Federative Republic of Brazil
State of Tocantins
Secretariat of Production (SEPRO -TO)
Secretariat of Planning and Environment (SEPLAN -TO)

Japan International
Cooperation Agency
(JICA)

ANNEX XV

RELEVANT STUDIES OF AGRICULTURAL PRACTICES FROM ADVANCED AREAS

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1. Rotation of Crops and Pasture

The introduction of the integration system is found in the cattle farmers' farms. The integration forms vary, depending on the technology used in each one of them. The details in the integration way are the following ones:

(1) Prodution of Beef Cattle using Rotation of Crops

This system is a form of rotation of crops, when we need to renew the pastures. Cultivating the soy for 3 years for later to convert in pastures, until the productivity of the pasture decreases again.

The disadvantages of this system are the low experiences of the cattle farmers in grans culture. This system is more common in the State of Mato Grosso, where initially it was an area producing of soy. Many producers that changed their production for the livestock, when the international prices of soy were very low. These producers, still possess machines and experiences to restart the activities of production of grains. Like this with the improvement of the international prices of soy, many producers returned to the soy production being used of the system of rotation of cultures.

Farmhouse using rotation of crops and pasture (Rio Verde ／Mato Grosso do Sul)

Farm : Bracinho Farm

- 120 km north from Campo Grande.near Camapua
- Owner - Orlando Ogata
- Soil - Cerrado

(1.1) Handling in the Farm:

9 year-old experience between grains and pastures. The soy cultivation was introduced 9 years ago. The renewals of the pastures take place after 3 years of soy cultivation. It is made them analyze of soils before the formation of pastures. The soy culture takes place to improve the qualities of pastures.

- Farmland : the area of the farm and the cultivated area are 4,240 ha and 3,500 ha (20% reservation area).

(1.2) Management of Pastures

Formerly, for improvement of the pastures, they applied the fertilizer of N,P,K with amount of 200kg/ha. But, being an alternative no profitable, they were introduced the soy cultivation for 3 years for the renewal.

- Cultivation of the Soy for the Renewal of Pastures

After the soy cultivations, they renew pasture this year after 4 years. The duration economically viable is from 7 to 8 years for appropriate manurings.

- The standard time of renewal

The standard time of renewal of declined pasture is the time when the capacity of raising livestock in high quality Guinea grass decreases from 3 heads/ha to 2 heads/ha, or that in low quality Braquiarão decreases from 2 heads/ha to 1～1.5 heads/ha.

(1.3) Advantages and Disadvantages of introducing soy bean for pasture

Before the protective policy for agriculture was cut since Civil Government established, in this

neighborhood soybean was cultivated. Therefore, farmers here have had an experience of soybean cultivation and the required machinery. They have the standard of soybean cultivation and can carry out cultivation of soybean without troublesome. They introduce the soybean to their pasture from the point of following view; they can not profit in soybean cultivation, but can profit in raising of cattle. If they can profit in soybean, they could wish for nothing better than that.

- **Method of Introducing Soybean : Cultivation and Yield**

Soybean has been introduced 330 ha in declined pasture every year as shown in following Table.

On condition that

1) the economical renewal years of grass in pasture is nine years,
2) the area of pasture is 3,600 ha,
3) soybean is introduced yearly 330 ha in declined pasture, and each field of 330 ha is cultivated for three years,

The area of soybean in the farm becomes 990 ha and the area of grass becomes 2,610 ha every year.

	1	2	3	4	5	6	7	8	9	10	11
1 st	Soybean	Grass	Grass	Grass	Grass	Grass	Grass	Grass	Grass	Soybean	Soybean
2 nd	Soybean	Soybean	Grass	Grass	Grass	Grass	Grass	Grass	Grass	Grass	Soybean
3rd	Soybean	Soybean	Soybean	Grass	Grass	Grass	Grass	Grass	Grass	Grass	Grass
4th	Grass	Soybean	Soybean	Soybean	Grass	Grass	Grass	Grass	Grass	Grass	Grass
5th	Grass	Grass	Soybean	Soybean	Soybean	Grass	Grass	Grass	Grass	Grass	Grass
6th	Grass	Grass	Grass	Soybean	Soybean	Soybean	Grass	Grass	Grass	Grass	Grass
7th	Grass	Grass	Grass	Grass	Soybean	Soybean	Soja	Grass	Grass	Grass	Grass
8th	Grass	Grass	Grass	Grass	Grass	Soybean	Soybean	Soybean	Grass	Grass	Grass
9th	Grass	Grass	Grass	Grass	Grass	Grass	Soybean	Soybean	Soybean	Grass	Grass
10th	Grass	Grass	Grass	Grass	Grass	Grass	Grass	Soybean	Soybean	Soybean	Grass
11th	Grass	Grass	Grass	Grass	Grass	Grass	Grass	Grass	Soybean	Soybean	Soybean
	330ha	330ha	330ha	330ha	330ha	330ha	330ha	330ha	330ha	330ha	330ha

The method using to interfere in the germinations of the pasture for the healthy soy cultivation to plow before the time dries, and graze in June to July.

- **Yield of soybean**

The average yield of soybean in the farm during eight years was 2.4 tons/ha. The yield of soybean on the first year rotated from pasture to soybean was low, 2.1 tons/ha, and the yield of soybean on the second and third year were high, 2.4 tons/ha.

- **Fertilization for soybean**

The first year rotated from pasture to soybean:
Lime 3~3.5 tons/ha (pH3~4→5.4~5.9)
Super phosphate 18% P_2O_5 + S 400 ~ 500 kg / ha
Compound fertilizer (0-20-20) 350 kg / ha
Micro-nutrient fertilizer (6 elements) 50 kg / ha
Seed is covered with Co, Mo, root nodule bacteria and pesticide.

The second and third year rotated from pasture to soybean :
Additional fertilization at 35 to 45 days after sprouting of soybean
K (60%) 60 kg / ha
Compound (0-20-20) 350 kg / ha
Micro-nutrient fertilizer (6 elements) 50 kg / ha
N fertilizer does not use at the farm, but some farmers use N fertilizer in the neighborhood.

- **Machinery for soybean cultivation**

For the rotative cultivation of 400 there is, the following implements will be necessary;

Farm Machines	Type	For 400 ha	Owned
Tractor	128 HP 4WD	2	2
Tractor	100 HP 2WD	-	2
Tractor	85HP 2WD	2	2
JTB	Tem as "sagyuki" nas traseiras e fronteira	1	1
Bulldozer		-	1
Combine harvester	Compativeis para soja e arroz	1	2
Planter	8 linas com as acessório para a lavoura mínima	1	2
Manure spreader	5.5 on para calcario, e fertilizantes	1	1
Disk harrow	20" x 18	1	2
Disk harrow	20" x 24, com control remote	1	2
Pack roller	3m	1	2
Disk Plow	26" x 4, com control remot	1	1
Broadcaster	Quicq Hitch to fertilizer	1	1
Power Sprayer	Tração de trator, Capacidade de Tanque; 2.000 litro	1	1
Power Sprayer	Idem, Tanque 600litro	1	1
Power Sprayer	Idem, Tanque 400 litros	-	1

- **Laborer**

The farm employees 4 operators, 6 persons for management of farm and cattle, and 2 persons for other works, total 12 persons as permanent laborers.

(2) Intensive pasturage in irrigated pasture

The growth and the quality of grass are promoted by irrigation with the system of center pivot in dry season. In the case of the stock farmer in Gurupi, Tocantins, a herd of cattle grazes grass in the plot, which is divided with electric fence and moves daily to the next plot by moving the fence. The system is required the cost of irrigation facilities and the running cost of irrigation, but can increase the profit due to shortening the period of fattening by reason of supply of high quality grass throughout the year.

The system of pasturage is the most labor saving method, because the machinery and facilities for silage are not required. However, as a cattle herd grazes the grass of the narrow plot, pasture is easy to be damaged by trampling. Therefore, it may be required to shorten the interval of renewal of pasture. The system of intensive pasturage in irrigated pasture can introduce the Barreirão method at the renewal of pasture

2. Prodution Nucleus

During the period of the Study, as the example of advanced areas that you/they apply collective and intensive production systems, we didn't find models to not to be the association in the State of Goiás.

(1) Union of association, Silvania at Goias State

In Silvania, associations have been established since 1987 and 30 associations were united on 1992. The activities of this union are group purchasing of agricultural inputs, group selling of products and the adjustment of finance. In this union, all the personal data of the members are input into computer once a month for the smooth implementation of the activities.

Disadvantage of the union is not accepted by law specially for the sale of their products and this union is trying to convert into cooperative. But members are looking for the different type of cooperative, for example, member's participation into management. Cooperative is accepted by law and there are many advantages for producers in financing system. This union is now employing 3 engineers on education and life improvement, agricultural engineer and veterinarian for farmers' training.

Followings are examples of one association under this union and one farmer belongs to this association. The total land area of the association is about 400ha and members are 20 households. The average cultivated area per household is 15-30ha. Out of 400ha, 70ha is utilized as group cultivation area. Corn and Soybean are cultivated by group and the profit is used for the operation cost for association. There is one tractor as a property of association and members are providing the operation and maintenance cost. Net income per household is

(2) Association of small-scale farmers (Araguatins)

This association was established on 1994 and the members were 50 in the beginning reducing down to 25 now. The total land area is 1,210ha and the average 48ha per household. The properties of the association are meeting room, milling facility for cassava, fruit processing facility, tractor, seeding equipment and artificial insemination equipment. Tractor and seeding equipment are commonly utilized for the production of cereals of self-consumption. Milling facility for cassava and fruit processing facility are not operational yet due to no power supply.

Followings are the results of interview survey for 10 members.

Labor	Average size of family : 6, Average family labor : 3
Income	Average monthly income: 142R$/M (70~300R$/M)
Land	Average land area: 43ha, Average cultivated area: 3ha, Average pasture area: 28ha
Crop Production	Cereals: rice, corn, feijão, cassava Commercial: Vegetable (spring onion, tomato, beet), Fruit (orange, banana, guava, pineapple)
Inouts	Seeds of cereals from previous cropping, Fruit from root stock, No fertilizer, No chemical, Slash & burn
Meet Pro.	Number of animal: 15heads, Variety: Nelore, Price of meat: female(27R$/Arroba) male(30R$/Arroba)
Milk Pro.	Number of animals: 21heads, Variety: Crossbreed of Holland type
Pasture	Pasture: Brachiaria brizantha, Burning: August-September (by group)

In this association, there are few progressive farmers who start small-scale commercial production of vegetables and fruits without depending on finance from outside. They are planning to introduce irrigation system in future and continuing constant efforts. It seems very important to support such progressive farmers in order not to waste their efforts. If those progressive farmers succeed in their commercial production, many other members will be followed.

(3) Group of producers organized by PRODIVINO (Itaguatins)

The group consists of 35 members are so far receiving 2 tractors, 1 track and irrigation facilities by the finance of PRODIVINO. Milk sterilization facility (2,000 liter/day) is also provided but is not operational due to no power supply. Since the price of milk is extremely cheap, there is a plan for the construction of cheese processing facility. In addition to those, the milling facility of cassava is being constructed by the finance of PRONAF. Repayment is scheduled to start after one year by utilizing a part of milk produced.

Followings are the results of interview survey for 10 persons (8 from PRODIVINO group and 2 from ordinary association).

Labor	Average size of family: 5, Average family labor: 3
Income	Average farm income: 540R$/M, Average non-farm income: 210R$/Maverage income: 540R$/M
Land	Average land area: 183ha, Average cultivated area: 10ha, Average pasture area: 70ha
Crop Production	Cereals: rice, corn, feijão, cassava, Group cultivation area arranged by municipal office, Fodder: corn, sugarcane, cassava, Fertilization in group cultivation area and for some cereals
Inputs	Seeds and fertilizer purchased according to the need, cereal seeds from previous cropping
Meat Pro.	Number of animals: 90heads, Variety: Nelore, Price of calf: Nelore(200R$/head) Crossbreed(150R$/head)
Milk Pro.	Number of animals: 30heads, Variety: Gilollanda, Milk pro.: 3.5liter/d/h, Lactation period: 5.5months

Here is a system of group cultivation under the arrangement of municipal office. One can get the right to use 0.5ha by drawing lots and a part of products should be delivered as school lunch. Many land-less farmer are actively participating in this system. Group cultivation area is secured according to the contract between municipal office and landlord. The contract period is usually about 4-5 years. The landlord provide the rough land and fertilization is carried out for cereal production. After the contract period, this area can be used as pasture land and the growth of pasture is good due to the effect of integration effect. That's why this system gives great advantage even to the landlord. This system is just started and active expansion is expected in order to save land-less farmers and also to implement the demonstration for the integration system of agriculture and animal husbandry.

One of the membes proposed the following opinion regarding the financing system. Orientation for the financing system is always insufficient and the detailed financing condition is not clearly stipulated. Although weed control is the financing condition for the regeneration of the pasture land, for example, farmers who controlled the weed of their pasture land have been fined by IBAMA. Further improvements are thus required for the better orientation of the financing system to the farmers.

(4) Association of small-scale farmers (Nazare)

This association was just established about one year ago and the current number of members is 42. Out of 42 farmers, 20% have their own land that is about 30 ha per household. Most of other members are land-less farmers. Before the establishment of the association, they have borrowed the land for crop production and paid the land rent to the landlord by a part of their products. The major objective of the establishment of the association is, therefore, to borrow the land by group. The land of 20ha was already borrowed under 2 years contract and this land is secured for group cultivation. Since the land under the current contract has good soil condition, the soil was not analyzed. But fertilization is being carried out for the crop production that gives better effect to the pasture to be grown in future. For the landlord, therefore, 20 ha is under the integration of agriculture and animal husbandry. Consequently, there is a high possibility for the group to extend the contract by obtaining another area from the landlord.

There are no properties that belong to the association so far. Seeds and fertilizers are distributed by the Government for the area applied by the group (20ha) and by individuals (50ha). The products are sold individually but 10% of the products should be converted into cash for the repayment to the Bank of Brazil. 3R$ of membership fee is collected every months in order to gain the operation cost of the association. The current balance is 800R$ and the association is expected to utilize such fund for purchasing tractor in future. This association is now planning to give priority to vegetable production first and then to introduce fruit culture. The fruit processing equipment will, therefore, be needed in future. Since the purchasing of land can be expected and if so the distribution of seeds and fertilizer might be terminated, careful discussion will be needed for this matter.

Existem planos futuros para aquisição de terras, maquinários e para instalação de processador de frutas em nome da Associação. Para a manutenção administrativa é cobrada uma mensalidade de R$ 3,00 por membro.

The leader of this association is the staff of Ruraltins and he is challenging the commercial production of watermelon as a demonstration for the other members. He introduced drip irrigation system by investing 10,000R$ for 1ha of land. In the last year, he produced rice, watermelon and corn and gained 2,200R$ of gross income. It means the repayment for the facilities can be performed within 5 years. This kind of village revitalization activity is indispensable for the small-scale farmers to get rid of the current situation satisfying only their self-sufficiency. Human resource development for such personnel suitable as a leader of the group and the supporting system of such vitalization activities will be an important subject for the future development of group formation of farmers and the intensification of production.

(5) Association of small-scale farmers (Araguaina)

This association was established on August 1996 and the number of current member is 42. Out of 42 members, 20 members have their own land (20-89ha) and 22 members are land-less farmers. An opportunity for the establishment of this association is that the present chief was feeling the necessity of group formation for effective extension activities and consequently the association was established through various discussions among the members. The main objective of the establishment was to negotiate with bank and municipal office as a group of small-scale farmers. The present chief of the association is promoting the general activities. 9 families are so far purchasing milking cows (9 female and 1 male per family) under the finance from BASA. Cheese processing and confectionery producing facilities are now under construction under the finance of PRONAF. Since the major problem is that there is no machinery for the land preparation, they are applying one tractor to PRODIVINO. 20 land-owners are mainly carrying out livestock raising and average number of animal per family is about 30-100. Association is collecting 2R$/month/family of membership fee but there are some irregular collections when needed.

Followings are the results of interview survey for 10 members.

Labor	Average size of family: 4, Average family labor: 2
Income	Average farm income: 625R$/M, Average non-farm income: 0R$/M, Average income: 625R$/M
Land	Average land area: 108ha, Average cultivated area: 9ha, Average pasture area: 70ha
Crop production	Cereals: rice, corn, feijão, cassava, Fodder: sugarcane etc. Fruits for self-consumption: orange, banana, acerola, guava, mango, pineapple
Imputs	Seeds of rice and feijão from previous cropping, Seeds of corn to be purchased, almost no fertilization
Meet Pro.	Average number of animals: 10heads, Variety: Nelore
Milk Pro.	Average number of animals: 40heads, Variety: Gilollanda, Hollandeza, Artificial insemination by 1 farmer Milk production: 5.0liter/day/head, Lactation period: 6.0months Milk: selling to the processing facility, selling directly to consumers, selling after processing to cheese

The chief of this association also installed the second hand irrigation system and is challenging the commercial production of watermelon. Preferable results are so far not obtained but this is a good demonstration for the other members. It is thus very important to have leaders who promote the activities for the formation of group by small-scale farmers. Female leader with vitality like this association might be fit for such position. Special support should be given to such a good associations with excellent leader to be grown as a good example for group and intensive cultivation in future.

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ANNEX XVI

TECHNOLOGICAL POSSIBILITY OF INTRODUCTION OF NEW FARMING METHODS

Pacific Consultants International

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TECHNOLOGICAL POSSIBILITY OF INDRODUCTION OF NEW FARMING METHODS

1. Grains Cultivation

(1) Direct sowing as countermeasure for veranico

The technology of direct sowing is effective for veranico, as soil can keep more soil moisture owing to no-tillage than that in tilling soil. In cropping system of soybean- maize, cultivation of the both crops is usually carried out by direct sowing. In case of the first cultivation of grains after reclamation of barren land, direct sowing should be introduced after soil improvement for five years at least. In case of the first cultivation of grains in declined pasture, direct sowing should be introduced after soil improvement for three years at least. It is not clear how many years to be able to continue direct sowing. In some cases, the yields of grains have kept though direct sowing has been continued for eight years. It is a noteworthy fact that if direct sowing is continued for long years, soil surface becomes acid and the productivity of soil decreases gradually after about the fifth years from the first direct sowing.

At present, the area of the soybean cultivation in cerrado, where has the cultivated area of 10,000,000ha, is about 6,000,000ha, and that of direct sowing cultivation in cerrado is about 1,500,000ha.

Direct sowing is effective for keeping the soil moisture and erosion, but has the problem of weed control. Weed in the field of direct sowing can be controlled by the present technology. Furthermore, weeds can be also controlled by cultivation of green manure crops as former crop of grain, and many farmers introduced actually the method.

The another advantage of direct sowing is the increase of cultivated area for the full use of agricultural machinery from 300ha in sowing after tillage to 500ha in direct sowing without tillage, based on the trial calculation by EMBRAPA. The advance comes from the saving of work time due to cutting of tillage process and the increase of sowed area within the optimal sowing period, because direct sowing machine can operate even in such wet soil as the machine can not work in the tilled soil after a rain.

(1.1) Use of gypsum as countermeasure for veranico

Another countermeasure for veranico is elongating of roots to deeper soil layer to use moisture in dry-weather. Gypsum, $CaSo_4$, has the effect of elongating of roots. Usually, 1.5tons/ha of gypsum is put on soil every 3 or 4 years. In general, 3 or 4 tons/ha of lime, CaO, is put in soil every 5 years to control the soil acidity, but lime has no effect on elongating of root.

Gypsum is the by-product of phosphatic fertilizer, and can get with inexpensive price. The factory of phosphatic fertilizer is in Uberlandia, M G State. The transportation cost from Uberlandia to the northern region of Tocantins, 600km, may be high.

(1.2) The presumption technology of the safe seeding period from damage of veranico in each municipal in Tocantins

The frequency and distribution of precipitation in wet season is important for grain cultivation. The interruption of precipitation in wet season for some days damages to crops in the week stage of crop growth. Such interruption of precipitation in wet season that damages to crops is called veranico.

EMBRAPA made the distribution maps of the damage of veranico for sowing of five crops, such as rice, soybean, feijão, maize and mandioca, at every 10 days in dry season. These maps were made every municipal and every soil type in cerrado, based on the climate data for fifteen years. Soil types were three, such as sandy soil of 30mm of moisture holding capacity (MHC), latosol soil of 50mm of MHC and gley soil of 70mm of MHC.

(2) Soybean

CPAC (EMBRAPA/Brasilia) recommended on the varieties of soybean and possibility of soybean cultivation in the northern region of Tocantins as follows:

The production of soybean in cerrado in 1975 was only 3% of the total production in Brazil. At present, the production is 12,000,000tons, 50% of the total in Brazil. The average yield of soybean in cerrado is also reached at level of 2.5tons/ha.

The high level of production of soybean owes to the improvement of varieties and the soil management technology. In cerrado, soybean can cultivate at anywhere regardless of altitude and soil character. There are no problems in cultivation of soybean in cerrado. The yield of soybean of 4tons in cerrado could be obtained by the full use of the technologies.

On the other hand, Soybean Research Center (EMBRAPA/Balsas, Maranhão) advised on soybean cultivation in Tocantins as follows:

a) It is necessary to cultivate in the land suitable for soybean, and to diversify in farming, e.g. integration of crops and animal husbandry.

b) Preservation of natural environment, e.g. introduction of direct sowing to agricultural mechanization.

c) Selecting the suitable varieties as follows;

> Characteristics of high yield, disease-resistance, over 65cm in the height of plant, over 12cm in the height of the lowest pod, lodging-resistance, uniform maturing period, active root, good quality (high protein for food, high fats for processing).
>
> Cist-nematoda is not found yet in Tocantins though has found in Goias State and Brasilia
>
> The medium-ripening varieties are desirable in Tocantins.
>
> It is ideal that each municipal has a peculiar variety, because climate, soil and occurrence of disease are different among municipals. Furthermore, farmers should cultivate the plural varieties to avoid the damage of these risks.

The research center has also several fields of adaptability tests of varieties of soybean in Tocantins. EMBRAPA has expressed the transfer of technologies, cooperation and guidance of soybean cultivation in the surveyed regions.

(3) Corn (Maize)

The main reason for the difference in yield of maize among farmers is the lack of obtaining loan for the production cost. Since they could not use the inputs such as fertilizers, chemicals at the suitable period, because of the non-availability of money (loan) at that time, the yield of maize decreased. For example, the farmer having high level technology in Goias State attained the yield of 8.4 ton/ha in 1997/98. But in 1998/99, he could not get loan from the bank for the supplemental fertilization with Nitrogen, and the yield reduced to 7 ton/ha. Similarly, the influence of climatic variations such as veranico decreased the yield from 7 ton/ha to 6 ton/ha.

Another reason for the difference in yields among farmers is due to difference of technology. Maize is a very sensitive crop and the factors such as sowing period, sowing space, variety, fertilization, especially supplemental fertilization, and weed control affect to the differences of the production cost and net income. In his farming, the usual production cost of maize is about R$ 500/ha (70 bags/ha, 4.2tons/ha) and the agricultural income is about twice as much as the production cost. If maize is irrigated with the center pivot system, as the irrigation cost is about R$ 400/ha, the total production cost may be about R$ 900/ha.

According to the farmer having the high level technology, the cultivation method of maize is as follows:

> The sowing period is October. The later sowing time is, the less maize will be inclined to produce.
>
> Seed is purchased the hybrid seed from the multinational companies, such as PAIONIA, CAGIL, ZENECA, etc. The price of hybrid seed is about US$ 60/20kg/ha, and that of domestic seed is about US$ 1.3/20kg.
>
> In the own field, the selection trial of the suitable varieties has been carried out by five varieties every year.
>
> The method of fertilization, especially amount and time of additional fertilization of nitrogen, is the most important to increase the yield. Basic fertilization is 500kg/ha of compound fertilizer (8:24:16). When the 6th leaf is open, urea of 170kg/ha is fertilized as additional fertilizer.
>
> Herbicides Argemix of 6 litters/ha (R$6/litter) is sprayed at the stage of the 1st leaf to the 3rd leaf of maize.

The farmer in Goias State has obtained the high yield of maize of 8,4tons/ha by such method as mentioned above.

With regard to the low profitability of maize, CNPMS (Centro Nacional de Pesquisa de Milho e Sorgo - National Research Center for Maize and Sorghum) expresses the view as follows:

The prices of the corn vary a lot, the corn is the domestic consumption product, while the soy is export product.

The prices of agricultural inputs are fastened in dollars, they influenced very much the exchange rate, while the price of the corn is fastened in Real, being resulted in elevation of the prices of agricultural inputs. In the case of the producer to abandon the activity, the first cultivation to be left is the corn.

But maize is an important crop as the rotation crop like beans, soybean and also as feed of cattle.

The methods to reduce the producion cost are the scale merit has greater importance for the soybean production. The cultivation should carry out at suitable area. For example, the yield of maize an high land over 700 m of altitude shows an increase of about 10% over as compared with lower land. Furthermore, maize should be cultivated at the high porductive soil.

There are the cost of transport in Brazil. Maize made in cerrado area is transported to the Southern States in Brazil, the transportation cost is very high. Currently there is a growth of maize's consumers. With this, the scenery of high transport cost should be solved by the permanence of the product in the area.

To increase the agricultural incomes, there is a trend of introduction of "safrinha" corn, there are two harvest during a wet season. The rotation within a short period (Safrinha) has increased in Brazil about 2,000,000 ha.

The topics of new technologies developed by CNPMS are as follows:

The varieties bred by pollination for the small-scale farmers and the hybrid varieties for the large-scale farmers are developed by CNPMS. The most spread variety for the small-scale farmers is BR106, and the most spread hybrid variety is BRS3060.

The domestic seeds share of the seed market in Brazil is about 8%, in pollination seed and in hybrid seed, respectively, and 90% of the domestic seeds is the varieties bred by CNPMS. CNPMS has

supported the twenty seed companies. The multinational companies supply about 90% of seeds in the seed market in Brazil. As the seeds of the multinational companies are very expensive (R$30~80/20kg/ha, and R$100~120/20kg/ha of special varieties), CNPMS is making efforts to develop the new varieties to supply the domestic and cheap seeds for farmers.

Farmers should cultivate the plural varieties to avoid the damage and select the suitable varieties for the own farm in consideration of productivity and disease-resistance.

The production of maize for feed market in the extreme northern and northern region of Tocantins would be in the difficult situation.

(4) Rice

(4.1) Paddy Rice

At present, The development of paddy field is planning in Sampaio of the extreme northern region by SEPRO.

CNPAF (EMBRAPA/Goiania) recommended on the cultivation of paddy rice in the northern region of Tocantins as follows:

(4.1.1) Problems of cultivation of paddy rice in Formoso do Araguaia, Tocantins

The amount of sowing is 120-150kg/ha as usual in Formoso. This is too much and the optimal amounts is 100kg/ha.

The farmers have a habit of using only one sort of fertilizer. They should choice the fertilizer suitable to their soils and growth stage of rice by the guidance of cooperatives

One plot of paddy field, 22ha, is too large. The optimal size of paddy field is 2ha to 5ha. If the area of one plot is too large, the paddy field can not be made even. Undulating field causes various problems in cultivation of paddy rice.

It is better to use common machinery in crop rotation, such as rice in wet season, soybean and maize in dry season, sweet melon, cotton, etc.

The water management suitable to soil is required. Amount of water use for paddy rice every year, which is ordinary 1,000m^3/ha, in Formoso is too much

To reduce the cost of chemicals, especially pesticides, they should choice the suitable varieties and carry out the suitable water management. For example,

Fungicide	14.64% of the total production cost
Pesticide	3.36%
Herbicide	12.38%
Extermination of rats	2.89%
Total chemicals	33.37%

(4.1.2) Profitability of Tocantins State in Cultivation of Paddy Field

The State this in the strategic point, being located espacialmente in the center of Brazil

Abundance of water resources with the two great rivers.

Lands relatively cockroaches. In the south area of the country takes place the cultivation of rice, being rented the lands.

Enough researches exist, because the cultivation of rice exists irrigated in Formoso.

High productivity (productivity of 37 sacks in the sequeiro), of 100 sacos/ha.

Tocantins State locates in the center of Brazil, and can ship the products to the surrounding States.

The State lies between two large rivers, and abounds in water.

The land price is cheap. The cultivation of paddy rice is carried out at leased land in the northern states.

The results of research on paddy rice are accumulated in Tocantins, because paddy rice cultivation in Formoso has preceded.

The yield of sucker (Soca) is more than expected. There is the case in Formodo, which yield of sucker was 37bags/ha in addition to yield of 100bags/ha of main cultivation.

(4.1.3) Recommendation on introducing of paddy rice in the northern region of Tocantins.

In paddy field, paddy rice should be rotated with the secondary crops, such as soybean, maize, sweet melon, etc., so that insects and diseases decrease.

(4.2) Upland Rice

CNPAP (EMBRAPA/Goiania) recommended on the cultivation of upland rice in the northern region of Tocantins as follows:

(4.2.1) Socio-economic changes of upland rice

The amount of production of rice, paddy rice and upland rice, began to decrease in 1991, after that, showed the temporary increase and has begun to decrease again recently.

The ratio of upland rice and paddy rice was half-and-half since 1986. However, recently, the percentage of upland rice has been decreasing.

The yield of paddy rice is higher than that of upland rice, that is, the average yield of paddy rice in Brazil is 5.5tons/ha, but that of upland rice remains yet at the level of one ton per ha.

The low level of yield of upland rice causes by customs in Brazil, which upland rice is cultivated in barren land or in reclaimed land at first. However, the yield of upland rice arrives in the same level as paddy rice, 8tons/ha, by means of use the new varieties bred by EMBRAPA since 1996.

From 1996 to 1998, the production of rice increased remarkably in Minas Gerais State and Goias State, and Minas Gerais State is at the top of other States in Brazil in the production of upland rice. This is owing to the extension of the new varieties bred by EMBRAPA and of irrigation for upland rice.

There were twenty-seven of the varieties, which were classified to "long" type, in 1985 to 1991. From 1992 to 1999, the new five varieties, which were classified to "long-fino" type, bred and the production of upland rice increased remarkably due to high productivity and high quality. The new varieties, bred by EMBRAPA, share of the seed market in Brazil is about 42%. Perola, bred by EMBRAPA, occupies the first place in varieties of upland rice in Tocantins State and the share is 34%.

(4.2.2) Restriction in upland rice cultivation in Tocantins

As the factor of restriction in upland rice cultivation in Tocantins,

Rice and bean suffer the damage when their flowering period meets with temperature

over 33℃, though the damage is reduced if their roots have penetrated to deeper soil. Therefore, rice and feijão should be cultivated so that their flowering period does not meet with temperature over 33℃, in August to October in dry season.

There is no problem with the minimum temperature in Tocantins.

Sandy soil may be one of the factors of restriction, because sandy soil is easy to suffer the damage of veranico due to the low water holding capacity of sandy soil.

The inclination of arable lands is almost 5 to 10 degrees in Tocantins State. Therefore, there is no problem on the inclination.

(4.2.3) Potentials in upland rice cultivation I Tocantins

In this year, rice was economically advantageous to bean, in future, rice may be more suitable in Tocantins than bean.

Tocantins State has the potentials as follows:

There are suitable varieties,

Mechanization in cultivation is easy because of much flat land,

The price of land is cheap,

Precipitation is comparatively even in every year,

The State lies between two large rivers, and abounds in water.

Tocantins State locates in the center of Brazil, and can ship the products to the surrounding States.

(4.2.4) Varieties of upland rice

The development of varieties of upland rice has commenced recently in Brazil. The first new variety bred by EMBRAPA was bone in 1992, and the new variety was spread first to farmers in 1996. The differences of characteristics between the traditional varieties and the improved varieties are shown in the below table.

	Traditional varieties	Improved varieties
Plant Height	1-2m	0.8-1 m
Tiller	Few (10)	Many(10-20)
Lodging	Easy	Difficult
Diseases	Easy	Resistant
Distribution of root	Shallow, few. Few absorbing power.	Deep, dense. Strong for dries.
Plant figure	Long leaves. Lying at full length.	Short leaves. Upright. Easy to use effectively solar radiation.
Yield	Low	High
Adaptability	Anywhere	

It is desirable that the suitable varieties in the northern region of Tocantins are the early-ripening varieties or medium-ripening varieties, which the growth period is 112 to 132 days. For sandy soil, Primavera is suitable.

When upland rice is rotated with soybean, rice is sown after harvest of soybean in February. At that time, the early-ripening varieties are sown in mid-February to March and are harvested in May. When rice is cultivated only throughout the year, rice is sown in November. At that time, the yield of upland rice arrives in the same level as paddy rice, 8tons/ha, and the price in market is the same as paddy rice.

The origin of the developed varieties is the mixture of the customary varieties, Philippine varieties and USA's varieties.

Variety"CARISMA/1999" of the five developed varieties does not be suitable to Tocantins.

(4.2.5) Direct sowing without tillage in upland rice cultivation

When States are arranged in order of the large area of upland rice cultivation, the order is Mato Grosso, Maranão, Para, Goias, Piaui, and so on. The total cultivation area of upland rice in Mato Grosso is about 763,000 ha in total, and the area of direct sowing is 152,000ha. The highest yield of the direct sowing cultivation was 7.8tons (130bags)/ha.

The low level of yield of upland rice causes by customs in Brazil, which upland rice is cultivated in barren land or in reclaimed land at first. With regard to productivity in farming, The rotation "soybean-soybean-upland rice" is better. The repeated cultivation of upland rice on the same field for three years causes the sudden decrease of yield.

In cultivation of soybean or upland rice, "safrinha", which is cropping period from harvest of main crops to the beginning of dry season, can be used in various crops cultivation. For example, when soybean is harvested until March, maize or millet as cover crop can be cultivated in safrinha.

The other hand, the direct sowing has several faults as follows:

Roots cannot penetrate into deep soil layer, as soil is not tilled.

Soil is easy to become compact, as soil is not tilled. Therefore, the roots system of direct sowing becomes shallow in soil and the density of root becomes thin. As a result, the root of the direct sowing becomes weak, and rice is easy to get disease " Brusone".

As the countermeasure in the direct sowing for this, it is considered that the tilling sub-soil of 20cm in depth and fertilization to two soil layers of 5cm and 20cm in depth should carried out. However, such machinery is not developed. It is expected that such machinery is more expensive than the present direct sowing machine of about R$ 18,000.

(5) Bean

Conform CNPAF about the bean cultivate as follows:

The CNPAF have 10 research camps. The registred varieties since 1982 amount to 66, among 22 originated of the EMBRAPA. The Fitotechnological Aim are following:

Marketability; The variety's share in the seed market is 80% of Carioca, 15% of Onix and 5% of other varieties,

Resistance for diseases and insects,

Prematurity; the early-ripening varieties has 70 to 75 days of growth periods. Such varieties are one variety in Carioca and one variety of Jalo. These early-ripening varieties are suitable to Tocantins,

Characteristics of high yield, disease-resistance, over 65cm in the height of plant, over 12cm in the height of the lowest pod, lodging-resistance, uniform maturing period, etc., that is, adaptability for mechanization,

Strong nitrogen fixation,

Deep penetrated root and high absorbing power of phosphate,

The discoloration of husk of feijão by oxidation can be controlled as possible. The discoloration decreases the market price,

The shortening of cooking,

Improvement of domestic and international estimation,

1) Recommended varieties to the northern region of Tocantins
   - CARIOCA: ICA, introducing from ICA, bred in 1974
   - EMGOPA: introducing from CIAT
   - JALO PREC: early-ripening variety, suitable to tocantins, large grain (34-35 g/100 grains)

2. Vegetables and Fruits Cultivation

(1) Vegetable Crops

Regarding the introduction of vegetable crops to the northern part of Tocantins, 2 ways should be considered and the first is the processing vegetable production for exporting and the second is the fresh vegetable production for consuming in the area. For the processing vegetables, the location of the processing facilities and the transportation means should be evaluated. For the fresh vegetables, on the other hand, the taste of local population, the distance to the neighboring consuming point and the transportation means should be evaluated. Even for the fresh vegetables, the improvement of transportation means like cooling container makes possible to deliver them up to the northern cities such as Belem. It is thus important to take the network of road, waterway and railroad and other infrastructures into account for the selection of vegetable crops to be introduced to Tocantins.

(1.1) Green vegetables to be Industrialized

The following two methods can be proposed for the producion of vegetalbes for processing.

(1.1.1) Production of vegetables for processing by relatively large scale facilities

Tomato for processing

The major production areas of tomato for processing in Brazil are Ceara, Pernambuco, northern Bahia, northern Minas Gerais, eastern Goias and São Paulo and the following table shows the trend of production so far.

Year	São Paulo		Pernambuco, Bahia		Minas Gerais, Goiás		Total	
	ha	1,000ton	ha	1,000ton	ha	1,000ton	ha	1,000ton
1985	10,350	350	6,500	215	-	-	16,850	565
1990	8,260	297	12,422	338	6,410	300	27,092	935
1991	7,620	301	6,877	291	5,050	168	19,547	760
1992	7,250	287	4,485	190	9,980	230	21,715	707
1993	5,690	238	5,200	180	6,314	273	17,204	691
1994	6,380	275	5,836	212	6,184	253	18,400	740
1995	5,560	267	6,000	235	6,000	258	17,560	760
1996	4,560	226	6,350	259	5,950	265	16,860	750
1997	4,407	322	8,600	160	9,300	613	22,307	1,096
1998	4,550	210	6,600	130	11,130	680	22,280	1,020
1999	4,300	240	2,850	93	13,400	840	20,550	1,295

The variety of Embrapa crossed VIRADORO is widely cultivated in northern Brazil as a tomato for processing. This variety occupies only 1-3% for the total production in Brazil but occupies 60-80% for the production in northern Brazil. Petrolina in Perunambuco is the major area for the production of this variety. This variety can be grown at any locations in case an appropriate management is established suitable to the soil characteristics.

According to the table above, the large-scale and year-round cultivation of tomato was carried out in Petrolina and the production reached to the peak on 1990. Large amount of pesticide has been applied to control white fly during this period and pesticide resistant white fly was consequently created.

White fly mediates the virus of Tomato Yellow Leaf Curl and the damage becomes bigger and bigger. In addition to this, the damage by the Broca-pequena (*Neoleucinodes elegantalis*) also increased and the production was sharply decreased after 1990. In Matogrosso and Goias, on the other hand, the production is steadily increasing.

Embrapa was always trying their best to control the damages mentioned above. Various know-how on the effective control methods are so far accumulated including the integrated pest management established by the combination of agro-chemicals and bio-control.

Although the tomato processing facility has been established in the industrial complex at Araguaina in the study area, the management reached a deadlock. This was originally planned to operate the processing facility by the association by utilizing the tomato produced from the field with center pivot irrigation system that was constructed under the finance of BASA. The capacity of the processing unit is 120ton/day and it was expected to operate the factory for 3months by the products from this field. At the first trial, the production of the factory was much less than expected due to unsuitable variety of tomato selected for the field and late construction of facilities compare to the production period. It seems that the plan was not sufficiently examined for the details on variety, cultivation method, production system etc. It might be possible to create a practical plan by utilizing the experiences in the advanced areas and the readily available information accumulated in Embrapa and other research organizations. Since this attempt can greatly contribute to the future development of agriculture in the region in case the products of small-scale farmers are purchased, the factory should be revived through proper planning and management.A EMBRAPA tem se dedicado às pesquisas para poder controlar os danos causados pela mosca branca, utilizando-se uma forma de controle combinada de agro-químicos e controle biológico. Atualmente conta com tecnologias suficientes para o controle dos danos deste inseto.

(1.1.2) Production of vegetables for processing by relatively small-scale facilities

Carrots

Carrots are processed through vacuum packing of cut pieces and this processing is already executed in many places. The major consumption areas are, however, limited to the certain areas with high standard of life such as Brasilia and Goiania.

Baby cucumber and baby onion

Both vegetables can be utilized as materials of pickles. Since the processing can be carried out in the small-scale facilities, this might be suitable for the association of small-scale farmers.

As for the baby onion, new variety suitable for the cultivation in Brasilia area is already released and is cultivated in Brasilia, Minas Gerais and Parana.Ambos utilizados como matérias-prima de picles.

Sweet potato

This is to process sweet potato into sweet paste as confectionery and the possibility of introducing this into Tocantins seem promising for future.

Potato

There are many forms of industrialization of potato but there are demand for research for this industrialization.

(1.2) Production of fresh vegetables to the consumed in the area

As for the supply of fresh vegetables to Araguaina area with the population of about 1.1 million, leaf vegetables are 100% supplied by the small farmers in the suburbs. Onion, cabbage and carrot are

100% imported from outside and 50% of tomato is also imported. Other 50% of tomato is supplied from Aragominas 40km away from Araguaina. 50% of sweet pepper is locally produced and the rest is imported. Among fresh vegetables produced in the suburbs, the details about the cultivation of leaf vegetables and tomatoes for fresh consumption are as follows.

Leaf Vegetables

There are 12 small farmers who perform year-round supply of leaf vegetables around Araguaina within the radius of 10km. The farm size is more or less quarter ha and the main crops are lettuce, spring onion, and coliander. Among these crops, lettuce is the major product and there are two varieties of Tayna and Verinica which are mainly cultivated. Products are sold directly to the consumer in the field and are also sold to the super market throughout the year. Lettuces are cultivated by transplanting the 20days old seedlings at the density of 40x30cm and are harvested one month after transplantation with 6 croppings annually. Irrigation is indispensable and mini-sprinkler is commonly used with pumping system of underground water. Selling prices of vegetables are 0.5R$ for 2 lettuces and also 0.5R$ for a bunch of spring onion and coliander. The total monthly sale seems around 1,200R$ for this kind of small-scale farmers.

Some farmers are introducing Hydroponics System (NFT) for the production of lettuce. As for NFT system, 10days old seedlings are further grown in the seed bed and then transplanted to the NFT system. Seedlings are first grown in the narrow pipe for 6 days and then in the wide pipe for 20 days. The total growth period is between 42-45 days for harvest. Varieties used are Veronica and Lucy brown. The construction cost of this system about 600m^2 including plastic house is approximately 25,000-30,000R$. The production cost is cheaper in Hydroponics because of less growing period and less labor requirement. The selling prices of the products from Hydroponics are same with ordinary products. The total monthly sale seems around 2,000R$ for this kind of progressive farmers.

The intensive cultivation of leaf vegetables by using Hydroponics seems promising for future. The necessary technical support is so far not carried out at all. The progressive farmers mentioned above introduced the system by own effort. In order to promote the intensive cultivation of such fresh vegetables, new technologies should be introduced under the proper agricultural extension system.

Existem 12 produtores de verduras de folhas em torno de 10km da cidade. As áreas produzidas são de menos de 1 hectare, cultivando-se alface, cebolacebolinha, coentro, etc. No caso de alface, as duas variedades de Tayna e Veronica são predominantes, vendendo vendidos diretamente no pátio da Feira e nos supermercados. A prática agrícola de cultivo de alface é cultivo continuo com 6 rotações, utilizando-se sistemas de irrigação. As rendas agrícolas estima-se aproximadamente de R$ 1.200/mes.

Existem produtores que utilizam o sistema de cultivo hidroponico hidropônico (NFT), com as áreas sistematizadas de 600m2 e a 1.500 m2 de terras. No sistema de cultivo hidroponicohidropônico, as mudas de alface de 10 dias de semeadura são colocadas dentro da solução liquida durante 6 dias, e depois é cultivado 26 dias dentro do sistema hidroponico, totalizando-se 42 a 45 dias de cultivo. As variedades utilizadas são de Verovica e de Lucy Brown. O custo de instalação do sistema é de R$ 25.000,00 a R$ 30.000,00. Mas os custos de produção são mais económicos econômicos do que o plantio tradicional , devido ao menor ciclo da planta. A renda familiar chega a R$2.000/mes.

Tomato for fresh consumption

The production of tomato for fresh consumption has been started in Aragominas since 1980 in the study area. In spite of unstable market prices of the products due to the fluctuation of the production in Goias and of the number of the farmers in the area, around 15 farmers are now producing tomatoes in Aragominas. The farm size is between half to 2/3 of ha for each and 50% of the demand of Araguaina is produced. Followings are the present situation of cultivation.

The land is usually borrowed for tomato production and one place for one cropping

basically. The rental fee of the land is usually 10% of the products.

The most important criteria for the selection of the land are water availability and geographic condition with suitable slope for the irrigation of pumped-up water.

The suitable variety is Santaclara (Brazilian variety to be purchased from Goiania) and the average planting density is 9,000 plants/ha.

The tractor is borrowed for land preparation and the rental fee is 35R$/hour. The necessary time for the land preparation of 1ha is about 9hours.

Two croppings are possible in one year and the first cropping from May to August and the second crop from September to December.

The average yield is about 20-23ton/ha.

The selling price fluctuate as it is 15R$/box now compared to 7-8R$/box during last week.

There are many obstacles for the production such as pest animals, pest insects, diseases and the deficiency of certain element. Many farmers were suffering from damages due mainly to the occurrence of diseases in the last year.

The technical support including irrigation, fertilization and pest control is not satisfactorily carried out for the farmers. The rapid increase in production and the improvement in quality can be performed through proper extension system of technology.

(2) Fruit Crops

Fruit crops are divided into two groups, one is cultivated fruits such as Coco, Cashew, Banana and Pineapple and the other is natural fruits such as Cupuaçu, Bacri, Açai and Babaçu.

(2.1) Cultivated Fruits

Coco

Coco can be grown well even in sandy area and many farmers are introducing this crop within the study area. Coco plantation project is just started in Wanderlandia with the scale of 8,200 plants/40ha. The production of 12ton/day is expected in fourth year. The variety used is Anon with green, yellow and red types. Seedlings were brought from Paraiba and this variety is suitable for juice because of high sugar contents. The yield of this variety is as high as 240-250 fruits/plant/year under the proper fertilization practices compared to 55-56 for the ordinary variety.

Cashew

Cashew is brazilian fruit with high percentage of Vitamin-C next to acerola. The flesh of fruit is utilized for juice and wine production and the residue is utilized for animal feed. Seeds are used for nuts and the oil produced as by-product is used as clutch oil. The total production of nuts and flesh is 124,000ton in Brazil and this is the third in the world following to India (440,000ton) and Nigeria (152,000ton). In Brazil, the production is high in Ceara about 90,000ton which is 80% of the total production. Cashew is very popular natural vegetation in the study area and it seems the climate condition of the area is suitable for the growth of this crop. It can be concluded that the introduction of Cashew to this area is promising for future.

Although it is possible to harvest fruits from the second year even grown from seedlings, grafting is the common practices for the following reasons and this technique is very useful for the producing farmers:

The color and size of the fruits can be adjusted by grafting, whereas the plant grown from seedling gives various color and size.

Necessary time to reach the maximum production is about 8 years for the plant from

seedling, whereas it becomes only 3 years for the plant grafted.

It is also possible to reduce the time to maximum production by grafting the several year old materials to 4-5 branches of second year plant.

The planting density of Cashew is 7.5x7.5m or 8.0x8.0m in general and irrigation is basically not necessary. The necessary maintenance includes pruning and soil management for the soil surface to be covered by dry grasses not to have weed. One tree can usually produce 90kg of flesh and 10kg of nuts. A part of flesh is sold for juice production at the price between 1-5R$/kg and the rest for animal feed. Nuts are sold in 1.3R$/kg to the processing factory and the nuts of complete shape which is about 20% of the total products can be sold as high as 6-8$/kg.Cashew cultivated without treatment

Banana

According to the researcher of Embrapa Amazinia Oriental, Banana is the most promising fruit to be introduced in the northern Tocantins specially in the area of Araguatins. Since the production of Banana is more or less limited in the state of Amazonas, it is expected to be able to export the products to the market in Amazon area. The careful selection of variety is needed for better marketing and there are various information on new variety at CNPMF in Bahia. There are 3 major diseases affecting the production of Banana and Embrapa is already accumulating the know-how to control such diseases. The commercial production of Banana is already planned at Aguiarnopolis and Xambioa in the study area.

Segundo as os pesquisadores da EMBRAPA - Amazônia Oriental (CPATU), o Estado de Tocantins é área adequada para as plantações as plantação de banana. A produtividade de banana no Estado de Amazonas é muito baixa, possibilitando-se ao Estado do Tocantins ser o exportador para o Estado de Amazonas. Existem porem, necessidades de implementar pesquisas sobre as variedades a serem introduzidas. Atualmente, no cultivo de banana possuem 3 grandes problemas de enfermidades. A EMBRAPA está realizando as pesquisas para resolver estes problemas.

Pineapple

Since Pineapple shows good growth even in sandy conditions, this crop is already introduced in many places in Tocantins. As an activity of association in Araguatins, some members are cultivating 27,000 Pineapple plants in the group cultivation area. INCRA supplied the fertilizer and agro-chemicals, agricultural school supplied the seedlings and carried out the technical support. The association sold the products and the profit was distributed among members. It might be a good idea to use Pineapple as a pioneer plant for the commercial cultivation by the association. In case of Pineapple, however, it is necessary to examine the market information before production.

(2.2) Natural Fruits

Cupuaçu

The cupuaçu is a wild fruit that is abundantly in the area of Esperantina. Even middles of the decade 1980, it was one of the natural resources and important source of incomes to the rural residents. The extracted fruits of forests, they were transported to Imperatriz's city (MA). After the deforestations of the areas and colonizations, they went being gradually reduced the areas of this fruit. The cultivated area of cupuaçu is of 12.000 there is.

The Area of Study is located in the ecótono among them Amazonian area and of cerrado. The cupuaçuzeiro is an Amazonian plant, that it requests high amount of hidrics resources.

According to the researcher of Oriental Amazonian Embrapa (CPATU), the difficulties of cupuçu introduction concentrate on the commercialization, being needed detailed studies about commercialization. As the prices of the Amazonian fruits are high, it would be interesting to develop

technologies of use of tropical fruits.

Bacuri

Cupuaçu is originally the fruit naturally collected and this fruit was one of the very important natural resources until 1980's especially in Esperantina and surrounding area in the study area. Collection of natural fruits such as Cupuaçu and Bacuri supported the cash income of local population during that period of time. Collected fruits were daily transported by truck to the market in Imperatriz. The number of this plant species decreased rapidly due to land reclamation and forest clearing. The cultivation area of this plant is increasing and now in about 12,000ha in the state of Para.

The northern part of Tocantins belongs in between Amazon and Cerrado climate zones. Since amazon vegetation including Cupuaçu shows high water requirement, irrigation might be needed during dry season. In relation to the soil characteristics, Cupuaçu can grow even without rainfall for about 4 months if the clay content of the soil is more than 40%.

According to the researchers of Embrapa Amazonia Oriental, the most important factor for the introduction of Cupuaçu to Tocantins is not the cultivation technology, but the marketing. The marketing condition should thoroughly be investigated beforehand. In the big city like Belem, confectioneries made from Cupuaçu are prevailing and the price is relatively high. Natural fruits of amazon are thus expensive and the price of 1kg of Cupuaçu is equivalent to 10 liter of orange juice. The food processing facilities including confectionery processing should be developed in order for the association of small-scale farmers to operate easily. Cupuaçu belongs to the same family of Cacao and the confectionery similar to chocolate can be produced from seeds. This is called Cupulate and already commercialized. The production of Cupuaçu will be activated, if the production of cupulate is increased.

3. Medicinal Plants and Industrial Crops

(1) Medicinal Plants

The information about medicinal plants were colected on Itaguatins and Araguatins. The possibility of introduction these crops are following:

(1.1) Itaguatins

Na prefeitura de Itaguatins, o projeto que aproveita as plantas medicinais estão em processo. As plantas medicinais que a prefeitura está recomendando são as seguintes;

Food	**Effect**
Mixture of aloe, honey and wheat	Vermifuge
Mixed jelly of mint, banana, sweet confectionery	Vermifuge
Tablets prepared by ginger and honey	Cold and throat treatment
Powder mixture of rice, cassava, wheat and corn	Anemia and poor appetite
Mixture of rice, egg shell and the leaves of cassava	Anemia and poor appetite
Mixture of orange skin, sugar and ginger	Stomach ache and heartburn
Oil extract of Angico (*Piptadenia*)	Treatment for crack on the heel and other cut
Angico (*Piptadenia*) tincture	Anemia, ulcer, gastritis, throat swelling
Extract of stone apple	Throat swelling, kidney disease
Confectionery from rice	Poor appetite, Anemia, growth promoter
Powder of egg shell	Deficiency of Ca
Mixture of sesame and cassava powder	Nerve strengthen
Extract of Mentruz (*Senebiera pinnafifida*)	Pneumonia, uterine swelling
Powder of pumpkin seed	Anemia, poor appetite, Ca deficiency
Jatoba (*Hymenaea courbaril*) Oil	Treatment for cut and swelling
Seeds of water melon	Menstrual pain

(1.2) Medicine Manufacturing Complex at Araguatins

Pharmakon Complexo Industrial is now under construction in Araguatins and one of their fututre activities is investigation on medicinal plants.

There will be 5 medicine factories, residence, restaurant, seminar room and recreation facilities and the first factory will be completed on 2001.

Chemical medicines will be produced as the first step and medicinal plant will be utilized in the second step. Investigations on materials, collection and cultivation for various medicinal plants are expected to be carried out under the cooperation with university and producers.

There is no special staff for the medicinal plants but some activity is already started. Two plant species of Sucupira (Bowdichia virgilioides) and Fava de Anta (Imorphandra mollis Bth.) are so far investigated.

Sucupira is one of the cerrado vegetations and is distributed in the study area. Antibiotics effective for the inflammation of tonsils can be obtained from seeds. To lick the seed of Sucupira when there is pain on throat is the common practices for the local people.

Further investigation might be needed to utilize Sucupira and Fava de Anta as materials for the agricultural development in the area..

(1.3) Botanical Garden for Medicinal Plant in Embrapa Amazônia Oriental (CPATU)

More than 60 species of medicinal plants were cultivated in the botanical garden of CPATU but there were no information about suitable species to be introduced to the northern part of Tocantins. CPATU is so far carrying out the research on the following plant species.

Ipeca (*Phychotria ipecacuanha*)

This is the medicinal plant effective for preventing cough and the disease caused by ameba. The test tube seedlings are produced through tissue culture and transplanted under the shade house. This plant should be protected from direct sunshine. Wet condition is not suitable to this plant and many plants tend to die during rainy season.

Jaborandi (*Pilocampus spicotus*)

This plant is effective as eye lotion and now drug manufacturer is doing own research on this plant. Only the basic research is being carried out in CPATU.

Pata de Vaca (*Bauhinia forficate*)

This medicinal plant is effective for diabetes. This tree is commonly planted as landscape trees in the study area and there will be no problems for the introduction to the northern part of Tocantins..

(2) Industrial Plant

When the introduction of industrial plants into northern Tocantins is discussed, it might be very common to select cotton and sugarcane. The factory for the production of starch from cassava is under construction at the industrial complex in Araguaina and this might affect greatly to the production of cassava in the study area. Cassava is commonly cultivated as a part of staple food for the local population in the study area. Although cassava should be treated as a root crop, it was decided here to consider cassava as an industrial crop by focusing on the use as the starch material.

The starch factory under construction will be completed on October this year. The total construction cost is 10,000,000R$ and the half of the amount is financed by SUDAM.

The capacity of the factory is 200ton of raw materials per one day and it is expandable to 400ton. All the machineries installed are made in Brazil and it will take about two hours from material supply to the completion of dry starch. It is planned now that the operation period is 10 months from February to November and one month for maintenance and one month for rest.

Since the average yield of cassava is about 20ton/ha, in order to obtain 200ton of materials 10ha of land should be secured every day. The growth period of cassava is about 300-500days and the operation period of the factory is 300days. It is therefore necessary to secure 3,000ha of land. As a first step, 500ha will be operated directly under the factory. In parallel to this, the required amount will be purchased through local farmers under the cooperation with the state Government and Ruraltins.

It seems many small-scale farmers and immigrants are interested in the production of pineapple, but the technology which they have so far is not sufficient for that. The cultivation of cassava is easy and it is possible for small-scale farmers to produce. Since the purchasing price is now planned as 60R$/ton, it must be very attractive for farmers.

The starch content is very high for cassava and the starch can be utilized for many purposes such as confectionery and glue. The demands are therefore very high. Even the waste as by-products can be utilized as animal fodder after mixing with leaves of cassava.

The most important point for the quality control for the starch is that the harvested cassava should be brought into the factory within 24 hours after harvest. It is also important to introduce the promising variety for improving the quality of starch. The distribution of the seedlings of the promising variety is also planned for future. The contract cultivation system should also be introduced and the exportation of the products is planned for future.

It seems that the operation of this factory will take an important role for increasing the cash income of small-scale farmers who produce material cassava for the factory. This project should specially be taken care by the state Government or Ruraltins to promote the activities above mentioned.

4. Afforestation

There are no major activities on afforestation except Teca plantation recently started within the study area. Many farmers are now converting their livestock raising from meat production to milk production specially around Augustinopolis and Araguaina. It is very important to give shade to the milking cow and many farmers are now insisting the afforestation activities within their pasture land. The activities on Teca plantation and the afforestation in the pasture land are discussed in this chapter.

(1) Teca Plantation

50,000 Teca trees are now planted in 30ha at Fazenda Aruanã located 30-40km north-west of Santa Fe Do Araguaia.

Teca (Tectona grandis) is deciduous tree belongs to Verbenaceae and originated in Asian country. This tree is distributed in the area with clear rainy and dry seasons such as India, Thailand and Laos. This tree can be grown on the alluvial soils in tropic and also at the perimeters of tropical rain forest.

Wood of this tree is very famous for its strength and long life. It is utilized as furniture, cabinet, ornament and sculpture. The yellow dye can be obtained from roots and new shoots and seeds can be used as medicine.

In Brazil, this tree was introduced to Matogrosso 7 years ago and planted. The seeds from Matogrosso

are used also for this project.

The seedlings are produced at the nursery in Araguaina and the germination rate is as high as 80%. 100,000 seedlings have been produced in this nursery so far and have been supplied to Palmas, Miracema, Colinas and many other areas.

In this project, 6 months old seedlings (0.5R$/piece) were planted 20 months ago. The suitable period for the transplantation is in the rainy season between November and February. The depth of planting hole is 30-40cm and 200g of lime and 100g of phosphate were applied to each hole. Top dressing is also done 1,2 and 3 months after transplant. The major maintenance activity after plantation is only weeding.

The planting density at the planting time was 2x3m (1,700trees/ha) and the thinning is carried out to the density of 3x4m (830trees/ha) on the 4th year. The thinned trees can also be utilized as piles and the 10 year old trees will finally be harvested. Since it takes 60-80years for harvest in southeast Asian countries, a qualified experiment should be carried out for future.

Although it is said that agro-forestry system is possible by combining with coffee, papaya and cupuaçu, many further investigations are needed on demands, selling prices and other detailed information.

(2) Afforestation in Pasture Land

As already mentioned above, it is very important to provide the shade with milking cows. The farmers converted their livestock raising into milk production are insisting the importance of afforestation in the pasture land.

In one of the Fazenda near Araguaina, Ipe and Mogno as local variety is actively planted in addition to Teca. Those tree species have high value as wood products. Such a tree plantation activity in the pasture land should be promoted as an investment for future and also as an effective land use system.

Such farmers are actively conserving the remaining vegetation along the stream in the pasture land and this is very helpful for the effective soil conservation of the area.

The active promotion of afforestation activities in the pasture land is thus evaluated from the viewpoint of both effective land use and environmental conservation.