amazon from 1975 to 1991, by state.

The data in Table 3 show that up to the mid-seventies deforestation was practically restricted to the so-called *Zona Bragantina*, located on the eastern border of Pará with Maranhão and to the north of Tocantins. In the latter, due to the overwhelming predominance of savanna (Figure 1), deforestation figures for 1975 and 1978 probably underestimate the extent of deforestation along the Belém-Brasília corridor that was opened up during this period.

During the late seventies and throughout the eighties, deforestation rates within the region showed spectacular growth, most specifically, in northern Mato Grosso, following a northwest path of expansion toward the states of Rondônia and Acre, stimulated by the paving of highway BR-364. Broadly speaking, the expansion of frontier in this period took place in areas where the predominant original vegetation consisted chiefly of savannas and zones of ecological transition to tropical forest. The broadleaved high forests of Amazonas remained nearly intact, except in areas surrounding Manaus.

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[7] Despite the robust nature of our sample and detailed physical data sources, it is important to caution that the agricultural census data correlated with proportional vegetation coverage at a municipal level is subject to error due to the impossibility of identifying specific crop or pasture lands that lie within original vegetation categories.

[8] Figures in Table 3 came from 229 Landsat Thematic Mapper (TM, 30 meter resolution) images in a color composite of bands 3 (red), 4 (near infrared), and 5 (short wave infrared), at the 1:250,000 scale (except for 1975 and 1978, which uses 232 Landsat Multispectral Scanner - MSS - black and white images at the 1:500,000 scale). The advantages of Landsat TM images are their frequency of availability (16 days orbit) and their more adequate resolution, especially when compared with the 1.1 km. resolution of NOAA Advanced Very High Resolution (AVHRR) which tend to overestimate the extent of deforestation.

Table 3
Deforestation in Legal Amazon States: 1975-1991

STATE	GEOG. AREA[a]	DEFORESTED SHARE (%)				GROWTH RATES	
		1975	1978	1988	1991	1975-91	1988-91
Acre	154.7	.76	1.60	5.78	6.96	14.9	6.4
Amapá	142.4	.11	.12	.55	1.19	16.3	29.8
Amazonas	1568.0	.05	.11	1.26	1.48	23.6	5.6
Pará[b]	1246.8	3.89	4.52	10.39	11.87	7.2	4.6
Rondônia	238.4	.51	1.78	12.60	14.51	23.3	4.8
Roraima	225.0	.02	.06	1.22	1.87	31.1	15.3
M.Grosso[c]	802.4	1.15	2.49	8.91	10.78	15.0	6.6
Maranhão[b,c]	260.2	23.55	24.55	34.90	35.47	2.8	1.2
Tocantins[c]	269.9	1.26	1.14	7.79	8.44	12.6	2.7
AMAZON	4906.9	2.55	3.10	7.64	8.68	8.0	4.3

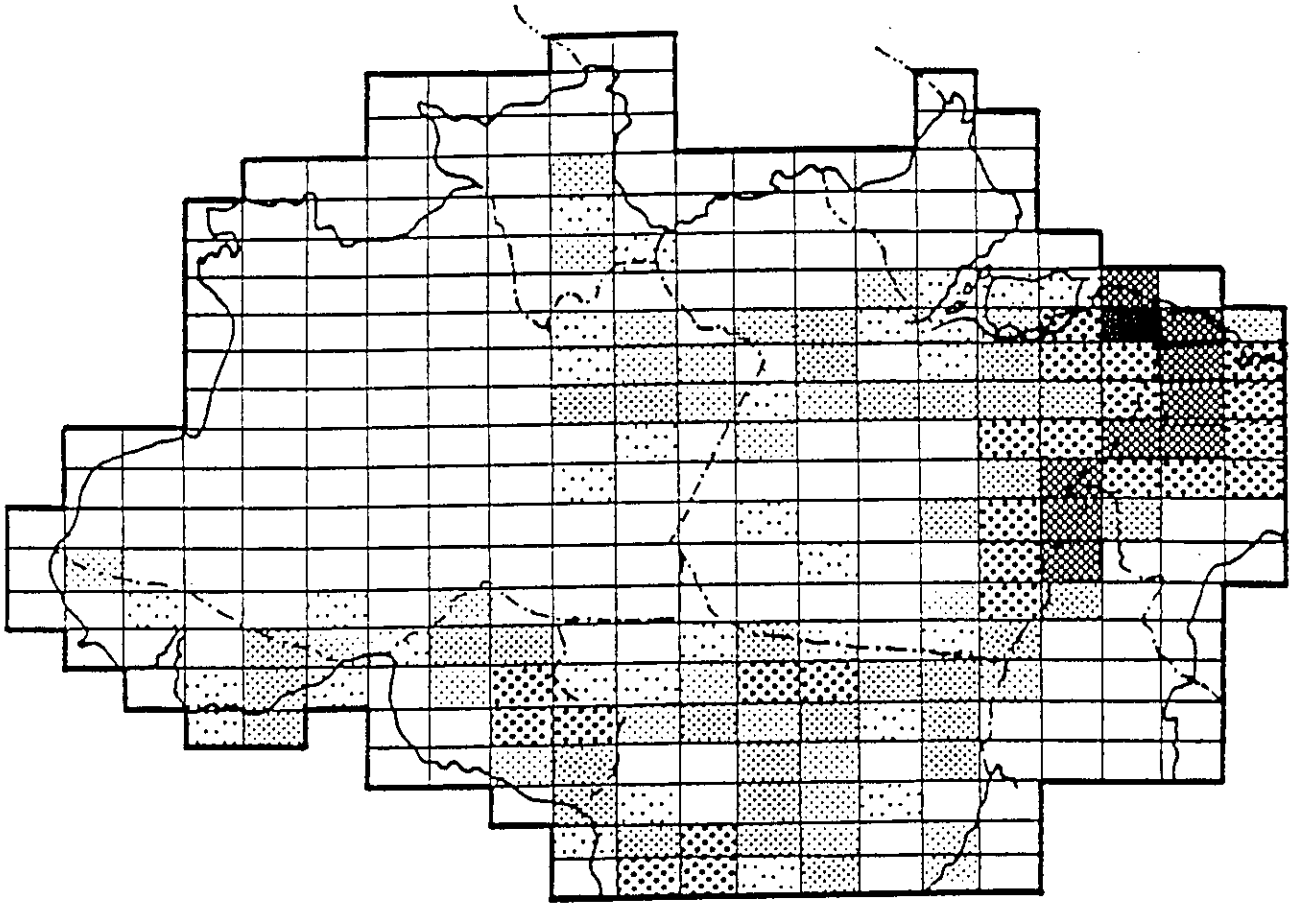
SOURCES: INPE-1649-RPE/103 for 1975 and INPE (1992) for the remaining years.
OBSERVATIONS: [a] Area in 10^6 km^2; [b] Includes only portion of the state pertaining to the Legal Amazon region; [c] Includes the "old deforestation" areas of the Bragantine Zone: 31,822 km^2 in Pará and 60,724 km^2 in Maranhão.

In more recent years, the process of deforestation experienced a significant slowdown, except in the states of Amapá and Roraima where frontier expansion maintained an accelerated pace.

Despite the strong growth over the past two decades, in 1991 deforestation in the Legal Amazon was still mainly restricted to the peripheral areas in the eastern, southern, and southwestern borders of the region (Figure 3). This area, not coincidentally, also received a disproportionate share of economic activity, government investments and regional development incentives.[9]

[9] See Serôa da Motta (1992) for a description of the policy instruments whose effects on deforestation were most pervasive in the Amazon region during this period.

Figure 3 – Satellite Images of Deforestation in Amazonia, 1989



Deforestation:
Percentage of Original Forest Cover

>75 50–75 20–50 10–20 5–10 2–5 <2

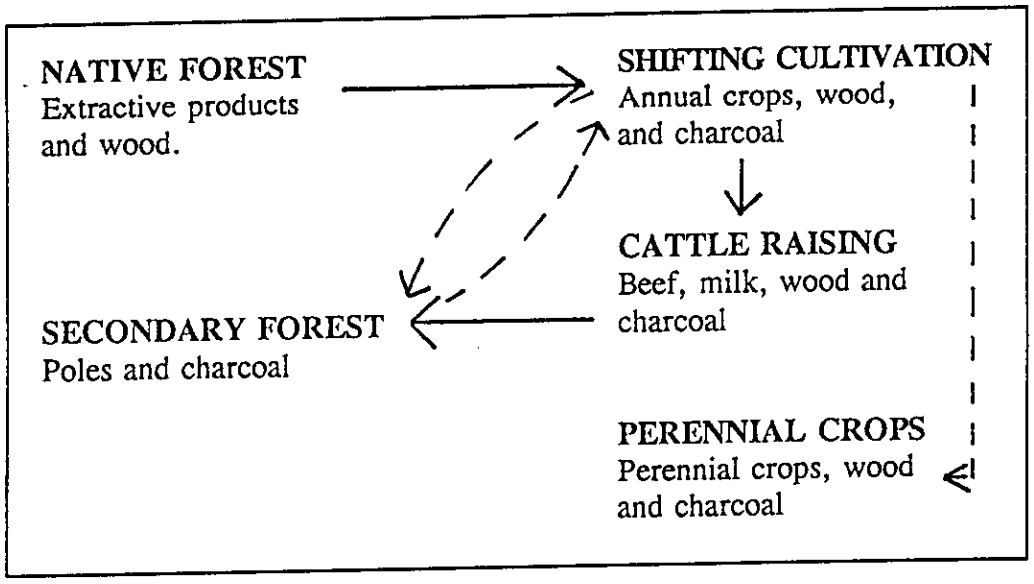
III. The Sources of Deforestation

This section characterizes the principal sources of deforestation in the Brazilian Amazon over the past two decades, with particular reference to the interlinkages between agricultural and forestry activities.

The accelerated deforestation in Brazilian Amazon in recent decades resulted from a multiplicity of factors which include road and railway construction, spontaneous and government directed colonization projects, timber extraction, charcoal production, subsidized agropastoral projects, hydroelectric facilities, mining (both placer and corporate), and uncontrolled forest fires associated with human activities.

The rapid expansion of the agropastoral frontier is probably the most important economic factor behind deforestation. Squatters who practice shifting cultivation are the leading agents in the conversion of forest lands to subsistence crops (rice, beans, maize, and cassava). Conversion to perennial crops (cocoa, coffee, pepper, orange, and bananas) or -- as is more common -- pastures, usually occurs in a second stage. Logging in Amazonia has generally been a by-product of clearing land for agricultural purposes. Mining and hydroelectric development, by contrast, played minor and indirect roles (Mahar, 1989:7).

Despite the differences in time, location and site specific conditions, the typical process through which forestland is converted to agropastoral uses could be schematically described by the following flowchart:



Last but not least, it should be mentioned that the expansion of the agricultural frontier was decisively conditioned by the government's construction of roads, since the existence of a road network was a prerequisite foor economic and demographic settlement of the so-called *terra-firme* (uplands between rivers that had previously served as principal transport corridors). The distribution of government subsidies through fiscal and credit mechanisms was another decisive factor for the profitability of certain agricultural activities, particularly cattle raising, which are considered economically unfeasible in the soil conditions prevailing in most areas of Amazonia (Hecht, 1985; Hecht et al., 1988; Mahar, 1989). Therefor , the government was a leading actor in the settlement of the region.

Due to the intricate relationship among these factors, it is very difficult to segregate specific causes of deforestation. The complex dynamics of the process makes almost impossible a rigorous identification of causes and consequences. Thus, sometimes, the profitability of cattle raising was the *primum mobile* of deforestation, though this activity arose subsequent to slash and burn agriculture.[10] In other instances, agricultural settlements were made possible by feeder roads built for logging, mineral extraction or hydroelectric facilities. Because of these complex dynamics it is better to talk of sources, rather than causes of deforestation.

The principal source of deforestation was decidedly agropastoral expansion. Table 4 presents evidence on the composition and growth of major agropastoral activities in the Legal Amazon according to IBGE Census data regarding rural establishments. The figures in Table 4 show, firstly, the small share of land used by rural establishments in the Legal Amazon: even as recently as 1985, more than 75 percent of the Amazon territory still remained in the public domain. Secondly, from 1975-85 the region exhibited impressive rates of agropastoral expansion averaging nearly 4 percent annually. Thirdly, the data shows that a substantial proportion -- more than 60 percent in 1985 -- of the area in rural establishments is maintained under natural pastures and forests. Fourthly, planted pastures represent at least two-thirds of land effectively employed for agropastoral purposes,[11] far overshadowing annual crops (17 percent) or perennials (3 percent) in 1985. Planted pasture area increased in both absolute and relative terms over the decade, accounting for an ever larger proportion of land within agricultural establishments, attesting to the process of conversion described above. Finally, the figures show the growing importance of fallow lands as croplands and pastures are abandoned due to soil exhaustion, increasing from less than 40,000 km^2 in 1975 to over 850,000 km^2 in 1985.

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[10] In some cases, shifting cultivators who arrived at a site were forced to abandon it after two or three years due to soil exhaustion, when they sold whatever rights they had to a rancher who then planted the already cleared areas with pasture grass. In other cases, ranchers allowed small farmers to plant annual crops on their lands with the proviso that they sow pasture grass before the harvest, this being a nearly costless means to clear forests and establish pastures.

[11] Land effectively employed for such purposes includes the following categories: annual and perennial crops, planted pastures, reforested and fallow lands.

Table 4
Legal Amazon: Agropastoral Land Use, 1975-85

Land Area Used	Year			Growth Rates		
	1975	1980	1985	75-80	80-85	75-85
In km^2 million	78.56	103.88	115.36	32.23	11.05	46.84
Share of Amazon (%)	15.69	20.75	23.04	-	-	-
Out of which, % in:						
• Annual crops	0.52	0.87	1.00	67.5	15.2	92.9
• Perennial crops	0.07	0.16	0.19	126.6	19.6	171.1
• Planted Pastures	1.43	2.67	3.82	13.4	6.14	43.3
• Planted Forests	0.02	0.05	0.04	118.1	-18.5	77.7
• Fallowlands	0.05	0.57	0.74	942.0	29.2	1246.
• Native Pastures	4.53	5.13	4.82	86.6	43.3	167.3
• Native Forests	7.05	9.25	9.31	31.3	0.6	32.0
• Idle Productive	2.02	2.05	1.98	1.3	-3.1	-1.8
• Inappropriate	n.a.	n.a.	1.14	-	-	-

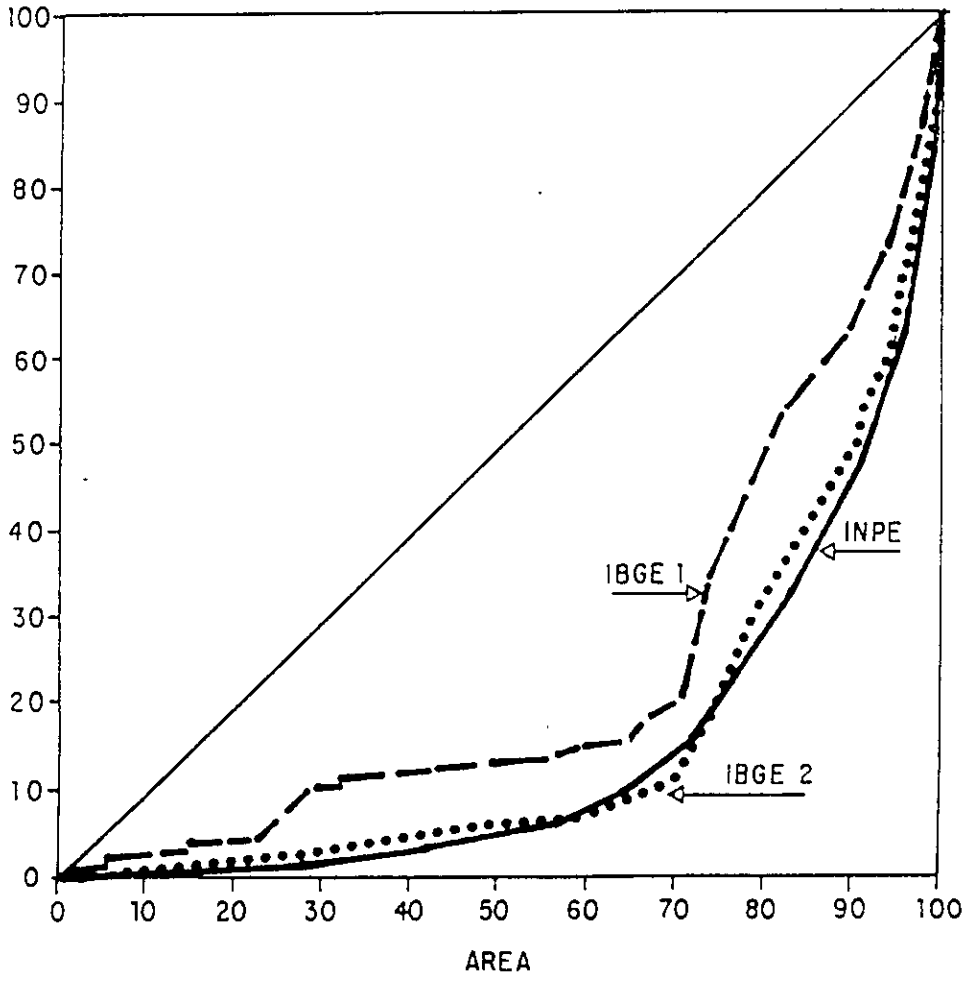
Source: IBGE. Obs.: n.a. = not available.

The relative importance of pasture lands suggests cattle raising is the main source of Amazon deforestation. Although the primacy of this source is evident from the statistics, figures could be biased to the extent that people tend to claim idle lands (whether deforested or not) as pastures to avoid any penalties for failure to make land improvements. This ploy is facilitated by the malleability of land requirements in extensive practices of cattle raising. Thus lands categorized as pastures are effectively used as a form of ensuring property rights, even though they may never have actually been used for grazing.

To conduct the detailed analysis presented here, we rely primarily on IBGE census data, which may be shown to represent adequate consistency with physical interpretation of deforested areas. We were able to compare deforestation estimates derived from satellite images by INPE with those obtained from agropastoral land uses surveyed by IBGE. Figure 4 compares Lorenz Curves for the geographic concentration of deforestation according to IBGE and INPE estimates for a sample of Amazon municipalities; the former with two alternatives, one including and the other excluding native pastures. The figure suggests that the IBGE estimate including native pastures does not correspond with the physical

Figure 4

GEOGRAPHIC CONCENTRATION
INPE, IBGE1 E IBGE2 (EXC. NATURAL PASTURES)



interpretation of cleared areas,[12] but that the estimate using planted pasture areas closely accompanies the INPE observations.

Unfortunately, neither INPE nor IBGE estimates allow the identification of specific sources of deforestation other than agropastoral activities. The only exception, in the case of INPE, is the contribution of large hydroelectric projects (namely Tucuruí, Samuel, Balbina, and Curua-Una) which in 1989 together amounted to 482,700 ha. in area flooded for reservoirs, which only represents one percent of the Legal Amazon territory. Individually, Balbina (AM) contributed with 239,900 ha., and Tucuruí (PA) with 192,600 ha. (INPE, 1992), the other two reservoirs being of comparatively negligible scale.

In regard to timber extraction, the scanty evidence available refer to volumes of output and not to cleared areas. Table 5 demonstrates that the gross value of wood, fuelwood and charcoal extracted in the Legal Amazon during the 1975-85 period represented a fairly constant share of total agropastoral output value of the region, exhibiting a slight increase from 32 percent to 39 percent of total crop output over the decade. There is a linear relationship between agropastoral output and timber extraction, although it is possible that more land has been cleared than converted to productive agropastoral uses at the frontier during the 1980s.[13] This evidence suggests that some logging and fuelwood consumption, although mainly a side-effect of the process of agricultural land conversion, may possess a dynamic of its own. Wood extraction over the past decade has remained a major contributor to rural income in the Amazon, accompanying the near tripling in real agricultural product.

Despite the growing importance of wood products to gross income, however, the probability that land initially logged over is then allowed to return to permanent forest use is quite small. Furthermore, researchers have found that the potential for recovery of original forest biodiversity after massive clearing and degradation is slim indeed (Uhl et al., 1990). There is no known natural forest concession in the Brazilian Amazon managed for sustained yield of timber. According to Rankin (1985), only a few hundred hectares in the entire region have been subject to sustained management and then only for experimental purposes. The concept of sustained management of non-timber forest products has become increasingly accepted.[14]

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[12] For this study, the following classification was used: crop areas (both annual and perennial), planted pastures, fallowlands and idle productive lands are considered deforested areas, while native pastures, forests, and inappropriate areas are treated as forested. Native pastures is an ambiguous category since IBGE surveys can be referring in this case either to the original vegetation or to the characteristics of the (non-cultivated) secondary regrowth of vegetation in deforested areas.

[13] It is important to discriminate the shares of this proportional growth due to changes in the relative prices of agricultural versus forest products and that due to actual growth in output. The decline in 1980 was possibly due to a drop in the relative prices of timber products as compared with crop values, since the growth in output of timber products has been fairly constant over this period.

[14] As of November 1988, there were over 22,000 km^2 in existing or proposed extractive reserves (Fearnside, 1989). Since that time, an additional 9,000 km^2 were added through establishment of the Chico Mendes reserve in Xapuri, Acre. The existence or proposal of extractive reserve establishment indicates that forest dwellers are already occupying these areas for non-timber forest product extraction. The extent to which such reserves constitute sustainable options for forest management in the Amazon remains an open question which we will not examine here.

Table 5
Value of Timber Output Compared with Crop Value
North Region and Mato Grosso (constant 1980 US$000)

	(1) WOOD[A]	(2) CROPS[B]	(1)/(2)
1975	155,017	483,300	0.32
1980	183,811	724,752	0.25
1985	459,267	1,190,160	0.39

SOURCE: IBGE, (1) Statistical Yearbook (various yrs.); (2) Agropastoral Census (var. years); . OBS.: [A] Includes the sum of roundwood, charcoal and fuelwood value reported by agricultural establishments. [B] Includes the sum of annual and perennial crop output value.

Use of wood for charcoal production, which relies mostly on waste from lumber mills, is also closely linked with agricultural land conversion. Over recent years there has been a considerable increase in charcoal production for iron smelting particularly in the Carajás railroad corridor in eastern Pará and northwestern Maranhão, a small portion of which may have been due to land clearing specifically for charcoal.

There are no significant commercial timber plantations in the Amazon region aside from the controversial Jari Florestal e Agropecuária enterprise planned for 100-200,000 ha. *Gmelina*, *Pinus* and *Eucalyptus* (Rankin, 1985). Despite optimistic proposals for sequestration of carbon through massive tree planting schemes such as the program for environmental reforestation - FLORAM (Centro de Estudos Avançados, 1991), and for charcoal supply in the Carajás corridor,[15] it is unlikely that major reforestation efforts will prove to be economically viable in the near future in the Amazon. We have hence restricted the remainder of the discussion in this study to agropastoral expansion.

IV. Land Occupation Patterns and Original Vegetation Cover

This section analyzes the relationship between the original vegetation cover and major dimensions of land occupation patterns, including agropastoral land uses, the size distribution of establishments, and tenure patterns within the region. For this purpose, characteristics of agricultural establishments are compared between "forested" and "non-forest" areas, as defined in Section I, above.

Table 6 presents evidence on agropastoral land use for Forested and Non-forested municipalities. The figures show that patterns of occupation do not differ substantially beyond confirming that uncleared areas of rural establishments in Forested municipalities tend

[15] A proposal by Companhia Vale do Rio Doce to plant 1 million ha. in eucalyptus was withdrawn from the Pilot Plan for Sustainable Development in the Amazon, at the insistence of environmental groups.

to be mainly native forests, while uncleared ares are predominantly native pastures in Non-forested municipalities.

The figures at the bottom of Table 6 show that the geographical density of rural establishments is significantly higher in Non-forested municipalities (over 40 percent of total geographic area lies within agricultural establishments) than in Forested municipalities (16 percent). It is possible to suggest that, due to the differential costs of clearing, non-forested areas have been the preferential direction for the advancement of the economic frontier. However, it also reflects the fact that Forest municipalities tend on average to be far larger, and their settlement more recent, so that the land area so far dedicated to agriculture tends to be less.

Table 6
Legal Amazon: Agropastoral Land Use, 1985
According to Original Vegetation Cover

Agropastoral Land Use	Percent of Rural Establishment Area in Municipalities with Original Vegetation:		
	Non-Forested	Forested	Intermediate
• Annual crops	5.09	3.84	3.84
• Perennial crops	0.34	1.32	0.46
• Planted Pastures	11.43	18.04	15.72
• Planted Forests	0.04	0.21	0.55
• Fallowlands	3.01	4.07	4.07
• Native Pastures	41.58	5.63	28.55
• Native Forests	19.38	55.31	32.54
• Idle Productive	12.46	8.22	8.45
• Inappropriate	6.66	3.35	5.82
Total	100.00	100.00	100.00
As % Geog. Area	40.85	15.68	18.93

Source: IBGE, *Sinopse Preliminar do Censo Agropecuário de 1985*. Obs.: Forested (>75%) and non-forested (<25%) and intermediate (between 25% and 75%). Percent of geographic area refers to proportion of total area in municipality occupied by rural establishments.

The proportion of establishment area effectively in use for productive purposes is greater in Forested municipalities (27.5 percent) than Non-forested (19.9 percent). This difference is primarily due to land area dedicated to planted pasture, somewhat higher in the Forested municipalities. The probable rationale for the larger share of lands in production

in Forested municipalities is the need to convert native forests to pastures -- which contrasts with the possibility of using native pastures in Non-forested municipalities. Forest clearing for pasture may also reflect the previously described strategy to ensure property rights through "improvements".

In contrast to their inferior share of area-dedicated to planted pastures, Non-forest municipalities show a slightly higher proportion of farm area in annual crops. Likely reasons for this pattern of specialization include the greater adequacy of Non-forested (chiefly savanna) soils for annual crops such as soybeans, once adequately fertilized and limed, as well as their better structure, suitable for mechanized tillage operations, which facilitate extensive agriculture.

Two other important dimensions of land occupation patterns are the size of rural establishments and their land tenure arrangements. These dimensions are especially important for their implications toward agricultural policy, in particular in those aspects related to agrarian reform and incentive mechanisms.

Table 7 presents cross-tabulations of land use patterns and the size distribution of rural establishments for the states of the "old" North Region and Mato Grosso.[16] For this purpose data on the size of area of rural establishment were grouped in three major categories: small (less than 100 ha.); medium (between 100 and 500 ha.); and large (area greater than 500 ha.).

The Figures in Table 7 show that small establishments are specialized in crop production (13.8 percent of land area) while the medium and large operations are specialized in livestock ranching (between 13.6 and 14.7 percent of land area devoted to planted pastures). Nevertheless, even the smaller units occupy a substantial share of total area in planted pasture, nearly equivalent to that in annual crops, suggesting that livestock is an intrinsic aspect of agricultural production strategies among all strata of Amazon producers.[17] It is disturbing to note that large establishments not only occupy the vast majority of land within agricultural establishments in the Legal Amazon (73.6 percent) but are also those which proportionally show the least area proportionally devoted to forest reserves and the highest proportion of idle productive land.[18] Evidently, whatever policy hopes to deal with the problems caused by deforestation must address land concentration as well.

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[16] Unfortunately, these data are not available at municipal level, therefore precluding presentation of such tables for the entire Legal Amazon.

[17] There are good reasons for the importance of cattle production to smallholders, which include their representing a form of savings that can be conveniently liquidated as need arises, and their relative ease of marketing unaffected by seasonal road conditions -- when necessary, cattle can walk to market (Hecht, 1991)

[18] As has been noted previously, however, the categories of "native pasture", "native forest" and "idle productive" lands tend to overlap a great deal, thus distorting the capacity to characterize land use based on these data.

Table 7
Agropastoral Land Use by Size Distribution
North Region and Mato Grosso: 1985
(Percent of Rural Establishment Area)

Agropastoral Land Use	Size of Rural Establishments		
	Small	Medium	Large
• Annual crops	10.16	5.10	2.04
• Perennial crops	3.63	1.48	0.27
• Planted Pastures	9.76	14.69	13.57
• Planted Forests	0.06	0.05	0.24
• Fallowlands	6.61	3.23	0.76
• Native Pastures	4.18	8.29	16.33
• Native Forests	55.73	60.21	38.39
• Idle Productive	9.87	6.97	28.41
Total	100.00	100.00	100.00
As % Geog. Area	12.4	14.0	73.6

Source: IBGE. Obs.: "Small" refers to establishments less than 100 ha in size; "Medium" to those between 100 and 500 ha. and "Large" those over 500 ha. Percent of geographic area refers to proportion of total area in municipality occupied by rural establishments in size category.

The tendency in areas of colonization has been toward aggregation of smaller units, due to colonist failure and speculation, but there is also some evidence of break-up among the large properties. At an aggregate scale, from 1975-85, the distribution of land showed a slight improvement, with the smallest units increasing from 10 to 13.6 percent of total land in agriculture in the region, but also increasing in average size from 17 to nearly 24 ha. The average area in large properties declined, although their size (3,300 ha) remained over 100 times that of smallholders (Table 9).

Land tenure patterns show that the majority of lands are occupied by their owners (86.5 percent), on lands over 500 ha. in size. In the smaller size categories, there are proportionally more squatters (25 to 27 percent) than renter or sharecropper categories, which are the least expressive in the Legal Amazon region, jointly accounting for only 3 percent of total land occupied (Table 8). The ready availability of land and the consequent lack of land markets in the region are the obvious explanation for the limited prevalence of renting or sharecropping, as well as for the considerable importance of squatting even in the medium size category. Since, in this context, land clearing is a legitimate mechanism to claim property rights on land, squatters have an incentive to deforest beyond what is required for immediate productive purposes, and then leaving this land fallow (Table 10).

Table 8
Size and Land Tenure Patterns of Rural Establishments North Region and Mato Grosso: 1985
(percent share of area in rural establishments)

Land Tenure Arrangements	Size of Rural Establishments			
	Small	Medium	Large	Total
Owner	67	68	95	87
Renter	4	5	1	2
Sharecropper	2	2	1	1
Squatter	27	25	3	10
Total	100	100	100	100

Source: IBGE. Obs.: "Small" refers to establishments less than 100 ha in size; "Medium" to those between 100 and 500 ha. and "Large" those over 500 ha.

Table 9
Area and Number of Agropastoral Establishments North Region and Mato Grosso: 1975-85

		1975	1980	1985
Large	Area (000 ha)	40,588	56,054	56,247
	Number	9,287	15,694	16,910
	Average Area (ha)	4,370	3,572	3,326
Medium	Area (000 ha)	7,807	11,875	13,944
	Number	52,256	72,313	89,645
	Average Area (ha)	149	164	156
Small	Area (000 ha)	5,658	8,185	11,057
	Number	331,567	381,937	466,982
	Average Area (ha)	17	21	24

Source: IBGE.

The characteristics of rural establishments are cross tabulated in Table 10 with major land uses within those establishments on a regional level. We observe here that property rights and associated economic incentives have played some role in directing economic activities toward specific land uses. Landowners are more likely to dedicate a significant share of land to planted pasture (16.8 percent), renters to annual crops (16 percent), while sharecroppers have more incentive to manage perennial crops than any other category of land occupant. These may not be sharecroppers in the traditional sense of sharing both in investment and output. Perennial crop operations are typically managed by hired laborers who earn a share of the crop as a payment. The distribution of land uses among native pastures, forests and idle productive land shows that all tenure categories retained over 75 percent of lands out of effective use in 1985, although the distribution among specific use categories differs somewhat.

Table 10
Agropastoral Land Use and Land Tenure:
North Region and Mato Grosso - 1985

Agropastoral Land Use	Percent of Rural Establishment Area			
	Owner	Renter	Sharecrop	Squatter
• Annual crops	3.79	15.94	6.67	5.32
• Perennial crops	0.93	0.98	5.65	1.44
• Planted Pastures	16.81	3.35	5.31	4.93
• Planted Forests	1.46	0.03	0.06	0.04
• Fallowlands	1.92	0.79	2.57	4.06
• Native Pastures	19.30	11.23	4.16	6.83
• Native Forests	44.43	64.86	73.90	70.51
• Idle Productive	11.35	2.82	1.69	6.87
Total	100.00	100.00	100.00	100.0
As % Geog. Area	86.5	2.0	1.14	10.4

Source: IBGE. Obs.: Establishments whose tenure categories was not reported were eliminated from total.

With regard to the distribution of tenure categories among forest cover types, the only significant contrast is found in the significantly higher proportion of squatters in Forested and Intermediate areas of 15.7 percent and 11.8 percent, respectively, while this proportion was only 4.0 percent in Non-forest municipalities. This reflects longer-term settlement patterns in Non-forest areas, and the consequent aggregation of squatter units into titled properties, or recognition of land rights through agrarian reform processes.

V. The Determinants of Agropastoral Productivity

This section analyzes the determinants of factor productivity in major agropastoral activities in the Legal Amazon region. The ultimate objective is to obtain estimates of labor and land requirement coefficients for these activities taking account of structural characteristics of municipalities, including the structure of production, the vegetation cover, the size distribution of establishments, and land tenure conditions.

Unfortunately, data on labor employment are not distinguished by major agropastoral land uses. Total employment in agriculture by municipality was the only information available. In consequence, labor productivity is restricted to an aggregate measure defined as the relation between the real value of total output (including outputs from forest product extractivism, as well as from agriculture and stock raising) and the number of workers employed in rural establishments. Table 11 shows that labor productivity in 1985 was significantly higher in "non-forested" areas.

Table 11
Employment and Labor Productivity in Rural Establishments, Legal Amazon: "Forested" and "Non-Forested" Areas, 1985

	OUTPUT VALUE (CR$ MILLIONS)	EMPLOYMENT (THOUSANDS)	LABOR PRODUCTIVITY (CR$ 1000/WORKER)
NON-FORESTED	2,990	748	3,994
FORESTED	5,097	2,990	1,704
ALL AREAS	8,726	4,227	2,064

SOURCE: IBGE. Obs: Figures do not add up due to elimination of "Intermediate" land cover class from this tabulation.

Data on land employment are distinguished according to major agropastoral uses, thus making it possible to define land productivity indices for major annual crops (rice, beans, maize, cassava, soybeans, and wheat), perennial crops (coffee, cacao, pepper, orange, banana, sugar cane), and for cattle raising.

For cattle raising, we define two alternative measures of range productivity, one including and the other excluding "native pastures" from the land area under consideration. In both of these measures, productivity is defined as the relation between size of cattle herd and the area of pastures. Figures in Table 12 show that, due to extensive cattle raising, productivity is obviously higher when natural pastures are excluded. Another obvious evidence is the relatively high comparative advantage of planted pastures in "non-forested" areas. The reason is probably due to the the more extensive use of natural pastures in "non-forested" areas. Time trends, however, show that these differences tend to decrease both in forested and non-forested areas, when measures are restricted to planted pastures, but

increase when natural pastures are considered. An explanatory hypothesis could be the adoption of less extensive practices of cattle raising, as well as the effects of overgrazing. Note, however, that planted pasture productivity does not decline in forested areas.

Table 12
Cattle Herd, Pasture Area and Land Productivity in Cattle Raising "Forested" and "Non-Forested" areas, Legal Amazon: 1975-85.

		NON-FORESTED		FORESTED		ALL AREAS	
		INCL.	EXCL.	INCL.	EXCL.	INCL.	EXCL.
CATTLE HERD (THOUSAND)	1975	5,708	5,708	2,552	2,552	9,390	9,390
	1980	7,752	7,752	7,426	7,426	15,220	15,220
	1985	9,186	9,186	7,811	7,811	18,998	18,998
PASTURE AREA (THOUSAND HA)	1975	21,454	3,783	4,631	2,874	29,813	7,154
	1980	26,154	6,066	8,585	6,327	39,044	13,346
	1985	26,634	8,590	7,811	12,077	43,246	19,126
PRODUCTIVITY (HERD/HA)	1975	0.27	1.51	0.55	0.90	0.31	1.31
	1980	0.30	1.28	0.62	0.95	0.39	1.14
	1985	0.34	1.07	0.65	0.85	0.44	0.99

SOURCE: IBGE. Obs. Incl. = includes natural pasture; Excl.= Excluding natural pastures. For the definition of "forested" and "non-forested" areas, see text. Due to the "intermediate" category, figures of "forested" and non-forested" areas do not add up to totals.

Table 13 shows productivity measures for aggregate categories of agricultural products, divided into annual, perennial and total crops. Productivity is defined as the real value of output in each category (deflated by the price index of major crops in the same category) divided by the area of land employed in the respective category.

Figures in Table 13 show that, for the Amazon region as a whole agricultural productivity increased over 4.9% p.a. in the 1975-80 period, but slowed down to 1.6% p.a. in the 1980-85 period. The increase in productivity was especially strong for temporary crops in "forested" areas, where growth reached nearly 10% p.a. over the 1975-80 period, undoubtedly reflecting opening up of inviolate frontier lands.

Table 13
Output, Crop Area, and Land Productivity for Major Categories of Agricultural Crops in "Forested" and "Non- Forested" Areas, Legal Amazonia: 1975-1985

		NON-FORESTED			FORESTED			ALL AREAS		
		Temp	Perm	Total	Temp	Perm	Total	Temp	Perm	Total
CROP OUTPUT (Cr$ million*)	1975	582	111	736	1531	698	2098	2347	860	3132
	1980	1601	187	1908	3142	1550	4476	5223	1815	6970
	1985	2821	168	2989	3247	1850	5097	6543	2183	8727
CROP AREA (thousand ha)	1975	818	79	897	1506	237	1744	2599	341	2944
	1980	2052	144	2197	1931	581	2512	4354	781	5135
	1985	2656	170	2826	1988	705	2693	5015	934	5949
PRODUCTIVITY (Cr$ 000*/ha)	1975	711	1412	820	1016	1945	1203	904	2496	1064
	1980	780	1295	868	1627	2664	1781	1199	2324	1357
	1985	1062	986	1057	1633	2623	1892	1304	2336	1466

SOURCE: IBGE. Obs.: Temp. = Temporary crops; Perm. = Permanent crops. For the definition of "forested" and "non-forested" areas see text. Due to the "intermediate" category figures of "forested" and non-forested" areas does not add up to totals. Differences in deflator explain the same problem for summation across crops. * Values are in 1985 constant Cruzeiros.

For individual crops, we define productivity as physical units of output per crop area. Estimates are presented in Table 14. Productivity was somewhat better for most subsistence and cash crops in Forest areas, although soybeans performed slightly better in Non-forest soils, where they have in consequence been planted on over double the area. Initial fertility after clearing of Forest soils appears to have been an important factor, explaining a difference of nearly 10 tons per ha in sugarcane, and nearly 4 tons per ha in cassava. The exhaustion of these soils after continuous cropping would tend to result in a decline in these productivities over time.

Finally, Table 15 present regression results which explain the differences of productivity among Amazonian municipalities based upon structural characteristics such as their structure of production, vegetation cover, size distribution of establishments, and land tenure conditions.

Table 14
Productivity of Major Crops in Vegetation Zones, Legal Amazon: 1985

	Non-Forested Areas			Forested Areas			All Areas		
	Quant. (000 t)	Area (000 ha)	Prod. (t/ha)	Quant. (000 t)	Area (000 ha)	Prod. (t/ha)	Quant. (000 t)	Area (000 ha)	Prod. (t/ha)
Annual									
•Rice	1,063	830	1.28	1,045	827	1.26	2,333	1,822	1.28
•Beans	23	50	0.46	110	193	0.57	143	263	0.54
•Cassava	232	45	5.06	2,964	350	8.47	3,510	450	7.79
•Maize	272	254	1.07	461	589	0.78	825	952	0.87
•Sugarcane	1,178	21	54.80	247	6.8	36.39	1,597	34	46.92
•Soybeans	1,640	852	1.93	3	2.7	1.12	1,652	860	1.92
Perennial									
•Cocoa	0.1	0.15	0.68	34	61	0.56	35	63	0.56
•Coffee	13	13	1.00	81	82	1.0	104	103	1.01
•Cotton	1.3	7.8	0.16	0.26	1.7	0.15	1.8	11.3	0.16
•Banana	19	28	0.69	39	55	0.72	63	88	0.72
•Orange	76	1.25	61.0	166	3.5	48.0	274	5	52.3
•Pepper	0.019	0.1	0.19	29	22	1.34	30	22	1.33

Source: IBGE.

Table 15
Regression for Agricultural Productivity in the Legal Amazon, 1985

	ALL AREAS	NON-FOREST	FOREST	INTERMEDIATE
CONSTANT	7.09**	7.12**	6.51**	7.04**
	(0.22)	(0.74)	(0.73)	(0.44)
LABOR/LAND	0.30**	0.15*	0.41**	0.09**
	(0.05)	(0.09)	(0.09)	(0.09)
AVG. HERD SIZE	-0.03	0.28	0.008	-0.09
	(0.03)	(0.18)	(0.04)	(0.05)
AVG. ESTAB. SIZE	-0.005	-0.24	-0.003	0.02
	(0.04)	(0.19)	(0.06)	(0.07)
MARKET INTEGR.	0.21	-0.49	0.52**	0.77**
	(0.16)	(0.39)	(0.25)	(0.30)
LAND CONCENTR.	-0.13	0.46	-0.48	-1.83
	(0.70)	(1.07)	(1.30)	(1.35)
SHARE SQUATTERS	-0.43**	0.25	-0.53**	-0.30
	(0.16)	(0.47)	(0.21)	(0.32)
DIST. STATE CAP.	-0.15	-0.45**	0.16	-0.34
	(0.11)	(0.22)	(0.15)	(0.22)
DIST. FED. CAP.	0.20**	0.45**	0.55**	-0.06
	(0.05)	(0.19)	(0.11)	(0.04)
SHARE OF FOREST	0.08	-1.10	-0.14	-0.03
	(0.11)	(0.76)	(0.65)	(0.42)
DENS. PAVED RD.	3.33**	14.66**	3.71**	3.35
	(1.15)	(5.07)	(1.37)	(2.22)
DENS. NON-PAVED	-0.87	1.37	-0.44	1.36
	(0.92)	(1.94)	(1.19)	(2.30)
DENS. RIVER	-2.00	1.35	-2.56	-3.12
	(2.43)	(10.3)	(2.92)	(4.60)
R^2 ADJ.	0.34	0.34	0.29	0.54
RMSE	0.55	0.46	0.58	0.33
N.OBS.	304	66	190	46

Source: Author's estimates. Obs.: Standard errors are in parentheses. RMSE = Root Mean Square Error. N.Obs.= sample size. Logarithms were taken in the cases of productivity, labor/land ratio, average herd size and average farm size; integration to markets, land concentration and squatters are percent shares; distances are in thousand km.; and roads and rivers are geographical density (divided by geographical area of municipality).

The dependent variable in all the regressions is the productivity of agriculture (including both annual and perennial crops), defined as the relation between the value of output and crop area, in 1985.

The explanatory variables in the regression are:

- the **land/labor ratio** measured by the relation between total employment of labor and total crop area in the municipality, introduced to capture the effects of diminishing returns in agricultural production;
- the **average size of agricultural establishments**, a measure of scale economies;
- the **average size of cattle herd**, measuring the importance of alternative employment of land and/or labor;
- **integration to product markets**, measured by the percent share of total production destined for industrial or commercial uses (as opposed to output consumed within the establishment) in the total value of output;
- **land concentration**, measured by the percent share of large establishments (greater than 500 ha.) in the total number of establishments in the municipality;
- the **percent share of squatters** in the total number of establishments, as a proxy for institutional conditions related to property rights in land;
- **distance to State and Federal capital**, expressed in thousand km., as proxies of access to local and national markets, respectively;
- **vegetation cover** summarized by the percent coverage of forests (including categories of dense, open and ecological transition) in the municipality;
- finally, transport conditions are represented by the proxies of geographical **density of paved and non-paved roads**, as well as by the geographical **density of rivers** (having class "A" navigability) .

All the variables refer to municipalities of the Legal Amazon, in 1985, and logarithms were taken in the case of productivity, land/labor ratio, average size of herds and average size of establishments.

Naturally, the model is not able to explain a large portion of the variance in cropland productivity, much of which has to do with soil and climatic conditions at an establishment level not measured by these variables. However, the effects of some variables are statistically significant. For the Amazon region as a whole, the labor/land ratio is the most important determinant of productivity. An increase of one percent in the labor/land ratio increases land productivity by 0.3 percent. However, there are significant differences in the value of this parameter between forested and non-forested areas.

Other important determinants of land productivity are the distance to the federal capital, the density of paved roads, and the share of squatters in the municipality. On the other hand, factors like the average size of herds, the average size of establishments, land concentration, and the share of crops marketed seem to have no clear effect on productivity.

The more distant from the federal capital the municipality is located, the higher productivity tends to be. Each additional thousand kilometers increases productivity by 0.2 percent. The reasons behind this geographic effect are not imediately obvious. Differences in the type or fertility of soil in more distant and recent settled areas is suggested as a possible explanation. On the other hand, it is interesting to note that distance from the state capital has the opposite effect, though estimates are not significant at reasonable levels of confidence. Probably, the latter distance is a proxy for the more profitable and/or productive crop mix of areas close to markets.

The higher the density of paved roads in the municipality, the higher are its productivity levels. Thus, each additional kilometer of paved road per square kilometer of geographical area leads to a 3.33% increase in producitivity. This is probably due to the fact that paved roads acts as a proxy for the more intensely urbanized areas, or for market integration. Note that the density of non-paved roads does not seem to have a significant effect on agricultural productivity, perhaps due to the fact that such roads are largely impassable in the harvest season.

Finally, the share of squatters in total rural establishments in the municipality has a strong negative effect on productivity. One additional percentage point of squatters leads to a decrease of 0.43% in productivity. A plausible hypothesis could be the incentives for the adoption of more extensive agricultural methods as a mechanism of granting property rights in larger tracts of land. Squatters also face institutional barriers to credit and tend to be located in areas least accessible to markets.

Results for Forested and Non-Forested areas show important differences in the size and statistical significance of the effects of different factors. Firstly, the value of constants show that, independent of all other factors, productivity tends to be higher in Non-Forest areas, though the differences are not strongly significant. Secondly, the elasticity of output in relation to labor tends to be lower in these areas. In Non-Forest areas, moreover, the average size of herds (closely followed by average farm size) is the most important factor in the explanation of the variance of productivity (highest standardized estimates). On the other hand, in Non-Forest areas, squatters and the degree of market integration are not significant factors for the explanation of productivity, in contrast to the Forest areas. Finally, variables related to distance and transport condition show stronger effects in Non-Forest areas.

The differences above are probably related to soil conditions and, as a consequence, to the greater specialization of Non-Forest areas in cattle raising activities, as well as in less labor intensive agricultural crops. The technological characteristics of these activities tends to increase farm area with no increase on land productivity in agriculture; they also tend to reduce the linkage of farming activities to markets, thus decreasing the importance of the latter as a determinant of productivity. Furthermore, cattle raising tends to show a stronger

complementarity to cropping activities and, finally, the less labor intensive techniques tend to reduce the elasticity of output to employment.

VI. Wood Removal

The average volume of timber per unit area in "non-forest" and "forested" municipalities has been estimated in cubic meter wood equivalent based on broad categories of vegetation from the specialized literature as shown in Table 16, below. For analytical purposes, we have taken estimates from the range of figures presented from forest inventories reported in the literature, and applied these to these broad vegetation types in the Legal Amazon to estimate total original standing wood volume, and total volume removed due to land use conversion from 1980-85.

Table 16
Estimated Timber Volume in Natural Forests, Legal Amazon

INVENTORY SOURCE	FOREST	NON-FOREST
RADAMBRASIL (IBGE, VAR.)[A]	107.6 m^3/ha	72.4 m^3/ha
FAO (1985)[B]	114.0 m^3/ha	63.0 m^3/ha
BROWN ET AL. (1991)[C]	156.9 m^3/ha	n.a.
ESTIMATED AVERAGE	133.9 m^3/ha	67.7 m^3/ha

[a] Data refer to total mean volume per ha. of standing wood in commercial categories. Forested municipalities refer to the following map sheets: Belém, Araguaia/Tocantins, Macapá, Tapajós, Santarém, Tumucumaque, Rio Branco, Içá, Juruá, Porto Velho, Purus, Manaus. Non-Forested: Boa Vista/Roraima, Pico da Neblina, Javari/Contamana, Guaporé, Juruema.

[b] Data refer to Radambrasil estimates for the North region, with Forested municipalities represented by Broadleaved Forest (category NHCf) , with DAP>30 cm, and Non-Forested by Productive Woodlands of *Cerrado* formation. (category NHO), with DAP>10cm.

[c] Data refer to average volumes from a range of inventories carried out in the Latin American tropical forest area.

To derive an estimate of approximate wastage, Table 17 compares the average annual output volume of roundwood, charcoal and fuelwood production for 1980-85 in wood equivalent volume with estimates of the areas cleared annually in each Amazon state.[19]

[19] Annual deforestation rates were derived using the formulation proposed in SERÔA DA MOTTA AND MAY (1992), which calculates deforestation in inter-censal years due to agropastoral expansion as $[(A_{t+1} - F_{t+1}) - (A_t - F_t)]$, where A_t = area in agricultural establishments, and F_t = native forest area within such establishments.

According to previous studies, it has been estimated that the volume actually commercialized (VAC) as being about 25 m^3 per ha. in the North region, or about 20 percent, considering extraction of 30 to 35 merchantable species. This is consistent with the average commercial utilization rate of 18.8 percent of deforested timber derived from the above analysis. However, the areas actually exploited tend to be limited to only five or six species, contributing between 5 and 10 m^3 per ha. This would tend to result in far lower estimates for wood utilization than those derived in Table 17. One explanation is the lack of consideration of fuelwood and charcoal in these market figures, although these uses in some states are even more substantial than roundwood extraction.

Table 17
Wood Removed due to Agropastoral Expansion and Commercial Timber Output
North Region and Mato Grosso: 1980-85 average

	1980 - 1985 Average			Timber Equiv. (000M^3)	Timber Removed (000 M^3)	Utiliz-ation Rate
	Roundwood (1000 M^3)	Fuelwood (1000 M^3)	Charcoal (T)			
Acre	171.0	1,250.4	2,342	864.9	1,807.4	47.9%
Amapá	594.2	312.6	710	756.1	8,214.5	9.2%
Amazonas	739.2	3,346.1	5,646	2,457.4	n.a.	n.a.
Pará	13,087.7	4,454.9	25,335	15,517.9	67,104.9	23.1%
Rondônia	787.6	118.8	3,096	871.8	14,693.4	5.9%
Roraima	40.6	64.0	35	72.9	n.a.	n.a.
Mato Grosso	750.7	3,310.0	706	2,411.3	30,333.2	7.9%
Total	16,171.0	12,956.8	37,869	22,952.3	122,153.4	18.8%

SOURCE: Author's estimates, based on data in Tables 1 and 16, IBGE, 1980 and 1985 Agricultural Census: annual change in native forest in agricultural establishments; 1980-85 Statistical Yearbooks: timber extraction volumes.
Obs: It is estimated that charcoal constitutes 25 percent of wood equivalent by weight, and 50 percent by volume. Fuelwood, usually measured in steres (1 m^3 stacked wood), is adjusted to wood equivalent at 50 percent of fuelwood volume. n.a. = agricultural establishment land use shows increase in forested areas, inconsistent with timber extraction statistics.

VII. Conclusions

This study has provided preliminary sub-regional estimates of land use change due to agropastoral expansion in the Legal Amazon region, and the relationship between these changes and both agricultural productivity and timber removal. To the extent feasible, the research has further disaggregated this analysis to characterize the form of occupation of areas originally forested and of non-forested areas, defined acccording to Brazilian vegetation formations predominant in the Legal Amazon, on a municipal level. Although this unique data source provides a more comprehensive picture of the sources of land use change, it is impossible to correlate vegetation characteristics with types of establishments and specific land uses on the basis of municipal census data. To further refine these estimates would require a survey of individual properties and their precise land use structure in relation to original vegetation cover characteristics.

For the Legal Amazon region as a whole, we have found that agricultural occupation rates are significantly higher in the Non-forested areas, a tendency which is reinforced by the difficulties of settlement in the dense tropical forest. Nevertheless, crop producitivities are higher in the Forest municipalities, at least during the period of initial settlement. This attraction is offset by the labor requirements of land clearing and the far more difficult access to markets. This can explain the conversion of croplands to pastures and secondary forests after initial occupation. Planted pastures in the Non-Forest areas appear more productive than in Forest lands, but this is primarily due to the extensive use of native pastures, more prevalent in these areas.

Wood removal rates associated with agropastoral expansion are on the whole quite inefficient, averaging only about 19 percent of estimated timber volume removed by land clearing, even when fuelwood and charcoal production is included in the estimate. Of total timber marketed in the region, the share of roundwood in total wood volume is about 70 percent. However, this proportion is far greater in Forested than Non-Forest areas. In the latter, a considerable share of timber extracted for commercial purposes is destined for fuel. With the growth of the steel industry in the eastern Amazon, the tendency for diversion of timber to fuel will increase, particularly given the improbability of investments in reforestation for charcoal production.

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